

Radio- Electronics

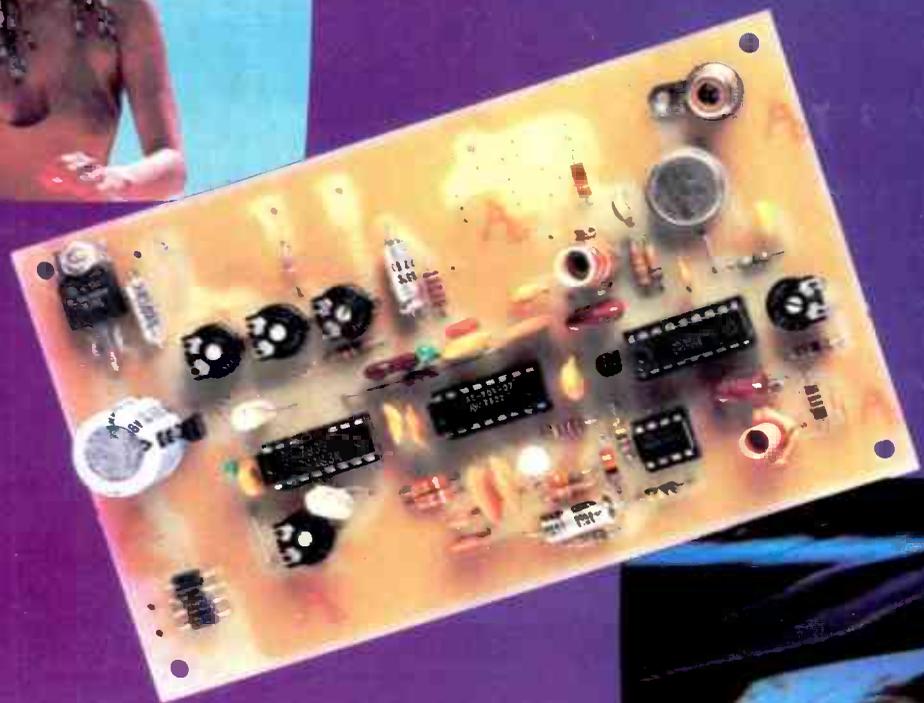
**YOUR NEXT CAR—
COMPUTERS UNDER THE HOOD**

\$1.25 JAN. 1981

Convert your TV into a video monitor
Hi-fi noise reduction techniques
Bells and whistles for your robot

How to use universal counter/timers
Designing with majority logic IC's
An easy way to make PC boards

BUILD YOUR OWN PAY-TV DECODER



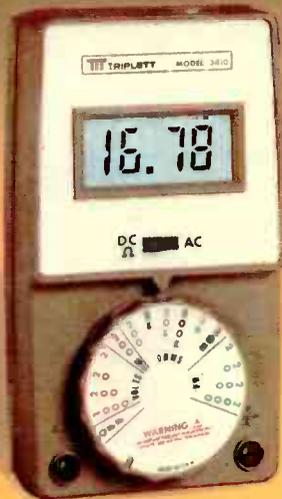
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CIRCLE 57 ON FREE INFORMATION CARD

CIRCLE 58 ON FREE INFORMATION CARD, IN-PLANT Demonstration



Bone Fone Clone

If you thought the Bone Fone was great, wait until you hear what's new. Here's the latest on the Bone Fone spin-offs.

It started with the Bone Fone. And this very unusual stereo system has created a whole new series of products.

The Bone Fone is an AM/FM stereo radio that drapes around your neck like a scarf. Two speakers, placed near your ears, not only provide excellent stereo separation, but vibrate slightly through your bones to give you the same sensation as standing in front of your home stereo system.

UNEXPECTED APPLICATIONS

Shortly after it was introduced, the Bone Fone became a very popular product for a variety of reasons. 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."

But 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."

LETTERS EVERYWHERE

Letters have come from mailmen, roller skaters, skiers, cyclists, motorcycle enthusiasts, hikers and even people who listen to the Bone Fone stereo while walking their dog. The Bone Fone appeals to practically every American.

The Bone Fone was designed by an engineer who wanted to listen to good stereo music without carrying heavy box radios or bulky headphones. Headphones block out all other sounds—even warnings which could be dangerous outdoors, and box radios are heavy and disturb those around you. So he invented the Bone Fone—"the stereo sound you wear around."

Weighing only 17 ounces and powered by

4AA cell batteries the Bone Fone stereo provides a sound that would be impossible to describe in an advertisement. The cliché, "you've got to hear it to believe it," certainly applies here. And for **\$69.95** it's the lowest priced stereo entertainment product available.

But what about the sport enthusiast who can care less about stereo music? Or the person who wants just the news? Or simply the person that just listens to AM radio and doesn't want to spend \$69.95?



The Bone Fone drapes around your neck like a scarf and has a sound that you find incredible when you first hear it.

Enter NUTS! NUTS is the AM version of the Bone Fone for sports nuts, news nuts, jogging nuts or anybody who wants a low cost Bone Fone without FM or stereo. NUTS sells for **\$39.95** complete with two speakers and a strap that firmly attaches the unit to you for any physical activity.

Sitting at a football game, walking your dog, jogging—NUTS gives you a convenient way to listen to music, news and sports without paying a premium for stereo.

But the Bone Fone spinoffs don't end there. There's the Neck Fone—a device you place over your shoulders and plugs into your home stereo system. This lets you enjoy your home stereo without disturbing those around you and without the bulk of headphones. The Neck

Fone sells for **\$34.95**.

So there you have it. Three exciting products—Bone Fone, NUTS, and the Neck Fone—three unusual solutions designed to solve any gift-giving problem.

LOWEST-PRICED STEREO

Compare the Bone Fone price with any box radio, stereo system or even the new \$200 Sony Walkman. The Bone Fone is the lowest-priced quality personal stereo system you can buy. It is also safer than headphones as it leaves you free to hear the sounds around you and keeps you in touch with the environment.

To order any of the above products, simply send your check or money order for the amount listed above plus \$2.50 for postage and handling (Ill. residents add 6% sales tax) to the address below, or credit card buyers may call our toll-free number below. Each unit is backed by a 90-day limited warranty and a service-by-mail facility as close as your mailbox. Service should rarely be required as the units use solid-state components and are designed to take rugged treatment. JS&A is America's largest single source of space-age products—further assurance that your modest investment is well protected.

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WK-7

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 - EX-1 14-16 EXTRACTOR
 - MOS-2428 24-28 CMOS SAFE INSERTER
 - EX-2 24-40 CMOS SAFE EXTRACTOR
 - MOS-40 36-40 CMOS SAFE INSERTER

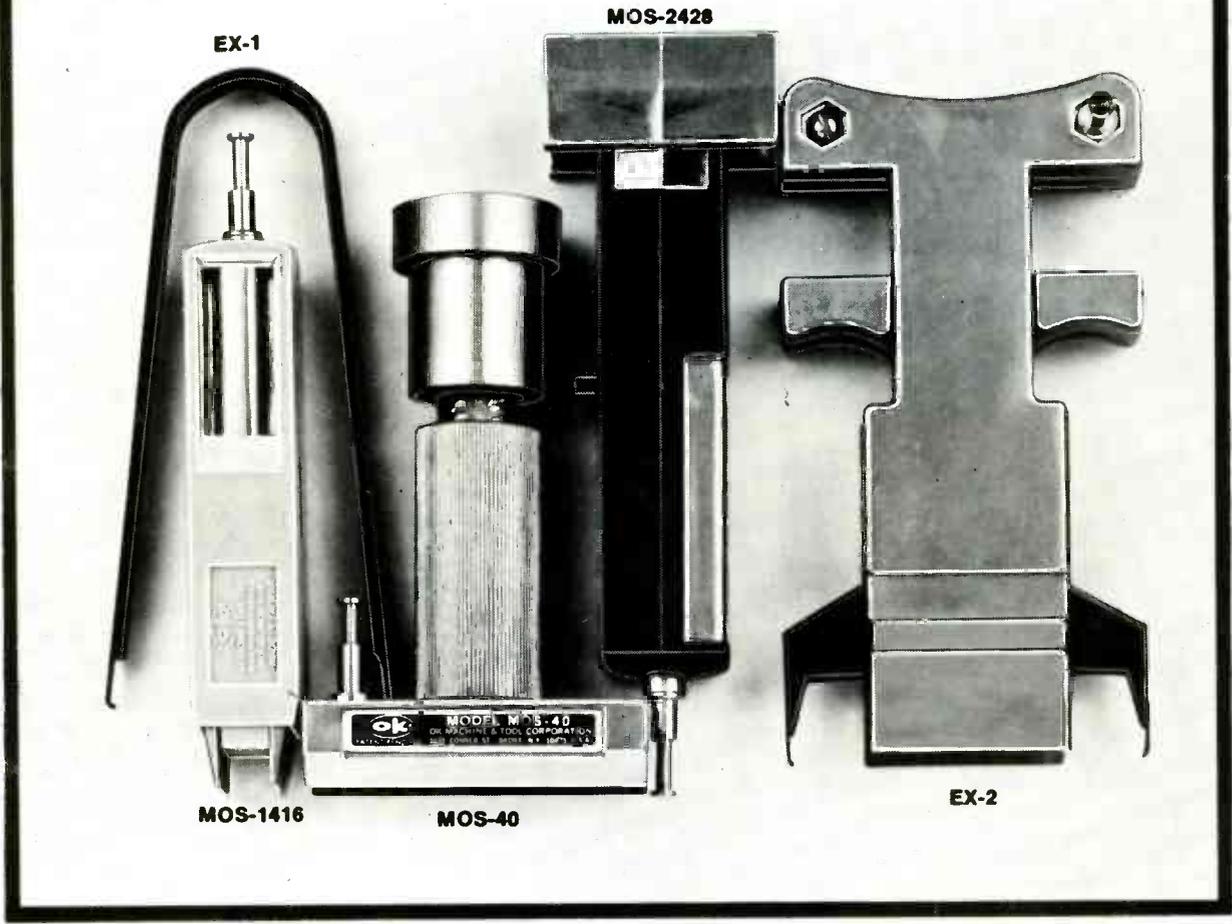


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MOS-40	36-40 PIN MOS CMOS SAFE INSERTER	\$ 7.95
EX-1	14-16 PIN EXTRACTOR TOOL	\$ 1.49
EX-2	24-40 PIN CMOS SAFE EXTRACTOR TOOL	\$ 7.95

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CIRCLE 48 ON FREE INFORMATION CARD

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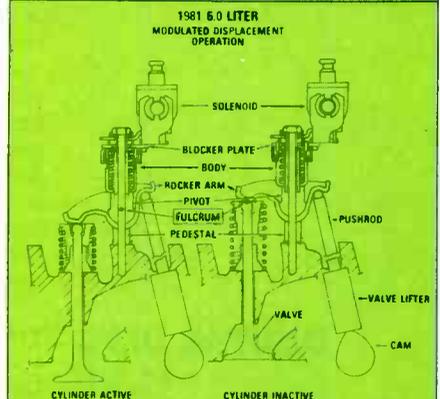
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ON THE COVER

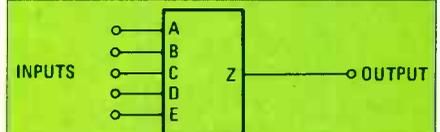
Over-the-air pay-TV stations are sprouting up across the country. Those stations broadcast encoded recently-released movies. An adapter connected internally to your TV set will enable you to decode those over-the-air broadcasts. The lower right-hand corner of the cover shows what the encoded broadcast looks like. The upper left-hand corner of the photo shows Bo Derek in a scene from the recent movie "10".

For a look at how the over-the-air pay-TV encoding system works, and how you can build your own decoder, turn to page 41.

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YOUR NEXT CAR. A look under the hood and how microprocessors will be controlling the engine in the next generation of U.S. cars.



MAJORITY-LOGIC IC's that will make designing digital circuits easier are available. To find out what majority logic is, and how you can use it, turn to page 64.

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looking ahead

INTERACTIVE VCR



Videocassette recorders can assume many of the interactive features of sophisticated videodisc systems, using Sony's new Video Responder, designed to enhance the users of Betamax and U-matic machines for education and training. It employs a microprocessor that enables the user to respond to questions presented in the program, and provides quick access to chosen segments of the videotape. It also is equipped with a printer that records answers on a paper tape, providing a record of all of the trainee's responses.

Rather than use an alphanumeric keyboard for responses to questions posed on the tape, Sony uses a text holder that resembles a sort of electronic clipboard, on which written questions coordinated with the videotape can be attached. The holder has nine keys for multiple-choice answers. Pressing the wrong answer can automatically cause the tape to speed to the segment that tells the user he's wrong and why, giving the correct answer or encouraging him to try again.

The Video Responder is designed to be used with existing tapes, and makes it possible to re-program them for interactive use.

DISC QUIETER

For some time, Dolby had the noise-reduction field virtually to itself. Then came ANRS, followed by dbx and Telefunken's system. Now comes CBS with its own system designed primarily for use with records, and claimed to eliminate surface noise totally, and to improve dynamic range. CBS says that its new system provides reproduction almost as good as the digital or analog master tape, with an 85dB signal-to-noise ratio. The system will also work with tape recorders.

One major advantage claimed for the new CBS system is complete compatibility—encoded discs or tapes can be played on standard home equipment lacking decoders without sound deterioration. One CBS source estimates that a decoder component for existing stereo systems could be made to sell for about \$50. Built-in decoders would add a lower figure to the cost. CBS plans to use the system in making its own records and is negotiating with other record and equipment manufacturers for adoption of the system. Meanwhile, at Dolby, all is not quiet. The company is talking with its licensees about the imminent introduction of a new consumer noise reduction system, the C-type, which presumably eventually would replace the standard Dolby-B system.

DIGITAL DISC PLUS

JVC's revised entry into the competition for the digital audio disc system of the future turned out to be a major surprise. It carries three channels of audio and provides optional still pictures. Designed as an optional component for its VHD videodisc system, JVC's AHD (audio high density) videodisc is designed as the first consumer digital-TV device. At its original demonstration at Japan's Audio Fair, the disc provided three discrete audio channels and a color picture that changed every seven to ten seconds, although the company says the production model will be able to change pictures every four to five seconds. As displayed, the picture showed photographs of the performers on the record and words to songs. JVC has set no date for commercialization, but is submitting the specifications to Japan's Digital Audio Disc Standardization Committee.

COMPETITIVE PROJECTION

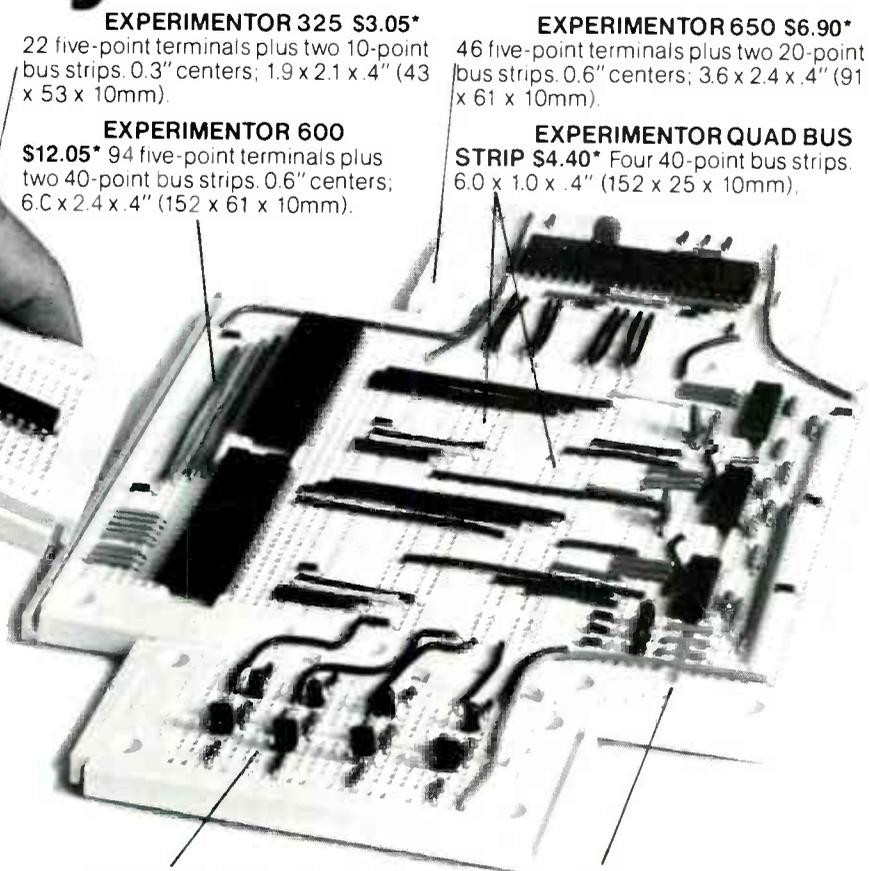
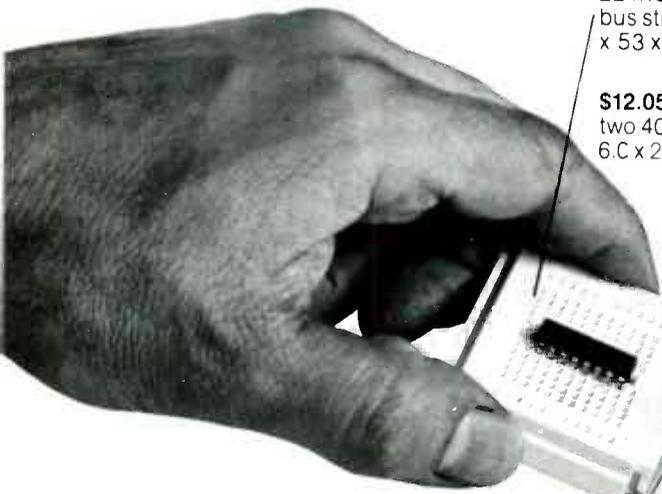
The new General Electric Widescreen 3000, which was designed to be priced in the \$3,500 area, has joined in the general projection-TV price competition with indications it will be competitive with the Sony, Advent and Kloss two-piece systems at just under the \$3,000 level. The GE unit is an improved three-tube version of the company's self-contained rear-projection set. When introduced in New York, one dealer put a pricetag of \$2,800 on it; at the same time, GE had a \$150 factory-rebate promotion on the model, bringing the cost to the customer down to about \$2,650. There seems to be no doubt that projection-TV prices are on the way down—and that may be just what the giant-screen medium needs to bring public acceptance.

TV STEREO PROCEEDS

The choice of a stereophonic sound system for television may be a more harmonious process. An industry-wide EIA subcommittee has been conducting field tests on three proposed systems—backed by the Electronic Industries Association of Japan, Telesonics, and Zenith. If the subcommittee reaches a strong consensus to present the FCC, multichannel sound could be broadcast along with the TV signal as early as 1982. Under the rules of the subcommittee, any system recommended must be capable of accommodating two discrete soundtracks, so it can be used for bilingual broadcasts as well as stereo.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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46 five-point terminals plus two 20-point bus strips. 0.6" centers; 3.6 x 2.4 x .4" (91 x 61 x 10mm).

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CIRCLE 32 ON FREE INFORMATION CARD

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Fluke perfected the handheld DMM and set tough standards for accuracy and reliability that have made analog meters obsolete, and other digitals seem clumsy by comparison.

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If your dealer doesn't carry Series D Multimeters yet, call this number. We'll be happy to tell you who does. 1-800-426-9182

D 804: A powerful, versatile handheld DMM with nine functions, 26 ranges, 0.1% basic dc accuracy and more. Direct temperature readings in °C with K-type thermocouples; peak hold on voltage and current functions; even an audible indicator for instant continuity and logic level detection. Available January 1981. \$229.*

Series D Bench/Portables.

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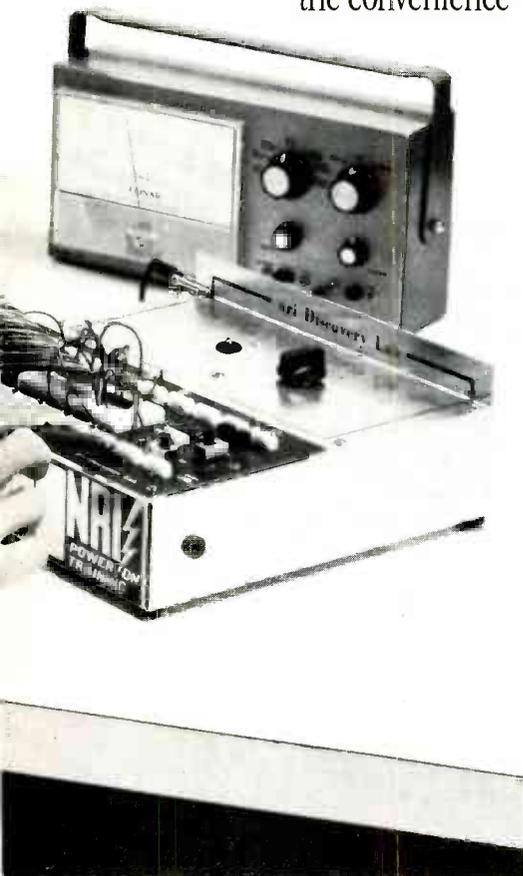
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Consumer Electronics 1981

This issue marks the beginning of another new year. On this happy occasion, I'll try my hand at predicting what will happen over the next 12 months and beyond. The only trouble with predicting is that you will either be right on target or miss it entirely. So with a grain of salt, here goes.....

Now that inexpensive voice synthesis is a reality, we will find more and more manufacturers incorporating this new technology into their products. Talking microwave ovens, household appliances, wristwatches, calculators and even talking test instruments are right around the corner. A little farther down the road we will see automobiles with talking dashboards.

This year we will witness the introduction of inexpensive IC's for speech recognition. However, manufacturers will look much more cautiously toward incorporating this technology into their products. They will wait until they've first gained some experience with speech synthesis. Then we will see the introduction of a whole slew of new products incorporating speech recognition. Imagine being able to shout a command to your TV set, having it respond giving a verbal confirmation.

True digital records will become a reality. Before the year is out, we will witness the market introduction of the Philips Optical Compact Disc system. This is a compact laser-based player. The discs are less than 5 inches in diameter with a 60-minute per side playing time. The system provides both a S/N ratio and dynamic range in excess of 90 dB. High-fidelity will never be the same.

Unfortunately, we will not see the introduction of teletext this year. It will remain caught up in FCC red tape and politics.

No matter how we slice it, whether I'm right on target or out in left field, its going to be another great year for the electronics industry. As consumers, we will be buying higher technology items for our dollar.



ART KLEIMAN
Managing Editor

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 - ac current
 - resistance
 - diode test
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- 0.25% basic dc accuracy
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- Overload protection

**Model 8020A:
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 - ac current
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- LCD display
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**ADVANCE
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Heath SOFTSTUFF Programs

Introduced at the PC-80 Personal Computer Conference August 21-24, 1980, the new Heath software line, SOFTSTUFF, is designed for computer users who want quality documented programs to expand the capabilities of their computers for home and business use, says a Heath spokesperson. The Heath Co. has scheduled release of as many as six new programs per month during 1981.

The first releases include a full screen editor and an improved text formatter; CPS, a file transfer utility with on-line access to Micro-NET Information Services available; a sort utility and Macro-80, an assembler from Microsoft.

Available by the beginning of 1981 will be a true CP/M. Languages to be offered include CBASIC 2 and a C compiler. Applications programs for small businesses—among them, Inventory and General Ledger—will also be a part of the first offerings.

The first offerings operate under the Heath Disk Operating System (HDOS). Programs operating under CP/M will have been introduced by 1980's end.

Many of the programs have been developed by members of the Heath Users' Group, while others have been written by a team of Heath software experts. Each program has been tested and evaluated by Heath software engineers. Each product is fully documented. The line will be available through the Heathkit catalog, as well as at the 61 Heathkit Electronic Centers in the

U.S. and Canada. Heath plans to offer the programs through other software retailers—in the U.S., Canada and internationally—in the future.

For details and price information, write for a free catalog to: Heath Company, Dept. 570-690, Benton Harbor, MI 49022. In Canada, write: Heath Company, 1480 Dundas Hwy. East, Mississauga, Ontario, Canada L4X 2R7.

Reader's Digest joins electronic information source

Reader's Digest announces that it has acquired a majority interest in Source Telecomputing Corp (STC), an electronic-information service located in McLean, VA.

By connecting their terminals to the mainframe of Source via telephone, the 7,000 STC subscribers have access to nearly 2,000 programs and data bases. Those include UPI news, financial information, airline schedules, language lessons, a guide to wine buying, point-to-point electronic mail, and many others. The cost is approximately seven cents per minute of connect-time.

New radiosonde

A radiosonde just developed by Atmospheric Instrumentation Research of Boulder, CO, is made of molded pieces of expanded polystyrene plastic fitted together mechanically, using neither adhesives nor fasteners.

The Airsonde, as the manufacturer calls it, measures atmospheric pressure, humidity

and temperature, and transmits the information through a high-frequency radio link to a ground-based computer, which prints out the information. Besides being used by such government agencies as weather stations, NASA (National Aeronautics and Space Administration), NOAA (National Oceanographic and Atmospheric Administration) and others, radiosondes are widely used in industry, by aircraft manufacturers, nuclear generating stations, air-pollution monitoring facilities, and laboratories.

