

# Popular Electronics®

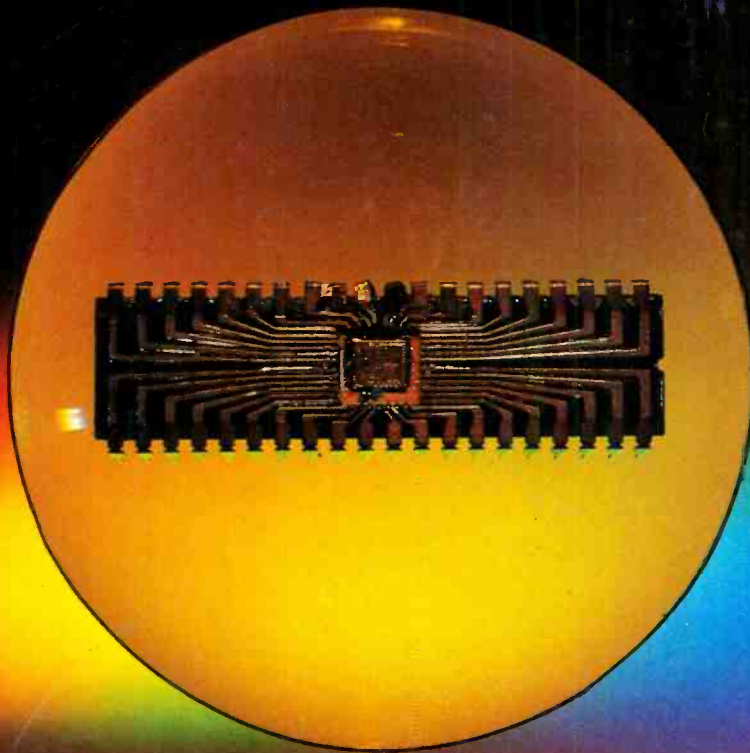
WORLD'S LARGEST SELLING ELECTRONICS MAGAZINE SEPTEMBER 1981/\$1

For Home Safety: A Toxic Gas Alarm

For Realistic Music: An Audio Peak Extender

For Better Circuits: VMOS Power Devices

## New Ways to Use 8080 Microprocessors



Tested in this Issue:

Beogram 8000 Turntable  
Apple II Plus Personal Computer



## Reddy Chirra improves his vision with an Apple.

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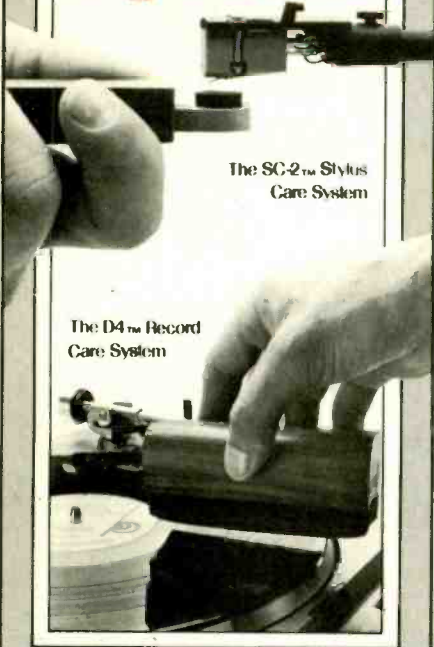
The personal computer.



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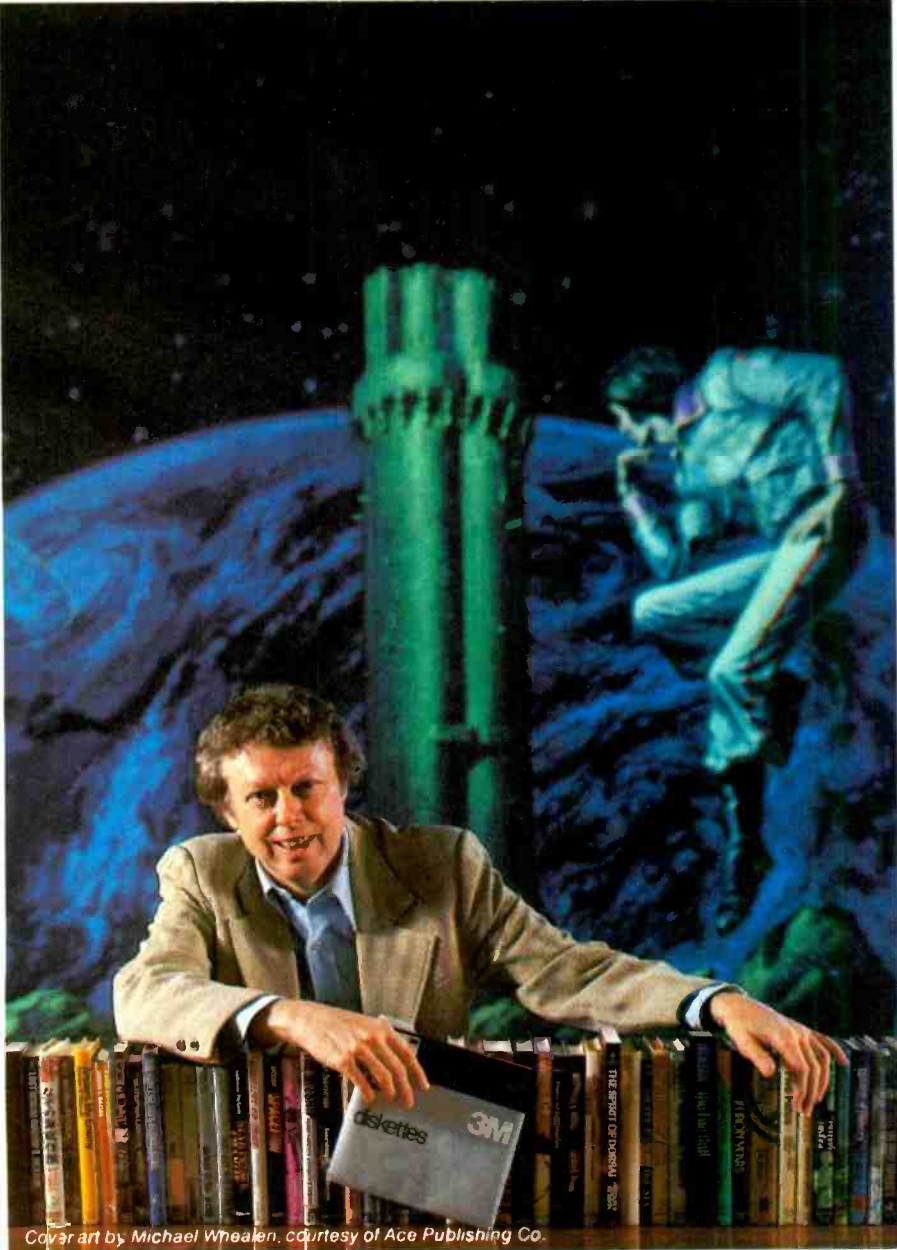
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# EDITORIAL

## 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 educa-

tion. 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.

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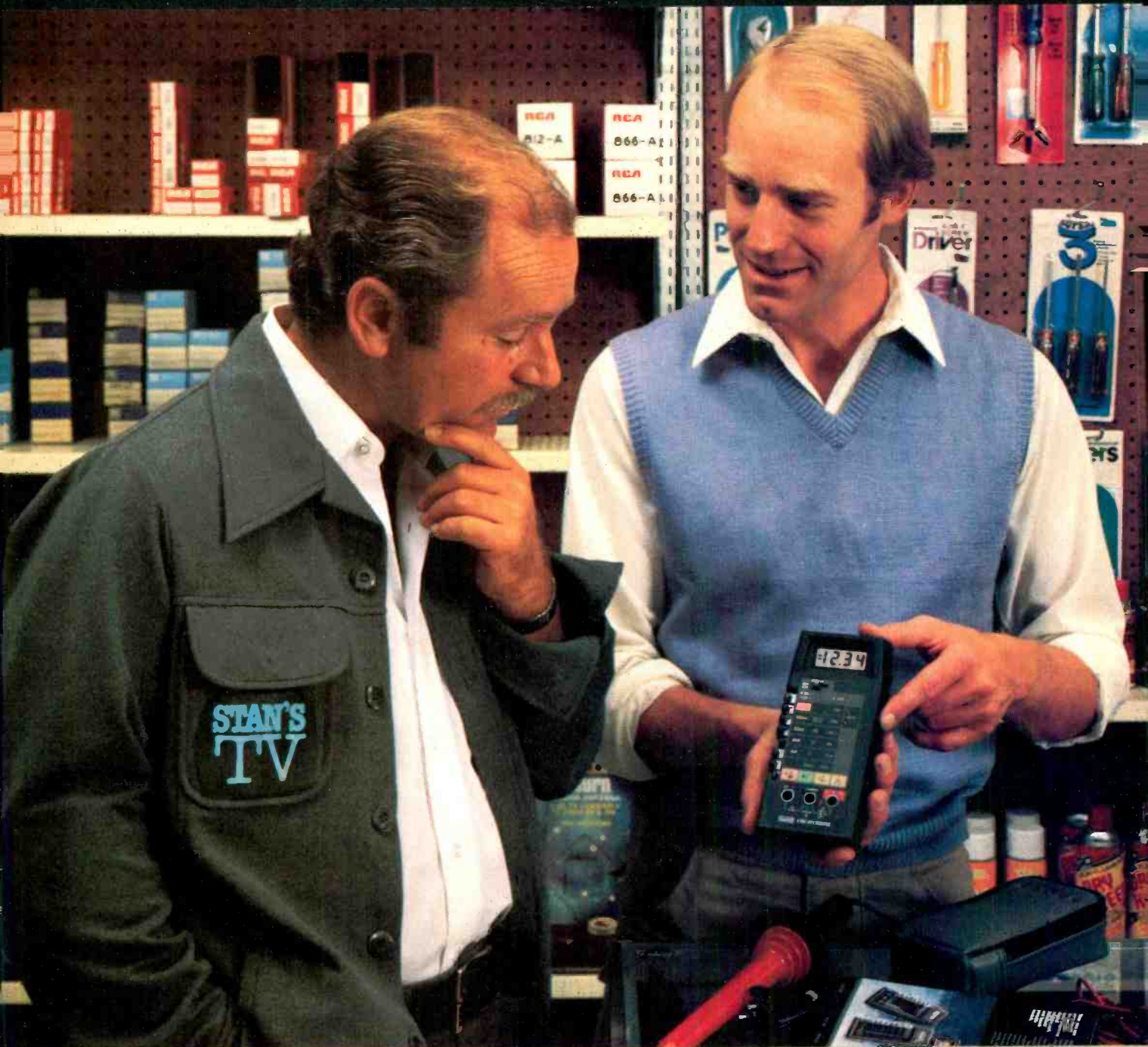
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## LETTERS

### 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 consider-

ation 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  $\pm 3$ db. Virtually all cassette recorders priced under \$600 are flat  $\pm 3$ db 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.



**DAK  
INDUSTRIES  
INCORPORATED**

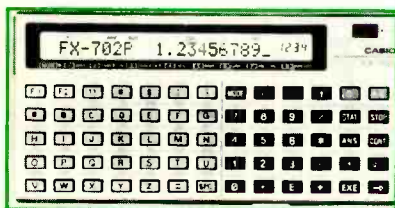
Call TOLL-FREE ..... (800) 423-2636  
In California Call ..... (213) 984-1559  
10845 Vanowen St., North Hollywood, CA 91605

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

## 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  $\pm$  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

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

## Audio Cassette Deck

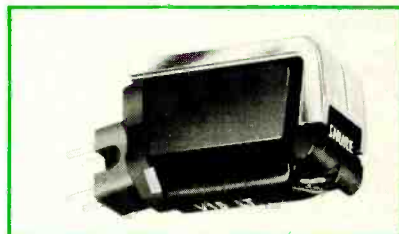


The Model 814 cassette deck from Dual features a Direct Lock and Load system that eliminates the usual door between user and cassette. Also featured are me-

ters 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  $\pm$  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 k $\Omega$  (70 k $\Omega$  maximum) in parallel with 200 to 300 pF capacitance. Inductance is 500 mH; dc resistance, 1380  $\Omega$ . Net weight, 6 g. \$130.

CIRCLE NO. 93 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

## 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 8 1/2", weighs about 20 lb, and has a 7.7" color picture tube. The VCR uses 1/4" video tape in two-ounce cassettes that play/record for 45 minutes. Tapes can be recorded either with a Technicolor video camera (in the 1/4" 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

# 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.

**JS&A** PRODUCTS  
THAT  
THINK

Dept. PE One JS&A Plaza  
Northbrook, Ill. 60062 (312) 564-7000  
Call TOLL-FREE ..... 800 228-5000  
In Nebraska Call ..... 800 323-6400  
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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, TTL, ECL, ECL as well as pulse output from the main amplifier. Pulse baseline is set from zero to  $\pm 15$  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 output. \$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

## 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  $4\frac{1}{2}$ "H  $\times$   $3\frac{1}{8}$ "W  $\times$   $1\frac{1}{4}$ "D. \$74.95.

CIRCLE NO. 97 ON FREE INFORMATION CARD

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

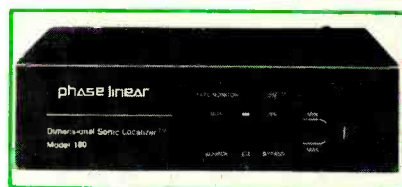
## Voice Recognition System



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 k $\Omega$ ; maximum output voltage, 10 V rms into 10 k $\Omega$ . \$149.95.

CIRCLE NO. 98 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  $\pm 0.5$  dB.

CIRCLE NO. 99 ON FREE INFORMATION CARD

## 4 1/2-Digit Hand-Held DMM

Data Precision's new Model 945 is a portable 4 1/2-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  $\mu$ V. Resistance, in 6 ranges, is measured from 200  $\Omega$ , with 10-M $\Omega$  resolution, to 20 M $\Omega$ . 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



# 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.

**JS&A** PRODUCTS  
THAT  
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Dept. PE One JS&A Plaza  
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In Nebraska Call ..... 800 323-6400

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"RATED NO. 1 FOR SERVICE & RELIABILITY"

## THIS MONTH'S SUPER SPECIALS!

### VIDEO AND AUDIO

#### HOME VIDEO RECORDERS

|                              |      |
|------------------------------|------|
| G.E. VC-1012 VHS Recorder    | 1799 |
| HITACHI VT-8500 VHS Recorder | 1895 |
| JVC HR-8700 VHS Recorder     | 1795 |
| MAGNAVOX 8310 VHS Recorder   | 1625 |
| PANASONIC PV-1300 VHS Rec.   | 1795 |
| PANASONIC PV-1700 VHS Rec.   | 1100 |
| Quasar VR-5015 VHS Recorder  | 1595 |
| RCA VET-250 VHS Recorder     | 1750 |
| RCA VET-450 VHS Recorder     | 1020 |
| SANYO VCR-5000 Beta Recorder | 1725 |
| SONY SL-5600 Beta Recorder   | 1775 |
| SONY SL-5600 Beta Recorder   | 1025 |
| ZENITH VR-9000 Beta Recorder | 1695 |

#### PORTABLE VIDEO RECORDERS

|                               |       |
|-------------------------------|-------|
| AKAI VPS-7350 VHS w/Tuner     | 11295 |
| JVC HR-2200 VHS w/Tuner       | 1975  |
| PANASONIC PV-3100 VHS Rec.    | 1595  |
| PANASONIC PV-A35P Tuner/Timer | 1295  |
| PANASONIC PV-2300 VHS w/Tuner | 1875  |
| SONY IT-3000 Beta Recorder    | 1695  |
| SONY IT-3000 Tuner/Timer      | 1229  |

#### VIDEO CAMERAS

|                              |      |
|------------------------------|------|
| HITACHI VCR-800 Auto Focus   | 1975 |
| JVC GX-88 Camcorder          | 1699 |
| PANASONIC PK-800 Camera      | 1695 |
| SONY HVC-2200 Camcorder      | 1985 |
| TOSHIBA IR-1550AF Auto Focus | 1849 |

#### VIDEO DISC PLAYERS

|                            |      |
|----------------------------|------|
| MAGNAVOX VH-800 Laserdisc  | 1599 |
| PIONEER VP-1000 Laserdisc  | 1599 |
| RCA SP-100 CED Disc Player | 1399 |

#### SONY COLOR TV

|                     |      |
|---------------------|------|
| KV-1207 12 Screen   | 1349 |
| KV-1515 15 Screen   | 1599 |
| KV-1913 19 Screen   | 1435 |
| KV-1948S 19 Remote  | 1559 |
| KV-2645RS 26 Remote | 1975 |

\*NOTE: ALL COLOR TELEVISIONS SHIPPED FRIGT-INSURE COLLECT ONLY!

### CAR STEREO

#### PIONEER CASSETTE DECK W/RADIO

|                       |        |
|-----------------------|--------|
| KP-5500               | 124.90 |
| KP-8500               | 141.90 |
| KP-2100               | 174.90 |
| KE-20                 | 214.90 |
| KE-402 (Foreign Cars) | 144.90 |
| KP-8000               | 154.90 |
| KPX-9000 (Reg. Amp.)  | 154.90 |
| KPX-9500 (Reg. Amp.)  | 176.90 |
| KE-5100               | 209.90 |

#### CASSETTE UNDER DASH

|                    |        |
|--------------------|--------|
| KP-373             | 84.90  |
| KP-575             | 94.90  |
| KP-500             | 106.90 |
| KP-772 (Reg. Amp.) | 102.90 |
| KP-600 (Reg. Amp.) | 118.90 |
| KP-707G            | 144.90 |

#### POWER AMPS/EQUALIZER

|       |        |
|-------|--------|
| AD-30 | 94.90  |
| AD-50 | 141.90 |
| GM-10 | 106.90 |
| GM-5  | 89.90  |
| GM-4  | 54.90  |

#### CAR SPEAKERS

|        |             |
|--------|-------------|
| TX-X9  | 133.90/PAIR |
| TS-168 | 73.90/PAIR  |
| TS-995 | 56.90/PAIR  |
| TS-13  | 39.90/PAIR  |
| TS-107 | 39.90/PAIR  |

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|                      |        |
|----------------------|--------|
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| R-406 Receiver       | 199.90 |
| R-410 Receiver       | 219.90 |
| R-420 Receiver       | 259.90 |
| R-512 (Auto Reverse) | 244.90 |

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|                         |             |
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| J-1201 6x9 Coax II Thin | 62.90/PAIR  |
| J-1130 4x10 Trax II     | 134.90/PAIR |
| J-1124 5x6 Trax II      | 84.90/PAIR  |
| J-1158 6x9 Coax II Thin | 40.90/PAIR  |
| J-1069 6x9 Coax II      | 43.90/PAIR  |
| J-1037 6x9 Coax II      | 44.90/PAIR  |
| J-1044 5x6 Coax II      | 53.90/PAIR  |
| J-1001 6x9 Separates    | 94.90/PAIR  |
| J-1065 6x9 Trax         | 62.90/PAIR  |

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|                       |        |
|-----------------------|--------|
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| SCOTCH Highlander C90 3 pk     | 3.99  |
| SCOTCH Master I C90            | 3.25  |
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| MEMOREX Hi-Bias C90            | 2.99  |
| SONY EHF C90                   | 3.29  |
| SONY FHC C90                   | 3.49  |
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| TDK D50 Demagnetizer           | 16.95 |
| TDK DC-90                      | 1.68  |
| TDK AD C90                     | 2.45  |
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| TDK MA C90 I (Metal)           | 2.49  |
| MAXELL UDXL I or UDXL II C90   | 4.49  |
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CIRCLE NO. 44 ON FREE INFORMATION CARD

# 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

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.