The six parts of the new sonde are the body cavity, which holds the transmitter and other instruments; the cavity door; two wings, so shaped as to cause the craft to gyrate as it is carried upward by a balloon or dropped from an aircraft with a parachute, and two wing tubes. One of those carries a wet-bulb and the other a dry-bulb thermometer. The dry-bulb thermometer measures the air temperature. The difference between it and the temperature registered by the wet-bulb thermometer is used to calculate the relative humidity of the air.

Solar-cell break through

The Department of Energy's Solar Energy Research Institute (SERI) reports development of a thin-film photovoltaic solar cell with an energy conversion of more than 9 percent. The new cell was produced by Boeing's Parts, Materials and Processes Division, under contract to the Solar Energy Research Institute.

The Boeing cell is a Copper Indium Selenide/Cadmium Sulfide (CuInSe/CdS) type, made by evaporating the material onto a low-cost substrate. Thin-film cells are simpler to make and when fully developed, are expected to cost less than 10 percent of the cost of the present dominant silicon cell.

The goal of SERI is to produce thin-film solar cells with an efficiency of 10 percent. Boeing believes it will achieve that 10 percent efficiency in the near future.

Old-time radio get-together

More than 700 radio amateurs, engineers, historians and just enthusiasts gathered at the 1980 National Historical Radio Conference of the Antique Wireless Association last September 25 through 27, at Canandaigua, NY.

Highlights of the Conference (according to each participant's individual taste) were the old tubes and old equipment contests, the historical discussions—ranging from a review of early radio-frequency alternators to a talk on identifying C. D. Tuska radio receivers—or the continuous flea market in the parking lot.

The two auctions, in which members disposed of tubes or equipment they didn't

continued on page 16



THE AIRSONDE BODY, body door, wings and wing tubes, and the tongue-and-groove method of connecting them together.



Model
3010
\$200

Model
3020
\$350

Generate virtually any wave shape with famous B&K-PRECISION cost-effectiveness!

The new B&K-PRECISION Model 3020 sweep/function generator is the most versatile signal source ever offered by B&K-PRECISION. This one instrument can actually replace a function generator, sweep generator, pulse generator and tone-burst generator. Frequency coverage spans 0.02Hz to 2MHz in seven ranges, with each range providing linear 1000:1 frequency control.

A low-distortion, high-accuracy signal source, the 3020 has the versatility to generate almost any waveform. Examples include sine waves, square waves, TTL square waves, tone-burst, pulses and ramps. All waveform types can be inverted. Internal linear and log sweep capability is also featured. Both modulation and carrier levels can be varied so even a double sideband suppressed carrier test signal can be generated.

For those applications requiring standard function generator signals only, B&K-PRECISION also offers the Model

3010 low distortion function generator. The 3010 generates sine, square, TTL square and triangle waveforms from 0.1Hz to 1MHz in six ranges. An external VCO input is provided for sweep frequency tests. Variable DC offset is also featured for engineering applications. Modestly priced, the 3010 is a stand-out value.

Like other B&K-PRECISION products, the 3020 and 3010 are available for immediate delivery at your local distributor. A ten day free trial is available at many locations.

For additional information and the name of your local B&K-PRECISION distributor, call toll-free 800-621-4627.

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CIRCLE 53 ON FREE INFORMATION CARD

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what's news

continued from page 14

need (often to buy as much other stuff), were the highlight to many. They were also extremely interesting to many others who bought or sold nothing, offering a clear look at much old equipment that could only be glanced at hurriedly during the preview sessions.

Several Atwater Kent breadboard models sold for over \$300 each, and an ancient marine receiver brought \$825. More than \$18,000 worth of tubes and equipment changed hands at the two auctions. Ten percent of the auction proceeds goes to the Association, enabling it to keep up the A.W.A./Electronic Communications Museum in Holcomb, NY and publish its *Bulletin*, a little quarterly magazine of historical articles and news items of interest to members of the Association.

Next year's Conference will be held at Dearborn, MI.

Bell uses standard approach in optical installation

Southern Bell Telephone has put into operation the first leg of a lightwave telephone system that connects three central offices in the Atlanta (GA) area, where lightwave telephony got its start some five years ago.

The remarkable thing about the installation, from Bell's point of view, is that the system was ordered and installed, and is being operated and maintained by local Bell personnel, using standardized Bell System procedures. To Bell, that opens the

door to general adoption of lightwave at some time in the future.

"Our successful use of standardized Bell-System procedures for ordering and installing this new technology means that the Bell System can now move ahead with larger-scale lightwave systems," states S. E. Jenette, Jr., vice president for Southern Bell in Georgia.

Moving ahead immediately with the new technology, Bell's plans include:

In March 1981, a 40.6-mile system in Pittsburgh, carrying up to 20,000 conversations.

In June, an 8.8-mile system in San Francisco, carrying 40,000 conversations, and a 27.6-mile system in White Plains, NY, carrying 20,000.

In July, a 16.7-mile, 20,000-conversation system in Philadelphia, and in December, a 26.1-mile system in Newark, NJ, also carrying 20,000 conversations.

Pioneer videodisc system now more widely available

Pioneer made its new LaserDisc videodisc system available through more than 400 retail outlets in 46 U.S. cities in October. That laser optical videodisc system consists of prerecorded discs and a player that can be connected to any standard TV set. A low-power laser reads audio and video information from the disc and transmits the picture and sound to the TV set. The audio may also be fed to a stereo-sound system.

The discs, which resemble mirrored LP records without grooves, never wear out, because no needle or stylus is used. They are recorded on both sides. Playing time is 30 or 60 minutes per side, depending on the mode of operation. Each disc contains up to 108,000 individual frames—enough for the entire Encyclopedia Britannica. Suggested retail price for the LaserDisc system is \$749, and videodiscs range from \$5.95 to \$24.95.

Semiconductor use up 23%

The world's consumption of semiconductors will increase from \$14.1 billion in 1979 to \$47.2 billion in 1985, according to Mackintosh Consultants of San Jose, CA. That represents an annual growth of 23 percent. During the same period the worldwide consumption of integrated circuits will grow from \$9 billion in 1979 to \$38 billion in 1985, an average annual increase of 27 percent.

United States companies, Mackintosh believes, will maintain a 63 percent share in worldwide semiconductor production. However, the U.S. share of integrated circuit production will drop from 71 percent in 1979 to 67 percent in 1985.

Worldwide semiconductor manufacturing equipment expenditures will increase from \$1.1 billion in 1979 to \$9.6 billion in 1985, an annual growth of 31 percent.

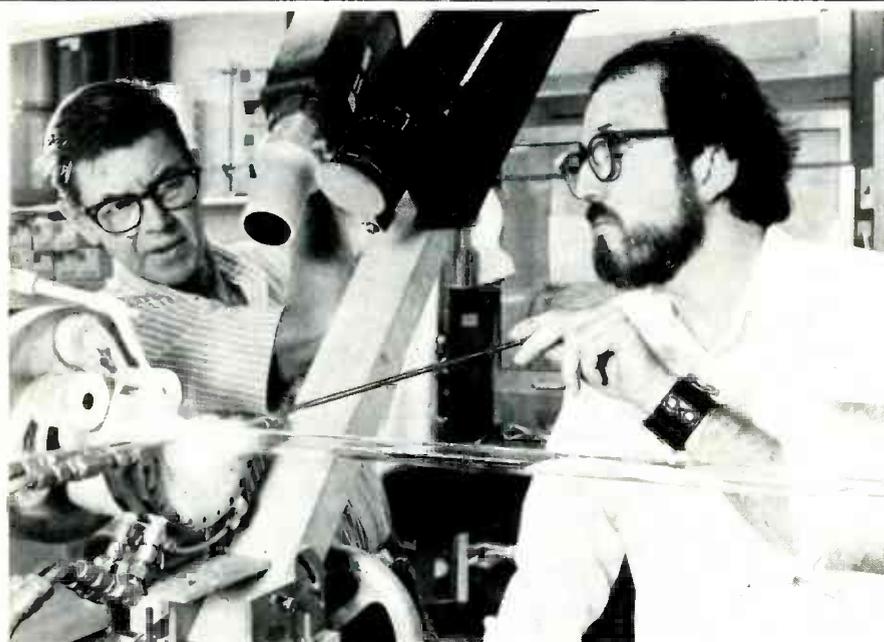
New home-computer facilities

Dow Jones & Co. put into effect a new price schedule with sharply reduced fees for personal computer users. The new schedule is designed to encourage them to use the Dow Jones News/Retrieval Service, a business and financial news and information base.

The new programming package, *Dow Jones News & Quotes Reporter*, permits users of the Apple II Personal computer to retrieve business and financial news and information quickly and easily from the data base. The software package is available on a diskette that stores the instructions for the Apple computer. Users of other computers may gain access to the Dow Jones data base by operating their computers in a "nonintelligent" mode.

Rates for the personal computer user during non-business hours have been set at 20 cents per minute for access to the news data base and 15 cents per minute for the securities price quotations data base, with a minimum charge of 50 cents. Formerly, personal computer users had access to only the securities price quotations, at a charge of \$3 for the first three minutes and 50 cents per minute thereafter.

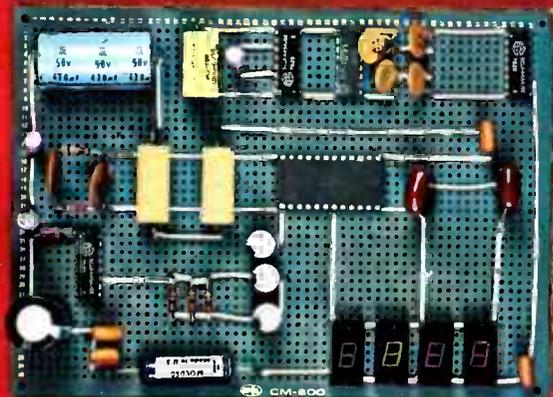
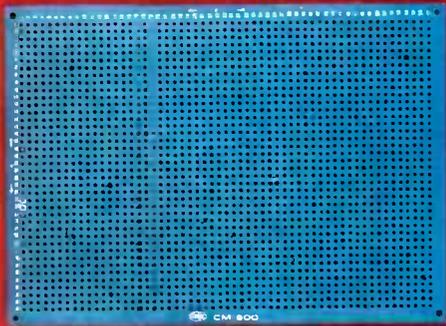
During business hours, the new personal computer rates will be \$1 per minute for news and 75 cents per minute for securities prices, with a minimum charge of \$2. **R-E**



THE ULTRATRANSSPARENT GLASS FIBERS that will carry light signals to and from the three Southern Bell switching offices in Atlanta are fabricated by a process that begins with a silica tube being heated on a glass lathe.



CM-600 Circuit Mount



CM-600 \$6.95*
RW-50 \$2.98*

NEW CM-600 SOLDERLESS PROTOTYPE BOARD

CM-600 is a unique system for solderless construction of circuit prototypes, useful to both engineers and hobbyists. The CM-600 is a neoprene board 4½" (114mm) x 6" (152mm) with 2280 holes on .100" (2.54mm) centers. Standard components including DIF's are mounted by simply inserting leads into the holes in the long life neoprene material. Interconnections are easily made using 20 or 22 AWG (0,8 or 0,65mm) wire jumpers. Positive contact is assured by the elasticity of the hole, which compresses the leads together. To remove components or leads, simply pull out. This facilitates easy circuit changes making it ideal for breadboarding experimental circuits. CM-600 also features numbered rows and columns for easy reference.

Accessory Kit RW-50 contains 50 pcs of AWG 20 (0,8mm) insulated jumper wires of assorted lengths from ½" (13mm) to 4" (100mm). Both ends are stripped and bent 90° for easy insertion. In stock directly from

OK Machine & Tool Corporation
3455 Conner St., Bronx, N. Y. 10475 U.S.A.
Tel. (212) 994-6600 Telex 125091

*Minimum billings \$25.00, add shipping charge \$2.00
New York State residents add applicable tax

CIRCLE 49 ON FREE INFORMATION CARD

If you have put off learning more electronics for any of these reasons, act now!

- I don't have the time.
- High school was hard for me and electronics sounds like it may be hard to learn.
- I can't afford any more education.
- I have a family now.
- I'm here. You're there. I've never learned that way before. I'm not sure it will work for me.

Read the opposite page and see how you can get started today!

Be honest with yourself. Are the reasons really excuses? You already know enough about electronics to be interested in reading this magazine. So why not learn more? If you need encouragement, read on and see how excuses can be turned into results.

You don't have the time. Be realistic. All you have in life is a period of time. Use it. Try to know more tomorrow than you do today. That's the proven way to success. CIE studies require just about 12 hours of your time a week, two hours a day. You probably do have the time.

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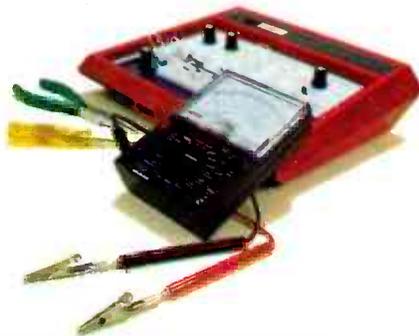
You can't afford any more education. Actually, you can't afford NOT to gain the skills that can put you ahead of the others. You know what inflation is doing to you now. Education—learning a skill—is an inflation-fighter that can be yours. If you are not able to pay full tuition now, CIE will lend you funds on a monthly payment plan.

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The kind of professional you want to be needs more than theory. That's why some of our courses include the Personal Training Laboratory, which helps you put lesson theory into actual practice. Other courses train you to use tools of the trade such as a 5MHz triggered-sweep, solid-state oscilloscope you build yourself—and use to practice troubleshooting. Or a Digital Learning Laboratory to let you apply the digital theory that's essential today for anyone who wants to keep pace with electronics in the eighties.



Your FCC License can impress employers.

For some electronics jobs, you must have your FCC License. For others, employers usually consider it a mark in your favor. Either way, your License is government-certified proof of your knowledge and skills. More than half of CIE's courses prepare you to pass this exam. Surveys show that some 80% of CIE graduates who take the exam are successful.

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RE-04

SATELLITE PROGRAMMING STILL GROWING

The never-ending feast of video programming transmitted via satellite continues to grow. Still another pay-TV service began aboard Westar satellites this fall: Golden West Subscription Television, a new subsidiary of Gene Autry's broadcasting company, will send 73 hours per week of movies and other shows to its stations in several cities, starting at 6 pm (Eastern Time) on weekdays and at 1 pm on weekends.

Thanks to a new series of Federal grants totalling \$1.2 million, four organizations will promote the use of satellite networking by public-service groups. Much of that will take the form of specialized teleconferencing, and the next trend will probably be towards originating video at multiple points. (Heretofore, most teleconferences involved one-way video, with telephone-line callbacks; but the increasing number of satellite uplinks makes it more feasible to originate video at several locations.) Most of the programming from those groups will be educational or informational in nature, and almost all of it will be transmitted during daytime hours aboard various satellites—wherever there is room.

Meanwhile, aboard the Westar system, look for more special-interest shows now that the FCC has formally approved "shared use" of public-TV downlinks. Every PBS station in the nation is now equipped with a satellite receiver—and all PBS programs travel via the Westar network. Many of those earth stations can now be used for video transmission by other program distributors to deliver shows to closed-circuit audiences in various cities.

In addition, the FCC recently removed several major cable-TV programming restrictions, which could open the door for the creation of new satellite superstations. Unless the new FCC ruling is overturned when it is appealed to the courts, it will permit TV stations from anywhere in the country to be beamed into a cable-TV system. That means that very popular independent TV stations—or even network affiliates from major cities—could be transmitted to distant CATV systems (probably via satellite) for use.

DIRECT BROADCAST SATELLITES

Direct-to-home broadcast satellites operating in the 12/14-GHz range may still be years away from regular use in the U.S. Nonetheless, plenty of business executives and Washington bureaucrats are spending time this fall making plans for how to operate such a system—or how to fight such services. For example, network-TV executives at ABC began lobbying on Capitol Hill recently in an effort to head off the Federal Communications Commission from making any policy that could hurt current network-TV operations. ABC argues that Congress itself should deal with setting up policy on such an important issue as DBS.

Meanwhile, the FCC itself is in the midst of a study to develop a formal American policy to present at the 1983 WARC (World Administrative Radio Conference), which will determine DBS guidelines for the western hemisphere. The FCC says its preliminary approach is "to foster, not stifle" the potential uses of direct broadcasting satellite.

Another government agency is urging the FCC to adopt a national satellite-planning policy—part of which would include DBS proposals. The National Telecommunications and Information Administration is pushing for a three-phase approach that would eventually lead to long-term planning for satellite orbit/spectrum allocation. And while all those ideas are drifting about Washington, other corporate and government officials are pleading for a DBS policy, which would permit the U.S. "to keep ahead in the area of DBS." One Comsat Executive warned that other nations are rapidly adopting DBS projects—and could soon outpace U.S. activity.

AROUND THE SATELLITE CIRCUIT

TV Ontario, a Canadian educational TV operation, is beaming a direct-to-home signal via Anik B. The programming travels in the 12/14-GHz band, and is intended especially for remote homes in northern Ontario province.

Although Satcom III replacement launch and operation is still about a year away, RCA Americom has already decided who gets the extra spaces aboard that bird, which will become the major cable-TV programming network carrier. In a recent lottery, RCA drew the names of United Video and Warner-Amex Satellite Entertainment Network; those two companies will join the 20 other programmers who will move over from Satcom I when the third RCA bird goes into service.

International satellite communications are expected to double within the next four years, according to a forecast of circuit capacity just prepared by Intelsat, the international satellite organization. The Atlantic Region will continue to be the busiest area, although Pacific-region transmissions will also jump twofold by 1984.

British Broadcasting Corp., is experimenting with satellite networking, to be used mostly for transmitting shows into BBC headquarters.

GARY H. ARLEN
CONTRIBUTING EDITOR

A superb frequency counter is frequently not counted—just because it doesn't have a high price-tag.



The truth is, our 8000B 1 Gigahertz is an excellent counter. In fact, it's preferred by many engineers, technicians, and electronic enthusiasts. Not a single competitor on the market today can surpass our price/performance ratio.

And we've deliberately kept our prices down. First, we've refused to join everybody else in their high mark ups. Instead of "charge what the market will bear," for us it's "charge a fair price." Second, we sell what we manufacture, directly to you. So extra costs of extra steps are automatically eliminated. Third, we have to build a lot of frequency counters to meet the demand. Because we do sell so many, we don't have to charge a high price to make a profit.

And about quality . . . Sabtronics frequency counters always have the most innovative features available. For example, our 8000B 1 Gigahertz Frequency Counter has a 10 Megahertz precision crystal timebase. But most important, the 8000B, using the most advanced LSI circuitry, has a guaranteed sensitivity of 30 millivolts up to 1 Gigahertz, with 20 millivolts typical. The three-stage differential amplifier IC makes this possible. Altogether, the 8000B uses only 6 IC's, making the chance of failure virtually nonexistent.

Three selectable gate times provide the measurement speed you need — and greater resolution. The resolution is further enhanced by our counter's 9-digit display.

Like the 8000B, Sabtronics' 8610B is a high-quality precision frequency counter. It features only 4 IC's, and offers a frequency range up to 600 Megahertz.

The cases of both counters are high strength impact-resistant ABS plastic. Elegant but very rugged. Sabtronics doesn't believe in skimping on the high quality construction that brings excellent performance. But we're not about to charge a high price just because we could get it!

Send in the coupon and order your new frequency counter now. Credit card holders may call.

BRIEF SPECIFICATIONS:

Frequency Range: 10 Hz to 1 GHz (Model 8000B), 10 Hz to 600 MHz (Model 8610B); **Timebase:** Frequency: 10 MHz, Stability: ± 1 ppm (20 to 40°C.), Aging Rate: < 1 ppm/year; **Sensitivity** (adjustable): Input A < 15 mV to 100 MHz, Input B < 30 mV, 100 MHz to 1 GHz (Model 8000B), < 30 mV, 100 MHz to 600 MHz (Model 8610B); **Gate Times:** .1 sec., 1 sec., 10 sec.; **Resolution:** 0.1 Hz to 10MHz, 1 Hz to 100 MHz, 10 Hz to 1 GHz; **Display:** 9-digit LED 0.4"; **Power Requirements:** 4.5 to 6.5 VDC (4 C-cells) or optional AC adapter; **Dimensions:** 8" wide X 6.5" deep X 3" high (203 X 165 X 76 mm), 1.3 pounds (590 g) excluding battery.

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RE



letters

THE COLOR-BAR GENERATOR

I feel that I must comment on the errors, omissions, and inconsistencies in the article, "Affordable NTSC Color-bar Generator" in your April 1980 issue.

Very few TV stations use special color-bar generators since the feature is included as a self-test signal in all professional camera encoders. That explains why they are often called camera-bars.

Figure 1 showed 75% bars but the text discussed 100% video. Chroma is not considered when measuring video levels, since a low-pass filter is used.

White is 12.5% carrier level, not zero modulation, which is the blanking level. Maximum modulation (-87.5%) occurs at white, not sync, which is +40%.

The staircase effect of the Y component of the bars is an artifact of the action of the NTSC color equation and is unrelated to the staircase test signal.

IWQ? You must mean IYQ, as used in the industry. The Y signal at the bottom of the split-bar display is always 100% regardless of whether the bars' part is 75% or, less commonly, 100%.

White is, by definition, *not* saturated. The term "saturation" is applicable only to chroma—not luminance.

Several important properties of the bars' signal were omitted completely. They have to do with the way in which the bars are made. Bars are the result of switching red, green, and blue into the encoder in such a way that the first four bars receive full-scale green, the first two, the 5th and 6th receive full red, and the first, 3rd, 5th, and 7th receive full blue. A look at the receiver screen with the beams turned off in pairs shows that clearly.

One of the properties of the process is that the first and 8th bars have zero saturation and all others have 100% saturation, regardless of level changes. Another is that when the primaries are viewed singly, the bar segments will have equal brightness if—and *only* if—the system is free of distortion, the demodulation axis is 90°, and the receiver color controls are set for correct color reproduction. That gives a visual check for hue and saturation settings.

TED DAVIS,
Riverton, IL

I think the differences referred to in Mr. Davis' letter lie in the interpretation. Some of the comments, I do not understand: For example, white is zero modulation; the tips of the horizontal sync pulses are 100% modulation. That is done deliberately to give better sync on a weak signal. With no signal, the screen is white.

The term "IWQ" was taken directly from the instrument manual. (As far as I know, this is the first time I have seen "IYQ" used, though it is quite applicable.) The manual uses "IWQ" to mean "minus in-phase chroma/white/quadrature chroma," and, to me, that is the more comprehensible term. (The "Y" confuses me: I keep wanting to call it "yellow.")

I don't know whether the statement that very few TV stations have color-bar generators is valid; but, in my opinion all TV stations should have them. I know of several that do: the color-bar generators are used at the start of the broadcast day for setting up the color cameras so that each has identical response. The most frequent offenders in the "purple people" department is continued on page 26

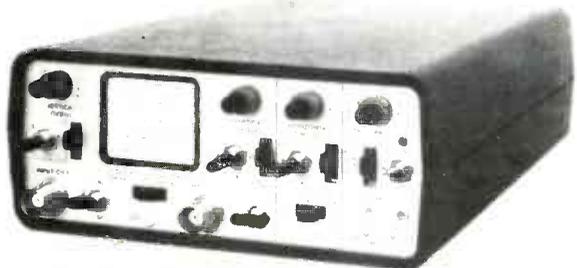


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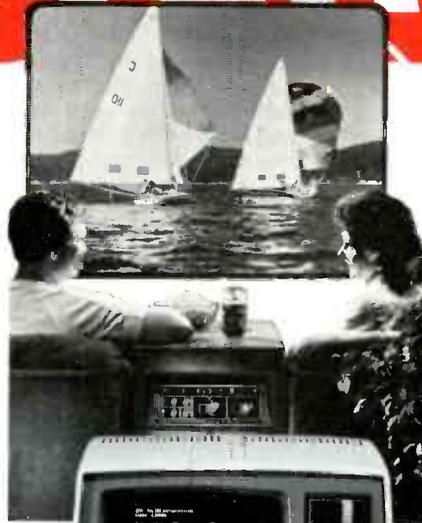
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CIRCLE 28 ON FREE INFORMATION CARD

LETTERS

continued from page 24

the film-camera chain. One of my "local stations" is a common offender in that area; they either don't have a color-bar generator, or they aren't using it!

The comment that Fig. 1 shows "75% bars" is mildly incorrect: the drawing says of the last bar "Gray: 75% white." The tip of that bar is at 100 IEE units, or zero modulation. Full modulation is at the -40 IEE-unit level, and the black or reference (setup level) is at a +7.5-unit level. The bars in Fig. 3 show the two different chroma levels, at 20 IEE-unit modulation and 40 IEE-unit modulation. The text explains why that was done.

All in all, I think the main differences here

lie in the interpretation of certain things, and are perfectly natural. Mr. Davis would agree, I am sure, that the color-bar generator is a very accurate and useful instrument, and should be of great help in TV stations and in the better TV repair shops.

—Jack Darr

THE CONTRACTION EQUATION

For the many readers whose curiosities were stimulated by my exposé on the unreality of Einstein's famous "train-and-simultaneity" thought experiment (Letters, April 1980), I propose another thought-provoker involving simply capacitor plates and measuring rod:

Matter, regardless of what it is—electrons, clocks, measuring rods, starships, you name it—is purported by Einstein's

theory to suffer length contraction in exponential proportion to velocity. The relativistic equation for the "revised" length is

$$L' = L\sqrt{1 - v^2/c^2}$$

where c is the velocity of light and L is the length at rest, which is also unchanged to an observer moving with the matter. If you suspect that it is unreal—that an object cannot be both contracted and not contracted—you are at the heart of the paradoxical nature of Einstein's theory. We are obliged to investigate further.

Consider, then, oppositely-charged capacitor plates attached to each end of a moving measuring rod. Einstein would say: (a) to an observer moving with the rod its length is "normal" and the plates remain separated by a substantial distance; (b) to the "rest" observer, and for v close enough to c, the rod is contracted into a thin disc, so the plates and charges are very close.

As should be obvious to anybody who learned "Electronics I," if (b) is true, and Einstein's equation is consistent with the laws of electronics, the field intensity between the plates is such that the charges must arc across the small gap separating the plates and neutralize them. But, that is rejected by (a)! The situation is self-contradictory.

It is self-contradictory because it is unreal, as mentioned, the culprit being Einstein's contraction hypothesis (b) which is itself unreal, nonexistent. Only (a) represents reality since the plates maintain their charges (presuming that conditions remain stable) and that must realistically be independent of any external observers not partaking in the motion.

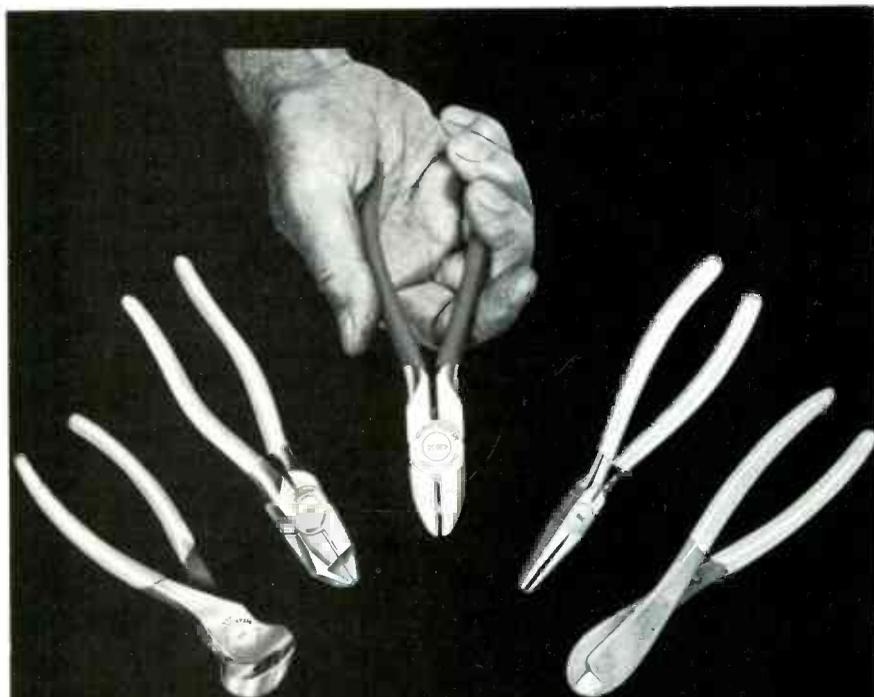
Simply because experimental evidence appears to endorse Special Relativity does not guarantee that the theory is physically possible and logically consistent. "Thought experiments" are excellent for identifying its fallacies. But is there any performed experiment contradicting Einstein? Yes. In 1971, the Hafele-Keating Experiment found that, compared with a clock at "rest", a high-velocity cesium-beam clock recorded a time loss, but another flown in the opposite direction recorded a time gain, grew older. The latter was an anomaly contradicting Special Relativity's time dilation predicted for relative motion. Yet, physicists never adequately and honestly admitted that, and texts exclude references to the clock that "aged" faster.

One experimental fact like that proves that the universe does not, in reality, obey rules postulated by Einstein. That happens because those rules were never real originally.

ANTHONY HANS KLOTZ,
Babylon, NY

The equation presented above is the first of the three Lorentz-Fitzgerald Contraction equations, and deals with length. The second deals with time, and the third with mass. The implications of the first equation are that at the speed of light, the length of the object so traveling would be zero in that direction. The third equation, dealing with mass, implies that at the speed of light, the mass of the object would be infinite. It was through his work on the Lorentz-Fitzgerald Contraction equations that Einstein arrived at his famous $E = mc^2$. But there was no specific Einstein contraction theory or equation. —Editor.

R-E



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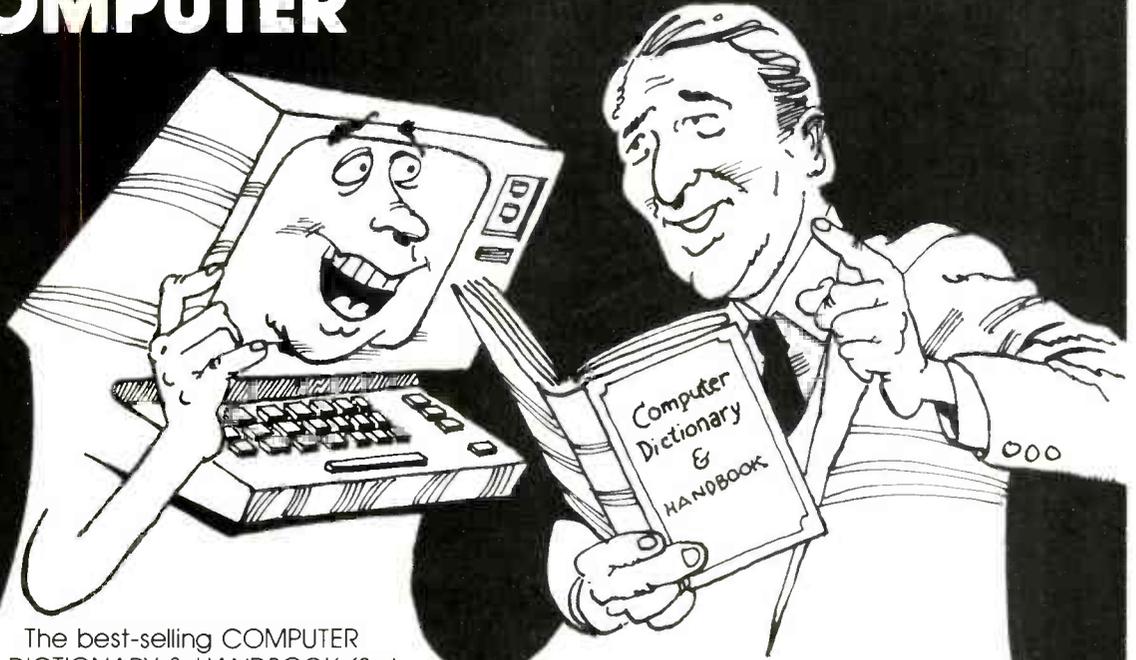


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equipment reports

Digital Meter Research Model DMR-100 Digital dB Meter



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DIGITAL METER RESEARCH COMPANY, PO Box 28, Arlington Heights, MA 02175, recently introduced their first entry into the field of specialized audio test equipment. That entry is their *model DMR-100* Digital dB Meter. It's a very accurate digital dB meter, with provisions for connecting into an audio circuit at a given point (input, output, etc.), for probing to

read stage gains, or for similar tests. Rated accuracy is 0.1 dB over the full range of 80 dB: -60 dB to +20 dB. At the -60 dB input level 0.1 dB means a resolution of 10 microvolts.

It's easy to use. There isn't a range switch. The main input jack is a BNC-type on the front panel, above two pushbutton switches. One of those switches lets you select readout in either dB or volts DC. The other will be covered later.

On the rear panel, along with the AC input and on-off switch, are two sets of dual banana-plug jacks. One of them is labeled dB INPUT, and can be used for offsetting the display by any amount needed when complex measurements are to be made. An input of +1.0 mV will cause the display to read -0.1 dB from the non-offset value. The offset is adjustable over a ± 8 dB range and is highly linear. The dB OUTPUT is a DC voltage proportional to the input-signal level. The voltage is the same as that displayed on the meter. Gain constant is 1.0 mV for 0.1 dB.

Also on the back is a BNC jack for COMPRESSED OUTPUT. As the input varies over the full 80-dB range, this signal varies by less than 10 dB. Distortion is very low. This output can

be used with a scope, or phones or an audio monitor.

The other pushbutton switch on the front panel is used to select between BUFFERED and UNBUFFERED inputs. The buffered input has an impedance of 10 megohms and is useable up to 12 volts, peak input. The unbuffered input has an impedance of only 100K ohms and can be used up to 150 volts, peak.

For production-line testing, this meter should be very useful, especially for final checkout. With a standard input, the *DMR-100* will read the output with high accuracy, and let the operator determine whether the units is in-spec.

For audio test work, two *DMR-100*'s may be used; for example, one to meter input and one for output. Or, one unit can read AC signals in dB, and the other the DC level or offset of the signal. The two-meter arrangement can be valuable in such applications as gain-readings in systems where input signal slowly varies or is a function of some other parameter; e.g., compression, expansion, etc.

The *DMR-100* has a 3 1/2-digit LED readout, with 0.56-inch high digits. It's housed in a *continued on page 30*

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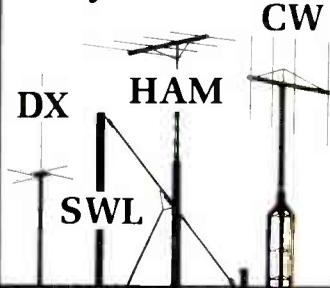
See March '79 "Radio-Electronics" *Hobby Corner* for additional information on Stamp It, Etch It Method.

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EQUIPMENT REPORTS

continued from page 28

light blue extruded-aluminum case, with black end-panels and bezels. That means durability, and also shields the meter from external interference that could affect readings. The *DMR-100* is powered by an 18 VAC input, from a wall-mounted plug-in power transformer. That reduces any chance of 60- or 120-Hz interference. The *DMR-100's* \$250.00 price is quite reasonable for an instrument of its high accuracy and simplicity. **R-E**

**B&K-Precision Model 1650
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IF YOU THINK THAT A DC POWER SUPPLY is nothing but "a transformer + a rectifier + a filter capacitor," well, that is the definition of a DC power supply. However, if you have one like the *model 1650* Tri-Output Laboratory DC power supply (from B&K-Precision, Dynascan Corporation, 6460 West Cortland Street, Chicago, IL 60635) that's something

else . . . like the difference between a moped and an MGB. One of them can do a lot of things the other cannot, and do them a lot more safely.

This is an instrument that can be used in design labs, experimental work, and the like; it's also a handy piece of test equipment to have in an electronics service shop. It's a fully-regulated, current-limited DC power supply with three separate and completely isolated outputs. It has an accurate meter that will read the voltage or current of each output; and that is what makes it a test instrument! Input voltage and current readings are awfully handy in diagnosis.

The *model 1650* has a five-volt output at five amperes for powering any kind of TTL logic circuitry. Five amps will drive a good many TTL gates! The other two outputs are identical twins, with a 0-25 VDC variable output, good up to 500 mA. The outputs can be used separately, with complete isolation, or they can be hooked in series or parallel for higher current-ratings. For a split-rail power supply, like those used for many op-amp circuits, they can be connected back-to-back.

All three outputs use "foldback" current-limiting. If the load current goes above the maximum rating, that automatically reduces the output current to at least 20% below maximum. The current meter will tell you if it happens. That feature not only protects the power supply, but also limits the damage to the equipment under test. All outputs are voltage-regulated, using IC regulators. That holds the voltage to a very tight tolerance anywhere below the maximum load.

An extremely useful feature of the *1650* is the ability of the variable "B" supply to track

the variable "A" supply. This means that, as the "A" voltage is varied, the "B" voltage will change proportionately. The "B" voltage can be set so that it will be any percentage of the "A" voltage.

Somebody put a lot of thought into the design of this power supply. Our normal tendency is to turn a knob clockwise when we wish to increase the output (in this case, the voltage) of the circuit it controls, and that is indeed the case when the "A" and "B" supplies are used independently.

In the TRACKING mode, though, 100%-tracking (where B = A) is at the counter-clockwise end of rotation of the "B" control. This means that, should you inadvertently switch from TRACKING to INDEPENDENT mode, the "B" voltage will never be greater than it was when in the TRACKING mode. Thus, you cannot accidentally overload a circuit being fed from the "B" supply . . . a nice touch.

The tracking function has many uses. In checking subassemblies and other things that have separate or different power supplies, by using 100% tracking you can simulate the effect of low or high supply-voltages on the unit's performance. You can also imitate power supply transients and so on; both voltages will vary at the same time.

The *model 1650* is a well-built and rugged piece of test gear. All controls are plainly marked, and conveniently sized. The panel is well laid-out. Operation is about as simple as it can be made.

The DC outputs all use 5-way binding posts, which can be hooked up to any kind of test-lead. There is also a green jack—for an earth ground—on the front panel. Despite all that,

continued on page 32



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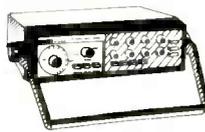
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"The NASA/Nola power saver," wrote a **Popular Science** senior editor, "was developed by Frank Nola at NASA's Flight Center in a program to reduce power consumption in spacecraft motors. Nola calls it a PFC — power-factor controller. I prefer to call it a power saver, however, because that's what it does."

NASA TESTED IT

According to NASA documents, "The device has been tested at Marshall Center on over 40 types of motors, with power savings ranging up to 60%, depending on the loading. The motors tested were both single-phase and three-phase, ranging from 1/2 H.P. to 5 H.P. Most motors will show up to 40 — 50% savings when running lightly loaded or unloaded, and some will show 5-to-7% savings at rated load."

NASA's Technical Support Package showed that "The Power Factor Controller applies to induction type electric motors — the most commonly used type in all major home appliances and the most commonly used by industry."

HOW IT SAVES POWER

Popular Electronics explained it this way: "AC induction motors characteristically run at a nearly constant speed that's fixed by power-line frequency and independent of load and supply voltage. When heavily loaded, the motor draws line current that is nearly in phase with the applied voltage...Under light load conditions, the motor develops less torque by allowing more lag between the voltage and the current. This reduces the power factor while leaving the current essentially the same in magnitude.

"To minimize this waste, Nola's device monitors the motor's power factor and when it detects light load conditions, it reduces the supply voltage..... The current, now more nearly in phase with the voltage, therefore does as much useful work as before, but it and the voltage are smaller, resulting in a net savings of electric power."

THE SAVINGS CAN ADD UP

The cost of electric power keeps going up. In 1980-81 and beyond you'll pay more and more for the privilege of running your electric appliances.

Right now, the typical consumer pays about \$8 per month to operate a 16.5 cu. ft. frost-free freezer...\$10 to run a 17.5 cu ft. frost-free refrigerator...and

*National Aeronautics and Space Administration
Patent No. 4,052,648*

about \$60 for an air conditioner used during summer months. That's what you're paying to run just **one** of these appliances per year.

Nola's power saver can soon pay for itself, then start reducing your electric bills. Until now, the device has not been **available** — except for industrial models priced at \$80 or more.

INTRODUCING THE WATT WIZARD

Cynex, an American manufacturer of electrical and electronic products and a prime contractor for the U.S. Army, has been licensed by NASA to manufacture Frank Nola's power saver. Cynex calls it the Watt Wizard.

The "Watt Wizard" says Ray Beauchea, the firm's **Marketing Director**, regulates the voltage fed into an induction motor making the motors run more efficiently and quieter, while lengthening motor life.



The Watt Wizard features a unique, constant power saving readout. So you can constantly monitor you're energy savings.

SIMPLE TO USE

Cynex makes several models of the Watt Wizard (all with solid state design), including the 110 v. AC plug-in model we're offering. It's for single phase fractional H.P. motors (less than 1 H.P.) used in most freezers, refrigerators, fans, swimming pool pumps, vacuum cleaners, sewing machines, etc.

Simply plug the Watt Wizard into any electrical outlet, then plug the appliance into the Watt Wizard. There's no wiring required. Unlike some competitor's models (if and when available), the appliance does **not** have to be turned on before being plugged into the power saver. You can leave the appliance — whether on or off — plugged into the Watt Wizard all the time. Or you can move the Watt Wizard to various locations.

OTHER MODELS AVAILABLE

Air conditioners, washers and dryers require wire-in model. If you lack mechanical skill, you probably need an electrician to install it. We also offer it in 220 VAC single or three-phase.



MERCURY 1980 ©

EXCLUSIVE ADVANCE FEATURES

The Watt Wizard also includes two more unique features which no competitor has. It's fused so if you accidentally overload the device, it won't burn out. Just change the fuse, which is available at any auto supply store.

And Watt Wizard features a unique LED readout, so you can actually tell, at any moment, exactly how much power you're saving — 10%, 20%, 30%, 40% or 50%. This feature is **available only on the Watt Wizard**.

There's a "power-on" light, too. And the Watt Wizard comes with the manufacturers 1 year limited warranty.

LOW COST — AND A TAX CREDIT

We're offering the Watt Wizard for only **\$39.95**, with **immediate delivery**. Want two? Then its just **\$37.95** each. Or splurge and get three at **\$34.95** each. Wire-in models for heavy duty motors are \$6 more for each unit. Add just **\$2.50** postage/handling for each order (not each unit).

And next year, when you fill out your tax return, you can deduct a full 15% energy tax credit — for additional savings.

30-DAY MONEY-BACK GUARANTEE

Try the Watt Wizard for up to 30 days. If not completely satisfied, return it (insured) for a full refund.

The sooner you send for the Watt Wizard, the more you can save on your electric bills. To order, send your check or money order to the address below. Or charge it to your Visa, MasterCard, American Express, or Carte Blanche credit card. If using your charge card, you can also order via our toll-free phone number:

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Detailed literature is available free on request. And, if you send \$1 to cover handling costs, we will send an extensive compilation of test reports by independent reviewers including both laboratory and listening tests. We will also include a kit construction manual (normally \$3) so you can judge the feasibility of assembling our kits.

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CIRCLE 36 ON FREE INFORMATION CARD

EQUIPMENT REPORTS

continued from page 30

the instrument is not big and cumbersome; it takes up very little room. A supply like that can be used for a lot of useful things around a shop, and would be a fine and handy thing to have on hand. Manufacturer's suggested list price is \$325. **R-E**

IET Model CM-500/ Capacitance Meter



CIRCLE 103 ON FREE INFORMATION CARD

THERE WAS A TIME WHEN NEARLY ALL capacitance measurements were made using a balanced bridge. The procedure often required interpolation of values. It was an analog process, often introducing operator error.

Times have changed. Instead of measuring capacitance indirectly by resonating a tuned circuit with the unknown capacitor, digital cir-

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circuitry can measure the fundamental property of a capacitor: its rate of charge.

The new IET *CM-500* autoranging digital capacitance meter does just that. By introducing an accurate pulse-voltage to the unknown capacitor through a known resistance, the rate of charge can be measured directly.

The *CM-500* autorange circuitry automatically selects the appropriate display values for the charge time. Range units include millifarads, microfarads, nanofarads, and picofarads. Since few of us have an intimate familiarity with millifarads and nanofarads, IET has located a conversion table above the display.

Why include millifarads and nanofarads when nobody uses them? The answer lies in the autoranging limits. Picofarads and microfarads, the common units, are six decimal places apart. With only 3½ digits in the display, autoranging would provide very limited accuracy for values that were too high to be measured in picofarads, yet too low to be measured in microfarads.

The display features four half-inch LED's. Measurements to a numerical value up to 1999 may be read before the meter autoranges to the next higher scale. The *CM-500* will measure any capacitance from 1 pF to 200,000 µF with 0.1% accuracy (±1 least-significant-digit). A thumbwheel offset-potentiometer corrects for stray lead-capacitance.

Front-panel provision is made for test leads or capacitor-lead insertion. A plug-in accessory (included) is used for rapid measuring of taped components.

The *CM-500* may be powered by its own internal batteries, or from an optional AC adaptor.

Accurate measurement of capacitors is only the beginning of the *CM-500's* flexibility. An edge connector can be used to connect the tester with a useful capacitance-limits comparator (model *CLC-502*, optional). With this instrument, a thumbwheel selection of upper and lower limits may be used to tighten up specs on incoming capacitors. This "go/no-go" technique makes accepting and rejecting of components a snap. For quality-control purposes, the optional comparator can pay for itself quickly during bin-sorting of critical components.

Since the accessory *CLC-502* is digital, it introduces no measurement error when plugged into the *CM-500*.

Our bench test

We found the *CM-500* to provide high accuracy, rapid autoranging, and clear readout-visibility. Settling time on large value capacitors was unusually short. A 2200 µF electrolytic was read in only four seconds.

The thumbwheel capacitance-offset control is a little touchy and required some getting used to. It is capable of introducing or subtracting approximately 50 pF, and some gentle persuasion is required to tease the control right to zero.

A pushbutton must be depressed each time a capacitor is measured. Not only does that prolong battery life, but a shorting position on the switch discharges the test capacitors when they are inserted to protect the instrument from overvoltage at the input.

The pulse-generating circuitry is built around a 1-MHz astable multivibrator (crystal oscillator). The squarewave output from this basic clock circuit is then divided down into useful sub-ranges for various capacitances under test. The lowest frequency (500 Hz) is used to measure the highest capacitance (20,000-200,000 µF), while the basic 2-MHz

frequency is used to measure the lowest capacitance (1-2000 pF).

The *CM-500* is ruggedly built, designed for long-term reliability. It carries a list price of \$299 and is manufactured by IET Labs, Inc., 761 Old Country Road, Westbury, NY 11590. **R-E**

Harada Electronic AM/FM Automotive Antenna



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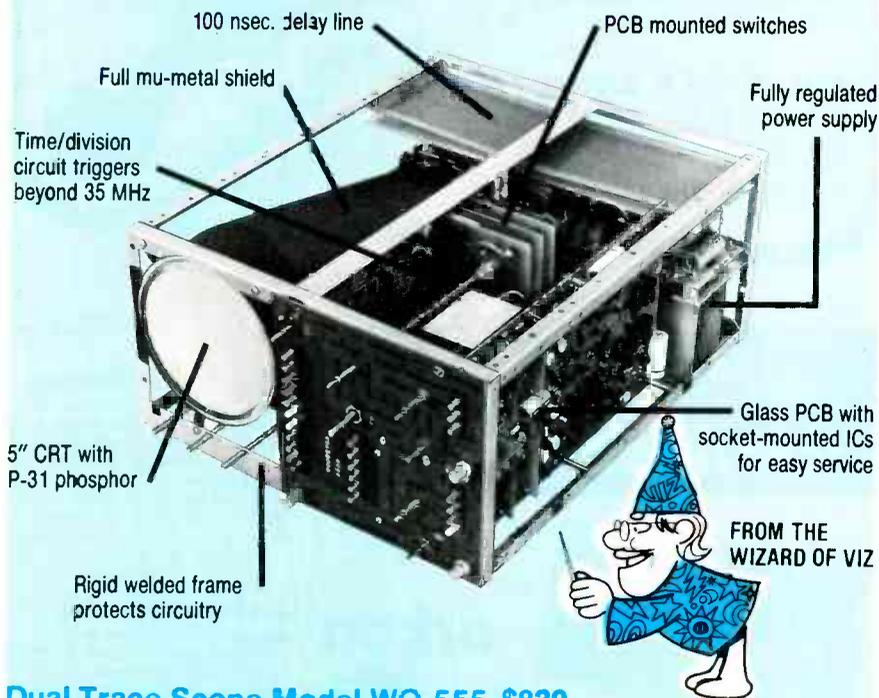
THE NAME "HARADA" PROBABLY DOESN'T SPUR instant recognition among most readers, but that company (1900 W. Artesia Blvd., Compton, CA 90220) claims to be the world's largest antenna manufacturer! Judging from their product-line catalog, they may be right.

Harada's specialty is producing original-equipment antennas and accessories for the automotive industry. AM, FM, AM/FM, and motor-driven antennas are available for roofs, gutters, fenders, mirrors . . . just about any spot on your vehicle where you would like to mount an antenna. And they are made for virtually every major automotive manufacturer in the western world.

As we flipped through the interesting Harada catalog, the unit which caught our fancy was the little *EA-50* "Electrona" antenna.

continued on page 34

Beauty Deep Down Inside



Dual Trace Scope Model WO-555 \$839.

The 15 MHz scope with more accuracy, convenience, versatility and a broader voltage capability (DC thru 600V) than others costing more money. Calibrated X-Y capability. Built-in delay line allows for viewing the full input waveform. "Undershoot and overshoot" can be seen and analyzed. **Unique simplified trig hold and adjustment control with LED indicator show trig polarity at a glance.** Two direct/X10 LcCap probes supplied.

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EQUIPMENT REPORTS

continued from page 33

Studying the specifications, we discovered that the little telescoping whip contains a base-mounted preamplifier designed to increase AM and FM signal strengths. Gain is specified as 15 dB on FM, and 10 dB on AM. Fully extended, the antenna is only 16 inches long. For protection, it may be collapsed totally and laid inconspicuously into a recessed groove in its base. A 59-inch cable, terminated with a standard Motorola plug, is supplied. A single red wire also emerges from the bottom of the mounting base to attach to the vehicle's 12-volt power system.