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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.)

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If you wish, you may choose to take your training with the Bearcat 210 scanner receiver. Also microprocessor based, it operates over five bands to give you automatic operation from 32 to 512 MHz.

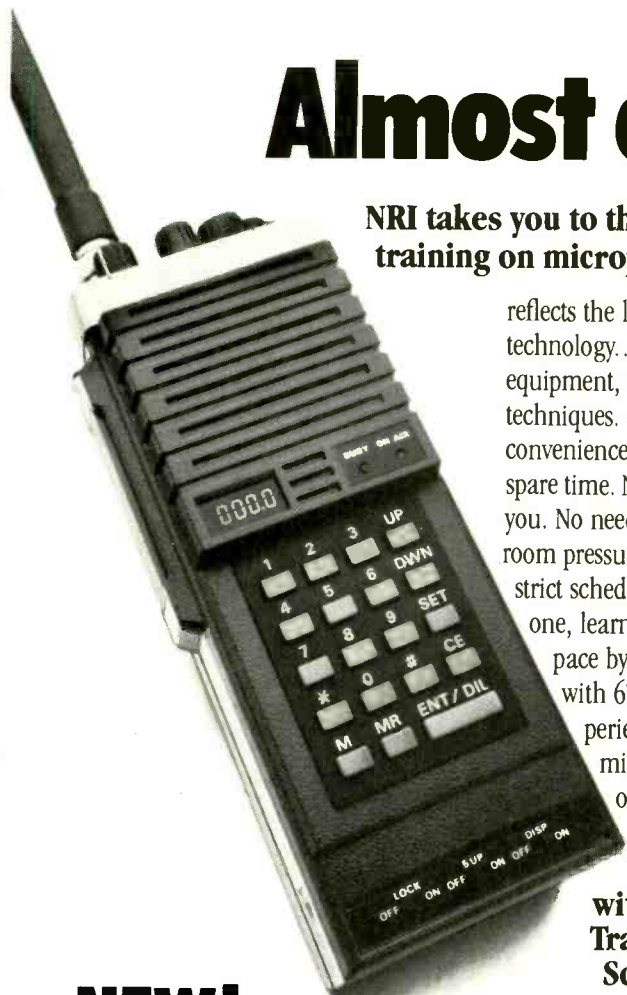
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### NEW!

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its function and interaction with others to make concepts crystal-clear.

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Your NRI Communications Electronics course also includes professional test instruments. Use them in the many experiments and demonstrations you perform, then keep them to use in your professional work. You get the Beckman Tech 300 hand-held LCD digital multimeter with six ranges and 26 scales to cover almost every IM-2400 measuring need you'll encounter. You also get the Heathkit UHF frequency counter, indispensable for both bench and field measurements of transmitter output frequency. Both instruments come with NRI Action Audio training backup.

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op amps, phototransistors, digital logic circuits and power supplies.

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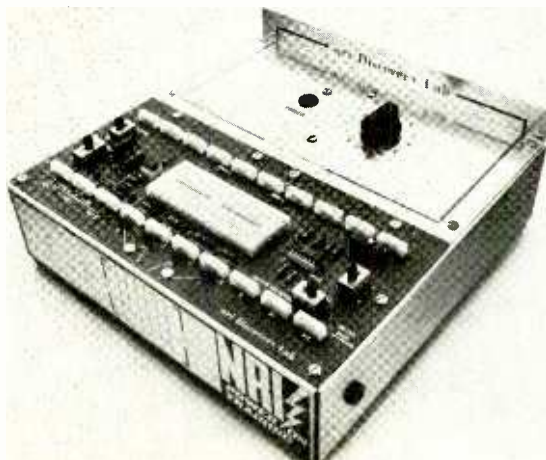
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Satellite communications is just one of the many fields covered by this complete communications program. You also learn how to install, service, and repair mobile radios; CBs; microwave antenna systems; aircraft and marine radio and navigational electronics; AM, FM and TV broadcast equipment; radar; just about any electronic communications equipment you'll ever run across. You're trained for the good-paying jobs in the secure, high-demand field of today's electronics professionals.

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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 over-used. 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 "vignettors" 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. ♦

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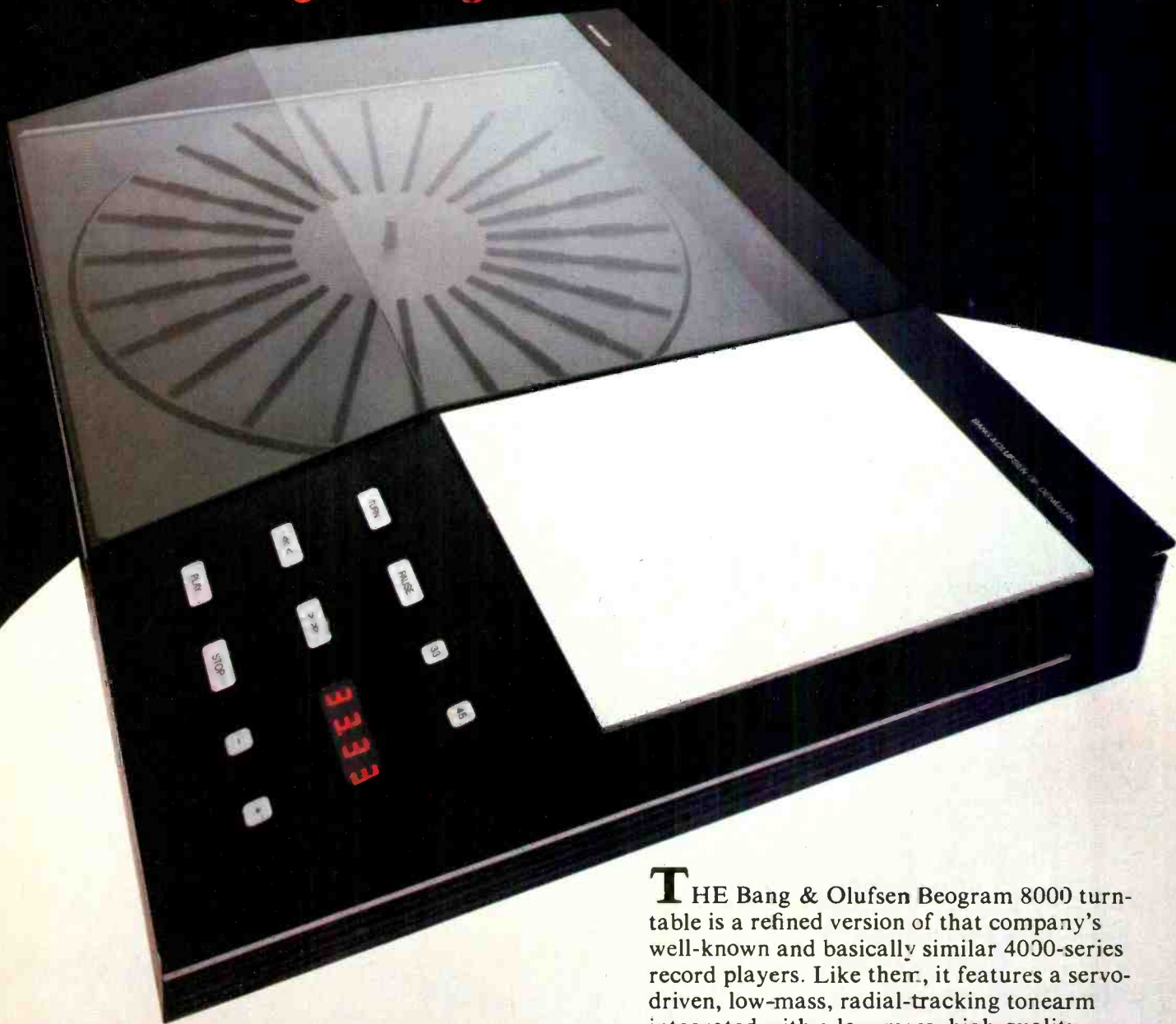
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CIRCLE NO. 73 ON FREE INFORMATION CARD

# Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

## *Bang & Olufsen Beogram 8000*



**T**HE 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

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If you have experience in any branch of the Armed Forces, you have the chance to earn good extra income while you hold one of the most important jobs in America. In an Army National Guard unit close to home.

Take income. In the Army National Guard, the work you've put into military service can really go to work for you. For instance, if you left as an E-4 with three years experience, you can earn over \$1500 a year. As an E-5 with 6 years experience, over \$1700. And, if you have a critical skill you may also qualify for a cash bonus. To see exactly how far your rank and experience can take you, check out the chart below.

|                   | PER YEAR (Including Annual Training) |
|-------------------|--------------------------------------|
| E-3 with 2+ years | \$1375.68                            |
| 3+ years          | 1427.34                              |
| E-4 with 3+ years | 1519.92                              |
| 4+ years          | 1630.17                              |
| E-5 with 4+ years | 1687.11                              |
| 6+ years          | 1789.80                              |

Plus, a part-time job in the Army National Guard fits in well with your current lifestyle. Because all it takes is two days a month of your time, along with 15 days annual training. And, in the Guard, you're serving close to home, helping the people in your community and state when natural disasters or emergencies occur.

Extra income that's important to you, in a job that's important to your community. It's just one reason to Guard your military experience in the Army National Guard.

To learn about other reasons— from benefits to new skills—contact your local Guard recruiter, or call toll-free 800-638-7600.

\*In Hawaii: 737-5255; Puerto Rico: 723-4450; Virgin Islands (St. Croix): 773-6438; Maryland: 728-3388; in Alaska, consult local phone directory.

The Guard is  
America at its best.



CIRCLE NO. 53 ON FREE INFORMATION CARD

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

### 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.

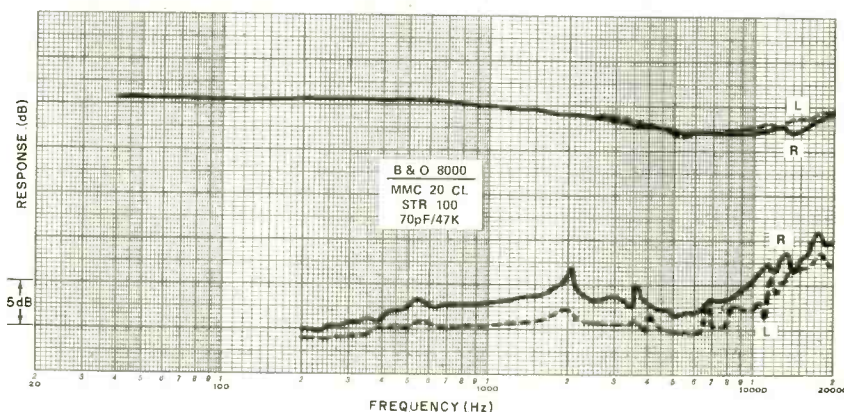
**+,- :** Varies speed in discrete increments. (Actual speed is shown on a four-digit numerical display.)

**<< >> :** 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.

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-



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

# 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.



## The HE Family: Hyperelliptical-Equipped



**V15 Type IV**  
¾-1¼ 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**  
1¼ grams

**M95HE**  
¾-1½ grams

**M75HE Type 2**  
¾-1½ grams

**M75HE-J Type 2**  
1¼-2½ grams

Go with the leader—Shure.



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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 33 $\frac{1}{3}$  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 out-

put 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  $\pm 0.06\%$  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  $\pm 3.3\%$  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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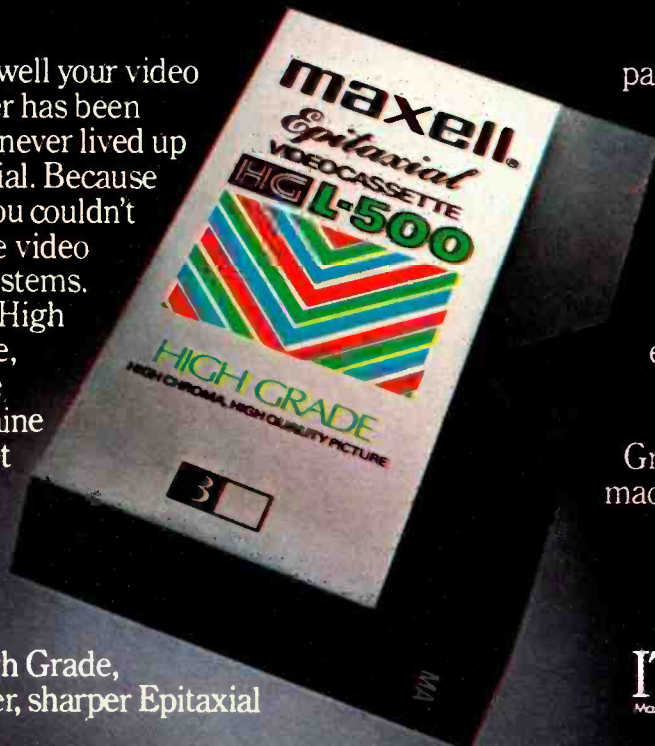
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# Popular Electronics Tests



Screen Picture by Discovision

## The Sampo Model 9519 19" Color TV Receiver

**T**HE Sampo Model 9519 is a 19" color receiver with two 5" black and white monitors nested alongside. Packaged in a mahogany veneer wood cabinet 25 $\frac{3}{4}$ "W  $\times$  19 $\frac{1}{16}$ "D  $\times$  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 con-

troller. 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 multi-screen 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-

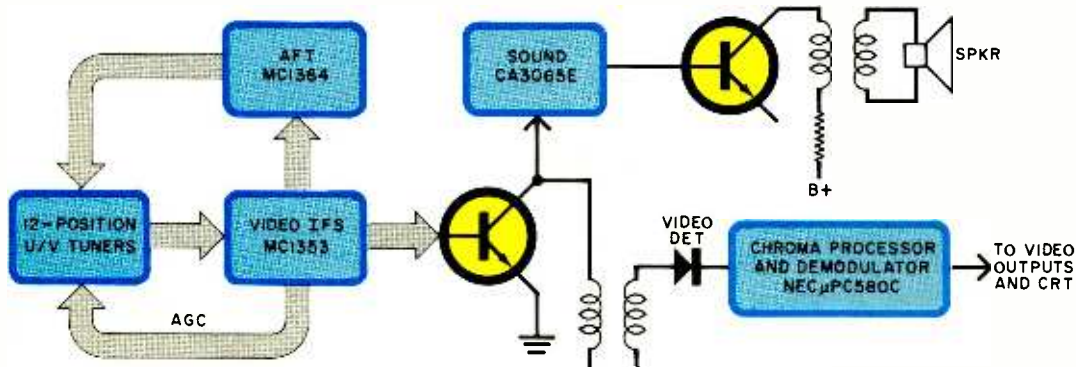


Fig. 1. Simplified block diagram of the main color chassis. Functions are performed by four ICs and 28 discrete transistors.

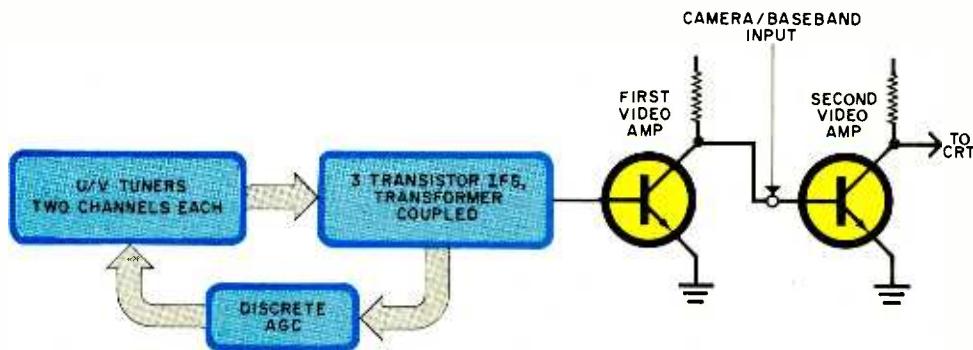


Fig. 2. Simplified block diagram of the chassis for one monitor, using all discrete transistors. The two 5-inch monochrome channels are identical.

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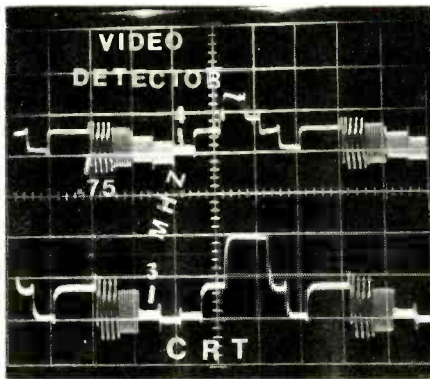
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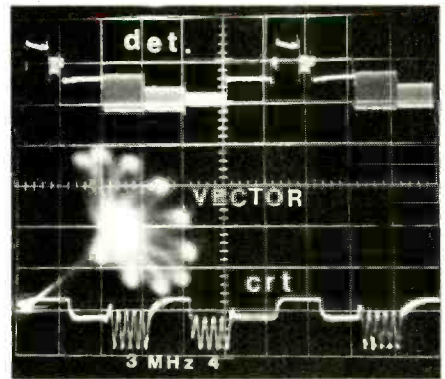
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**video**



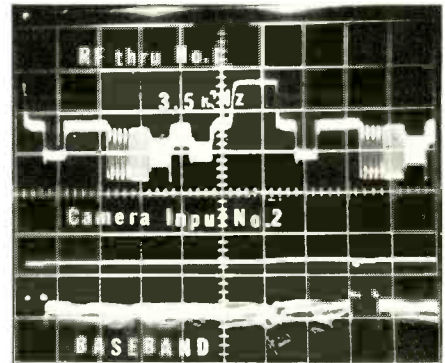
**Fig. 3**

*Fig. 3. Multiburst tests on main-screen receiver showing 3 MHz at cathode 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<br>(min. signal for snow-free picture): | vhf (Ch. 8): -6 dBmV<br>uhf (Ch. 30): -4 dBmV  |
| Voltage regulation<br>(line varied from 105 to 130 V):             | Low voltage: 120-V supply—93.7%<br>24-V supply—93.9%<br>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/Tequipment 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

CIRCLE NO. 103 ON FREE INFORMATION CARD

POPULAR ELECTRONICS

# Popular Electronics Tests

## The Sencore SC60 Widebander Dual Trace Oscilloscope

**T**HE 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.

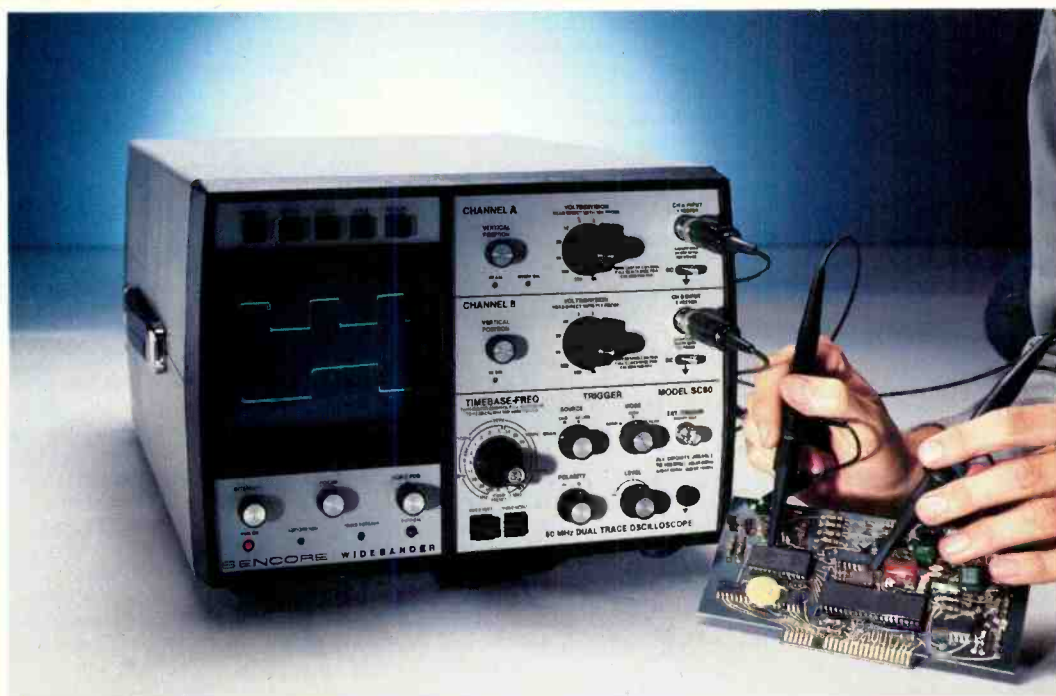
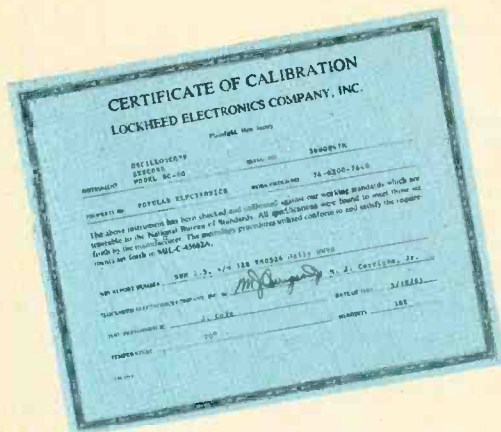
Because of the 6-ns risetime of the vertical amplifiers, this new scope is able to display waveforms up to 100 MHz. The input level to each channel can be from 5 mV to 1.6 kV peak-to-peak. The vector function, provided for color-video servicing, operates to 5 MHz.

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 PICAL 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,  $\pm 3$  dB, -6 dB at 80 MHz, -12 dB at 100 MHz; ac mode is from 10 Hz to 60 MHz,  $\pm 3$  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:**  $\pm 4\%$  from 20° to 30° C  
 $\pm 6\%$  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  $\mu$ s/div, 1-2-5 sequence, 19 steps, with variable vernier; special pushbuttons select 2 cycles vertical or horizontal of NTSC composite video.

**Accuracy:**  $\pm 4\%$  typical

**X10 magnification:** Sweep becomes 10 ms/div to 10 ns/div; accuracy is  $\pm 5\%$ , except on .1, .2, and .5  $\mu$ s/div where it is  $\pm 8\%$ .

**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  $\pm 3$  dB

**Phase shift:**  $\pm 3$  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  $\mu$ s/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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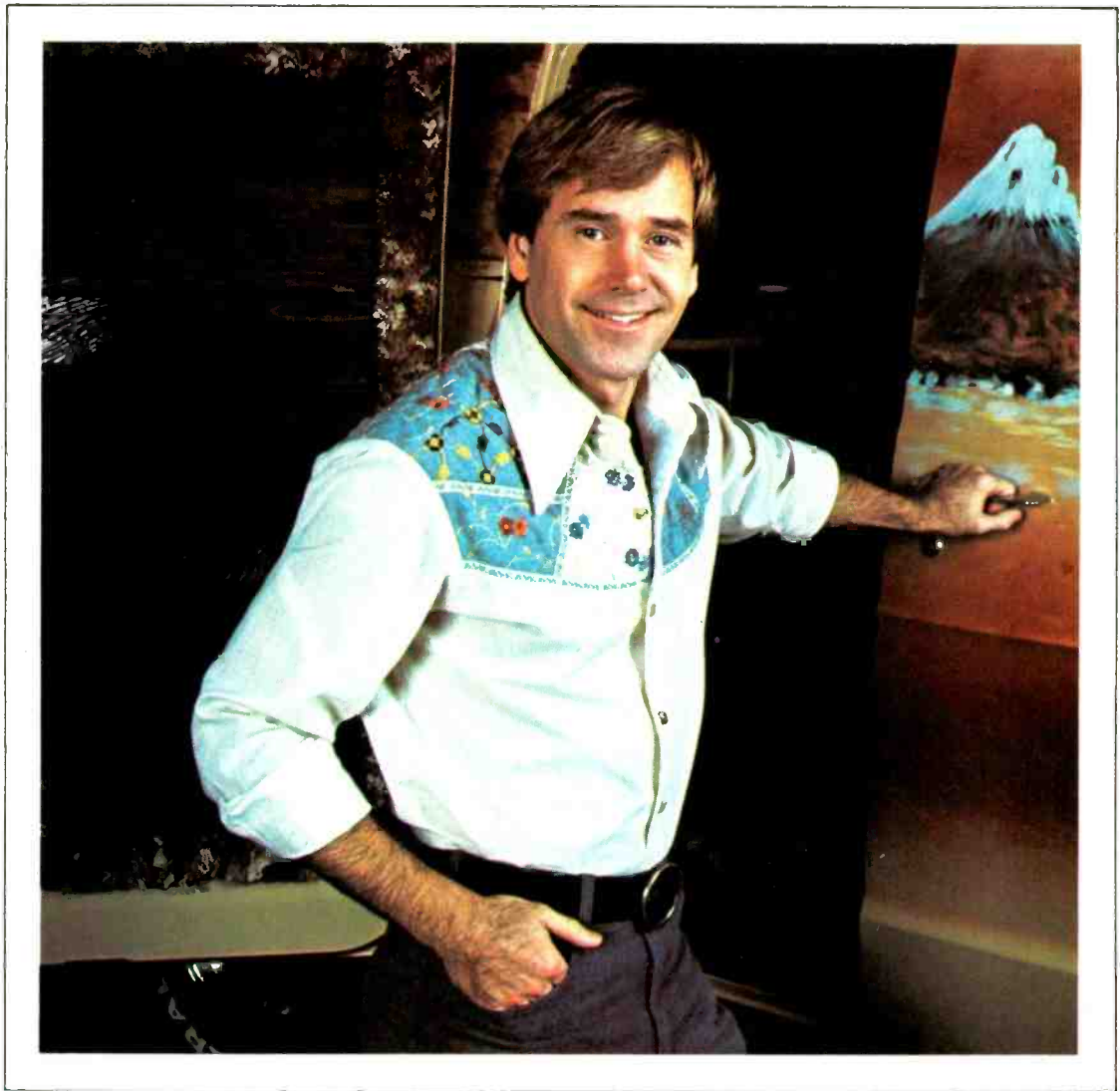


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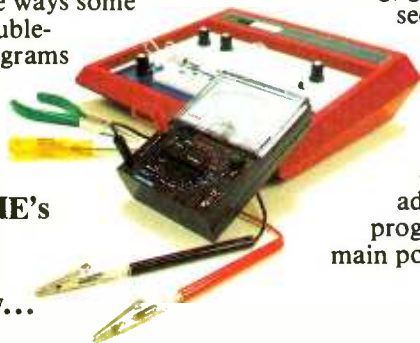
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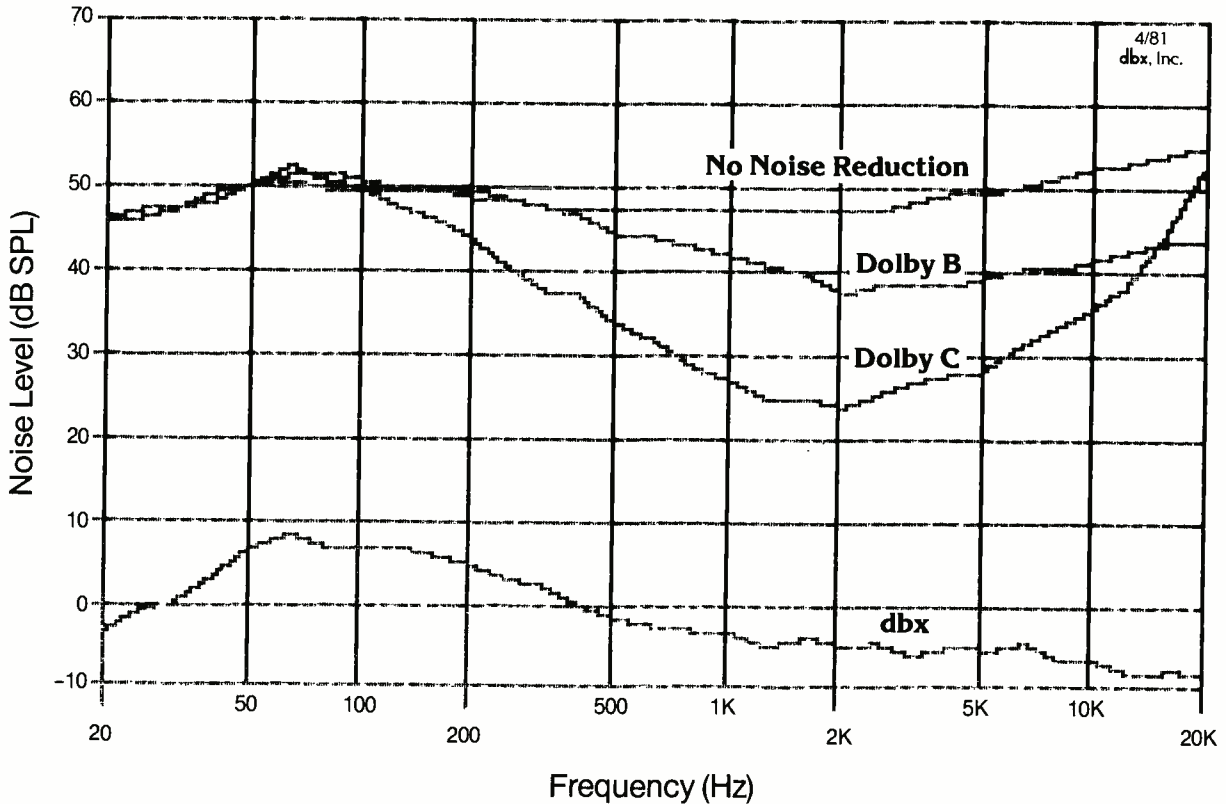
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# Popular Electronics Tests



## The Apple II Plus Personal Computer System

**A**LTHOUGH 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 Ap-

plesoft 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            |
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In addition to the above, Personal Software has made available: VisiCalc, Visi-dex, 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 output 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  $\times$  40 columns), with each character generated in a  $5 \times 7$  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  $\times$  48 array) in a total of 16 colors. In the high-resolution mode, 53,760 dot locations (280  $\times$  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 alphanumeric 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.

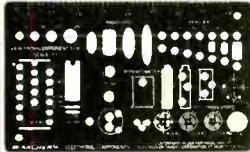
One annoying shortcoming was the lack of upper/lower case character set. Even though correctable through purchase of an ROM for about \$65 this omission seems out of place in an otherwise sophisticated system. Furthermore, the location of the arrowed keys is a problem since it is easy to hit one when 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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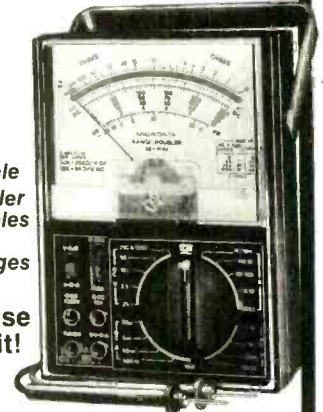
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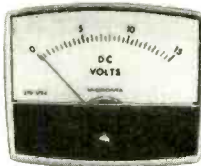


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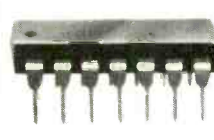
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ple, its attributes could then be requested and held in a system map file. Application programs could use this file by simply calling the device.

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.

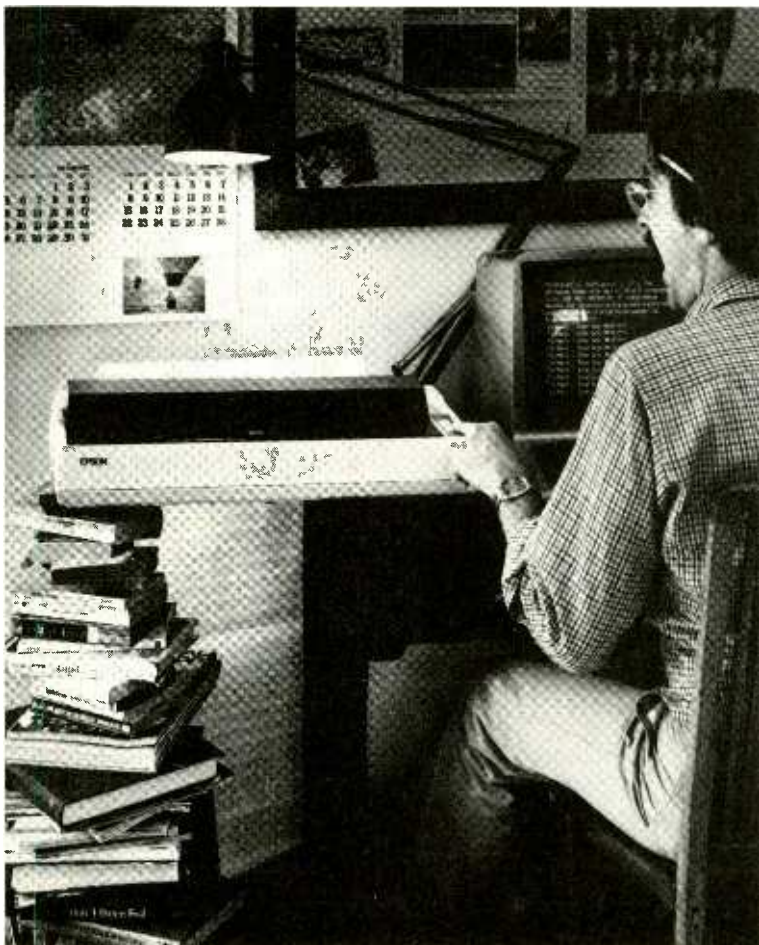
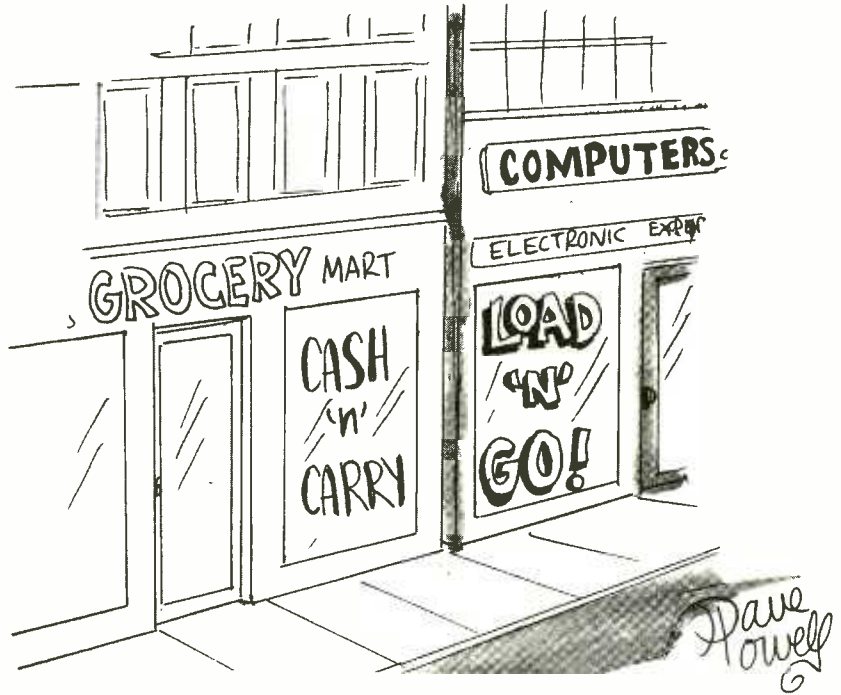
Interestingly, though this may be strictly our perception, the audio aspect of the machine has not caught on. But this may be changing. According to some observers, sophisticated voice-output devices will make the machine downright conversational.

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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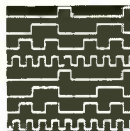
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- External 9 VDC power supply included (Model MMAC-2).
- Size 6.25" x 3.75" x 2"
- BNC Output Cable Accessory (Model PSA-2 add \$14.95).