The *EA-50* is designed to be mounted as a replacement or supplementary antenna on any of a variety of locations on a vehicle. The illustrated literature which accompanies the antenna shows a number of recommended positions, including front or back fender cowls, rear trunk lid, and roof.

The antenna is supplied with a universal mounting kit, consisting of two different rubber gaskets to align with various flat or contoured surfaces. Because the gaskets are preformed, the cutouts may be used as a drilling template for the antenna mount. Additionally, a full-size printed template appears in the accompanying literature.

Since the antenna depends upon the car-body ground return of the vehicle to complete its 12-volt circuit, a good electrical connection to the metal mounting must be provided by the screws. If the antenna is mounted on a non-conductive surface, an additional wire connection must be provided to ground the unit's base.

Inasmuch as the total current consumption of the *EA-50* is only 10 milliamps, it may be connected directly to the automotive battery without fear of running it down! Alternatively, voltage to the positive wire may be switched on and off if desired . . . but frankly, we don't really see a need for it.

After the antenna is installed, the element is extended, and the antenna is positioned by hinging it through several detent positions until the desired angle is attained. The antenna may be collapsed and recessed for protection from vandalism and carwashes.

As with any other antenna, the AM trimmer screw on the car radio should be adjusted for stronger response of a weak signal near the top of the AM band. FM peaking is unnecessary.

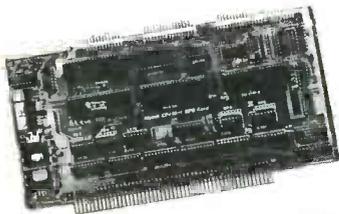
The accompanying literature is bilingual (German/English), and provides adequate mounting and operating hints. Suggestions are made for avoiding electrical interference due to grounds.

To check the *EA-50*'s claims, we compared it with a full-size four-foot vertical antenna element. An AM/FM radio using a common antenna input was used to simulate an installation in a vehicle. Testing the antenna using AM broadcasts, and FM as well, we found that the *EA-50* gave a good accounting of itself. Its short length was certainly deceiving in terms of ability to deliver strong signals on both bands.

In addition, the antenna worked quite well on signals outside of the bands it was designed for. For example, lower shortwave signals (up to perhaps 10 MHz or so) were quite receivable on the electronic antenna. Similarly, low-frequency signals in the 200-400 kHz range were quite readable using the *EA-50*.

Scanner buffs will be in for a disappointment, though. The *EA-50* has a rather sharp passband for FM-broadcast, and rejects signals

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outside of that range quite sharply.

We would judge the best application for the EA-50 to be where low-profile reception of AM and FM broadcast signals is desired. As with most other products, this antenna works best (if not exclusively) doing the job for which it was intended—and it does it well. Suggested retail price is \$52.90. **R-E**

Tri-Star Tiger 500 Capacitive Discharge Ignition



CIRCLE 105 FREE INFORMATION CARD

THERE ARE MANY AFTER-MARKET DEVICES sold to improve automotive performances. A prime target for improvement is the ignition system. Various schemes are available, most of them electronic.

The Tiger CDI (Capacitive Discharge Ignition) system uses an electronic-switching approach to increase engine performance. Silicon-controlled rectifiers are used to pulse the ignition coil. Tri-Star, the manufacturer, claims that the system will increase gas mileage up to 15%, reduce maintenance, and improve performance. That's an unbeatable combination if it works!

Theoretically, a capacitive discharge ignition should improve automotive engine performance several ways. It increases spark voltage, enhancing fuel combustion. At the same time, horsepower is increased. Because of the shorter spark time, spark plugs should last at least 50,000 miles. Because switching is done by the CDI system, the points hardly know they are being used. Expect considerable life from them as well. Cold starts should also be improved because of the higher spark voltage of the CDI system.

The CDI ignition is designed to work with a 12-volt ignition system, using either a generator or alternator. Triggering may be provided by breaker-type or breakerless points. Input amperage ranges from .6 to 6 amps, depending upon engine RPM. Output pulse rises to a peak in .3 to .35 μ Sec. There is .15 Joules of power available for each pulse. Minimum firing voltage is 5.5 volts. Output voltage (using the original ignition coil) will be 30,000 volts (engine is cranking and the battery voltage is reduced to 8 volts) to 45,000 volts (500 RPM engine speed). Peak spark current is .175 amps. The Tiger CDI weighs 2 pounds and measures a compact $4\frac{1}{2} \times 3 \times 5$ inches.

The Tiger 500 is available both factory-wired, and as an easy-to-assemble kit. The PC board is clearly labelled, parts are high quality, and the assembly manual is excellent. It even provides periodic self-checks to insure proper assembly.

To test the ease of assembly, the kit was given to a high-school student with no previ-

ous kit-building experience. It took him $1\frac{1}{2}$ hours to build. When it was finished, an examination revealed that the product looked professional. Power-switching components are adequately heat-sunked by the die-cast aluminum case.

It took less than a half hour to install the little CDI unit fully on a test vehicle. Directions were reasonably clear, although somewhat sketchy in places. By looking at the accompanying diagram, however, the owner should have no problem completing the installation correctly.

Several alternate installation diagrams are included for a variety of different ignition systems. The diagrams are clear, and the parts are of good quality.

A number of precautionary measures must be taken to insure proper operation of the

Tiger CDI: Proper grounding, removal of interference-suppressor capacitors from the coil, use of standard plugs, and low-resistance ignition wires are a few of them.

Our tests

After the unit was assembled, checked for wiring errors, and installed, it was time to try it out. The test vehicle was a 1975 Toyota Corolla station wagon. Several nearby hills would make an ideal track for time trials.

In all, eight time-trials were run. For each trial, the accelerator was floored at a dead stop at the bottom of each hill. The ignition system was alternated between original Toyota and Tiger 500. The results were generally disappointing. While Tiger literature said that improvements of up to 15% might be realized,

continued on page 104

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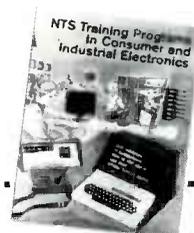
Digital Multimeter

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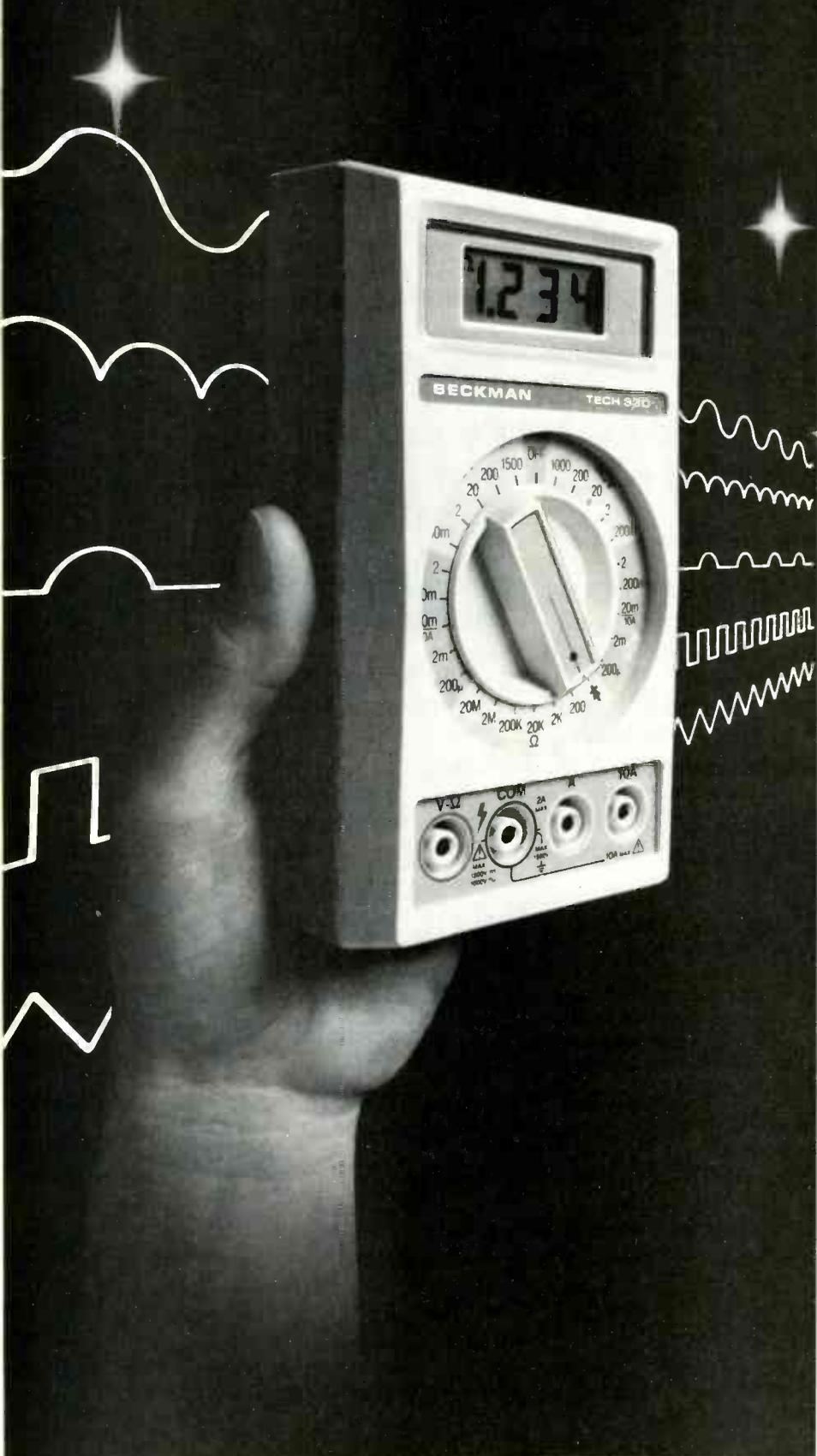
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True RMS makes a significant difference in accuracy when measuring switching power supplies, flyback power circuits, SCR or TRIAC controlled power supplies or any other circuit generating a non-sine signal.

The TECH 330 also accurately measures the entire audio band up to 20 kHz. But that's not all you can expect from Beckman's top-of-the-line multimeter.

Measurement Comparison Chart

Waveforms (Peak = 1 Volt)	Average Responding Meter	Beckman TECH 330	Correct Reading
Sine Wave 0	0.707V	0.707V	0.707V
Full Wave Rectified Sine Wave 0	0.298V	0.707V	0.707V
Half Wave Rectified Sine Wave 0	0.382V	0.500V	0.500V
Square Wave 0	1.110V	1.000V	1.000V
Triangular Sawtooth Wave 0	0.545V	0.577V	0.577V

You also get 0.1% basic dc accuracy, instant continuity checks, 10 amp current ranges, a separate diode test function, 22 megohm dc input impedance, and an easy-to-use rotary switch.

With so much capability in hand, you'll be able to depend on the TECH 330 for a long time. That's why Beckman designed it tough enough to go the distance.

Enclosed in a rugged water-resistant case, the TECH 330 can take a 6-foot fall onto concrete and still perform up to spec. And to further ensure reliable, trouble-free operation, the TECH 330 gives you 1500 Vdc overload protection, RF shielding, 2000-hour battery life, gold switch contacts, and fewer electronic components to worry about.

Add another dimension to your world of electronics. Visit your Beckman distributor today for more information on the TECH 330 and Beckman's complete line of digital multimeters, starting at \$120.

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BUILD THIS

PAY-TV DECODER

Pay-TV puts cable-quality programming on the air. This is the inside story of the methods used by broadcasters to insure privacy.

D. LANDFEAR

ONE OF THE FASTEST GROWING TV MARKETS today is the subscription-TV, or pay-TV, business. Most pay-TV broadcasters use one of the standard UHF or VHF channels but transmit an encoded, or scrambled, picture. In order to watch those scrambled signals, a subscriber needs to have a decoder attached to his set. Subscription TV is much like cable TV...without the cable.

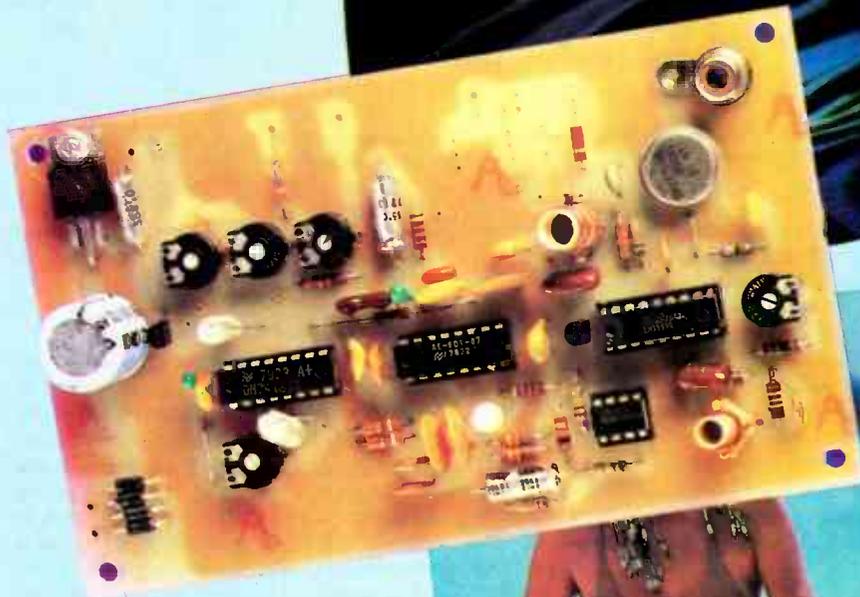
New pay-TV stations are coming on the air every month; and with over a million subscribers already watching, the prospects for still more stations are indeed good. All of those stations offer approximately the same fare: During prime time they show full-length movies and special-event features, such as night-club acts and sporting events. A special bonus for their monthly subscription fees is that the subscribers are never subjected to commercials.

Pay TV isn't based on any new technology; indeed, the technique of scrambling TV pictures is almost as old as TV itself. In the past there have been at least a dozen different pay-TV schemes that have come and gone because of cost, complexity, or market

NOTE:

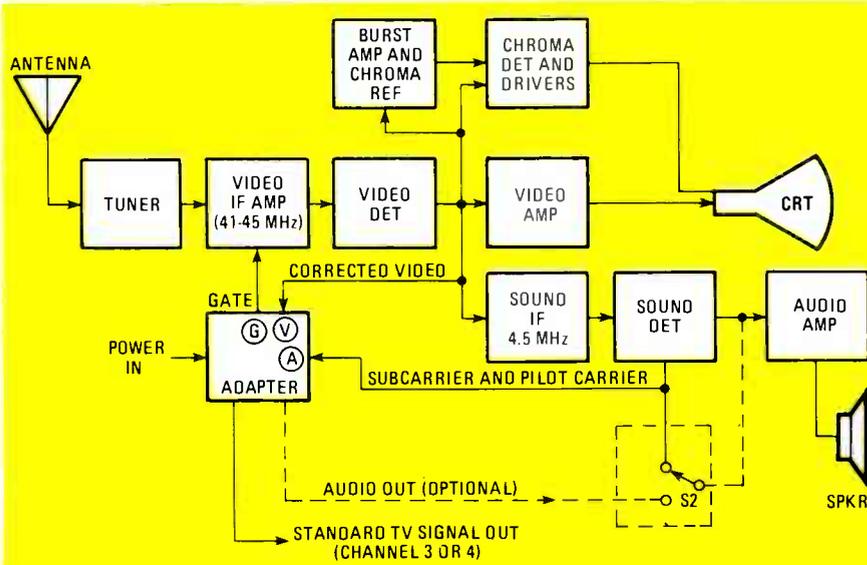
The legality of the use of privately-owned devices to decode subscription TV broadcasts is currently the subject of much debate and pending litigation. The subscription companies have taken the position that decoding of broadcasts without payment is "theft of service" and the FCC has issued a notice to the effect that subscription-TV decoders are subject to FCC approval.

This article merely explains how such decoding devices are built and used, and you should obtain independent advice as to the propriety of its use depending upon your individual circumstances.



conditions. However, current technology has played a part in the recent success of those systems: Decoders in use today are a complete receiver which merely attaches to the antenna terminals of the subscriber's set. Contrast that to earlier designs which require connections *inside* the set to the sync, video, audio, and other signals.

Presently, five different encoding schemes have been authorized by the FCC; at least three of them are in use now. All of those systems use essentially the same approach to encoding the signal. Either the audio channel is taken off the main channel and put on a subcarrier, or another audio channel is added somewhere in the composite signal, usually below the video carrier. The video is encoded by removing, suppressing, or masking the sync pulses; that disables the receiver's sync-separator circuit. A viewer who received such a scrambled signal on a normal receiver would see no coherent picture and would probably hear a "barker" or announcer telling him how much he was missing by not being a subscriber!



CONNECTION POINTS FOR PAY TV UNSCRAMBLER are indicated in block diagram. A thorough schematic will be necessary for you to locate these points in your own TV receiver.

CONNECTIONS TO TV SET(S)

Connecting the adapter to a TV receiver will require some amount of "digging" and TV knowhow on the part of the builder. There are two possible ways to use the adapter: The TV receiver with the adapter installed can serve as the monitor in which the program is watched; or the program can be watched on a second TV receiver tuned to the channel 3 or 4 output of the adapter's RF modulator.

To install the adapter it will be necessary to find the following connection points in the receiver:

- Power (12 volts or greater)
- Audio-detector output
- Emitter(s) of one or more video IF-gain stages
- Video-detector output

The diagram at the left shows a simplified block diagram of these connections, and each will be discussed next month.

All three of the encoding systems now in use throughout the country make use of one variation or another on that theme. The unscrambler described below works for only one of those three systems but the principles involved are applicable to all of them.

To determine whether the system used in your area is the same as the one discussed here, there are two things you can do. The simplest is to check for the presence of a 5.750-kHz pilot tone at the audio detector of your TV set. If it's there, you're all set. The other is to use your scope (preferably dual-trace) to observe the video waveform. If it matches that shown at the bottom of Fig. 1, once again, you're on the right track.

The significance of the pilot tone and unusual waveform will be made clear below.

How scrambling works

First, let's review the characteristics of a standard TV signal. In order to produce a picture, the entire face of the picture tube is scanned line-by-line, starting at the top left and continuing to the right and down, in what is called a raster scan. Each complete scan is called a frame, and takes 1/30th of a second to complete. During that 1/30th of a second, however, 525 lines are transmitted. Therefore, in one second, there are 525 × 30, or 15,750 lines transmitted. In order to produce a coherent image on the screen, it is neces-

sary to transmit synchronizing (or *sync*) pulses. Those pulses are used to insure that the scan begins at precisely the correct time. Both vertical- and horizontal-sync pulses are used for this purpose.

A vertical-sync pulse defines the beginning of each frame and field (half a frame) and a horizontal-sync pulse defines the beginning of each line. In addition to sync pulses, there is an additional signal called a blanking pulse. To understand the purpose of the blanking pulses, recall how the raster scan goes line-by-line from left to right down the screen. In order for it to get from the end of one line (or one frame) to the beginning of the next, it must sweep back or retrace its path. However, during the brief period when it is doing that, it is necessary to turn off the beam, or blank it. That is the function of the blanking pulse. The sync pulses are superimposed on the blanking pulses.

What happens is that every time the beam sweeps to the end of a line, or frame, it is extinguished or blanked by the horizontal or vertical blanking pulse, respectively, before it is reset to the beginning of the next line, or frame, by the sync pulse.

Now, suppose we alter the characteristics of the sync pulses, or even remove them entirely. What happens? You guessed it—a mess on the screen instead of a picture. The waveforms of a scrambled signal have these characteristics: non-standard sync and blanking pulses. That non-standard signal is compared to a standard signal in Fig. 1, which represents about 1½ lines of video information as viewed on an oscilloscope. The upper trace represents a normal video signal and the lower trace a scrambled one.

Note that in a standard signal, the horizontal-blanking pedestal estab-

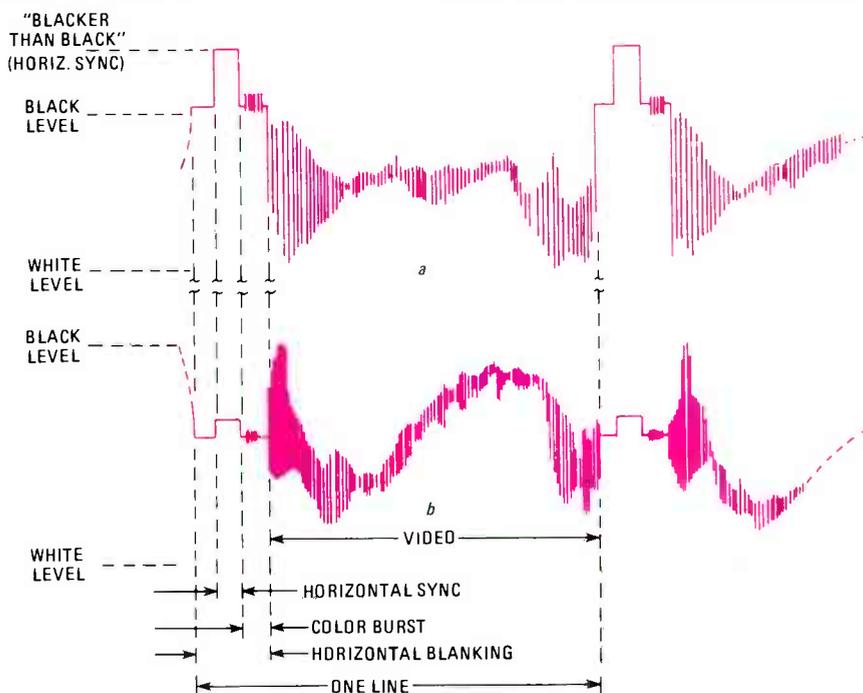


FIG. 1—NOTE DIFFERENCES in horizontal-blanking intervals between normal (top) and encoded (bottom) signals.

PARTS LIST

Resistors ½ watt, 5%

R1, R28—470 ohms
 R2—10000 ohms, potentiometer
 R3—22000 ohms
 R4, R5—3900 ohms
 R6, R7—100,000 ohms, potentiometer
 R8, R21—1000 ohms, potentiometer
 R9, R10, R26—15000 ohms
 R11, R27—100,000 ohms
 R12, R13, R20—10000 ohms
 R14-R16—not used
 R17—2200 ohms
 R18, R19—not used
 R22—75 ohms
 R23—100 ohms
 R24, R25—240 ohms
 R29—1000 ohms

Capacitors

C1, C15—10 μ F, electrolytic
 C2, C8—1.0 μ F electrolytic
 C3—0.033 μ F ceramic disc
 C4—0.003 μ F ceramic disc
 C5—470 pF, mica
 C6, C7—0.022 μ F ceramic disc
 C9—0.0047 μ F polystyrene or mylar
 C10—0.0047 μ F polystyrene or mylar
 C11—100 pF ceramic disc
 C12-C14, C27—0.1 μ F ceramic disc
 C16, C17—not used
 C18—22 pF ceramic disc
 C19, C20—0.001 μ F ceramic disc
 C21—56 pF mica
 C22—82 pF mica
 C23, C26, C28-C30—0.01 μ F ceramic disc
 C24—1000 μ F electrolytic
 C25—6.8 μ F tantalum electrolytic

Semiconductors

D1—1N914
 D2—not used
 D3-D6—1N4001
 LED1—jumbo red LED
 IC1—LM1800 PLL FM stereo demodulator
 IC2—74123 dual retriggerable monostable multivibrator
 IC3—LM741 op amp
 IC4—LM1889 TV video modulator
 IC5—7812 12-volt positive regulator
 IC6—78L05 five-volt positive regulator
 Q1—not used
 Q2—MPSA05
 L1—0.068 μ H slug-tuned coil (2½ turns #18 wire on ½-inch form) (J.W. Miller 48A77MPC or equivalent)
 L2—7-12 μ H slug-tuned coil (J.W. Miller 23A105RPC or equivalent)
 S1—SPST switch
 S2—SPST or DPST switch
 T1—14-18-volt, one-amp transformer (optional)

Miscellaneous: PC board, phono jack, vestigial sideband filter FL-1 (Plessey SW300 or equivalent—optional), solder, IC sockets, etc.

NOTE: The following are available from Micro-Mart, 552 Summit Avenue, Westfield, NJ 07090 (Tel. 201-654-6008) or Sterling Technology, POB 5929, Incline Village, NV 89450 (Tel. 800-538-9787 except CA. CA residents call 800-662-9238): Etched & drilled, solder-plated PC board with instruction manual, \$20.00; PC board only, \$15.00; kit of all parts with manual, \$69.00. Visa and Mastercard accepted, please add tax where applicable. All prices postpaid within contiguous 48 states.

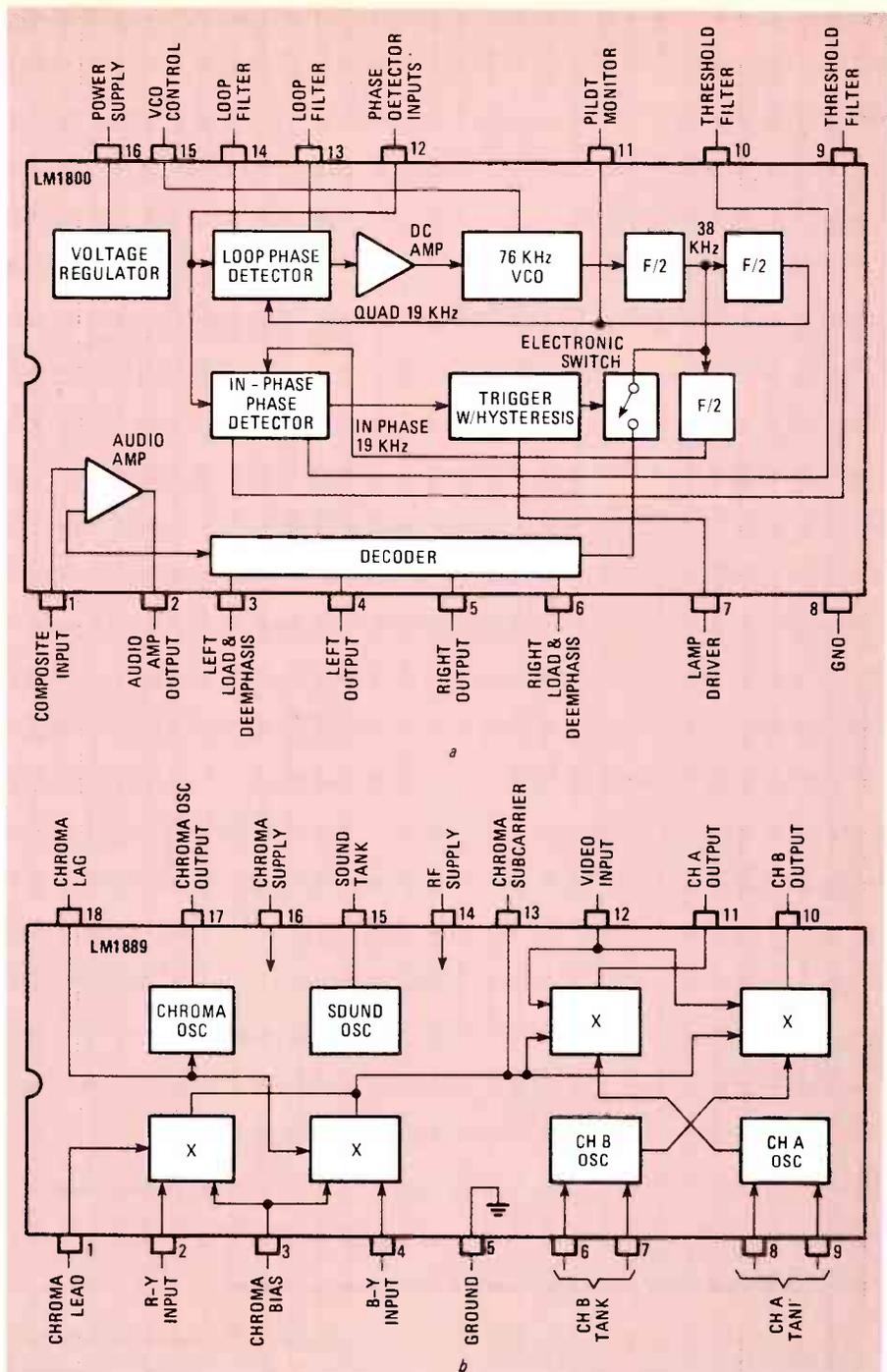


FIG. 2—ALTHOUGH DESIGNED for other purposes, the LM1800 and LM1889 can be used in decoding applications.

lishes the black level for the line. The sync tip is in the "blacker-than-black" region. In the non-standard signal, however, there is no clearly recognizable blanking pulse. Thus, there's no black reference; the video signal itself is seen in the "blacker than black" region by the set, making synchronization impossible. It should also be noted that during the horizontal-blanking interval, a color-synchronization signal is also transmitted. That signal, called the color burst, is used to synchronize the color-detection circuits in the TV set. With a normal signal, the set's circuitry expects to see the color-burst signal during a specified interval. If it doesn't recog-

nize the blanking pulse, then it can't recognize the color-burst signal either; thus, the set's color circuitry is either unsynchronized or doesn't work at all. So just by changing one part of the signal—the blanking pulse—it is possible to destroy not only the picture sync but also the color sync.

All that has been done to the scrambled video signal has been to reduce the horizontal blanking-signal level below the video-signal level. To reconstitute the picture, all that is required is to restore everything to its original levels. That can be accomplished very simply by momentarily increasing the gain of the TV receiver during the horizontal-blanking interval. The trick

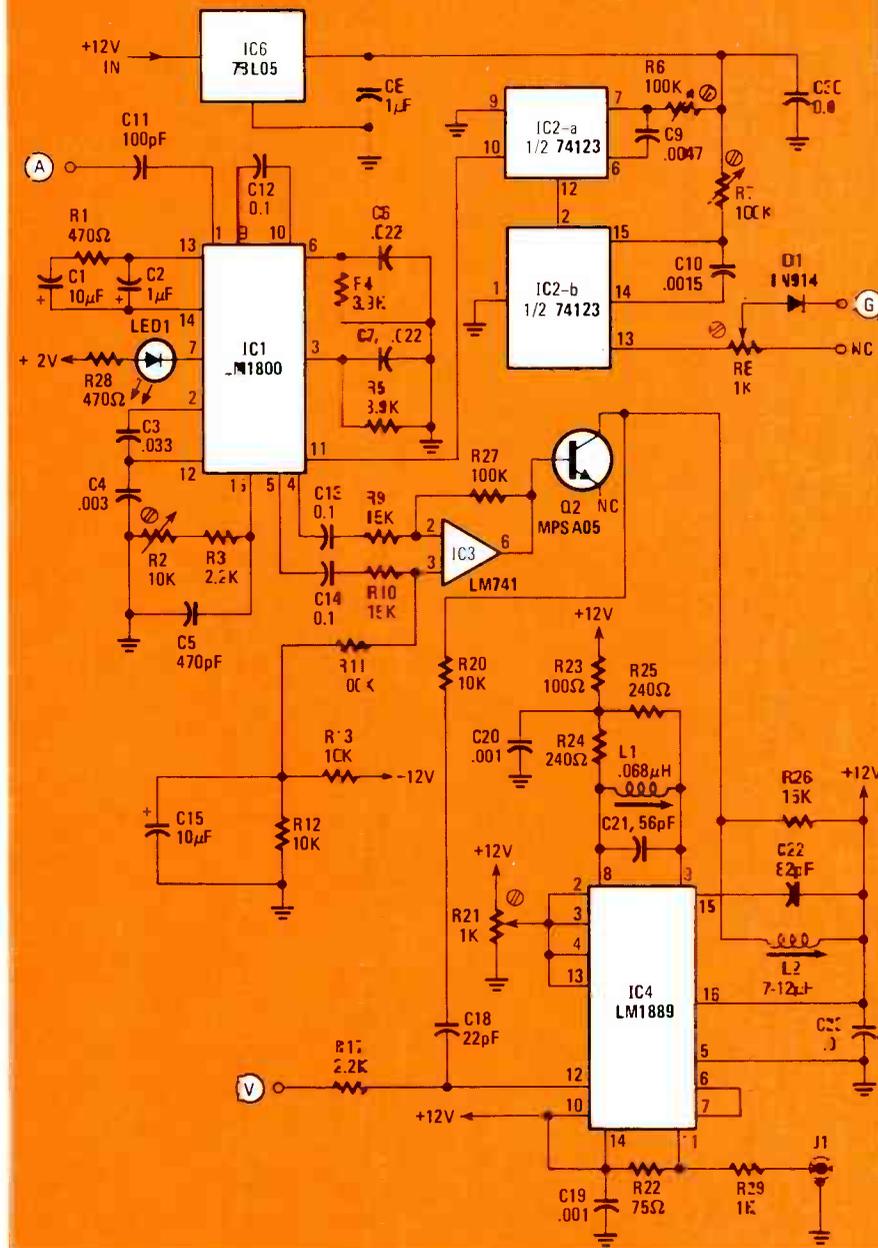


FIG. 3—A SIMPLE PAY-TV DECODER uses just four IC's and a transistor.

is to know exactly *when* to increase the gain. Since the video signal is such that the blanking pulse is almost unrecognizable, perhaps we should look elsewhere.

An unscrambler

Let's digress for a bit and talk about the sound. As you will see, there is a very important correlation between the sound and the restoration of the sync- and blanking-pulses. Program audio is transmitted via a 31.5-kHz sub-carrier. The information on that sub-carrier is a double-sideband, suppressed-carrier signal. In order to demodulate it, a reference signal, or pilot carrier, is required. The frequency of that pilot carrier is one-half the modulating-carrier frequency ($31.5/2 = 15.75$ kHz). That number—15.75—is the horizontal-line frequency we talked about earlier, and represents

the number of horizontal-sync pulses generated in one second. Obviously there is some correlation here.

The pilot-carrier signal can be used as a timing reference to recreate the sync and blanking pulses. The pilot carrier generates a 15.75-kHz square-wave signal in a decoder IC such as an LM 1800. That signal in turn is used to trigger two cascaded one-shot multivibrators that produce a gate pulse of exactly the same width and phase as the horizontal-blanking pulse. That gate pulse is used to increase the IF gain of the TV receiver during the horizontal-blanking interval, restoring the sync- and blanking-signal strengths to normal.

The method is the same as the one used to transmit the difference information that produces an FM-stereo signal. And, since the same process is involved, the same hardware can be

used to retrieve the signal. The only difference between the stereo system and this system (other than the choice of frequencies) is in the way the signals are retrieved on the output. In a stereo system, the main-channel signal is added to the sub-carrier signal to produce two separate channels. In the unscrambling application, the main-channel signal is subtracted, and only the subcarrier signal is used.

Block diagrams of both the LM1800 PLL stereo decoder and LM1889 TV video modulator IC's are shown in Fig. 2 to help you understand the workings of the unscrambler.

The circuit

Fig. 3 shows a schematic diagram of a decoder circuit. Assume that the circuit is connected to a TV receiver tuned to a scrambled broadcast. The outputs from the TV's audio and video detectors are connected to points "A" and "V" respectively.

The signal from the TV audio detector is applied to pin 1 of IC1, a PLL FM-stereo demodulator, through C11, a 100-pf coupling capacitor. That capacitor removes most of the main-channel information while allowing the high-frequency subcarrier and pilot carrier to pass through. The pilot carrier is used to phase-lock a 15.75-kHz oscillator that's part of IC1. The free-running frequency of the oscillator is determined by R2, R3, and C5. Phase-lock is indicated by LED1, which lights when lock occurs.

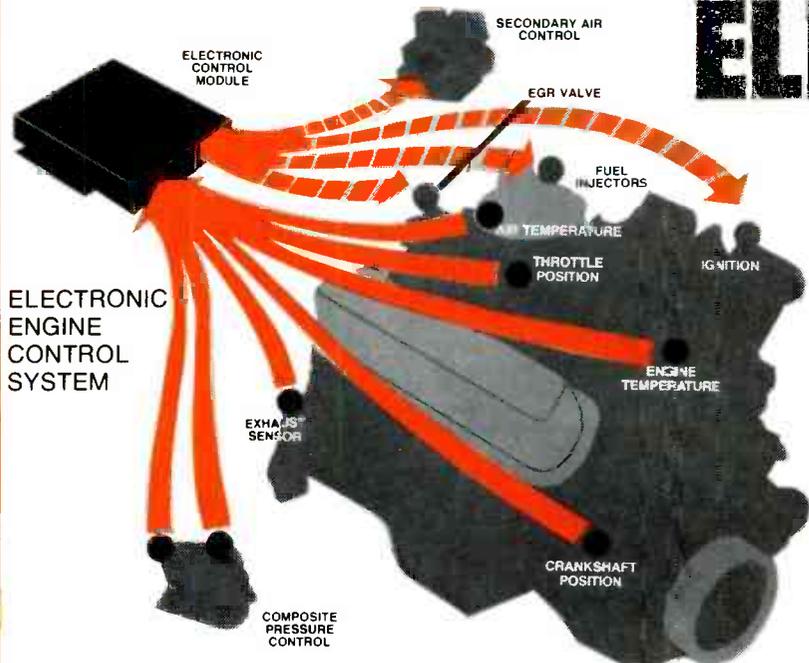
The audio outputs appear at pins 4 and 5 of IC1; they would normally be the left- and right-channel outputs if a stereo signal were being decoded. However, since the intent is to recover only the subcarrier audio, those signals are applied differentially to a 741 op-amp, IC3. The main-channel component is in phase at both the inverting and non-inverting inputs and is cancelled out by IC3. Since the subcarrier signal is 180° out of phase with itself at those two pins, it is not cancelled and appears at the output of IC3.

Next month we will finish discussing how the decoder works and will show you how to construct such a device. We will also provide step-by-step instructions for connecting it to your own TV set. **R-E**



"Now tell me how smart you are!"

ELECTRONICS IN YOUR NEXT CAR



Microprocessor-based technology is making your car's engine a more efficient machine. It's bringing about other improvements, too.

MARTIN BRADLEY WEINSTEIN

FIG. 1—FORD'S MICROPROCESSOR CONTROL UNIT controls carbon monoxide, hydrocarbon, and nitrogen-oxide engine emissions. An oxygen sensor in the engine's exhaust manifold monitors the content of the exhaust and signals the electronic control unit to adjust the air/fuel mixture in the carburetor to maintain the precise mixture for proper operation of the catalyst.

Looking Under the Hood

LAST MONTH, IN PART ONE OF THIS FOUR-part series, we looked at electronics and how it was being applied in the passenger compartment in the new breed of automobiles from Detroit. We looked at digital dashboards and trip computers.

This month, we continue with a look at how electronics is being applied under the hood—engine controls.

Ford claims the "fastest and most versatile interactive electronic control system in the automobile industry... probably two years ahead of its closest competition in the use of electronic control systems."

The New Chrysler Corporation offers what "company engineers believe...is the world's only known continuous-flow method of electronic fuel injection."

Cadillac, the creme de la creme of GM, claims to provide 1981 model buyers "with one of the most advanced engine control, fuel-metering, and emissions-monitoring systems in the automotive industry."

Disregarding for the moment the industry's penchant for claims of superiority, we find some fascinating new approaches to electronic engine control, continued development of some recent trends, and a surprising degree of ingenuity and sophistication.

Here's a closer look at what's changing under the hood, in and around the carburetor, through the ignition system,

and inside the cylinders. You don't have to know much about engines to follow this—and, even if you are an automotive expert, there is a lot to be learned from these new technologies.

The Ford EEC and MCU

Like so many other improvements in the engine compartment, Ford's Microprocessor Control Unit (MCU)—shown in Fig. 1—and Electronic Engine Con-

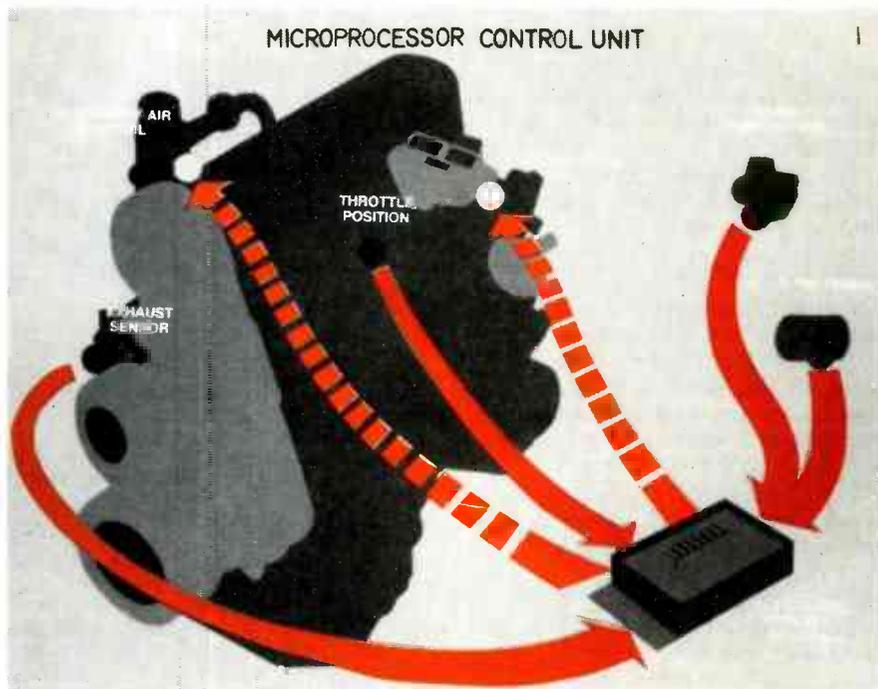
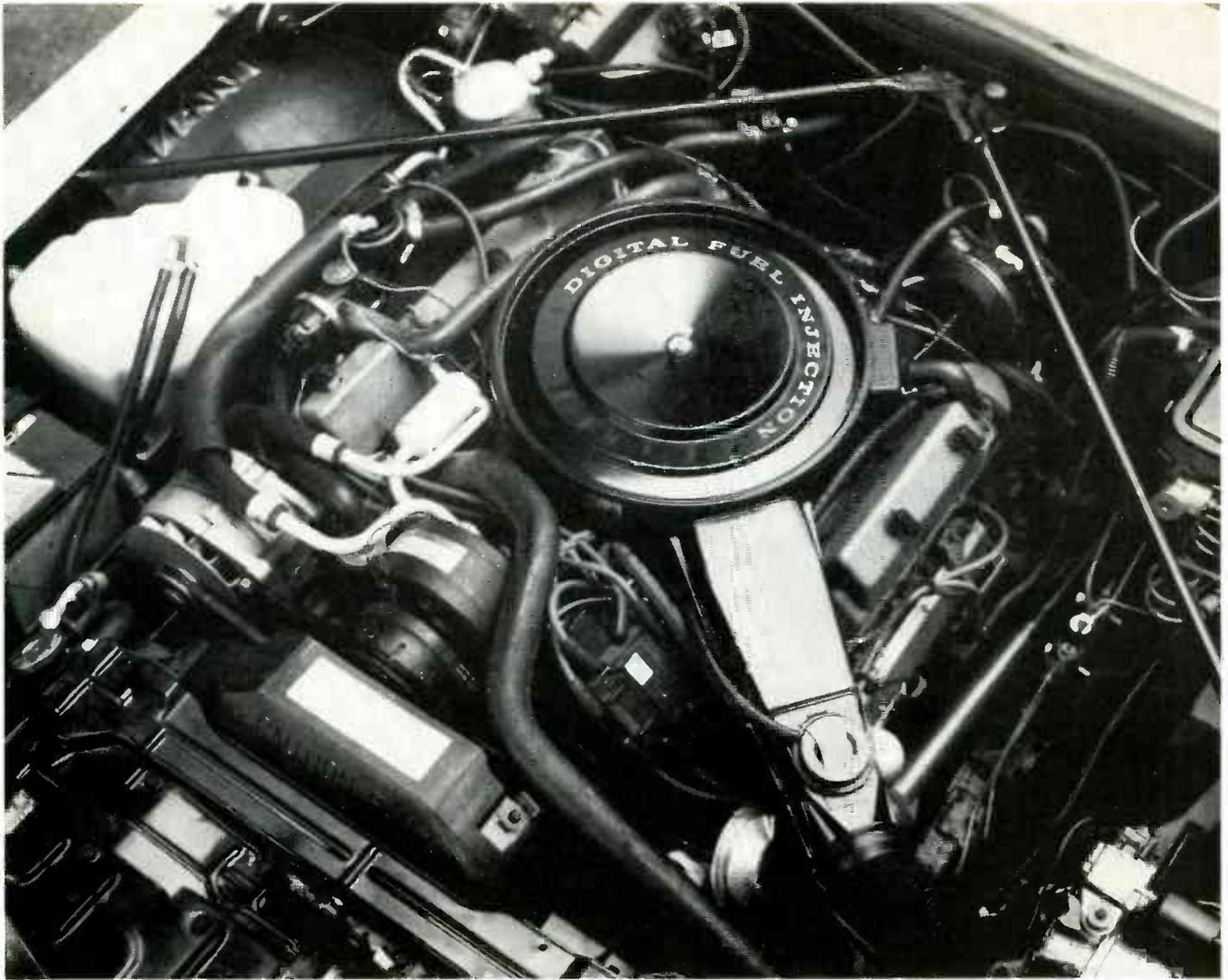


FIG. 2—FORD'S ELECTRONIC ENGINE-CONTROL system senses internal and external engine parameters of the engine, then adjusts the air/fuel mixture, spark timing, and exhaust-gas recirculation for optimum engine performance. At 55 MPH, the system can read seven engine parameters and adjust six engine functions in less than one engine revolution.



SHOULD ANYTHING EVER MALFUNCTION in this Cadillac engine, an Electronic Control Module will take over and do its best to keep the car running until service can be obtained.

control (EEC) system—shown in Fig. 2—evolved from stiff federal emission requirements, and even stiffer ones in California.

The MCU evolved from a unit introduced on some 25,000 Ford vehicles sold in California in 1978, and will have appeared on some 597,000 Fords by the end of the 1981 model year. Inputs to the microprocessor include engine speed and temperature, throttle position, and the oxygen content of the gases in the exhaust manifold. The microprocessor analyzes those conditions and controls the fuel-air mixture (lean) in the carburetor.

EEC broadens the scope of engine sensing and control. That system, first available in its third generation as EEC-III on top-of-the-line Ford 5.8-liter engines in 1980, monitors both air and engine temperature, both throttle and crankshaft position, composite pressure, and exhaust gases. It controls fuel injectors, exhaust-gas recirculation (EGR), ignition timing, and air intake.

EEC-IV, which is the next generation system, offers even more im-

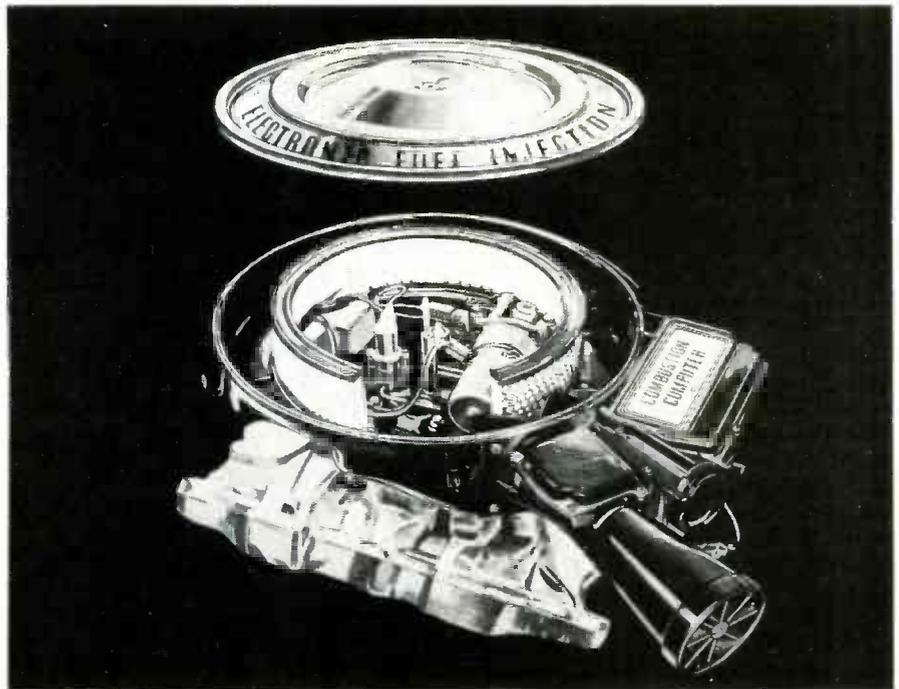


FIG. 3—CHRYSLER'S ELECTRONIC FUEL-INJECTION system replaces the carburetor with a complex pod of electronics, sensors and electromechanical devices.

provements, according to Ford VP John Betti. "It will be several times faster than our present system, have 20% more memory efficiency, and it will accomplish that with two-thirds fewer LSI chips...meeting more stringent emissions standards for oxides of nitrogen...plus Federal tamper-resistance and altitude-compensation standards."

Chrysler's EFI

Remember when Frank Sinatra drove his new 1981 Imperial off the line last summer? That was the first car with Chrysler's "continuous-flow" Electronic Fuel Injection (EFI) system, a rather remarkable accumulation of technology.

EFI controls the amount of fuel pumped from the tank, the mix, and the spark advance; that is based on air and fuel temperature and flow, engine speed, coolant temperature, throttle position, exhaust-gas oxygen content, and more. There's no choke, no separate idle-metering system, no separate wide-open-throttle metering system, no diaphragm-type fuel pump, and no special starting procedure. See Fig. 3.

There are three major parts to the EFI system. In the fuel tank, in addition to the usual plumbing, there's an electric turbine pump and several check valves.

In the air-cleaner assembly, there's an air-flow metering sensor, EGR vacuum sensing, and both metering and ignition-control electronics modules.

Third is the throttle body assembly, including the fuel-control pump and its power electronics, fuel-flow sensing, pressure-regulating valves, spraybars, and an automatic idle speed motor. See Fig. 4.