## LOW COST CAPACITANCE METER MODULE, DM-8

Connect this high quality low cost Capacitance Meter Module, DM-8 to your digital Volt Meter and turn it into a Digital Capacitance Meter — the Low Cost Way!



Completely assembled and tested! Ready to use!

**\$69<sup>95</sup>**

- Push to read range (button) from 1pF to 20,000pF
- Zero calibration control
- In one easy to use, self-contained package.
- Battery powered, with "push to read" battery saver circuit (9V batteries not included).
- Size 6.25" x 3.75" x 2"

## REGULATED TRIPLE POWER SUPPLY, LOW PRICED!, DM-6

A fully assembled and tested power supply that provides a solid, fully wired triple power supply including fixed 5V @ 1 Amp, 5V to 15V @ 0.5 Amp, and 1 — 5V to 15V @ 0.5 Amp — all supplies regulated, short proof. Each supply has short indicator LED. Complete and ready for use in a durable (8" x 6" x 1 1/2") metal case.

**\$99<sup>95</sup>**



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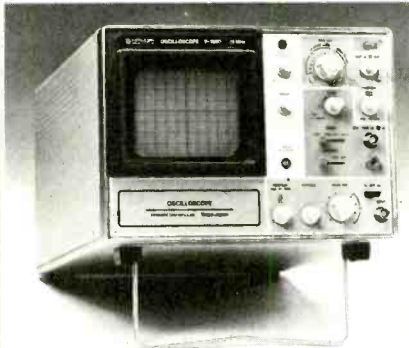
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- **CRT**  
Display area 130BUB31 (5-inch, round shape)  
Acceleration potential 8x10div (1 div = 9.5mm)  
Intensity modulation Approx. 2kV  
Over 5Vp-p
- **Vertical deflection**  
Sensitivity and bandwidth 5mV/div — 5V/div ± 5%, DC — 15MHz, — 3dB  
1mV/div — 1V/div — 6%, DC — 5MHz Typ. — 3dB  
(Using x5 amplifier)
- **Rise time** 24ns  
**Dynamic range** More than 4div at 15MHz  
**Input R and C** Direct 1M Ohm, approx. 30pF  
**Maximum input voltage** 600Vp-p or 300V (DC + AC peak)  
**Display mode** Single-trace  
**X-Y operation** DC — 500 kHz, 200mV/div  
Phase difference DC — 10kHz 3'

- **Horizontal deflection**  
Sweep mode Auto, NORM, TV (+), TV (-)  
TV synchronization TV sync-separator circuit  
Internal Over 1 div (V sync-signal)  
External Over 1 Vp-p (V sync-signal)

| Frequency   | Internal | External |
|-------------|----------|----------|
| 20Hz — 2MHz | 0.5div   | 200mV    |
| 2 — 15MHz   | 1.5div   | 800mV    |

- **Trigger slope** =
- **Sweep time** 0.2µs/div — 0.2s/div ± 5%, 19 calibrated steps
- **Sweep-time magnifier** 10 times (± 7%)
- **Max. sweep rate** 100ns/div
- **Amplitude calibrator** 1kHz ± 10% Typ. Square wave
- **Waveform** 0.5V ± 3%
- **Voltage** 100V (120/220/240V) = 10%
- **Power requirements** 50/60Hz, 40W  
Approx. 275(W) x 190(H) x 400(D)mm
- **Dimensions** Approx. 8.5kg
- **Weight** 0 — 40°C
- **Ambient operation temperature**

**MODEL V-151B WITH 2 YEAR MFG. WARRANTY**

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## LOW COST HIGH FREQUENCY COUNTER



### MODEL NO. DM-7

The Albia Model DM-7, 8 Digit High Frequency Counter is easy to use, switch selectable time base input by a single BNC, nothing to build!

- 5 Hz to 550 MHz
- 8 big easy-to-read, 4 1/2" high intensity LED display
- Crystal (± 3 ppm @ 25°) controlled 0.1 or 1.0 sec. gate times
- Convenient benchtop size (7" x 10" x 3") durable attractive case

COMPLETELY ASSEMBLED PRE-CALIBRATED PRE-TESTED

**\$149<sup>95</sup>**

## LOW OHM METER MODULE, DM-10

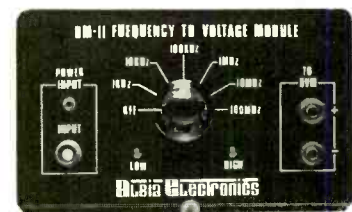


Measures resistance from 10 milliOhms to 20 Ohms. Now you can measure resistance down to 10 milliOhms with this low cost, easy to use DVM module. Check coil resistance, transformers, relays, chokes, printed circuit board copper paths and ground cables. Special zero balance control nulls out input cable resistance to insure accurate readings. Your DVM has to be set to 2V range during operation.

- Resistance range 10 milliOhms to 20 Ohms
- Zero Calibration control
- Battery powered (push to read battery saver circuit). Requires 1.9 Volt Battery (not included).
- Size 6.25" x 3.75" x 2" (input cables not included or available)

**\$69<sup>95</sup>**

## FREQUENCY METER MODULE "5Hz to 100MHz", DM-11



Measure frequencies from 5Hz to 100MHz on your digital voltmeter with a resolution of 3 1/2 digits — easy to use — perfect for field service — lab testing — home hobbyist! Connect the DM-11 to your DVM, set the DVM to the 2VDC range, connect a signal to the DM-11 via a BNC cable (not included) and measure the frequency of any source. Hi Lo Range LED's insure fast accurate readings.

- Frequency Range 5Hz to 100MHz
- Input Impedance 1 MegOhm
- Input Sensitivity: < 100Hz < 80mV  
100 Hz — 60MHz — 30mV  
> 60MHz < 70mV

- Size 6.25" x 3.75" x 2"
- External 9V DC power supply included (Model MMAC-2)
- BNC Input Cable Accessory (Model PSA-2 add \$14.95)

**\$69<sup>95</sup>**

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# Now you don't have to spend a fortune to enjoy a complete woodworking shop.

The Shopsmith MARK V combines five major power tools into one unique, big-capacity unit.

Whether you're an experienced craftsman, a dedicated hobbyist, or a week-end "do-it-yourselfer," at one time or another, you've probably dreamed of owning a complete woodworking shop. A few hand-held power tools just aren't enough for most projects you'd like to try.

If you purchased the five separate tools woodworkers use most — table saw, vertical drill press, horizontal boring machine, disc sander and lathe — you could expect to pay *at least* a couple of thousand dollars. And even if you had the money, would you have enough space for them?

## Save space, save money with the Shopsmith MARK V.

There's one answer that can solve both those problems — the Shopsmith MARK V. This remarkable piece of equipment is a single precision tool that combines all five of the major power tools in one unit that actually takes up less space than a bicycle... and that can be yours for about ONE-THIRD the price of the five separate units!

## Outperforms individual tools

The MARK V's unique design not only gives you greater accuracy and more convenience — it allows you to do things you just can't do with other power tools.

This ingenious woodworking system combines a 10" table saw, a 16½" vertical drill press, a horizontal boring machine, a 34" lathe and a 12" disc sander — all powered by *one* rugged variable-speed motor.

After only about an hour's practice, you'll be able to change from one function to another in less than 60 seconds. And you'll be able to perform dozens of sophisticated woodworking operations, including edge sanding, spindle turning, and doweling. We call the MARK V "the tool to start with, the system you grow with," because with optional accessories, you can perform more

specialized operations, like mortising, routing, molding, and many others.

With the Shopsmith MARK V, the skill and accuracy are built right into the machine. It's so simple to operate that even if you're a beginner you'll soon be making your own furniture, cabinets, and gifts. In no time you'll be doing money-saving home repairs and impressive remodeling projects.

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Find out more about this amazing 5-in-1 tool. Simply mail the coupon below and we'll send you a FREE Information Kit. Your Kit will include a booklet,

"What to Look For When You Buy Power Tools," PLUS all the details on the incredible MARK V. You'll also learn how you can actually use it in your home, without risk, for a full 30 days, *without risking a penny!*



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# COMPUTER BITS

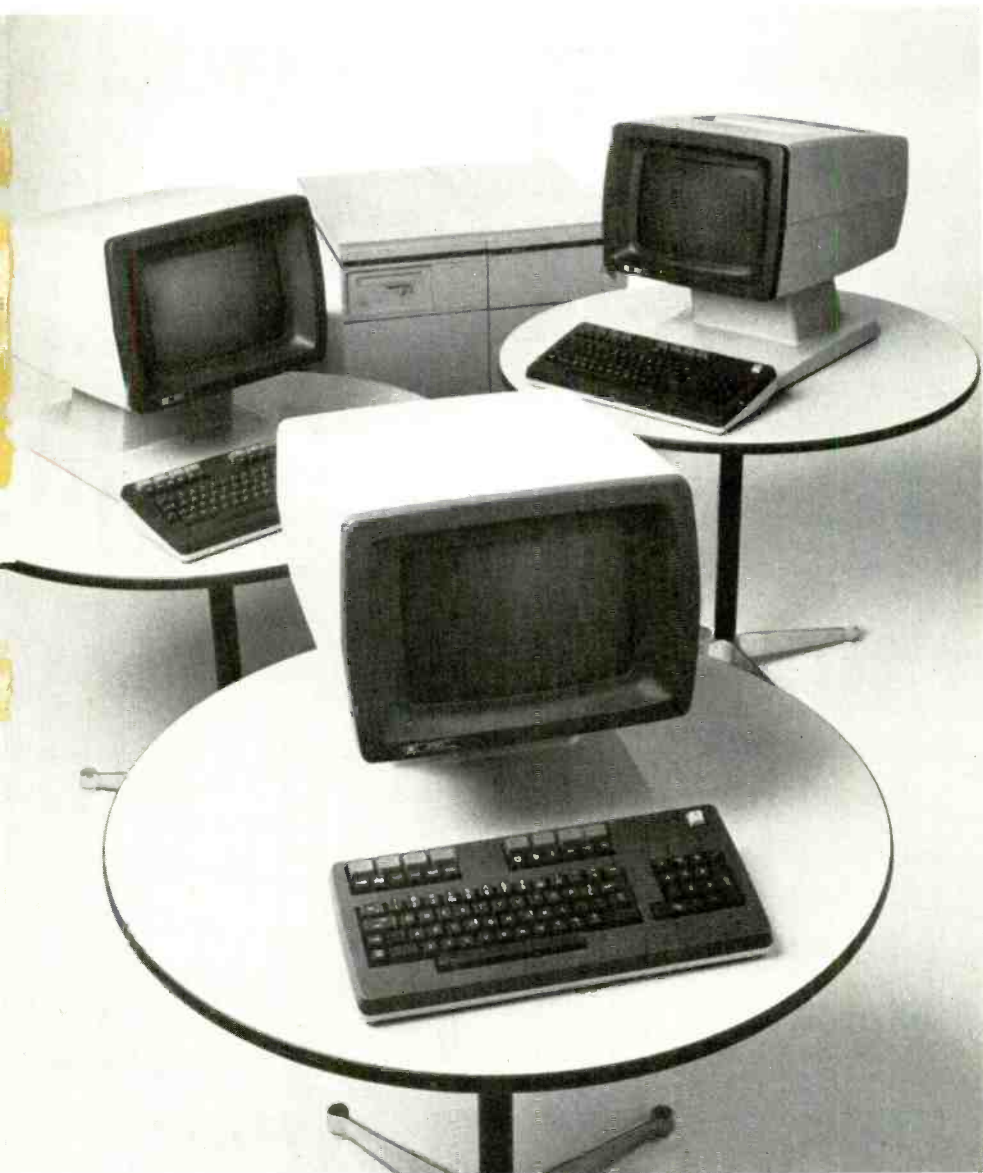
By Carl Warren

## High-End Systems (for Low-End Buyers)

**T**WO 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.

## NEW!!! THE ELECTRIC MOUTH\*



ELF II VERSION

for \$100, Elf II, Apple, TRS-80 Level II\*

From \$99.95 kit

**Now — teach your computer to talk, dramatically increasing the interaction between you and your machine.**

That's right: the ELECTRIC MOUTH actually lets your computer talk! Installed and on-line in just minutes, it's ready for spoken-language use in office, business, industrial and commercial applications, in games, special projects, R&D, education, security devices — there's no end to the ELECTRIC MOUTH's usefulness. Look at these features:

- \* Supplied with 143 words/letters/ phonemes/ numbers, capable of producing hundreds of words and phrases.
- \* Expandable on-board up to thousands of words and phrases (just add additional speech ROMs as they become available).
- \* Four models, which plug directly into S100, Apple, Elf II and TRS-80 Level II computers.
- \* Get it to talk by using either Basic or machine language (very easy to use, complete instructions with examples included).
- \* Uses National Semiconductor's "Digitalker" system.
- \* Includes on-board audio amplifier and speaker, with provisions for external speakers and amplifier.
- \* Adds a new dimension and excitement to programming; lets you modify existing programs and games to add spoken announcements of results, warnings, etc.
- \* Installs in just minutes.

**Principle of Operation:** The ELECTRIC MOUTH stores words in their digital equivalents in ROMs. When words, phrases, and phonemes are desired, they are simply called for by your program and then synthesized into speech. The ELECTRIC MOUTH system requires none of your valuable memory space except for a few addresses if used in memory mapped mode. In most cases, output ports (user selectable) are used.

### Spoken Material Included

|           |          |               |         |        |             |        |   |   |
|-----------|----------|---------------|---------|--------|-------------|--------|---|---|
| one       | eighteen | cancel        | dollar  | inches | number      | so     | c | l |
| two       | nineteen | case          | down    | is     | off         | second | d | u |
| three     | twenty   | error         | equal   | it     | off         | set    | e | v |
| four      | thirty   | cent          | kilo    | on     | space       | f      | w |   |
| five      | forty    | 40hz tone     | left    | out    | speed       | g      | x |   |
| six       | fifty    | 80hz tone     | flow    | less   | over        | star   | h | y |
| seven     | sixty    | 20ms silence  | fuel    | lesser | parenthesis | start  | l | z |
| eight     | seventy  | 40ms silence  | gallon  | limit  | percent     | stop   | i | k |
| nine      | eighty   | 80ms silence  | go      | low    | please      | than   | k |   |
| ten       | ninety   | 160ms silence | gram    | lower  | plus        | the    | l |   |
| eleven    | hundred  | 320ms silence | great   | mark   | point       | time   | m |   |
| twelve    | thousand | cent          | greater | meter  | pound       | try    | n |   |
| thirteen  | million  | check         | have    | mile   | pulses      | up     | o |   |
| fourteen  | zero     | comma         | high    | milli  | rule        | volt   | p |   |
| fifteen   | again    | control       | higher  | minus  | re          | weight | q |   |
| sixteen   | ampere   | danger        | hour    | minute | ready       | a      | r |   |
| seventeen | and      | degree        | in      | near   | right       | h      | s |   |

\*"Elf II" and "The Electric Mouth" are reg. trademarks of Netronics R&D Ltd. "Apple" is a reg. trademark of Apple Computer Inc. "TRS-80 Level II" is a reg. trademark of Tandy Corp.

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- TRS-80 Level II "Electric Mouth" kit ..... \$119.95

Add \$20.00 for wired & tested units. All plus \$3.00 postage & insurance. Conn. res. add sales tax.

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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.

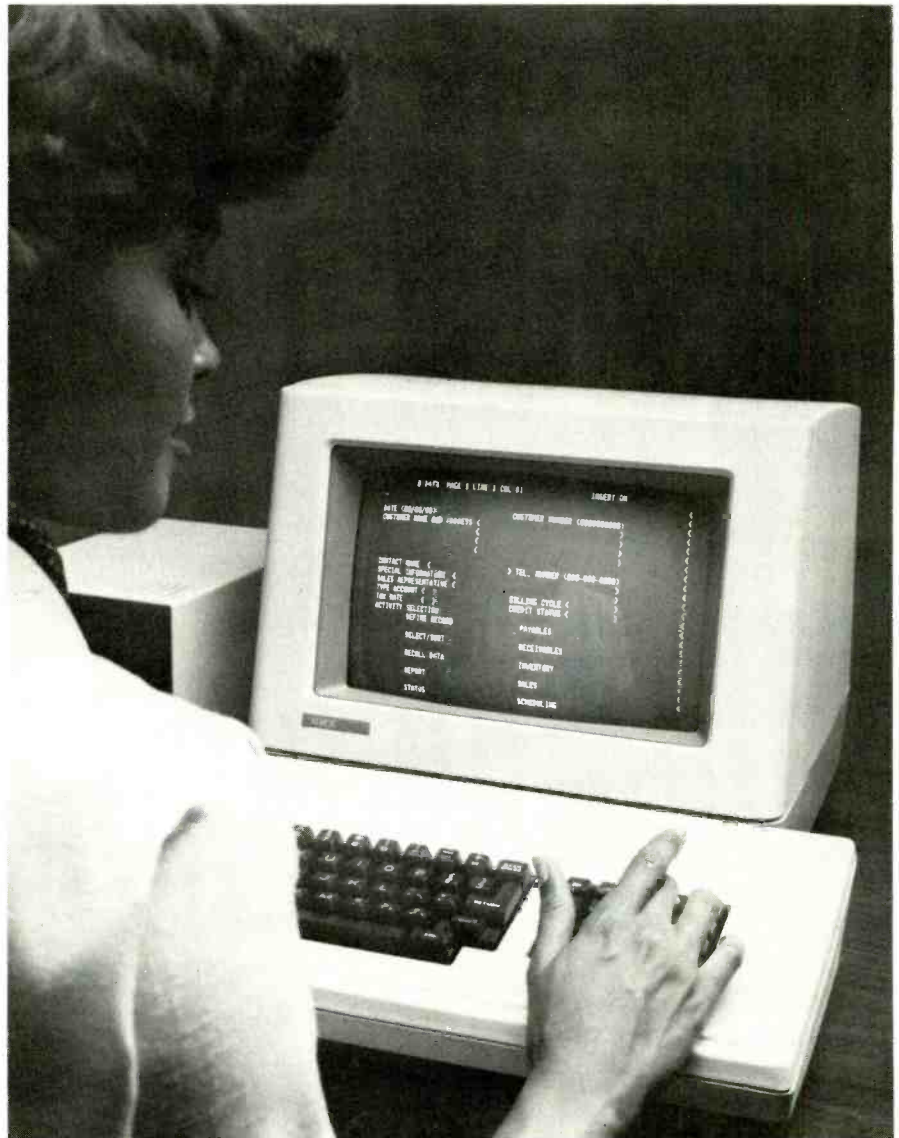
To support the lowest end of the personal computer spectrum, observers speculate that IBM will offer a stripped-down version for less than \$1,000 when the larger unit is introduced. Interestingly, both IBM systems are based on its 3101 terminal with add-ons.

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 "Terminal" 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. Terminal T1 requires Model I with 16K RAM and Level II BASIC. Terminal 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).

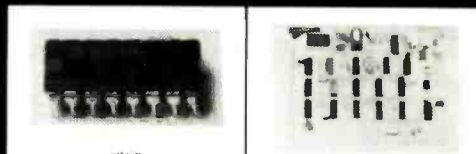
**Color Computer Utilities.** The "Color Editor" designed for the Radio Shack Color Computer allows both upper- and lower-case features and will print via the RS232 port. It has change and search commands, and can copy or

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 additional 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 recat-

alog 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).

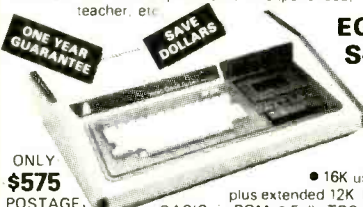
**Information Management.** INF080 is an automatic information filing and management system for the TRS-80 Model I and Model III. It creates a virtual dictionary of information that can be quickly located. It supports continuously variable record input length and automatically extends disk files. The 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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your maximum heart rate. This is your "training zone." The Genesis computer tells you how many minutes you've exercised at the right pulse rate and warns you if you're not working hard enough.

The other reason has to do with life itself. The Genesis computer will give an audible warning if you're pushing your heart dangerously. While you exercise—or during a stressful day at the office. If your doctor has warned you about your heart rate, you know right away if things are getting out of hand.

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# 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*



**I**N 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 in-

ternal 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).

**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 address 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

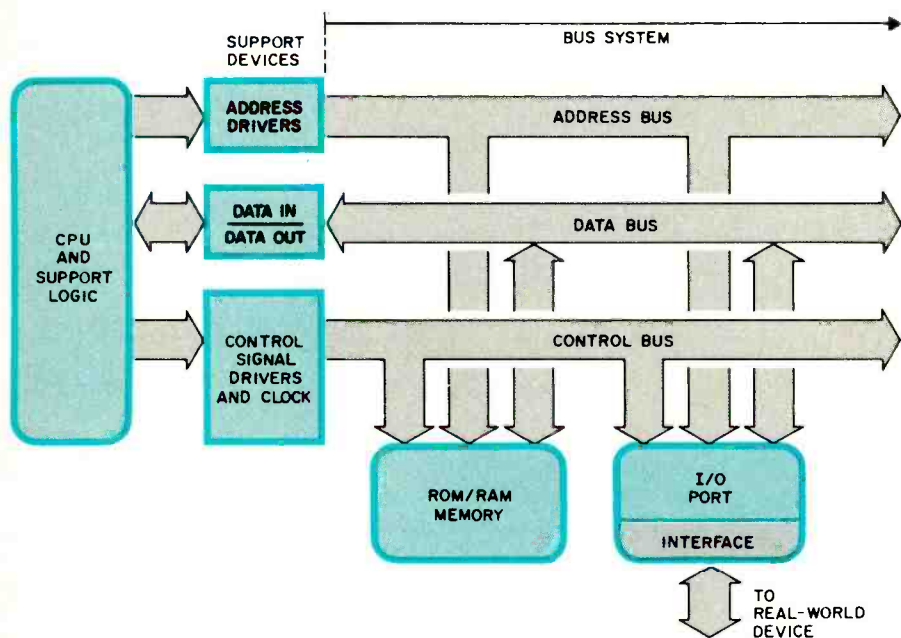


Fig. 1. A typical bus system contains three major elements: address bus, data bus, and control bus.

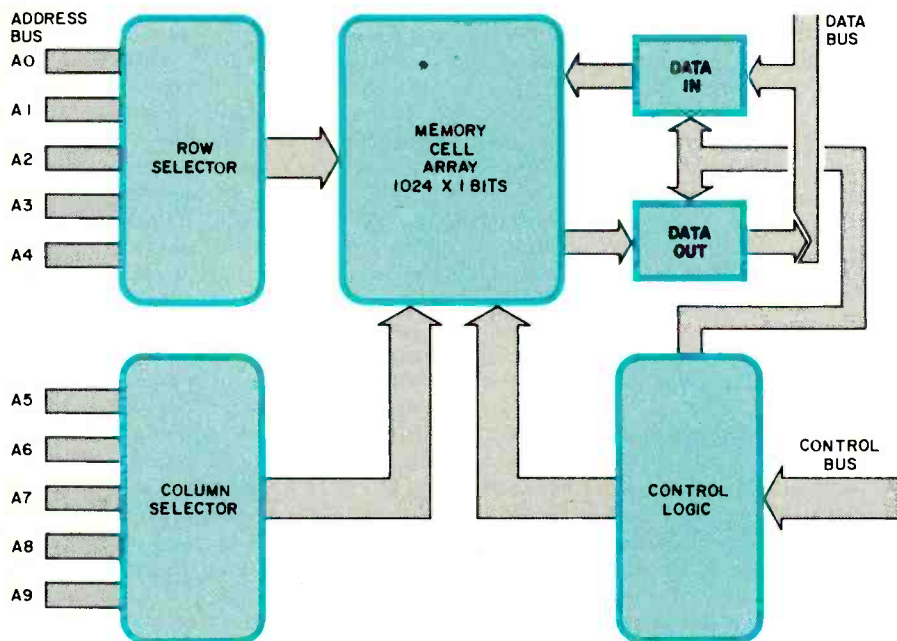


Fig. 2. Arrangement of a 2102 random-access memory. Eight of these are needed for 1024 by 8 bits.

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.

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

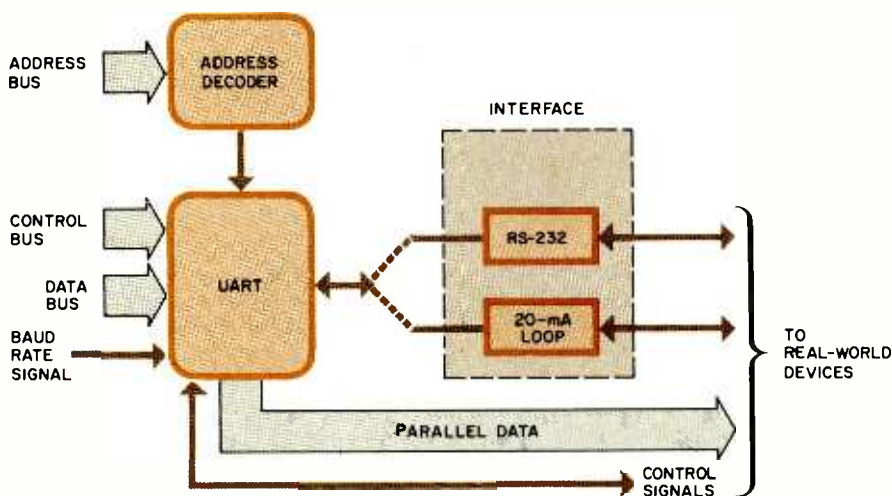


Fig. 3. Each peripheral communicates with the CPU through an associated I/O port and data bus.

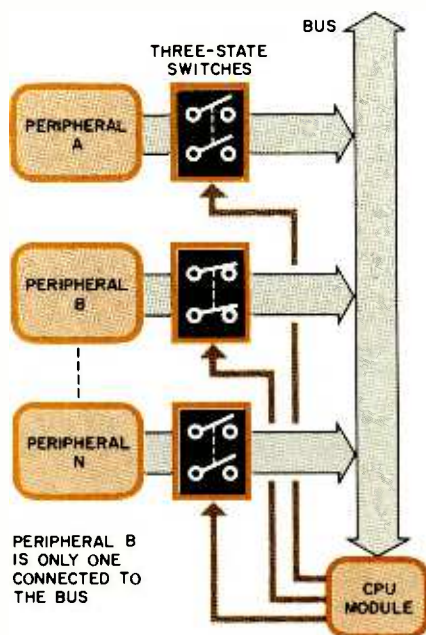



Fig. 4. A three-state device is an electronic switch connected between each bus line and associated logic.


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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

**V**MOS 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

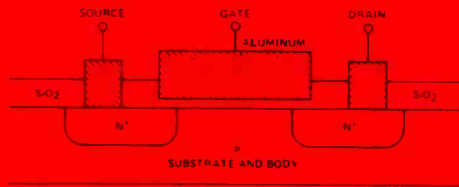


Fig. 1. Cross section of a conventional MOSFET.

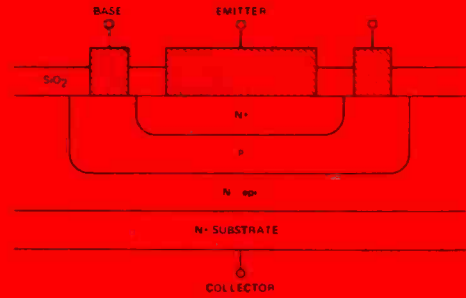


Fig. 2. A double-diffused epitaxial planar transistor.

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.

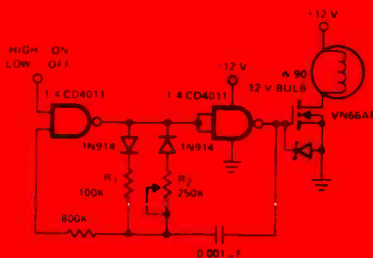


Fig. 5. A simple lamp dimmer circuit.

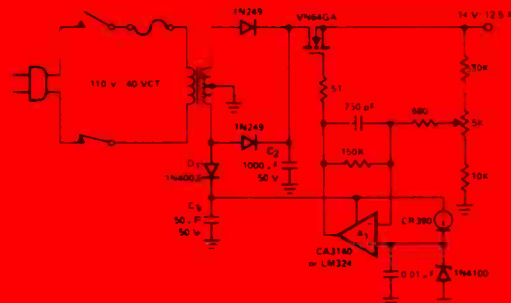


Fig. 6. An automatic battery charger.

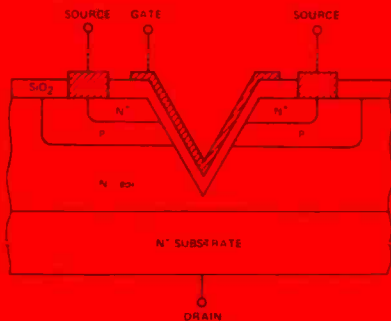


Fig. 3. Cross section of a VMOS channel.

Illustrations courtesy of Siliconix, Inc.

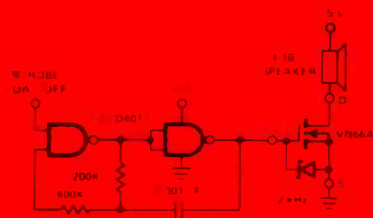


Fig. 4. Circuit for a 2-kHz audio alarm.

**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 conven-

tional 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 ( $\text{SiO}_2$ ) 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  $\text{SiO}_2$  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

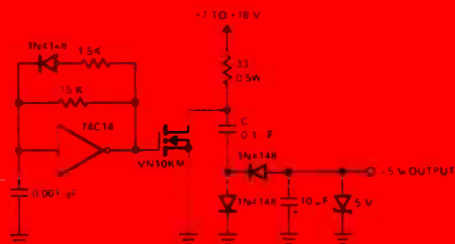


Fig. 7. A "flyback" dc-dc converter

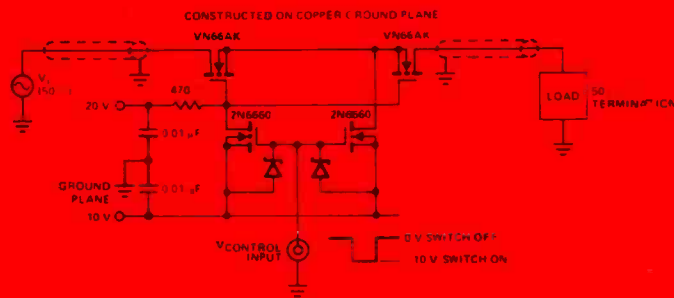


Fig. 8. An r-f switch using VMOS

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-k $\Omega$  resistor, or the 0.001- $\mu$ F 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 con-

trolling 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-k $\Omega$  potentiometer, with a constant-voltage reference source. The reference consists of a CR390, a 390- $\mu$ A 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.  $\diamond$

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### ABOUT THE AUTHOR

Robert C. Genn is the Director of Engineering at Columbia College in Los Angeles, and President of the Genn Technical Institute. He has been involved in the electronics field for more than 20 years as a Field Engineer, Director of Engineering and Electronics, technician and instructor. Mr. Genn is certified by the California Institute of Technology to teach technicians to troubleshoot, service and repair microwave systems.

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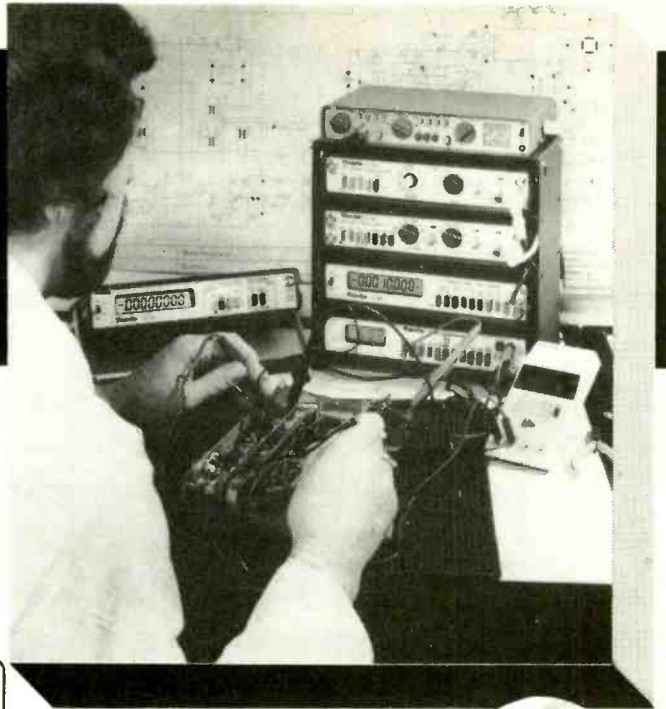
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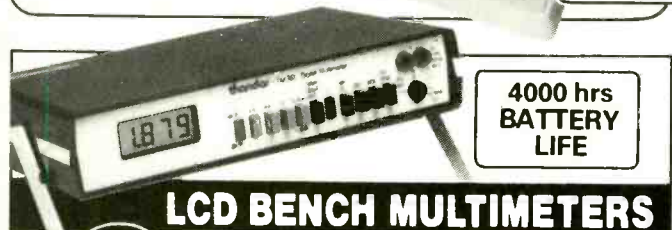
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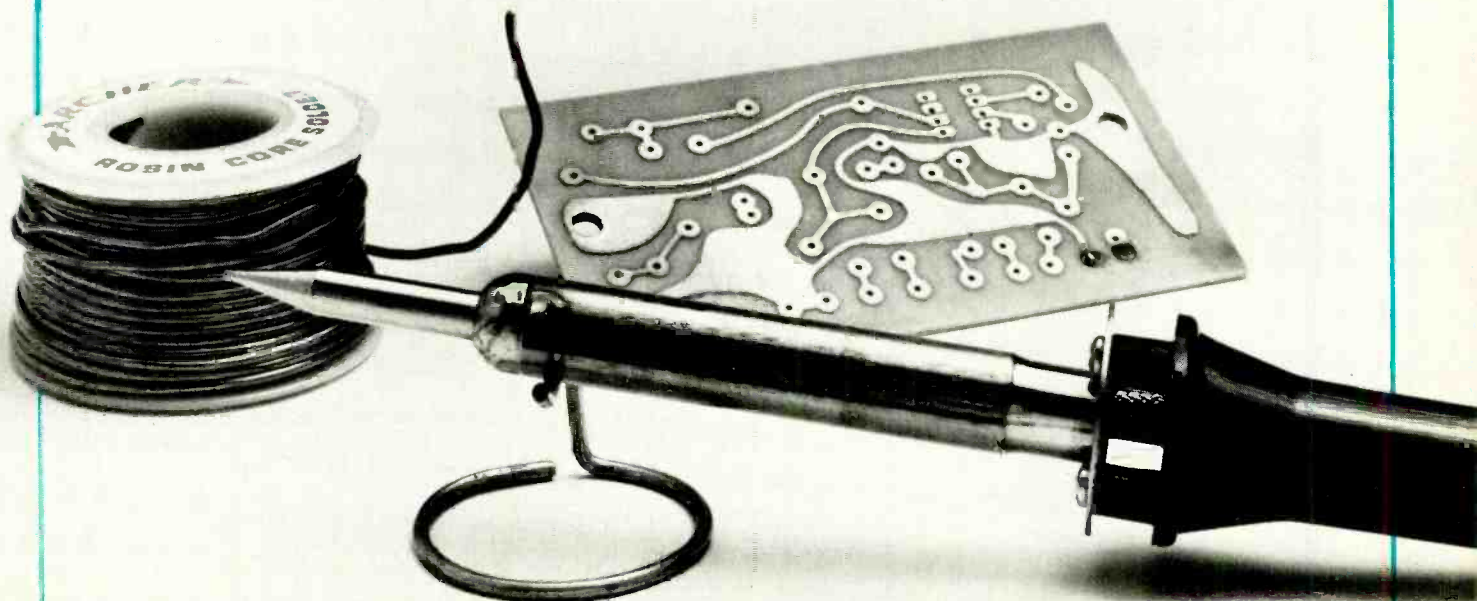
*Helpful tips  
on materials, tools,  
and techniques*

BY JOHN D. BORNEMAN

**I**N 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

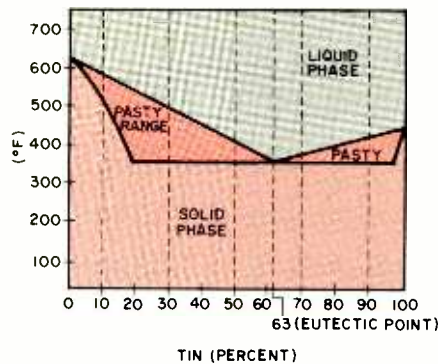


Fig. 1. Melting point, including pasty phase, of alloys of tin and copper.

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.