Here, Chrysler Engine Electrical Engineering Chief Engineer E. W. Meyer, Jr., explains how the system works:

Basically, the computer senses the flow of air into the engine, the flow of fuel and oxygen content in the exhaust gas. It compares those signals to an ideal calibration. When any of the signals is different from the calibration, the computer signals the control-pump motor to deliver more or less fuel, depending on whether the air/fuel mixture is too rich or too lean.

The pump in the gas tank sends fuel to the control pump. The control pump takes a small portion of it (see Fig. 5) and delivers the fuel at 21 pounds-per-square-inch at idle through the fuel-flow sensor and the fuel-delivery regulator valve, into the delivery spraybar, and then through the nozzles of the spraybar and into the engine.

Since the openings are fixed, pressure has to vary to deliver more fuel at higher speeds, up to 60 psi. The spraybar is designed to produce an even flow of fuel at low

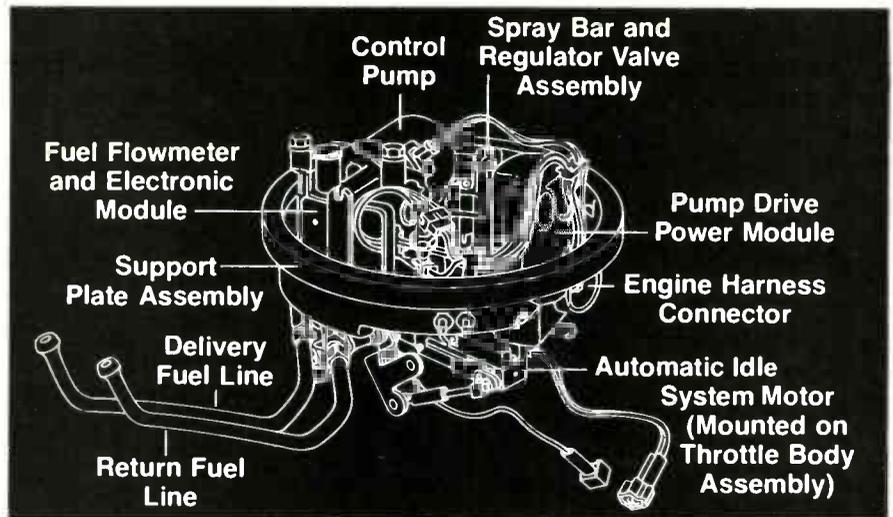


FIG. 4—THE AIR-CLEANER AND THROTTLE-BODY assembly in Chrysler's Electronic Fuel-Injection system contains the fuel-control pump and power electronics, fuel-flow sensing, pressure-regulating valves, spray bars, and automatic idle speed motor.

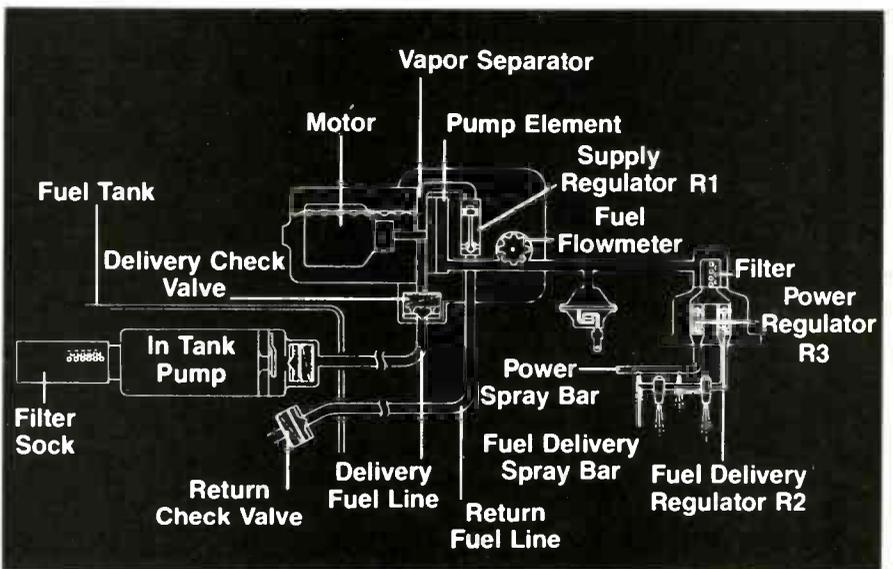


FIG. 5—FUEL FLOW in Chrysler's Electronic Fuel-Injection system is measured, monitored, metered, and manipulated by electronics.

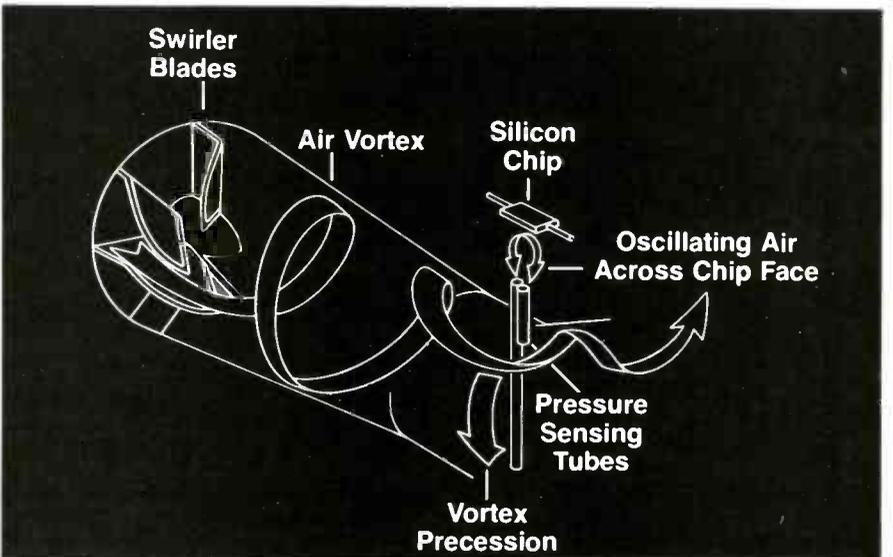


FIG. 6—THE AIR-FLOW SENSOR in Chrysler's Electronic Fuel-Injection system contains blades that swirl the air as it enters a vortex. Centrifugal effects makes the air pressure lower at the center of the vortex, higher at the outside. As the swirling air expands, the low-pressure center begins to rotate around the wall. A silicon pressure-sensor pulses faster as the air flow increases, and slower as the air flow decreases, providing air-flow data to the combustion computer.

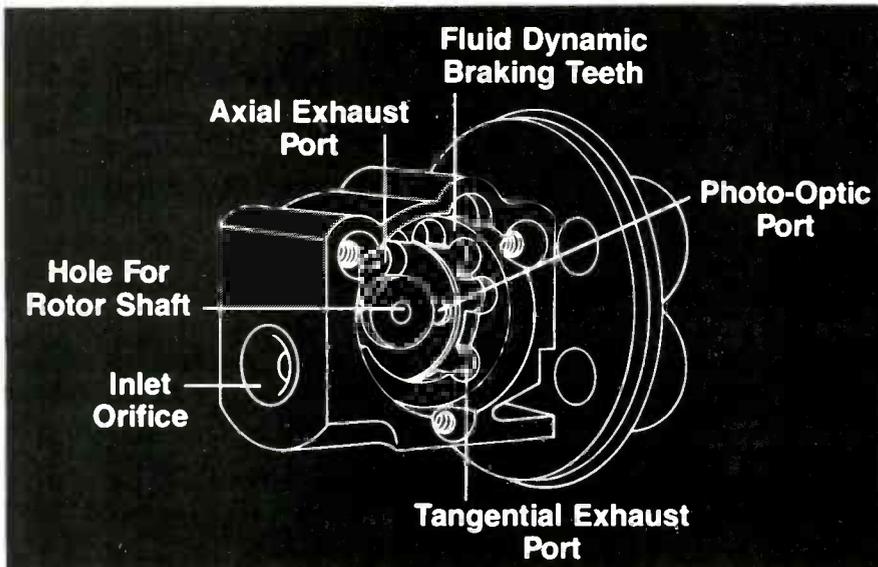


FIG. 7—CHRYSLER'S FUEL SENSOR is essentially a paddlewheel flowmeter with an optoelectronic interrupter providing a pulse rate proportional to fuel-flow rate.

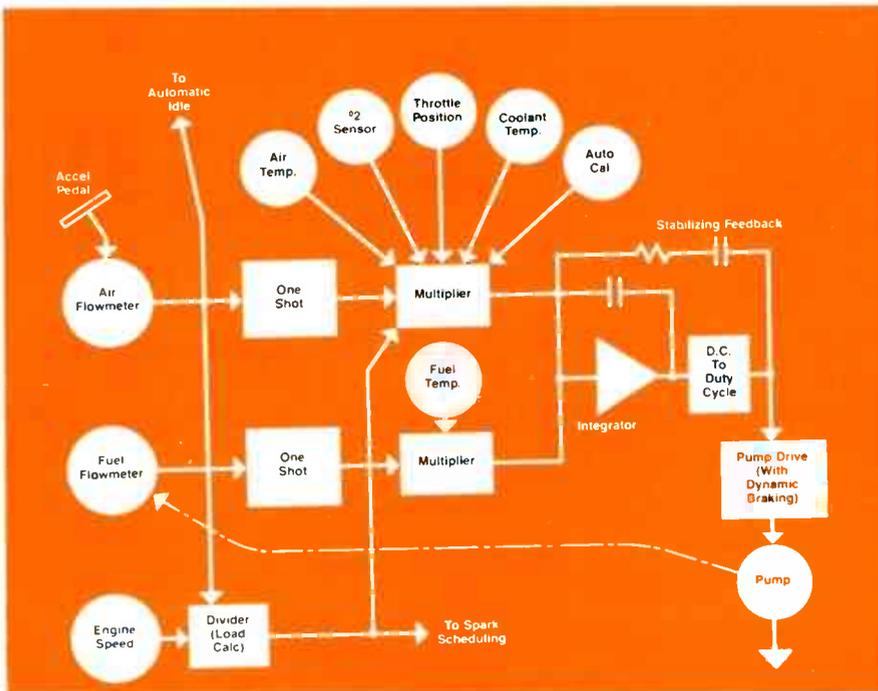


FIG. 8—SIGNAL PROCESSING in Chrysler's EFI system. Block diagram gives you some idea of the complexity of the system. The air and fuel one-shots are of opposite polarity, resulting in a continuously variable net charge on the integrator and extremely fine control of the duty cycle of the drive pulse to the pump-control transistors.

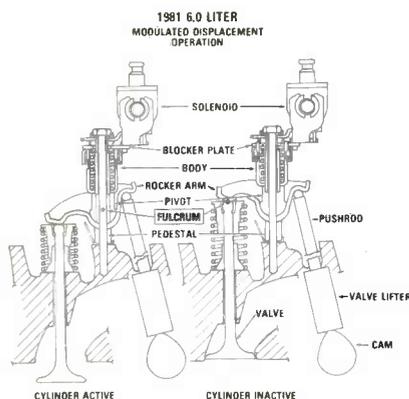


FIG. 9—CADILLAC'S MODULATED DISPLACEMENT system activates 4, 6 or 8 cylinders, as required.

EFI maintains the quality of the air/fuel mixture by arranging the throttle blades and bore in geometrical relationships that make the inducted air shear, entrain, and distribute the fuel evenly to each cylinder.

Chrysler's EFI is on the 1981 Imperial 318 CID V-8 engine. If you're fascinated, stop by a dealer for a look under the hood.

Cadillac's DFI and MD engines

Modulated Displacement (MD) and Digital Fuel Injection (DFI) are the tricks Cadillac's new 6.0-liter engine is up to. It's an eight-cylinder engine—no, six—no, four—hey, hold on there!

MD is an electromechanical system that calls up 4, 6, or all 8 cylinders, depending on driving requirements, based on commands from a controlling micro-processor to four engine-valve selector units. Those are capable of simultaneously deactivating both the intake and exhaust valves of the cylinder. (See Fig. 9.) And modulated displacement is just one factor in that remarkable engine.

Digital Fuel Injection (DFI) uses electronically pulsed fuel injectors under the control of the Electronic Control Module (ECM), central intelligence for all systems under the hood.

The ECM monitors manifold absolute pressure, engine-coolant temperature, intake-manifold air mixture temperature, engine speed, and throttle position. It computes ignition timing and air/fuel mixture requirements and controls them; and it also relays sensor data both to the cockpit (dashboard) systems (like MPG Sentinel and Cruise Control) and to a service-diagnostics connector.

Idle speed is programmed into the ECM memory and is maintained regardless of whether or not the car is in gear, the air conditioner is on, or any other change in engine loading is introduced. That is said to reduce stalling, improve fuel economy, and eliminate idle adjustments.

The ECM also actively participates in a number of continuous diagnostic-checking routines, which result in one of the industry's most intelligent "idiot lights" ever, one marked simply CHECK ENGINE. The ECM monitors the engine control system, sensors, and actuators for proper operation. Any malfunction, no matter how temporary, is memorized. The CHECK ENGINE light is turned on. Nominal values are substituted for critical sensors until repairs can be made. And when you eventually get the car to the repairman, he can tell what's wrong by instructing the ECM to display the fault code on the digital dashboard display that is normally used as part of the climate-control system.

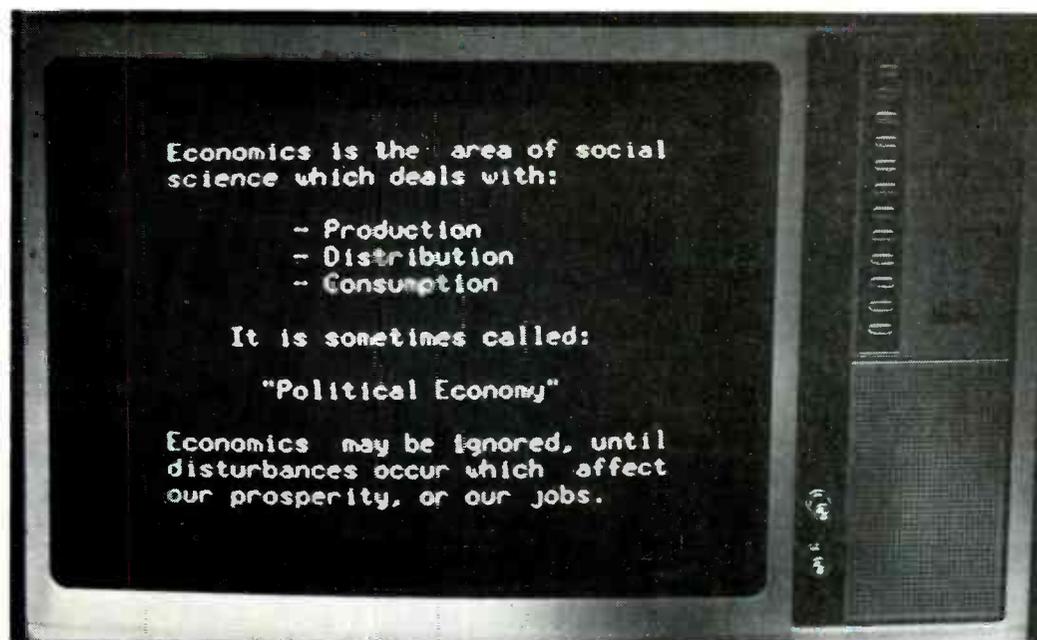
continued on page 81

speeds. At higher speeds, a second spraybar, the power spraybar, opens to deliver the full amount of fuel at the correct pressure. Fuel that is not needed for a given speed automatically returns to the tank through the return check valve and return fuel line.

The air and fuel sensors report the volume of flow. The air and fuel sensors are shown in Figs. 6 and 7. Three additional sensors change the volume readings to mass readings. Basically, the signals from the two flowmeters trigger one-shot pulses of opposite polarities. Those are fed into an integrator, which controls the pump motor. The block diagram of the signal processor is shown in Fig. 8.

BUILD THIS

COMPUTER/TV



INTERFACE

A SHORT TIME AGO I BUILT A SMALL MICROCOMPUTER. As it neared completion, I realized that, since it had a composite video output, I would need a video monitor to use it. Because of my low budget, I decided to convert a 12-inch black-and-white TV set for this purpose. As is well known, you cannot connect an AC/DC TV set to a transformer-based computer without running the risk of electrical shock or of blowing up one or the other...or all of those. Therefore, I decided to build a circuit that would couple the computer to the TV set using optoisolators to separate the two electrically.

The circuit I designed is simple in concept, inexpensive, and not very critical with respect to parts-replacement or wiring. It can be built using wire-wrap or point-to-point wiring techniques on perforated construction board.

The one sensitive area, however, is the speed of the components used. Because the video rate of a 64-character line, using 5 × 7 dot-matrix characters with one space between characters (the output of the video board I am using) is about 8 MHz, high-speed components must be used.

Ordinary analog optoisolators won't even begin to do the job—they're much too slow. Instead, I used a *digital* device, the HP-5082-4360, that can run

Any black-and-white TV set can safely serve as a monitor for your computer when you build this inexpensive optically-isolated interface.

DAVID E. CARTIER

at speeds up to 20 MHz. Similarly, the NE529 comparators used in the circuit are high-speed devices.

Theory of operation

To understand how the analog TV signal is turned into a digital one for the optoisolators, refer to Fig. 1. It shows an idealized video waveform of the kind generated by the computer's video-board circuitry. You can see that only three voltage-levels are really involved. The sync level is at or near ground potential—close to zero volts. Black (the background) is at about 0.5 volt and white (the color of the characters) is around one volt. By using

comparators to check the level of the video signal against reference voltages for black, white, and sync, it is possible to separate those three pieces of intelligence and then pass them through the optoisolator circuitry as logic-“highs” and logic-“lows”.

The complete circuit is shown in Fig. 2. The composite video signal from the computer is input at J1 and supplied to the inputs (pin 3) of two NE529 high-speed comparators.

To recover the sync signal, IC1 is referenced by resistor R4 close to—but slightly above—ground potential (about 0.1 volt). That is done because a TTL or CMOS logic “0” actually may be slightly higher than zero volt. Since the sync pulse is the low-level part of the composite video signal, IC1 produces an output pulse for each sync pulse and ignores the video—the video level never gets that low.

On the other hand, IC2 has its reference voltage set higher by R3, to accommodate the video portion of the signal. That resistor is variable so as to make it easy to define the threshold level at which black turns to white.

Two outputs are available from the NE529's, inverted and non-inverted. I used the inverted output to complement the inverted output of the optoisolators. (The two inversions restore the signal to its original polarity.)

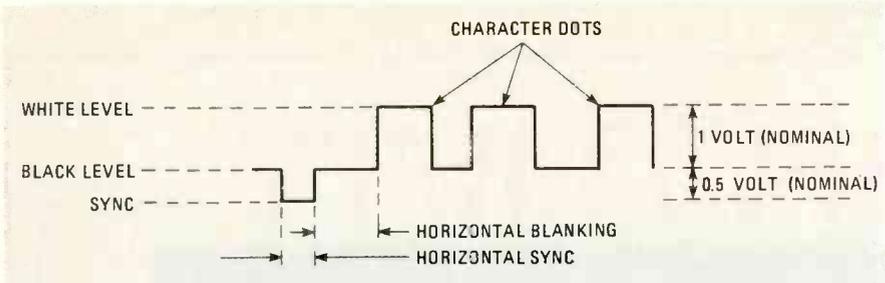
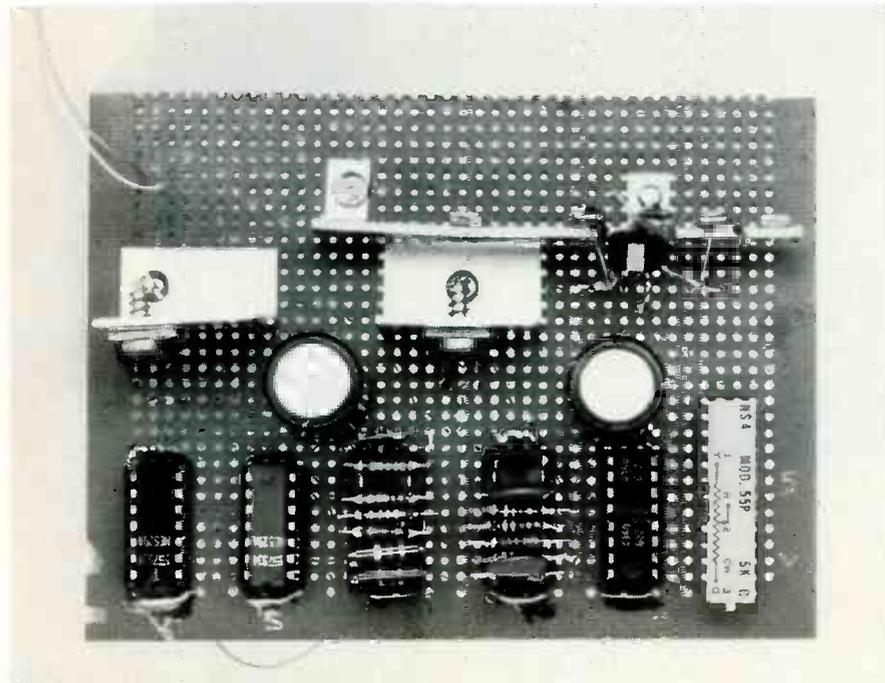


FIG. 1—COMPOSITE VIDEO SIGNAL from computer's video board has three main components: sync, black, and white.



COMPONENT LAYOUT is not critical. Tie-strip at upper-right holds bridge rectifier. Use of DIP headers simplifies mounting and connection of resistors and small capacitors.

PARTS LIST

- Resistors** 1/4 watt, 5%
 R1, R2—4700 ohms
 R3—5000 ohms trimmer potentiometer
 R4—100 ohms
 R5, R6—560 ohms
 R7—3600 ohms
 R8, R10—2200 ohms
 R9—10000 ohms
- Capacitors**
 C1, C2—1000 μ F, 15 volts, electrolytic
 C3-C5—.1 μ F ceramic disc
- Semiconductors**
 BR1—full-wave bridge rectifier, 50 PIV, 1 amp
 IC1, IC2—NE529 high-speed comparator (Signetics)
 IC3, IC4—HP-5082-4360 or 6N137 optoisolator (Hewlett-Packard)
 IC5, IC6—7805 five-volt positive voltage regulator
 T1—12.6-volt, 100 mA, center-tapped transformer
 J1—female BNC connector
 S1—SPDT switch
- Miscellaneous: perforated construction board, IC sockets, 75-ohm coaxial cable, heat sinks, etc.
- NOTE:** If unavailable from your usual supplier, the optoisolators may be ordered from: Surplus Electronics, 9600 Baltimore Boulevard, College Park, MD 20740 for \$4.95 each, postpaid. Visa and Mastercard accepted. MD residents add 5% tax.

With the sync and video components of the signal separated and translated to logic states, the individual signals are fed to the optoisolators, IC3 and IC4. Those IC's can sink 13 mA with just 5 mA of input current, and that is well within the drive capabilities of the NE529 comparators.

The video recombining network.
continued on page 80

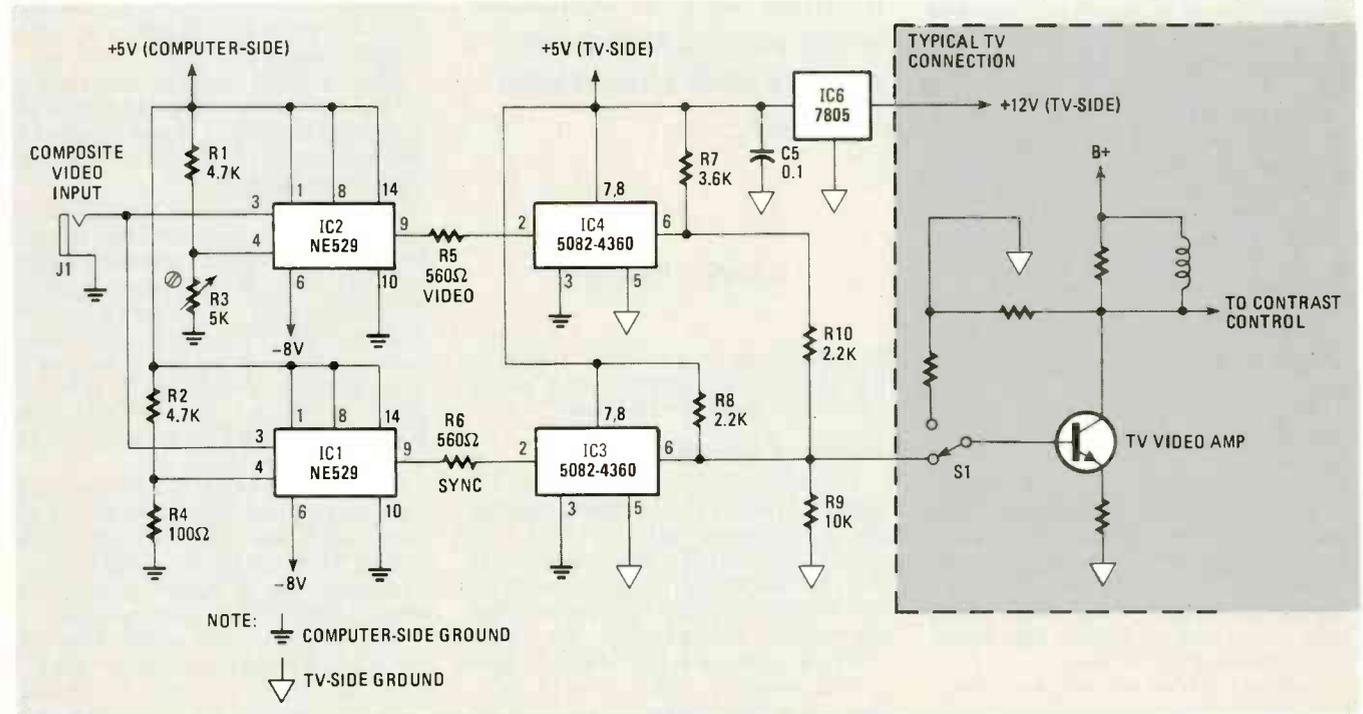


FIG. 2—TWO SEPARATE GROUND SYSTEMS are used by the interface. Make absolutely sure that each ground is made to the proper system!