**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, preferably on the part having the larger mass (Fig. 2). The solder should not be brought to the joint until the

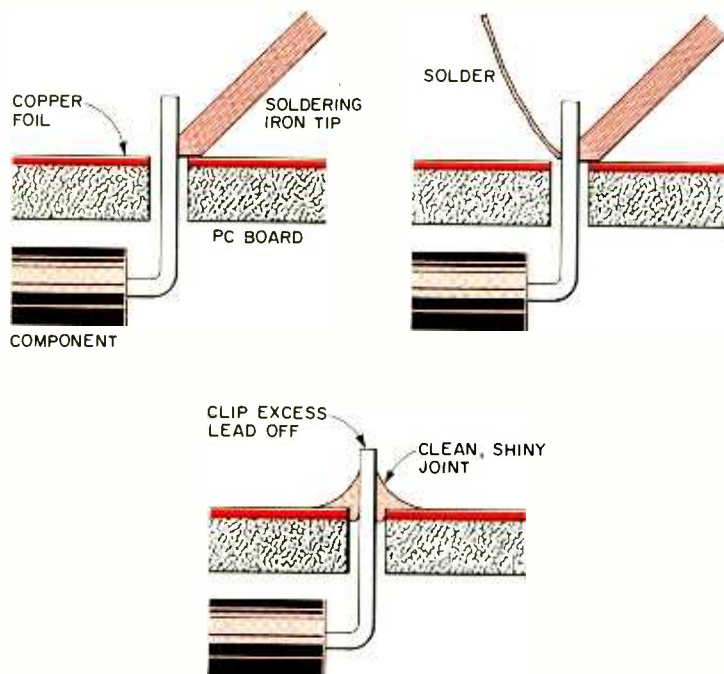


Fig. 2 Steps in soldering. Place heated iron to junction of parts to be soldered (top left). Bring flux-cored solder to the joint after it is hot enough to melt solder (top right). When a smooth-contoured fillet has formed, remove the solder and allow to cool without moving.



## IRON WATTAGES FOR DIFFERENT SOLDERING TASKS

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

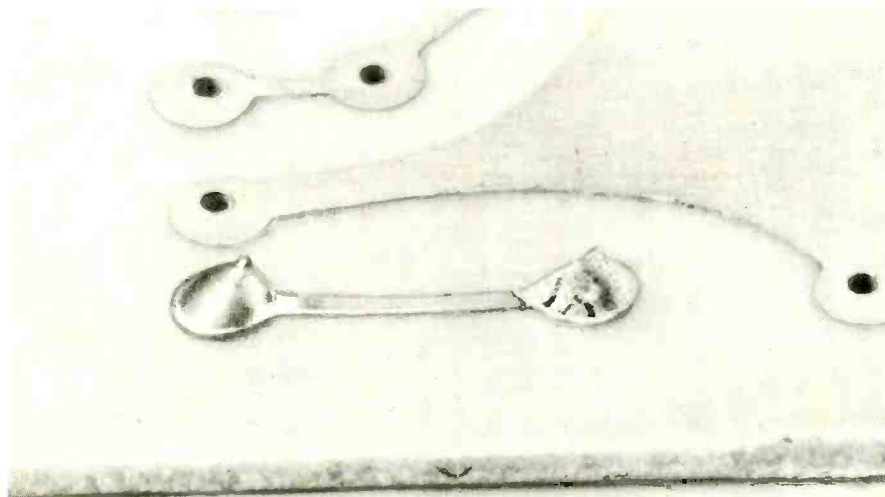


Fig. 3. Photo of two soldered joints. The one at left is shiny indicating a good joint. At right, is a "cold" solder joint.

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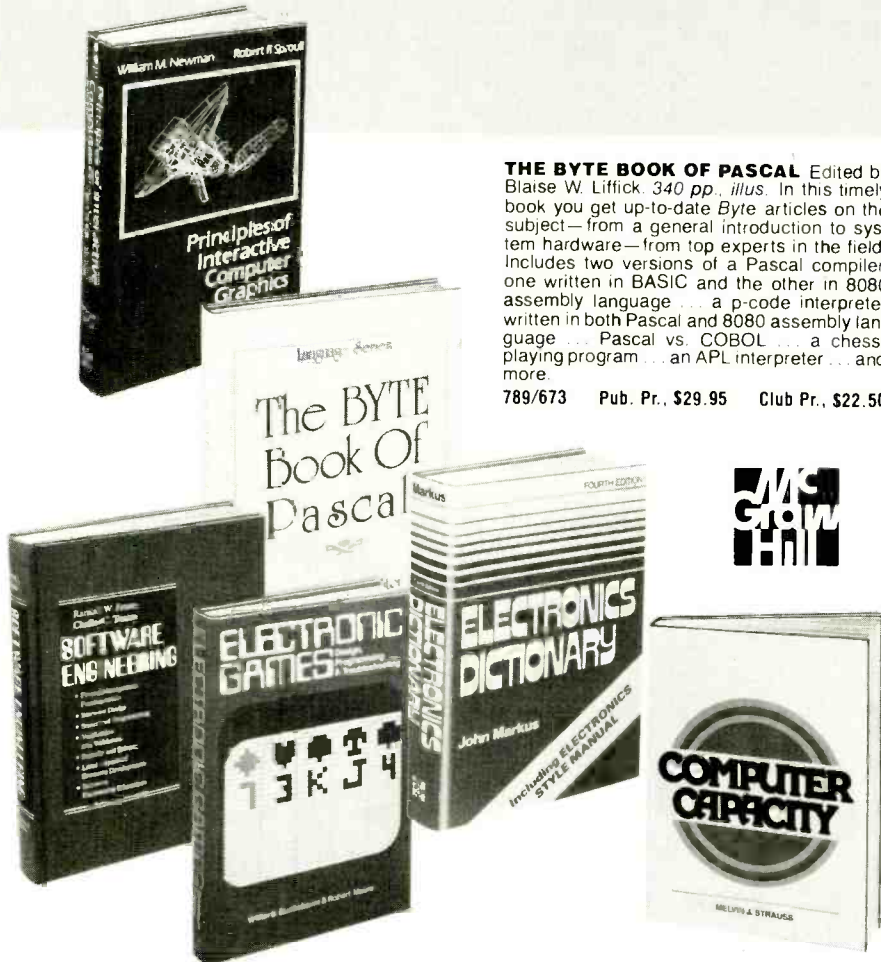
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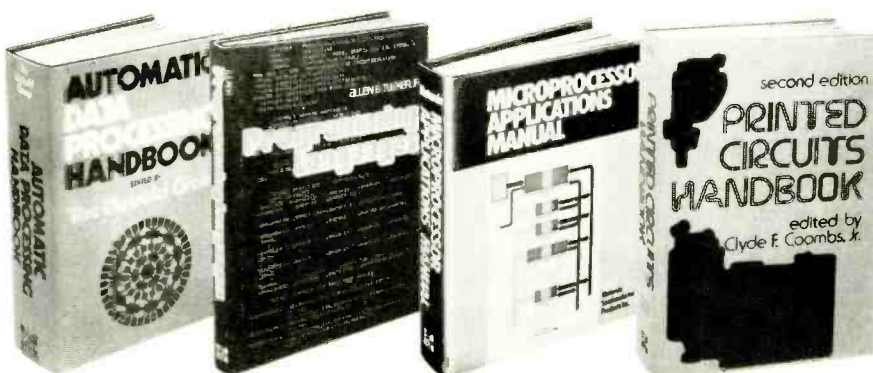
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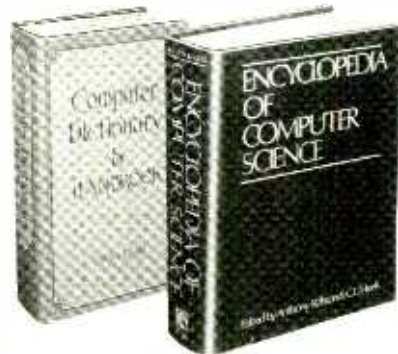
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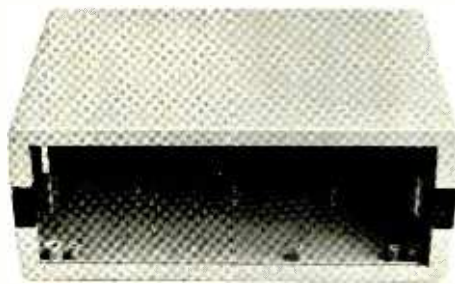
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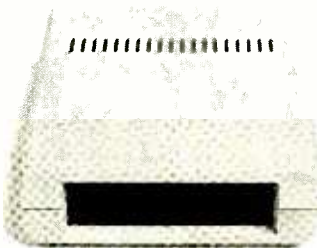
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## soldering

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 trouble-shooting 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

**L**IVE 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*

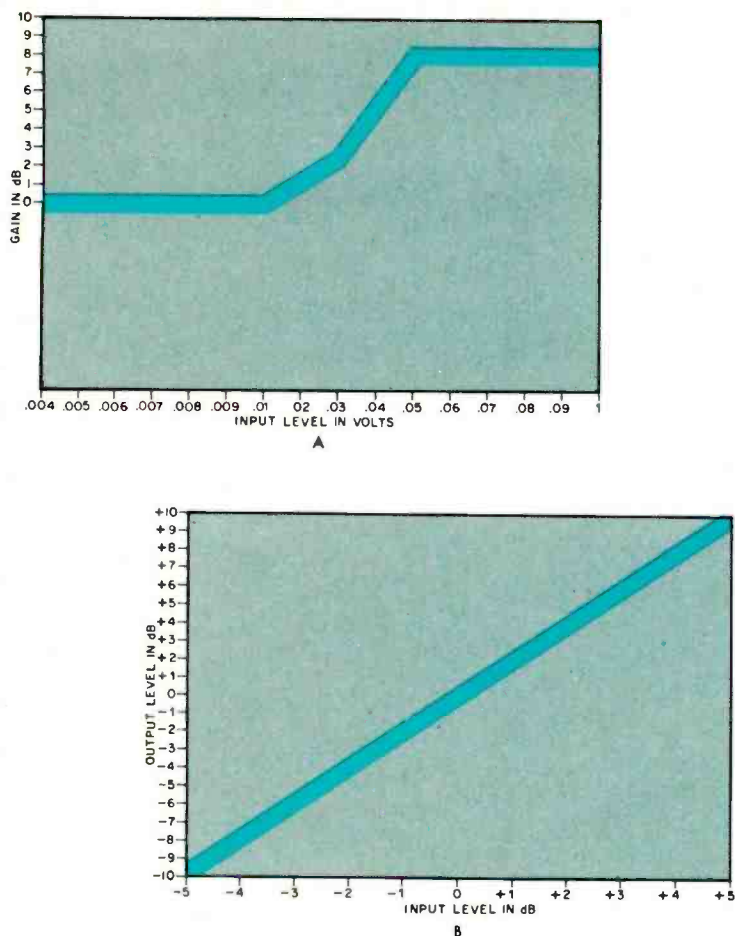


Fig. 1. Peak unlimiting (A) shows a 7.5-dB change, while linear expansion (B) shows a 20-dB variation.

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 preliminary

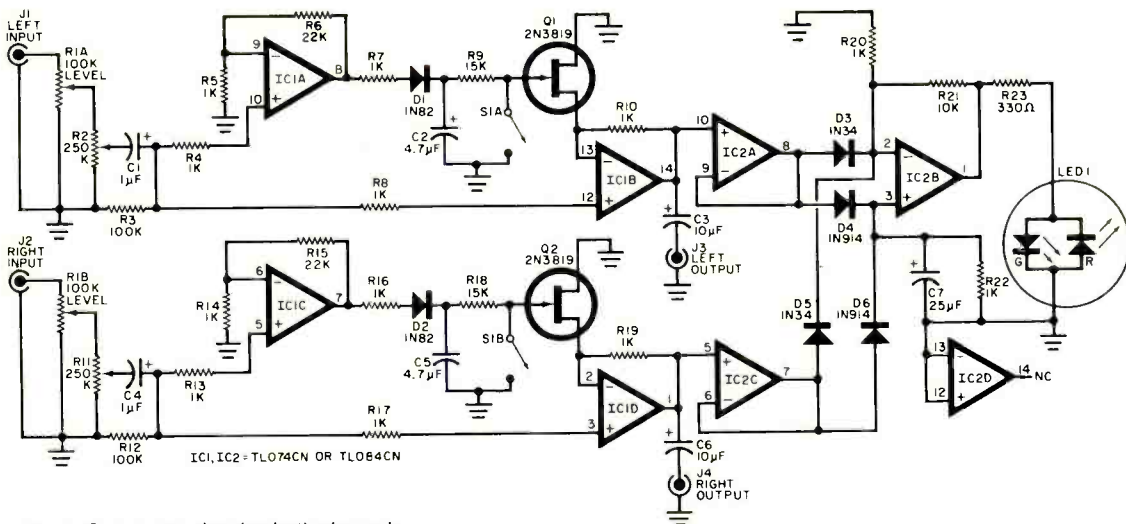


Fig. 2. Schematic showing both channels of the Peak Unlimiter circuit and LED indicator.

### PARTS LIST

- C1, C4—1- $\mu$ F, 35-V tantalum capacitor
- C2, C5—4.7- $\mu$ F, 25-V, radial-lead aluminum electrolytic
- C3, C6—10- $\mu$ F, 16-V, axial-lead aluminum electrolytic
- C7—25- $\mu$ F, 25-V, axial-lead aluminum electrolytic
- C8, C9, C10, C11—1000- $\mu$ F, 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— $\frac{1}{4}$ -ampere fast-blow fuse
- IC1, IC2—TL074CN or TLO84CN 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  $\frac{1}{4}$ -watt, 5% tolerance, carbon-composition fixed resistors.
- R1—100-k $\Omega$ , linear-taper dual potentiometer
  - R2, R11—250-k $\Omega$ , linear-taper trimmer potentiometer
  - R3, R12—100 k $\Omega$
  - R4, R5, R7, R8, R10, R13, R14, R16, R17, R19, R20, R22—1 k $\Omega$
  - R6, R15—22 k $\Omega$
  - R9, R18—15 k $\Omega$
  - R21—10 k $\Omega$
  - R23—330  $\Omega$
  - 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.

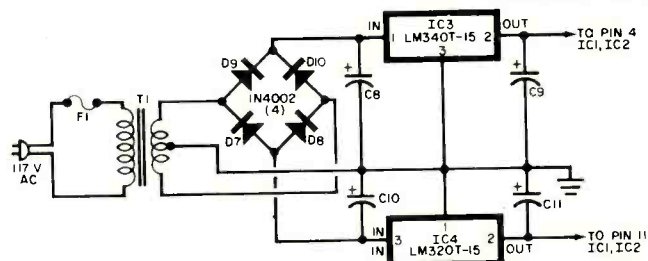
Next, connect a pair of stereo headphones using clip leads to the "hot" sides of output jacks *J3* and *J4*. Do not make any connection to the common (shell) lead of the headphones.

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.



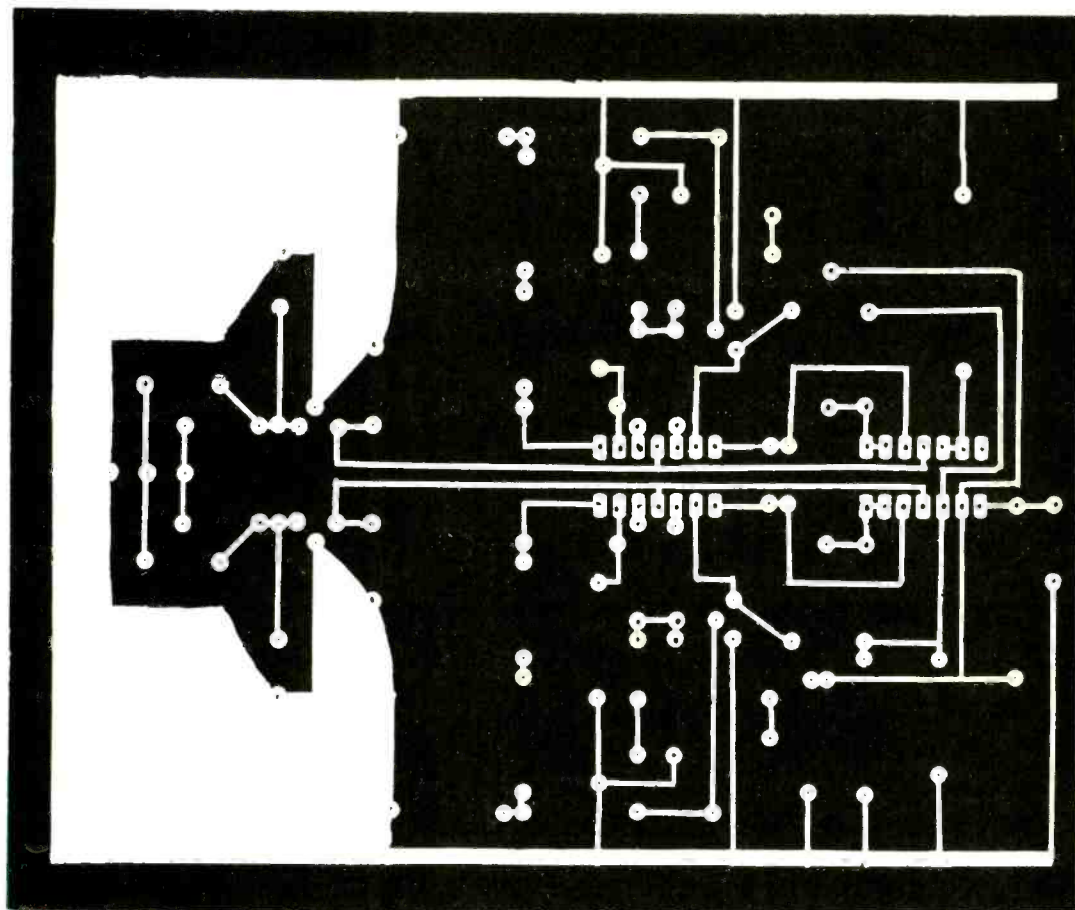


Fig. 4. Etching and drilling guide for pc board.

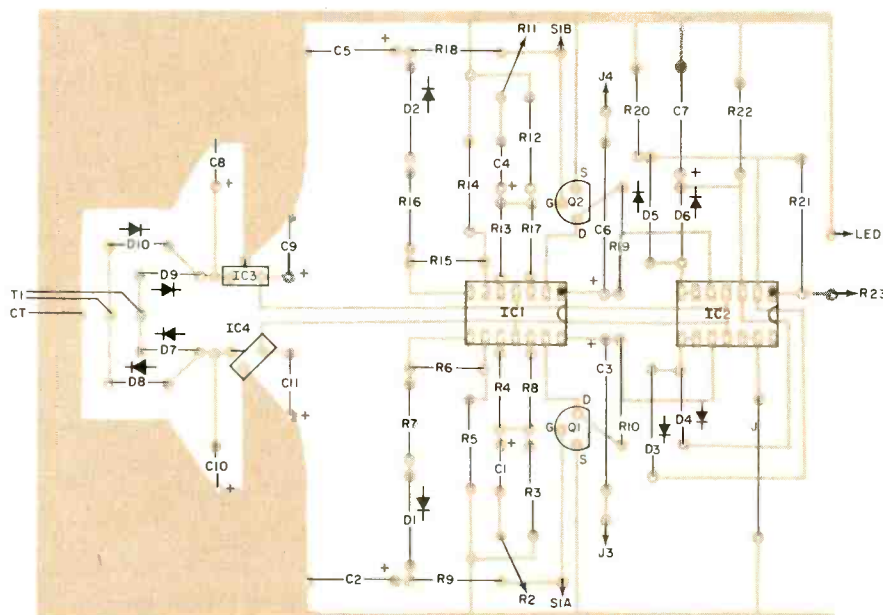


Fig. 5. Component-placement guide for pc board.

**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 comparison 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. ◇



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BY CASS LEWART

**W**HEN 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<sub>4</sub>), 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



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## gas alarm

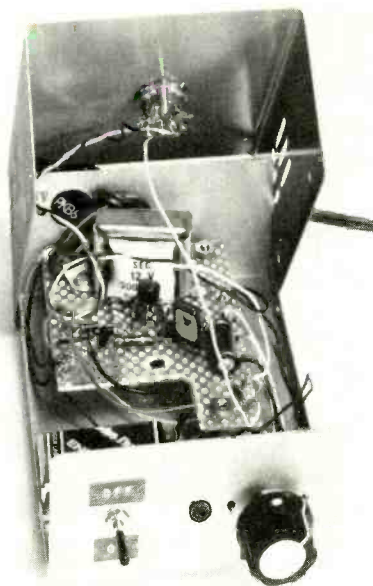


Photo of the author's prototype.

resistance of its sensor element drops, raising the voltage applied across calibration potentiometer *R4*. The rotor of *R4* is connected to the gate of

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 *BI* 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

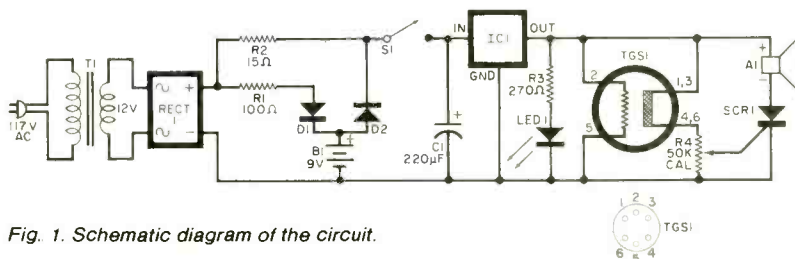


Fig. 1. Schematic diagram of the circuit.

### PARTS LIST

- AI—Piezoelectric buzzer (Radio Shack 273-060 or similar)
- BI—Battery (six rechargeable 1.5-V cells)
- C1—220- $\mu$ F, 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- $\Omega$ , 1/2-W resistor
- R2—15- $\Omega$  1-W resistor
- R3—270- $\Omega$ , 1/2-W resistor (optional)
- R4—50-k  $\Omega$  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 2 1/2" 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.

*SCR1*, and when voltage at that point reaches approximately 0.3 V, *SCR1* turns on, supplying power to alarm *AI*. The piezoelectric alarm specified for *AI* 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 2 1/2" metal cabinet, and all components except the alarm and gas sensor can be mounted

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*.  $\diamond$

# SINGLE-LED ANALOG METER

Complete LED changes "color" with input voltage

BY DAVID LEITHAUSER

**T**HERE 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.

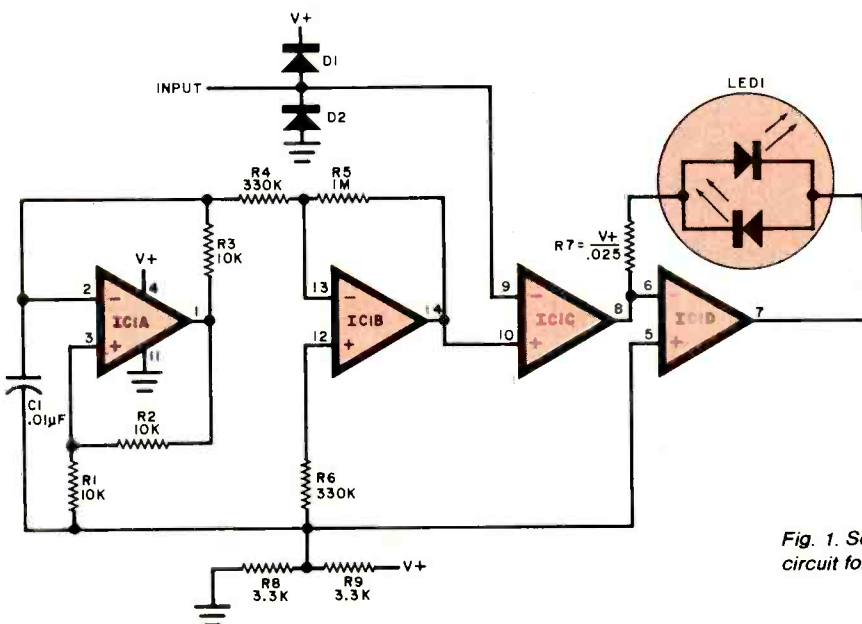
**Circuit Operation.** Op amp *IC1A* generates a ramp waveform at point A that drives amplifier *IC1B* via *R4* (*R5* acting as the gain-determining feedback resistor) with the amplified ramp voltage applied to the noninverting input (+) of comparator *IC1C*. The input voltage (referenced to ground) 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 *IC1C* 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-



## PARTS LIST

- C1—0.01- $\mu$ F 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-k $\Omega$ , 1/2-W resistor
- R4, R6—330-k $\Omega$ , 1/2-W resistor
- R5—1-M $\Omega$ , 1/2-W resistor
- R7—See text
- R8, R9—3.3-k $\Omega$ , 1/2-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.

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

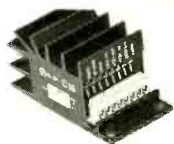


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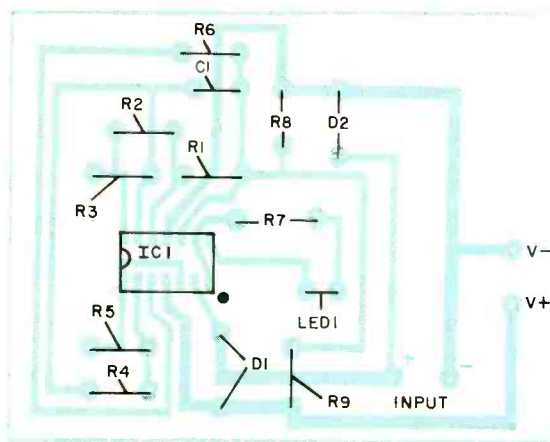
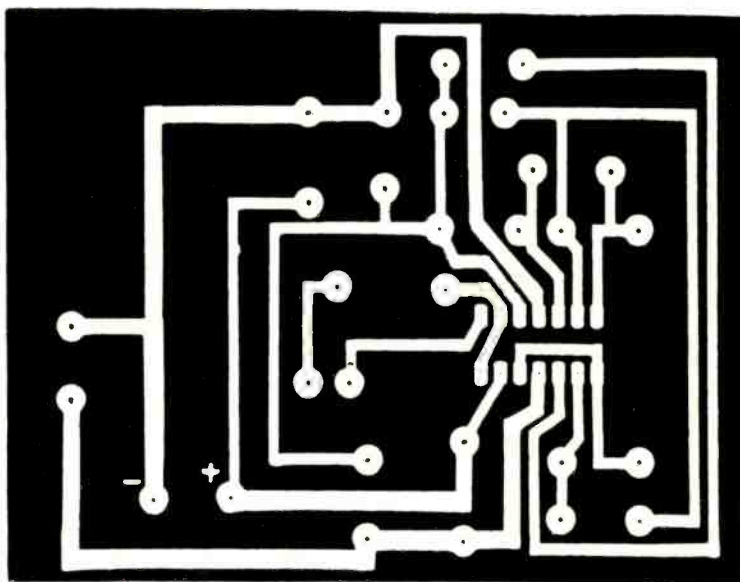
**analog meter**

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

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



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

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

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. ◇

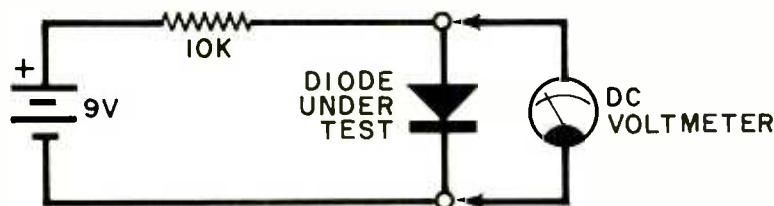
# HOBBY SCENE

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, con-

nect 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 ca-

bles 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. ♦

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| PSU36 (±20V) for 1 or 2 HY30 .....  | \$3.60  |
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# SIMPLE DISPLAY AND OPERATING PROGRAM

BY JACK DOLLHAUSEN

**T**HE 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; 1/2K for display buffer storage, and 1/2K 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
001C 3A 15
```

clear display buffer

```
001E F8 00 B4 F8 25 A4
0024 D4
```

R4 is "main" pgm. ctr.

## MAIN PROGRAM:

```
0025 E2 69
0027 37 27 3F 29
002B 6C BE
002D 37 2D 3F 2F
0031 6C AE
0033 37 33
```

TV on  
ENTER high byte  
memory location displayed  
ENTER low byte  
in RE

```
0035 8E FF 07 AE 33 3F
003B 9E FF 01 BE
003F F8 02 B6 F8 00 A6
0045 16
0046 9E 7A D3 9E 7B D3
004C 8E 7A D3 8E 7B D3
0052 16
0053 0E 7A D3 4E 7B D3
0059 86 FB C0 3A 45
005E F8 8B A3 F8 10 D3
```

RE has top of display  
R6 is display buffer pointer  
display loop:  
R3 is pgm. ctr. for digit  
configuration subroutine

```
0064 3F 64 3E 77
0068 F8 8B A3 F8 8D A6
006E F8 11 D3 2E 6C 5E
0074 1E 30 33
```

one display line  
loop for eight lines  
display filled

ENTER opcode or EF=3  
EF3=1, put flag and change  
byte  
inc display and loop for more

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

opcode 00  
shift display up

```
0087 6C FB 01 3A 90
008C 2E 2E 30 35
```

opcode 01  
shift display down

```
0090 6C FB 02 3A 97
0095 30 33
```

opcode 02  
single step display

```
0097 6C FB 03 3A 9E
009C 30 27
```

opcode 03  
change display address

```
009E 6C FB 04 3A B3
00A3 61
```

opcode 04 (TV off)  
run program at :  
ENTER high address

```
00A4 2E 9E B0 8E A0
00A9 37 A9
```

ENTER low address

```
00AB D0
00AC 00 00 00 00
00B0 00 00 00
```

R0 is pgm. ctr.

```
00B3 6C FB 05 3A 64
00B8 F8 01 BA F8 EB AA
```

opcode 05 (TV off)  
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
00C7 6C B9
00C9 3F C9 37 CB
00CD 6C A9
00CF 3F CF 37 D1
00D3 6C 1A
00D5 3F D5 37 D7
00D9 6C 2E
00DB 49 5E 1E 89 F3 3A DB
00E2 2A 99 F3 1A 3A DB
00E8 49 5E 30 25
    
```

ENTER beginning add. of data  
to be moved (high byte)  
ENTER (low byte)

ENTER last add. of data to  
be moved (high byte)  
ENTER (low byte)

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
0183 FE FE FE FE
0187 F6 F6 F6 F6
018B A8 08 A8
018E F8 05 A7
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
    