BUILD THIS

YOU SHOULD HAVE YOUR OWN VERSION OF Unicorn-1 in action by now, and have probably been using this time to practice controlling the robot.

In this section, we'll not only describe some simple electronic circuits that will give the robot a more impressive appearance but will provide you, as well, with one of the options promised earlier—a rotatable end-effector.

The next installments of this series will provide circuits that can be used either for radio control (R/C) and/or for computer control—the computer being either part of the robot or external to it and transmitting commands via a radio link.

Before we get involved, though, we'd like to correct an error that crept into Part 2 of this series (September 1980) and that was brought to our attention by several readers: The red and green wires between switch S1 and the barrier strip were transposed in Fig. 18. The red wire should go to ground at the bottom-right of the switch, and the green one to +12-volts at the top right.

It's good to see so many readers taking such an interest in the project!

Electronic embellishments

Flashing lights always attract attention and—you can admit it—that's what you'd like your version of Unicorn-1 to do. We'll consider two different LED-indicator circuits: one to show that the arms are in motion, and in what direction they're moving; the other (just) to attract attention by announcing that Unicorn-1 is "alive."

The first circuit, which shows that the shoulder-motors have been activated, is presented in Fig. 42. You'll remember

UNICORN-1 ROBOT

Part 6—Add some pizzaz to your robot with two different sets of flashing lights. For the more serious-minded, there's also a twist-of-the-wrist end effector.

JAMES A. GUPTON, JR.

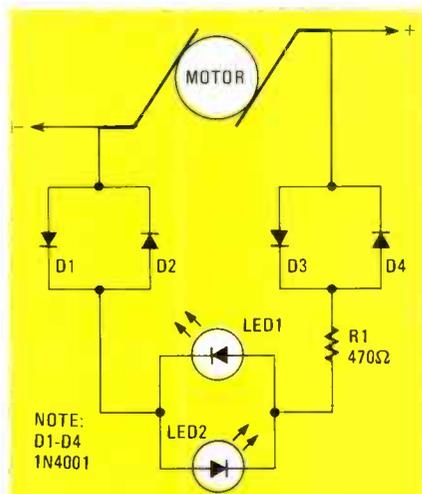
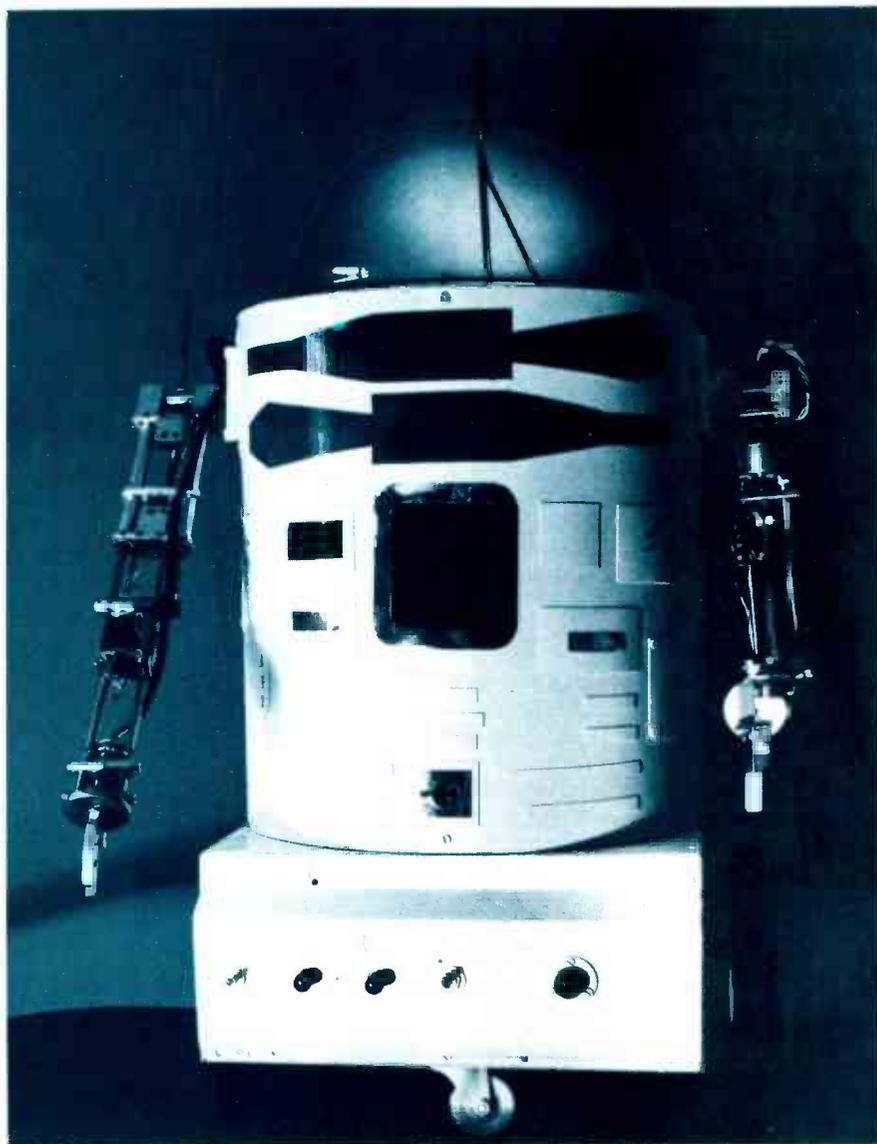


FIG. 42—MOTOR-DIRECTION INDICATOR uses twelve volts. Diodes and resistor reduce voltage and current to safe levels for LED's.



PARTS LIST—MOTOR-DIRECTION INDICATOR

R1—470 ohms, 1/4 watt
 D1-D4—1N4001
 LED1, LED2—jumbo LED's (different colors)



FIG 43—WHEN YOU MAKE THIS BOARD, be sure that pads *do not touch* rectangular border.

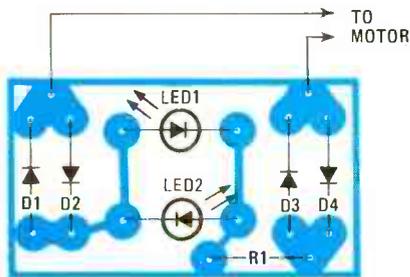


FIG. 44—PC BOARD for motor-direction indicator was designed for rectangular LED's. Circular ones will need their leads bent a bit.

that the direction of motor rotation is changed by reversing the polarity of the current used to power the motor. That circuit detects which way the current is flowing and indicates it via LED's.

Looking at the schematic for the circuit, it can be seen that—if we assume the right-hand terminal to be positive and the other one negative—a stream of electrons will flow through diode D2, LED1, and through D3, causing LED1 to light. (Remember, though, that the current flow is from the positive pole to the negative.) Also bear in mind, as you consider the schematic, that, in a LED—or in any other diode, for that matter—current flows from the cathode to the anode.

Current-limiting resistor R1 is used to prevent burning out the LED's. A value of 470 ohms will be about right to provide the LED with the 20 mA it needs, based on a 12-volt system.

If a command is given to reverse the current flow—where what was previously positive becomes negative—current will then flow through diodes D4, LED2, and D1. Use different colored LED's for LED1 and LED2 so you can tell at a glance which way the motor, and its associated mechanism, is moving.

A foil pattern for the circuit is shown in Fig. 43, and the parts-placement diagram in Fig. 44. Two of those can be built on one board to take care of both arms (see Fig. 45). The LED's used on the board shown in the foil pattern were rect-

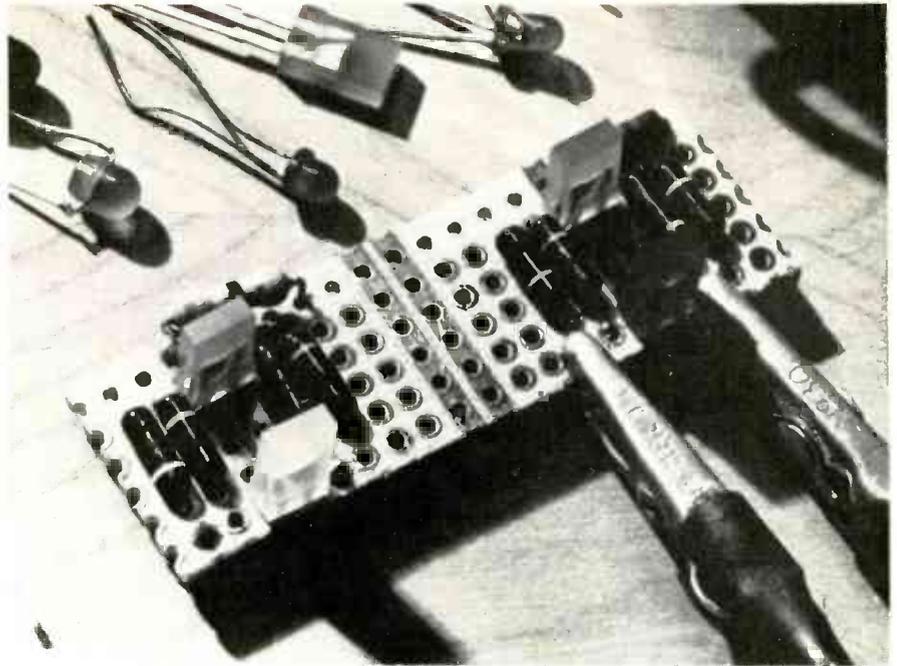


FIG. 45—ONE SMALL PIECE of board holds two complete motor-direction indicators. Current-limiting resistor is visible at top-left of board, above LED.

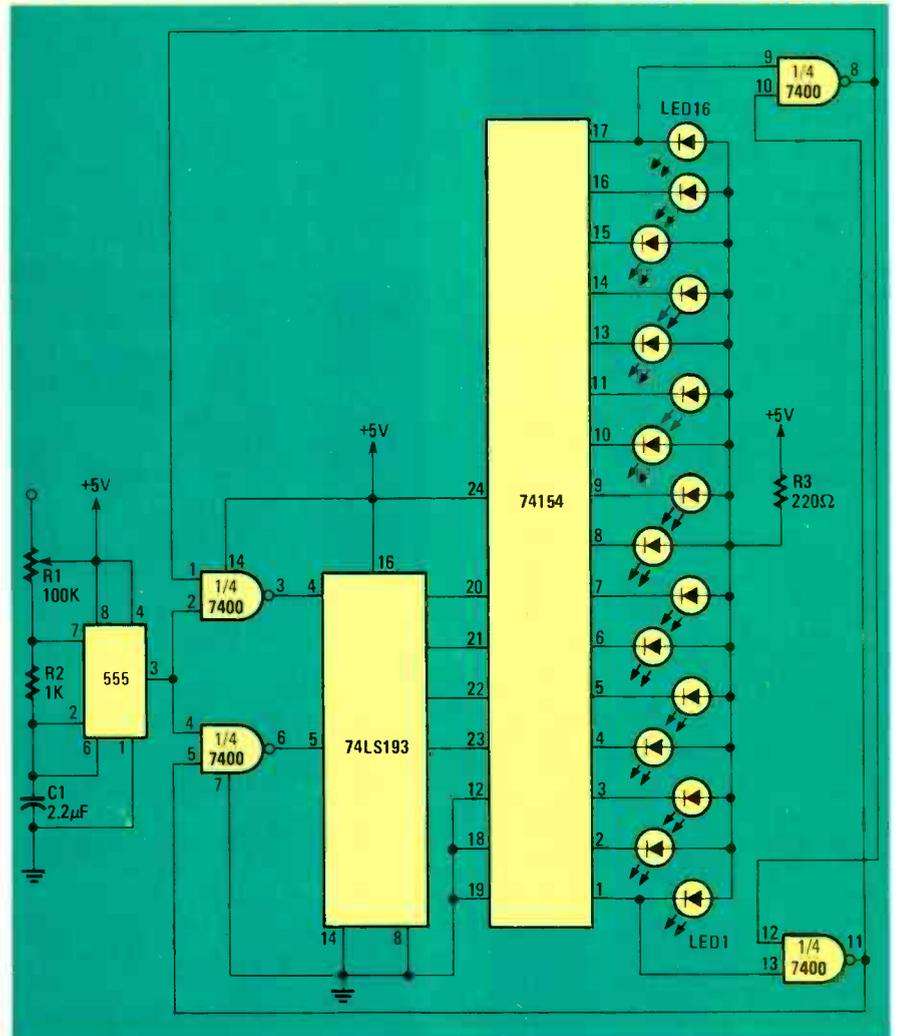


FIG. 46—SEQUENTIAL-FLASHER CIRCUIT uses 74LS193 up/down counter to drive 4-to-16-line decoder.

PARTS LIST—LED FLASHER

All resistors ¼ watt, 5%

R1—100,000 ohms, trimmer potentiometer

R2—1000 ohms

R3—220 ohms

Capacitors

C1—2.2 µF, 16 WVDC, electrolytic

Semiconductors

IC1—555 timer

IC2—7400 quad NAND gate

IC3—74LS193 up/down counter

IC4—74154 4-to-16 line decoder

LED1-LED16—jumbo red LED

Miscellaneous: 7805 voltage regulator with heat sink

angular, which explains the wide spacing of the pads. Round LED's would probably be better, since it is easier to drill round holes in the skin for displays than it is to drill rectangular ones.

One of the best attention getters is an array of flashing lights. One such LED circuit appears in Radio Shack's *ARCHER Engineer's Notebook*, and is the one described here. A display that creates a more random pattern was described in *Radio-Electronics'* Hobby Corner department in the December 1980 issue.

The sequential-flasher circuit in the original Unicorn-1 uses four IC's and five external components to operate 16 LED's. Its schematic is shown in Fig. 46. Resistors R1 and R2, working together with capacitor C1, determine the rate at which the 555 timer IC will cause the LED's to light, and R3 is the current-limiting resistor for the LED's.

The LED's are arranged in five columns of three each (see Fig. 47) with the sixteenth LED at the bottom of the middle column. In operation, they will light starting from the bottom-right, going up the column, then jump to the bottom of the next column, etc. When the last LED has lit, the process will reverse itself, working from left to right and finishing up at LED1.

Although a foil pattern and parts placement diagram (Figs. 48 and 49) are provided, the circuit, and the motor-direction indicator, are both easy enough to build on perforated construction board using wire-wrap techniques. If you have never done any wire-wrapping before, this would be a good place to start because of the simplicity of the circuits. (Articles on wire-wrapping techniques and materials appeared in the August 1979 and March 1980 issues of *Radio-Electronics*.)

You'll need nine jumper wires on the LED-sequencer board. Those can be made from wire-wrap wire, stripped at both ends and tack-soldered to the wiring- or foil-side of the board.

A few words about power supplies for those circuits: TTL IC's are very particular about their working voltage—it should be five volts, ±5% (4.75–5.25 volts). While five volts can be derived

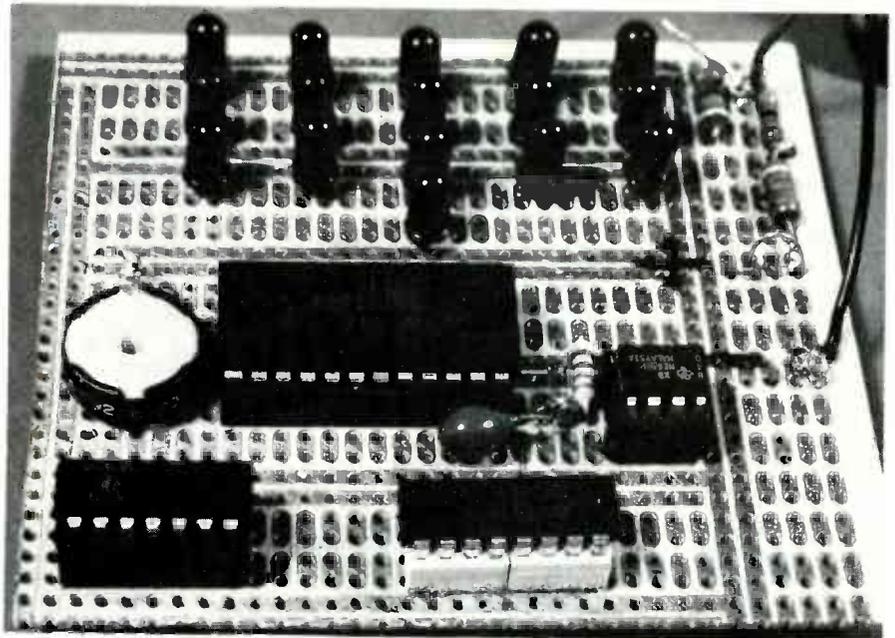


FIG. 47—TRIMMER PCTENTIOMETER at left of 74154 IC varies rate at which LED's flash. Mount board so LED's are visible through opening(s) in skin of robot.

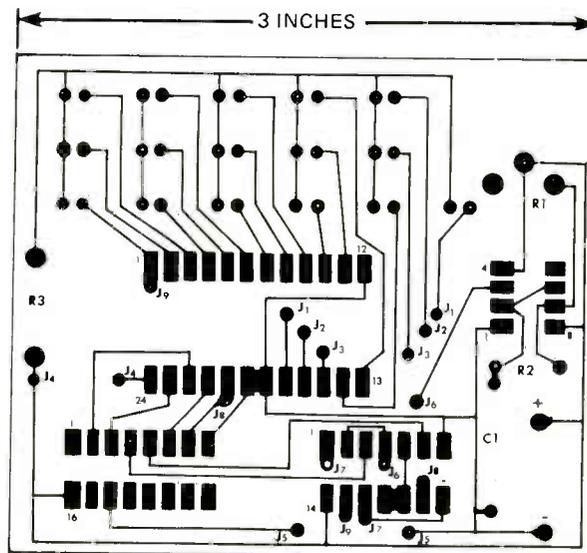


FIG. 48—PC BOARD for sequential-flasher circuit shown in prototype-version above.

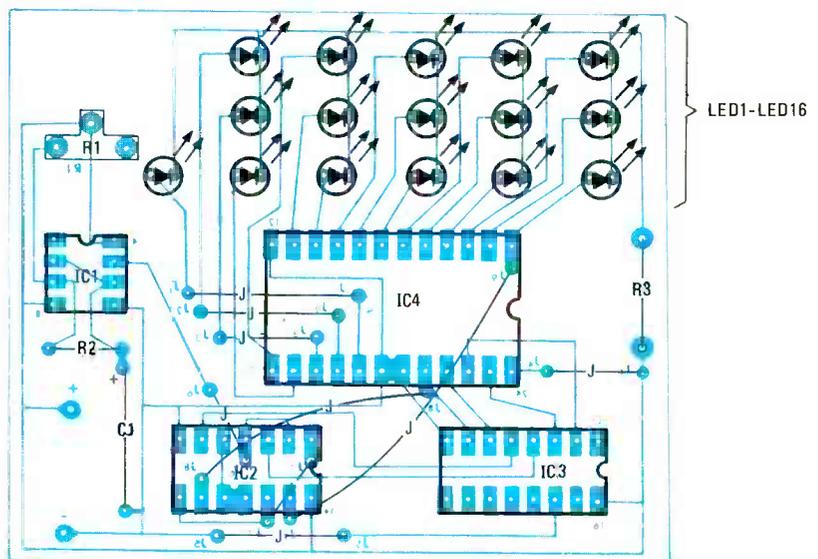


FIG. 49—NINE JUMPER WIRES are required on sequential-flasher board. "Odd" LED at left can be omitted without upsetting anything if symmetrical layout is desired.

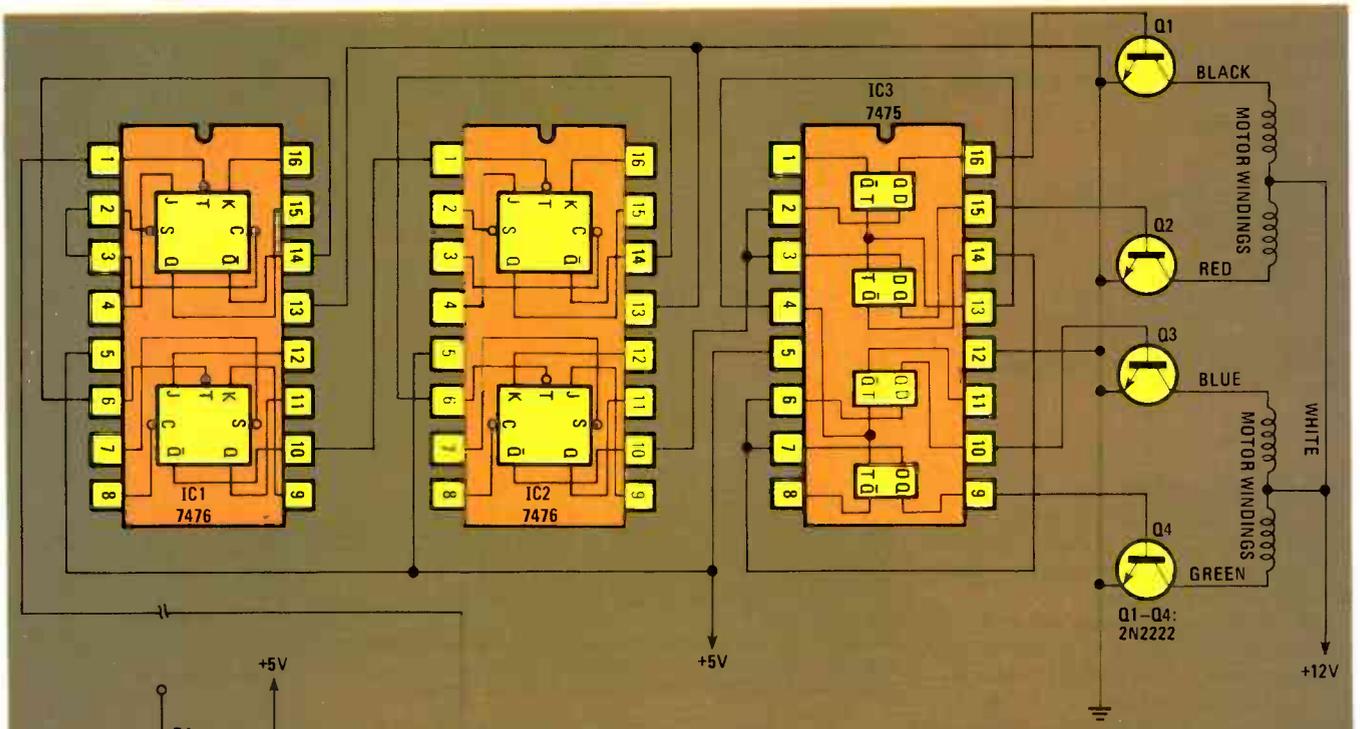


FIG. 50—TWELVE-VOLT LINE goes to end-effector control switch (see text). Five-volt supply is derived from circuit-side of this line through 7805 regulator, not shown.

from the 12-volt supply by means of a dropping resistor, that method leaves itself open to fluctuations, depending on how much of a load the rest of the robot's electrical and electronic parts present to the battery at any given time. It's better to derive the five volts through a 7805 regulator, well heat-sunk to dissipate the heat generated in dropping the twelve volts to five. The addition of an intermediate resistor to drop the 12 volts to eight would ease the load on the regulator.

Other TTL circuits will be described later and they, too, will benefit from a regulated five-volt power supply.

A twist-of-the-wrist

One of the options hinted at earlier in our series was an end-effector (hand) that could be rotated at the "wrist" to give an additional degree of freedom.

That "twist-of-the-wrist" end-effector uses the claw-type mechanism described in Part 2 (September 1980) but, rather than being firmly attached to the manipulator (arm), it is attached to the shaft of a stepper motor. A stepper motor is a motor whose shaft turns just a little bit each time an electrical pulse is applied to its windings.

Figure 50 shows a circuit that gener-

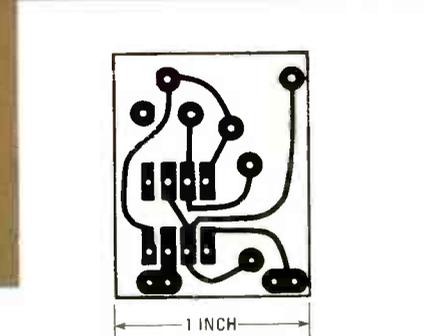


FIG. 51—CLOCK-SIGNAL GENERATOR board for stepper motor controller.