```

Q state identifies hi/lo/digit

enter here for single digit  
R5 counts 5 lines per digit

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. ◇

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# SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

## The Billion Transistor Chip?

**Y**OU 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

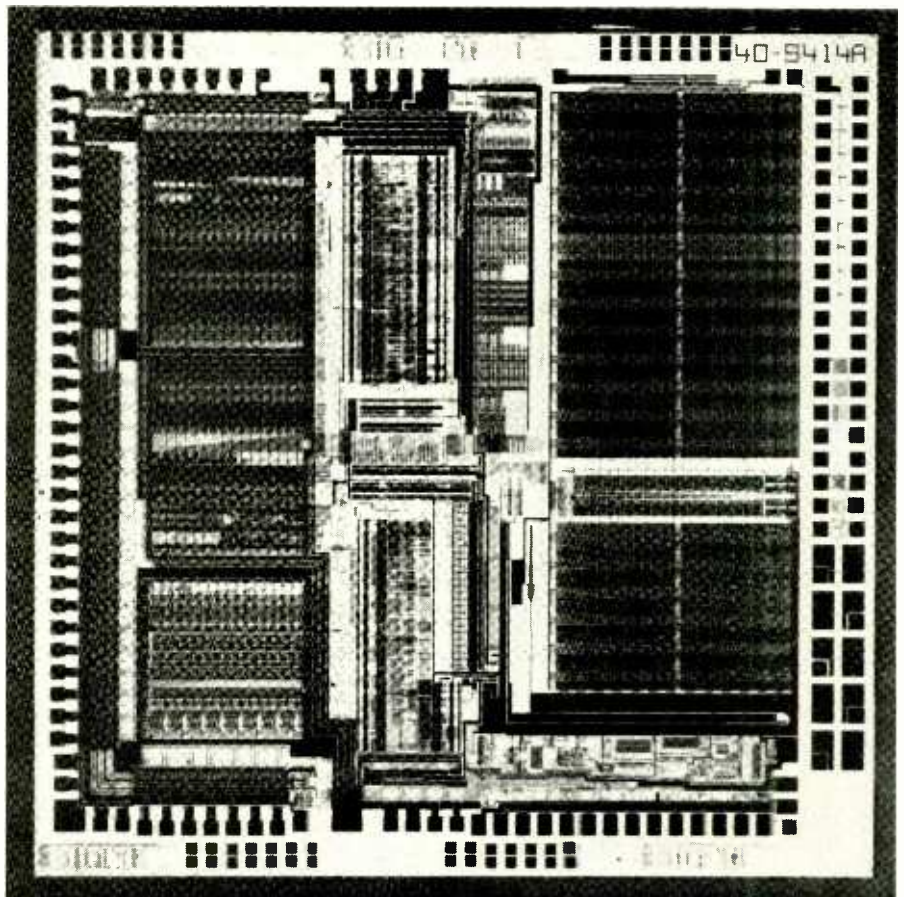


Fig. 1. Photomicrograph of Hewlett-Packard's new CPU containing 450,000 transistors on a single chip.



## solid-state developments

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 metalization 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 sub-micrometer 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

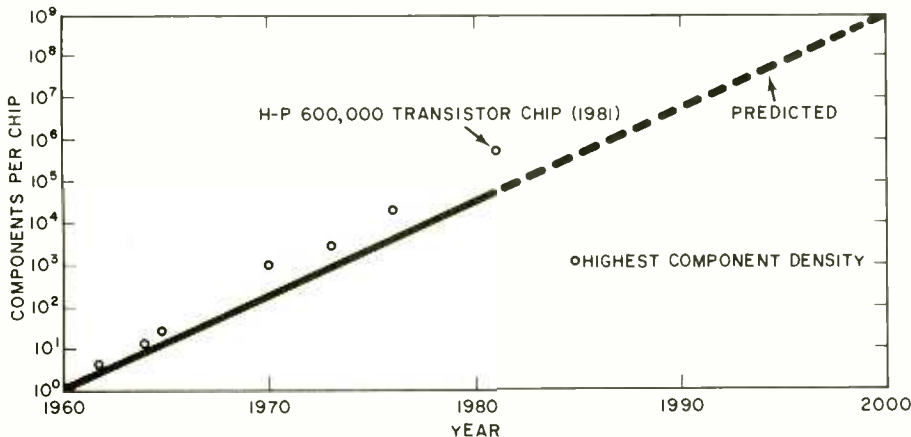


Fig. 2. Maximum number of components per chip from 1960 to the present and projected to the year 2000.

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## solid-state developments

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.

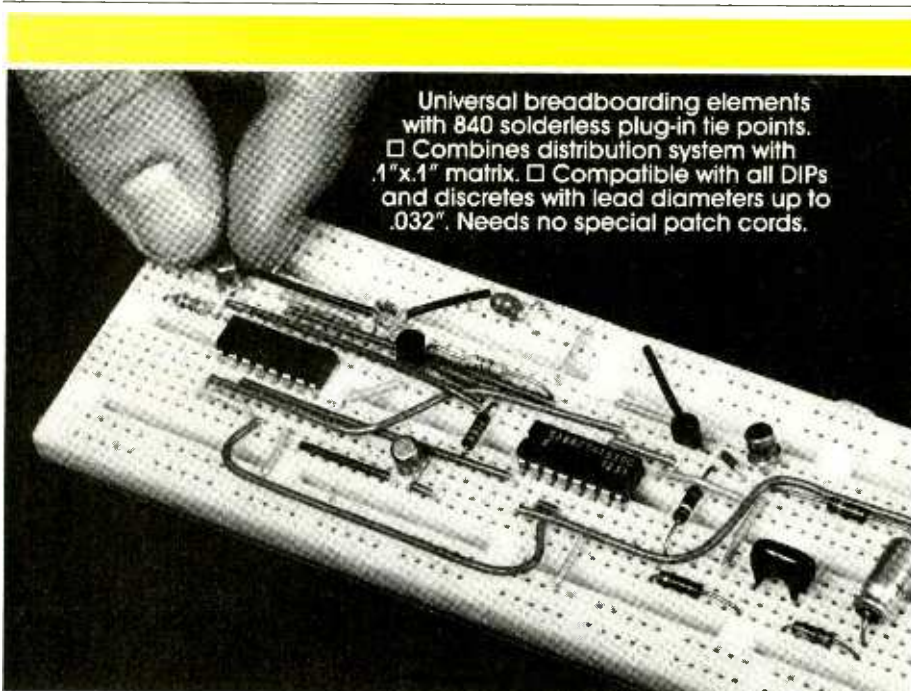
**Applications for ULSI.** The development of practical ULSI will substantially improve the outlook for such extraor-

dinarily 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.



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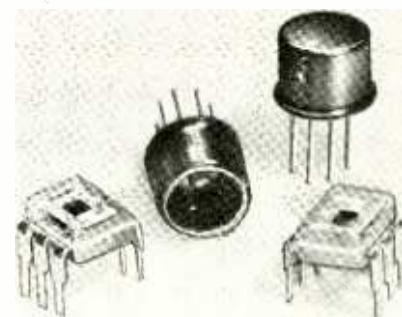
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Integrated photodetectors with on-chip interfacing made by AEG-Telefunken.

**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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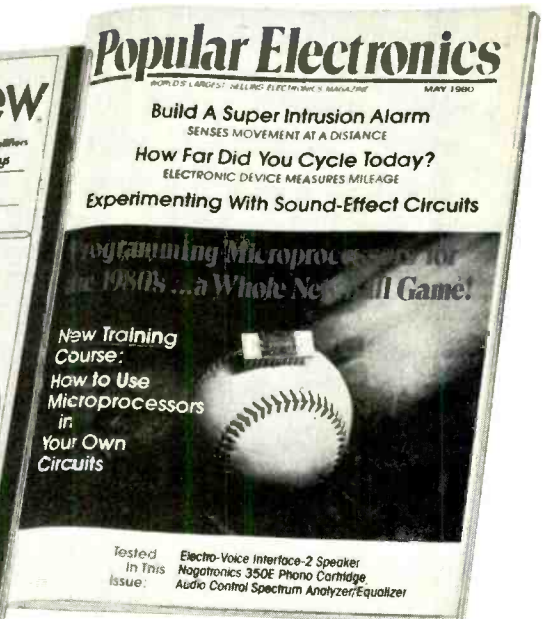
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# EXPERIMENTER'S CORNER

By Forrest M. Mims

## Experimenting with an Air Pressure Switch

**R**ECENTLY, 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.

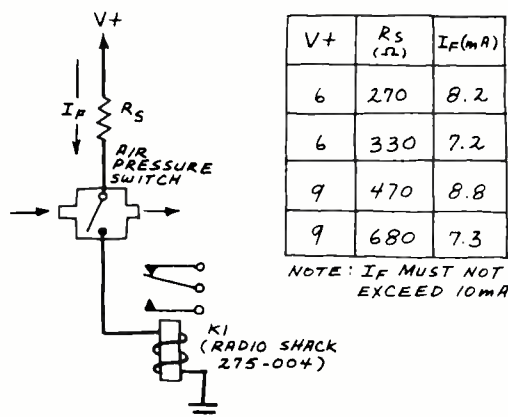


Fig. 1. Using a relay to increase current capacity.

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 air-speed 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

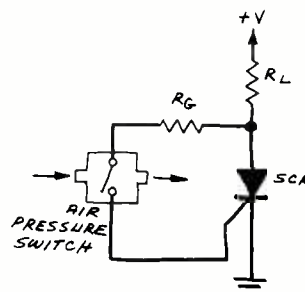


Fig. 2. An air pressure switch can be used to trigger an SCR as shown here.

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.

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

## experimenter's corner

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 |

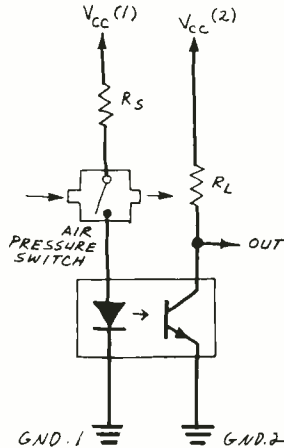


Fig. 3. The air pressure switch can be isolated from the controlled circuit by an optoisolator.

**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 ( $IC_2$ ) is a 4017 with self-contained 1-of-10 output decoding. In operation, a clock formed by two NAND gates in  $IC_1$  repeatedly cycles  $IC_2$  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  $IC_2$ .

Channel 1 is controlled by pins 3 and 2 of  $IC_2$ . At the beginning of a count cycle, pin 3—the lowest order decoded output from  $IC_2$ —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

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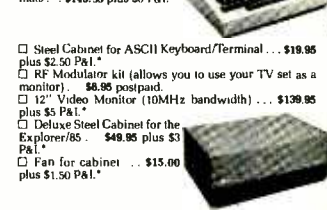
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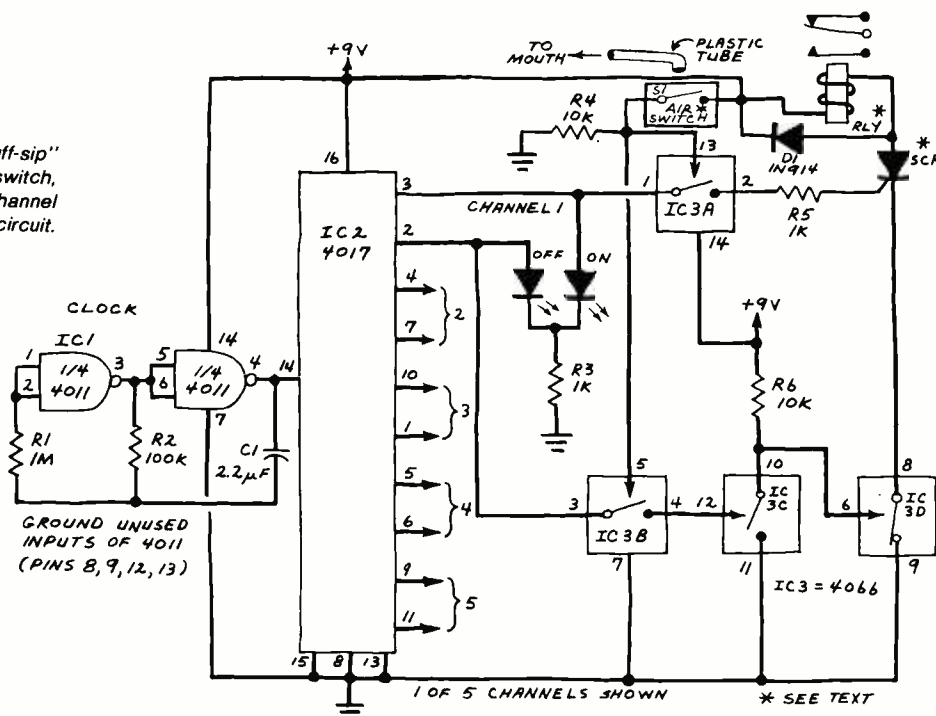
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Fig. 4. A "puff-sip" single-switch, multi-channel controller circuit.



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

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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.

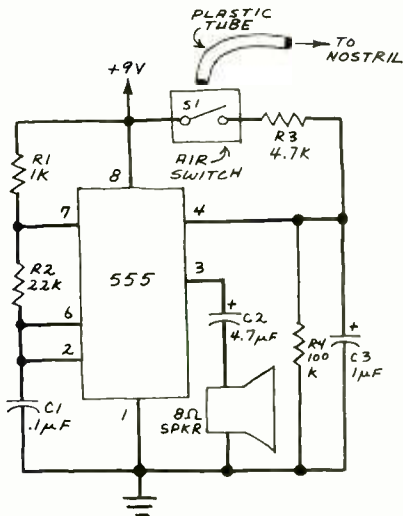


Fig. 5. Respiration indicator provides audible signal.

**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

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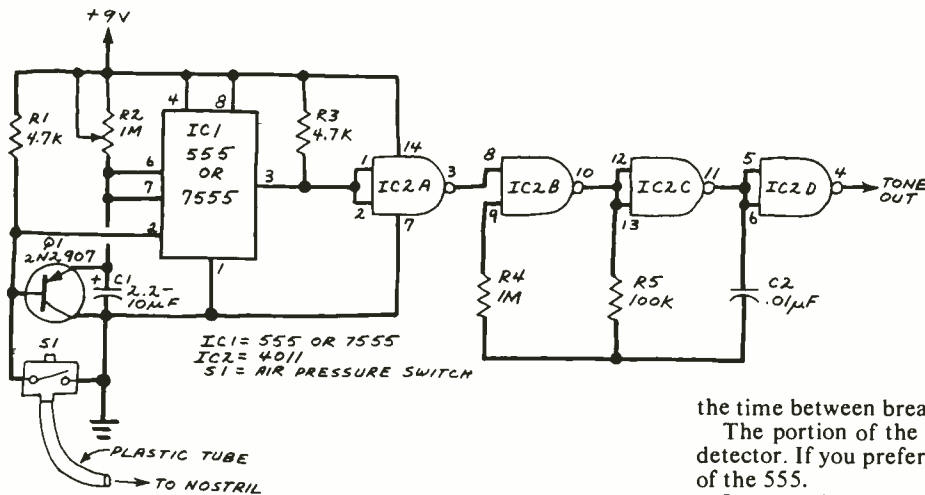


Fig. 6. This circuit monitors respiration and emits a warning tone when time between breaths exceeds a predetermined interval.

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.

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**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.



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# DX LISTENING

By Glenn Hauser

## Strikes Disrupt International Broadcasting

**R**adio 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 sub-carriers, 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. ♦

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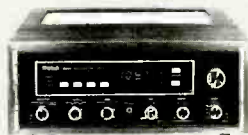
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| <b>PANASONIC CAR STEREO</b> |          | D C-90                      | 1.69   |
| COS-900                     | 341.99   | D C-60                      | 1.29   |
| COS-820                     | 266.99   | LX-35-1800 Reel             | 18.49  |
| COS-790                     | 242.99   | LX-35-180 Reel              | 15.29  |
| COS-761                     | 222.99   | LX-35-900 Reel              | 6.79   |
| COS-742                     | 199.99   | LX-35-90 Reel               | 5.49   |
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## TIPS & TECHNIQUES

### Negative Logic Gates

An experimenter 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

AND GATE WITH NEGATIVE-LOGIC INPUTS



TRUTH TABLE FOR AND GATE WITH POSITIVE-LOGIC INPUTS

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

TRUTH TABLE FOR AND GATE WITH INPUTS INVERTED

| $\bar{A}$ | $\bar{B}$ | Y |
|-----------|-----------|---|
| 1         | 1         | 1 |
| 1         | 0         | 0 |
| 0         | 1         | 0 |
| 0         | 0         | 0 |

TRUTH TABLE FOR NOR GATE WITH POSITIVE-LOGIC INPUTS



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

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# 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.

SEPTEMBER 1981

## 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.

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# 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 tech-

niques 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 Superin-

tendent of Documents, Washington, DC 20402.

## Miniature Tool Catalog

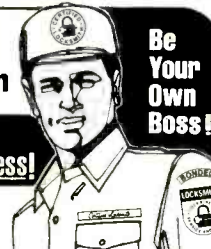
Catalog C-8010 describes the Moody line of miniature screwdrivers, sockets, hex key wrenches, drills, and taps available in sets and kits. Tools are interchangeable in a solid-locking, chuck-type, knurled handle and are intended for work on models and electronics. **Address:** Moody Tools Inc., 42-60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



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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

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#### 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.

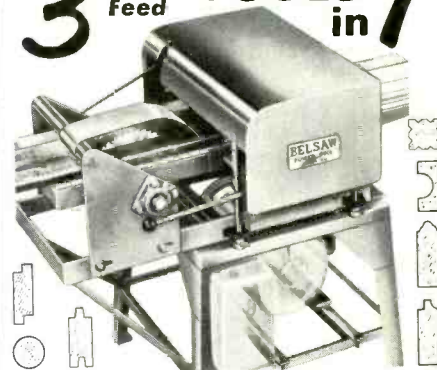
#### FCC Regulations on EMI

"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.

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**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.

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

**Claricon** 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.

**Hellcrafters** 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 06086.

**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.

**Hellcrafters** model S-40A receiver. Need operation manual, schematic, and service manual. C.H. Nelson, 4712 School, Yorba Linda, CA 92886.

**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.



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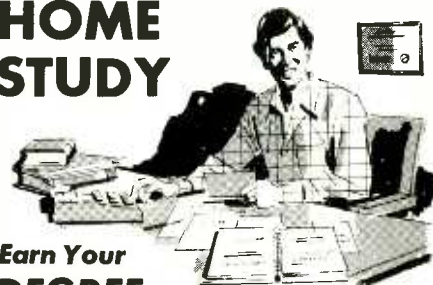
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# operation assist

**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.

**Typograph 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.

**Tequipment** type S51A servoscope. 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.

**Hammurand** 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.

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

**Stromberg-Carlson** model AWPB 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. Weiden Dupre, W5SNK #7 HMS Court, Houma, LA 70360.

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

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

**Hallcrafters** 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, 3916 1/2 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.

**Hallcrafters** 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.

**Boston** 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. Celina Way, Layton, UT 84041.

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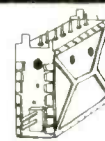
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# PROJECT OF THE MONTH

By Forrest M. Mims

## Precision CMOS Clock Generator

**S**EQUENTIAL 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

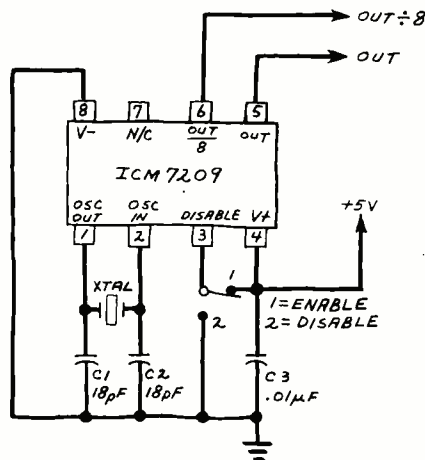


Fig. 1. A clock pulse generator using the ICM7209 chip with just three external components.

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 ICM7209's data sheet.

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. ◇

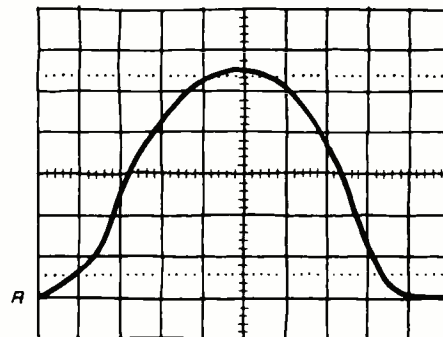


Fig. 2. Output waveform from an ICM7209 with a 10-MHz crystal.

VOLTS/DIV: A. 1 TIME/DIV: 10 ns  
B. \_\_\_\_\_

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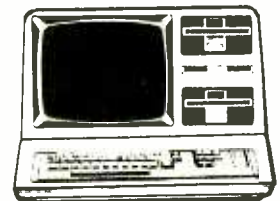
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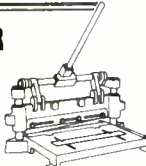
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# Popular Electronics

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PE-981

# ELECTRONICS WORLD®

## Personal Electronics News

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**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.

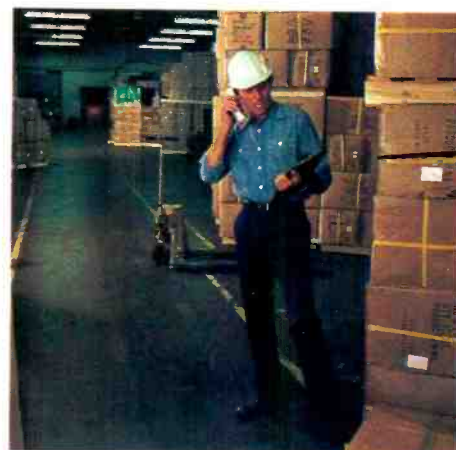
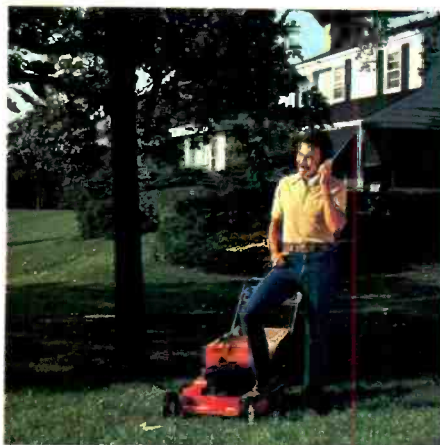
**A UNIFIED APPROACH TO VIDEOTEX STANDARDS** has been taken by 26 European countries, members of the European Conference on Posts and Telecommunications. The new basic alpha-mosaic system has a high degree of compatibility with existing British, French and German systems and will be able to receive serial 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.



## Now—anyone can afford to stay in touch— with the newest Cobraphone...

**It goes wherever you go—indoors or out—and makes sure you receive calls you might otherwise miss...**

With this new economical Cobraphone cordless extension phone, you can stay in touch for less than \$100.00! And you can use it anywhere in and around your home or even at your neighbors.

Uses for the new Cobraphone are limited only by your imagination: on the patio or at poolside; in the yard, garage, or basement; in the sick-room, by recuperating patients or invalids; in a warehouse or on a construction site. Also use it while watching TV—take calls without leaping up from your favorite chair. Or leave it at your next door neighbor's home, so they can answer your phone while you're away—a great aid to home security!

You'll marvel at the outstanding quality of voice communications on your Cobraphone. That's because Cobra's famous power and quality make sure conversation is "loud and clear" with your Cobraphone—as with Cobra CB radios. And it



features the same full FM duplex system found on all Cobraphones: talk and listen as you would with a conventional phone—no annoying push-to-talk buttons.

The CP-16S installs in seconds: just plug into the nearest AC outlet and phone jack. That's all there is to it!

So visit your favorite retail, department or electronics specialty store today. Ask to see the full Cobraphone line. Then take home your choice and enjoy all your activities—and still be in touch with everyone—anywhere in the world.

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# KOSS

# FIRE



## Finally, there's a speaker that lives up to its promise. The Kossfire dual tweeter loudspeaker system.

It's about time a speaker at a reasonable price lived up to its promise. Not just in the bass and midrange. But in the all-important treble range where power handling really counts. That's why we've designed the Kossfire/210 loudspeaker with not only a 12-inch woofer and a 5-inch midrange, but also with unique dual Kossfire tweeters that double the power handling capability over the high frequency range while virtually eliminating distortion. By placing the Kossfire dual tweeters in the optimum geometric alignment, we've created an ideal horizontal listening plane that's remarkable in its wide and uniform dispersion characteristics. The result is an exciting 4-driver speaker system that won't make you choose between the high road and the low road. And that's a promise!

But then, the Kossfire/210 loudspeaker

has a lot of very promising things going for it. There's a linear phase constant voltage crossover network for seamless transition between drivers. There's a built-in circuit breaker that automatically resets so no fuses are necessary. There's a vertical alignment of woofer, midrange and tweeter array for perfect stereo imaging. And there are separate continuous level controls for midrange and treble response ranges. Not to mention, the Kossfire's beautiful pecan-veneer cabinet.

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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