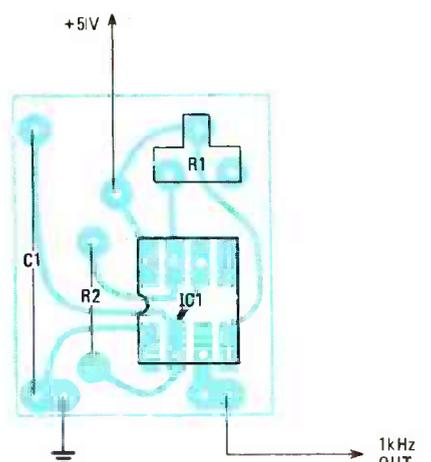


FIG. 52—INTEGRATED CIRCUIT, IC1, is a 555 timer (shown at lower-left in Fig. 50). One-kHz clock signal is fed to second PC board.

ates those pulses and drives the motor. The circuitry actually consists of two parts. The first, used to generate the

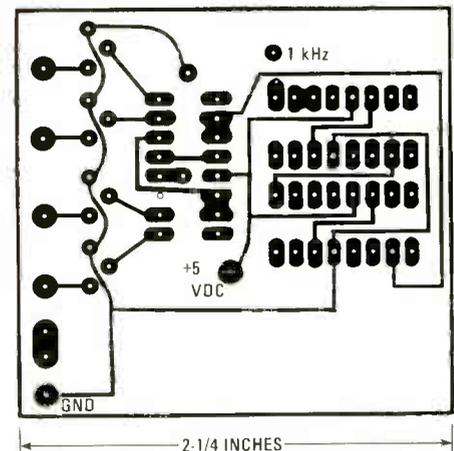


FIG. 53—DIVIDER CHAIN AND LATCHES are located on separate PC board.

pulses, is identical to the 555-IC section of the LED sequencer board, except for the values of R1 and C1, which are chosen to give an output of one kHz.

The second uses two 7476 IC's to divide that one-kHz signal by four (giving an output of 250 Hz), and that output is applied to a 7475 quad latch that feeds driver transistors Q1-Q4. Those transistors are connected so as to provide 12 volts to the four windings of the stepper motor.

Figures 51-54 show foil patterns and parts placement diagrams for the two-board circuit. The 12-volt and 5-volt (through a 7805 regulator, not shown) supplies are derived from the wiring to the solenoid of the end-effector mounted on the stepper motor's shaft.

PARTS LIST—STEPPER MOTOR CONTROLLER

All resistors 1/4 watt, 5%

R1—100,000 ohms trimmer potentiometer

R2—1000 ohms

Capacitors

C1—0.068 μF, 10 WVDC, any type

Semiconductors

IC1, IC2—7476 dual J-K flip-flop

IC3—7475 quad latch

IC4—555 timer

Q1-Q4—2N2222 or equivalent

Miscellaneous: 7805 voltage regulator with heat sink

PC boards for the above are available from PPG Electronics Co., Inc., 14663 Lanark St., Van Nuys, CA 91402. (213) 988-3525: Motor Direction Indicator and Stepper Motor Oscillator, \$3.00 each, LED Flasher, \$5.00, Stepper Motor Controller, \$5.00. Please add \$1.00 per order for shipping and handling. CA residents add 6% tax. MC and Visa accepted.

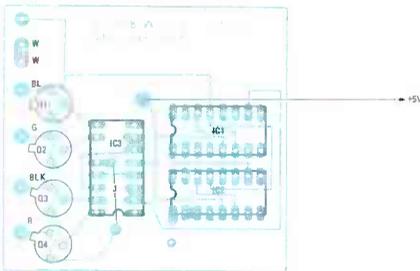


FIG. 54—COLOR CODES shown here should correspond with those on motor wires.

PARTS LIST—STEPPER MOTOR ASSEMBLY

Item	Size	Quantity	Supplier's part no.	Supplier
Stepper motor	12 VDC, 0.9°-step	1	Haydon 31612 or 31618, or equivalent	(L)
Shaft	3/16-in. diam. X 1 inch	1		(K)
Bearing	3/16-in. I.D.	2	B2-9	(A), (B)
Gear	.593-in. diam., 36-T, 64 pitch, 3/16 I.D.	1	P64A19-36	(A), (B)
Note: small mating gear comes with stepper motor				
Solid steel wire	20 gauge	5 inches		(K)

SUPPLIERS

- (A) **The Robot Mart**
Room 1113
19 W. 34th St.
New York, NY 10001
(\$3.00 for catalog)
- (B) **Winfred M. Berg, Inc.**
499 Ocean Avenue
E. Rockaway, NY 11518
- (K) Local hardware or building supplies store
- (L) **Haydon Switch & Instrument, Inc.**
1500 Meriden Rd.
Waterbury, CT 06705
(Write for list of distributors)

end-effector. The next time the circuit is activated, the end-effector closes again, but the wrist turns the other way.

The end-effector and wrist actions can be made independent of each other by the addition of another switch to the control console.

Several stepper motors that have been found to work well in this application are indicated in the parts list. The attachment of the motor to the robot's end-effector and manipulator is shown in Fig. 55. A



FIG. 56—COMPLETED rotatable end-effector mounted on forearm shows modified connection to solenoid using solid steel wire.

shaft passed through two flange bearings in the end cross-bar rod. Not shown in the mechanical drawing is a hole bored through the axis of the shaft to pass the wire that operates the claw. Fig. 56 shows the assembled rotatable end-effector with the 20-gauge solid wire pivoted where it is attached to the solenoid to allow free rotation.

To mount the stepper motor and rotatable end-effector, the end cross-bar rod has to be drilled for the bearings and shaft, and the next cross-bar rod up should be filed to accept the shape of the motor. The motor is clamped and/or bolted to the arm assembly.

In the next installment, in preparation for radio- and computer-control, we'll describe motor-control circuits that operate from logic-level signals, and start making radio-control system.

R-E

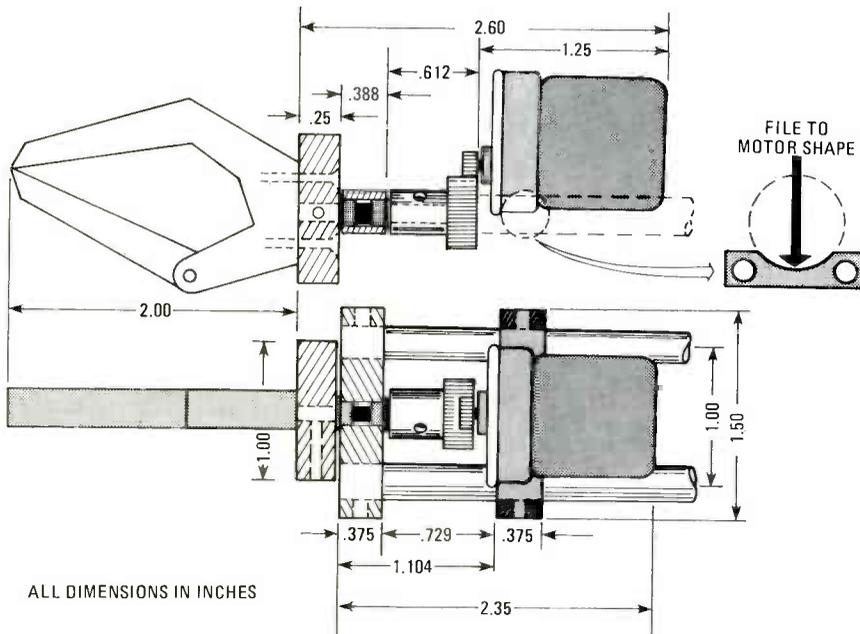


FIG. 55—SMALL GEAR ON STEPPER-MOTOR SHAFT does not have to be purchased separately—it comes with the motor. Note use of bearings through first cross-bar rod.

In practice, when the switch controlling that end-effector is thrown, the "hand" closes and the wrist begins to turn. Returning the switch to the "off" position stops the motor and opens the

9-T (nine-tooth), 64-pitch gear is mounted on the shaft of the stepper motor and drives a 36-T, 64-pitch gear attached to the end-effector mounting flange by means of a 3/16-inch diameter

ALL ABOUT

UNIVERSAL



THE UNIVERSAL COUNTER/TIMER IS A new breed of test instrument, born of LSI (Large Scale Integration) technology that makes it possible to include the essential central circuits on a single IC, in many cases. To be entirely fair, there were Universal Counter/Timers (or UCT's for short) available before LSI made building them easy, but this is the first time that a number of units have been available for under \$500.

The Universal Counter/Timer makes five basic kinds of measurements:

Frequency: In that mode, the UCT counts the number of selected signal transitions which are appearing at its primary input.

Period: In that mode, the UCT measures the time between successive signal transitions at its primary input. For example, the time between the rising edge of the input signal crossing a 0.5-volt threshold and the next time the input signal rose above 0.5-volt (see Fig. 1) would be displayed in the period mode. Although that might not correspond exactly to the classical explanation of period, it is proper by definition.

Event counter: In that mode, the UCT counts selected input signal transitions until manually "frozen" or reset.

Interval: In that mode, the UCT measures the time between the occurrence of a selected transition of an input signal at its primary input (which starts the measurement) and the occurrence of a selected transition of an input signal at its secondary input (which ends the measurement).

Frequency ratio: In that mode, the UCT counts the number of selected transitions that occur at the primary input between successive selected transitions that occur at the secondary input.

All that talk about selected signal edges or transitions is necessary because of the extensive input-signal conditioning that is provided for at one or both inputs. A *slope-selector* switch determines whether a positive-going transition (or *rising edge*) or a negative-going transition (or *falling edge*) will be used in any measurement. An *attenuator* is usually provided, usually offering factors of attenuation of one (unity), 10 and 100. Also since those inputs are usually DC-coupled, a *trigger level* control selects the threshold level at which the selected edge (rising or falling) is recognized by the counting circuits.

The front panel of a typical UCT is shown in Fig. 2.

We will see that extensive input conditioning makes those delightful instruments all the more useful.

Let's take a look at some hints and tips and application notes to help us get all we can out of our UCT's.

Frequency counter

UCT's are not generally intended for high-frequency use, as they usually provide about a 10-MHz ceiling on their response as frequency counters. On the other hand, they are highly sensitive, offering input impedances on the order of 1 megohm.

Even with its sensitive, high-impedance inputs, a UCT can "pull" the frequency of an oscillator because of the capacitive effects of its connecting

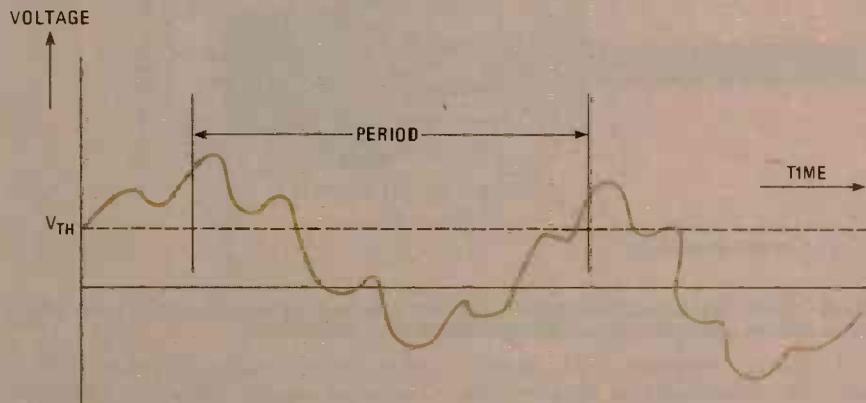


FIG. 1—PERIOD FUNCTION measures time interval between successive signal transitions. (In this example, threshold voltage V_{TH} defines the transition-point.)

COUNTER/TIMERS



DATA PRECISION MODEL 5845 (above) has a pulse-resolution of 15 nS. Low-pass filter maximizes noise-rejection when working with low frequencies.

MODEL 5001 UNIVERSAL COUNTER-TIMER (top of opposite page) from Global Specialties features two inputs, permitting one counting function to modify another.

AUTORANGING MODEL 1820 (below) from B&K Precision, Dynascan Corp., counts from 5 Hz to 80 MHz. Elapsed-time function can be remotely controlled.



When does a counter become a super counter? When it becomes a Universal Counter/Timer, capable of measuring and displaying the occurrence of events in several different ways.

MARTIN BRADLEY WEINSTEIN*

cable (if nothing else) and its input pre-amplifier.

A 10:1 oscilloscope probe (which happily, readily mates with the BNC input connector usually provided) can minimize circuit loading and oscillator pulling. Better yet, measure the oscillator frequency after a stage or more of buffering instead of at the oscillator whenever possible.

If the oscillator is radiating, as in a transmitter, a short piece of wire—or a telescopic antenna—connected to the UCT may provide adequate coupling for reliable measurements. However, any *direct* connection of the UCT to the transmitter at its antenna can turn the works of both into slag before you can utter a four-letter word.

In many cases (video comes to mind), it may be important to match the UCT input impedance to that of the signal source with a 50-ohm, 75-ohm, 300-ohm or other termination. Because of the high input impedance of the UCT, a termination resistor can be applied directly to its input.

For fast, accurate measurement of very low frequencies, don't measure frequency. Instead, measure period (P), which is the reciprocal of frequency. $F(\text{MHz}) = 1/P(\text{microseconds})$; $F(\text{Hz}) = 1/P(\text{seconds})$. Keep your pocket calculator handy.

Using a microprocessor? Set your UCT up for a 2-volt threshold and your UCT can give you an exact peg on its clock frequency—which may explain why your cycle-counting software doesn't quite get its times right.

*At the time this article was written, the author was Director of Marketing for Global Specialties

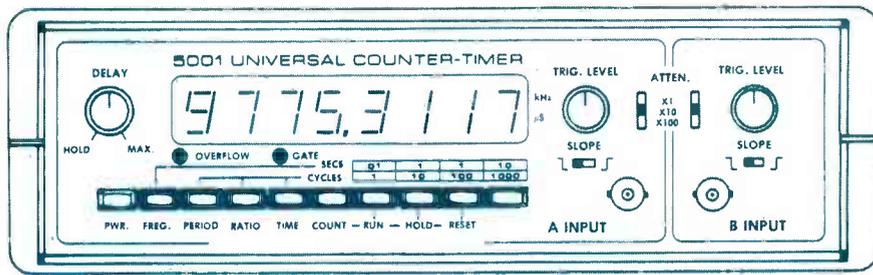


FIG. 2—TYPICAL UCT FEATURES are exemplified by front panel of Global Specialties' model 5001.

For additional accuracy, many UCT's offer multiple gate-times. The longer the gate-time, the longer the wait between display updates but the greater the resolution of the display.

Period measurement

Just as people tend to be either right-handed or left-handed, flip-flops tend to produce one very clean edge and one sloppy edge. And since flip-flops are the most common way that edges are processed in digital circuits (or gates that follow flip-flops—either way, one edge is lots cleaner), there will always be one edge at an output that gives better measurement results than does its opposite.

When the UCT measures frequency, there are lots of events being counted and generally very little noise-induced error, assuming that a non-critical trigger-level was selected. In the period mode, though, the input signal starts and stops the beat-counting of an internal clock.

To improve the odds, most UCT's provide the option of multiple-period averaging. That means they measure either 1 or 10 or 100 or 1000 periods (you decide) and position a decimal point appropriately to preserve the proper display units—seconds or milliseconds or microseconds or nanoseconds or whatever. Using a multiple-period average substantially reduces the susceptibility of measurement accuracy to noise present at the input.

We've seen that low frequencies are easy to measure by using period measurements instead of frequency measurements, and then performing a mathematical inversion. Now you can see why that is both a faster and more accurate technique.

In the frequency-counter mode, it would take 10 seconds to provide 0.1-Hz resolution in measuring a 110.4-Hz signal. But in the period-measurement mode, a 100-cycle average of 9057.971 microseconds is available in less than one second. Say the actual reading is 9057.946 microseconds: that tells us the actual frequency is 110.4003 Hz, which is three accurate digits better than we could do measuring frequency directly.

Want to know the exact speed of a movie projector? An indirect measurement using a UCT is both more con-

venient and more accurate than measurements of mechanical motion made directly. The units of measurement for a film projector are frames per second, which is called its frame rate. The frame rate of most projectors is usually 24. Most of the time, tweaking the speed is only done when things get really bad and Nelson Eddy starts sounding like Rocky the Flying Squirrel—but there are a number of places where precise speed is important.

Your UCT can make the measurement very accurately, as we know, using its period-measurement mode. With no film in the projector and with its motor running and lamp on, a photodetector can be tied to the UCT input to convert the flicker into a measurable signal, as shown in Fig. 3. Depending on the specifics of the detector, some degree of optical filtering, limiting, or shadowing may be desired.

A photovoltaic cell in parallel with a 10 K resistor can be connected to the UCT input directly. Or a phototransistor, photodiode, or photoresistor can be used with the conditioning circuit shown.

Time interval

The first point here is that multiple time-interval averages—available with most UCT's—accumulate errors. The period-measurement mode reduces errors when multiple periods are measured, but the multiple time-interval averaging mode accumulates them. Whenever possible, use the period mode. A device as simple as an OR gate (or flip-flop, or any convenient logic) between the signal coming in and the input to the UCT can often permit time-interval measurements using the period mode. If the time-interval mode is used (remember, a signal at the primary inputs starts the measurement, one at the secondary input completes it), expect some small variance between readings

of identical intervals—that is an inherent error.

Nevertheless, tremendous accuracy and utility are available using the time-interval mode of the UCT. For example, it provides an excellent means of determining pulse parameters—especially pulse width, pulse spacing, pulse period, pulse repetition-rate, and pulse duty-cycle.

The pulses being investigated are fed to both the primary and secondary inputs of the UCT, and appropriate identical thresholds (trigger levels) selected. The selection of identical trigger levels at both inputs is important because it reduces errors due to pulse rise-and-fall-times. For a TTL-level pulse, for example, select a trigger level near 2 volts DC.

To measure pulse width, select the rising edge (using the slope-selector switch) at the primary input, the falling edge at the secondary input. To measure pulse spacing, select the falling edge at the primary input and the rising edge at the secondary input. The other pulse parameters can now be determined by simple calculations:

$$\begin{aligned} \text{Pulse period} &= \\ &\text{Pulse width} + \text{Pulse spacing;} \\ \text{Repetition rate} &= \text{Pulse frequency} = \\ &= \frac{1}{\text{Pulse period}} \\ &= \frac{1}{\text{Pulse width} + \text{Pulse spacing};} \\ \text{Duty cycle} &= \frac{\text{Pulse width}}{\text{Pulse period}} \\ &= \frac{\text{Pulse width}}{\text{Pulse width} + \text{Pulse spacing}} \\ &= \text{Pulse width} \times \text{Pulse frequency} \times 100. \end{aligned}$$

Note that pulse period can be determined using the period-measurement mode of the UCT.

Time-interval measurements are also very important for any study involving rate, time, and distance, since any two of those can always be used to find the third. We'll take a look at the problem in terms of ballistics, but consider that it also applies to timing slot-cars, camera shutters, and lots of other interesting things.

Ballistics got its name because of the rifle balls and ball-shot originally studied—not to mention cannonballs. It's very important for an artilleryman to know where the next shot is going to land. The power charge, the characteristics of the gun, its azimuth and eleva-

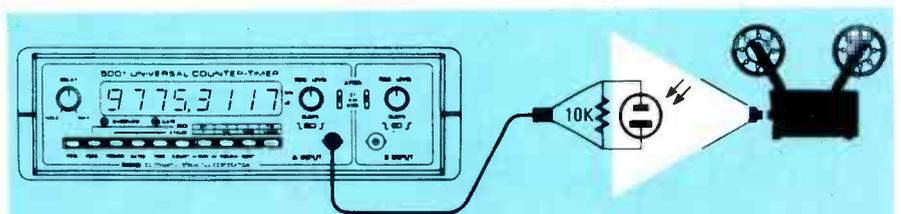


FIG. 3—PROJECTION RATE is determined using UCT to count pulses generated by photodetector.

tion, and the distance to the enemy are the only information real to him. So, to improve the odds, the science of ballistics emerged to make shooting-gallery instinct into hard mathematics.

Originally, an observer with a stopwatch and field glasses would watch as the ball hit a distant target—the distance to the target and the transition time told him what he needed to know.

The UCT helps apply the same principle over much shorter distances and a wider range of speeds, sizes...whatever. Something as simple as a pair of electrical contacts (for a conductive projectile) or a breakable (or frangible) conductor or a microswitch-type rollover (see Fig. 4) can be used where the path of the projectile is precisely known and its flight will not be disturbed by the act of opening or closing the contact.

Note that by using contact *openings* as the significant event (the rising-slope edge using the conditioning circuit shown), you can avoid the problems of contact bounce in most cases.

Even better, non-contact sensing can be used. Photoelectric beam-break arrangements are an excellent and inexpensive alternative to physical contact. Depending on materials, you may also want to look into Hall-effect magnetic sensors, photoreflexive proximity de-

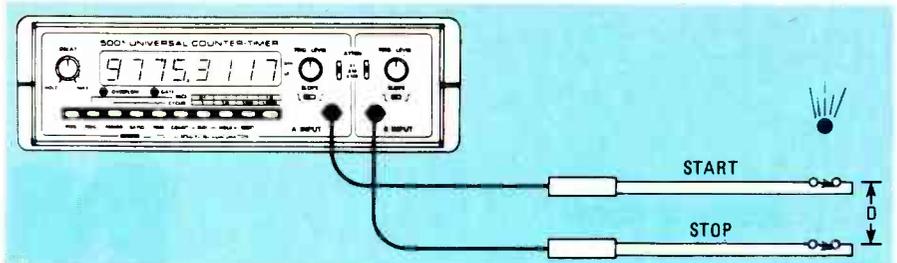


FIG. 4—TIME INTERVAL between opening of two switches can be applied in ballistics calculations.

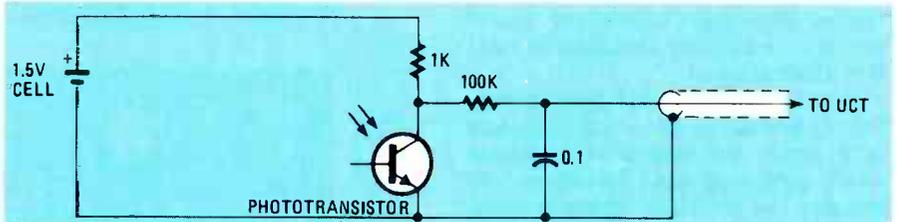


FIG. 5—SIMPLE CONDITIONING CIRCUIT provides clean pulses for input to Universal Counter/Timer.

tectors, etc. A typical photosensitive circuit that can be connected to the input of a UCT is shown in Fig. 5.

Frequency ratio

Many times, the inputs for the UCT will come from transducers that measure real-world phenomena, like flow or rotation or weight or linear speed. The frequency-ratio mode lets you translate the input signals directly into

digital displays in *standard* units—like gallons per minute, RPM, kilometers per hour, etc.

That *scaling* capability (also called *rescaling*) of the frequency-ratio mode happens because the secondary input behaves exactly like the gating circuit of a frequency counter. (Remember, frequency ratio counts the number of events at the primary input during a single cycle at the secondary input.) We could display frequency in Hz simply by using a one-Hz signal (one-second cycle-period) at a secondary input; by substituting a different secondary-input frequency, we can make the display do all kinds of tricks.

For example, an encoding disk on a motor shaft might provide 1024 pulses per revolution. A 1024-Hz signal (1/1024-second period) at the secondary input makes the UCT display the actual motor speed in RPS (*Revolutions Per Second*). Want RPM? Divide the secondary input frequency by 60 ($1024/60 = 17.07$ Hz).

Following these rules to determine the correct secondary input frequency:

1. Determine how many pulses you can expect for any event of interest, stated in the units you wish to see displayed. If you know how many pulses are delivered per pint, for example, multiply by 16 to find out how many pulses are delivered per gallon.
2. Express one second in the units of time you wish to see in your displayed reading. For example, 1/60th minute, 1/3600th hour, 1000 milliseconds, etc.
3. Multiply the pulses per event by the time units in seconds to determine the proper frequency to feed into the secondary input.

Event counter

Since the input of the UCT is voltage-responsive, a simple contact closure or

continued on page 100

UNIVERSAL COUNTER-TIMERS

B&K-Precision Dynascan Corp.
6460 West Cortland St.
Chicago, IL 60635

Model 1820
Frequency: to 80 MHz **Period:** 1 microsecond to 200 milliseconds
Interval: .01 to 9999.99 seconds **Event count:** to 999,999. **Price:** \$300
CIRCLE 96 ON FREE INFORMATION CARD

Fluke Mfg. Co.
Box 43210
Mountlake Terrace, WA 98043

Model 1900A
Frequency: to 80 MHz **Period:** 1 microsecond to 200 milliseconds
Event count: to 999,999 **Price:** \$345
CIRCLE 97 ON FREE INFORMATION CARD

Global Specialties
70 Fulton Terrace
New Haven, CT 06509

Model 5001
Frequency: to 10 MHz **Period:** 400 nanoseconds to 10 seconds
Interval: 200 nanoseconds to 10 seconds **Event count:** to 99,999,999
Frequency ratio: to 10 MHz at A, 2 MHz at B. **Price:** \$360
CIRCLE 98 ON FREE INFORMATION CARD

Non-Linear Systems
533 Stevens Ave.
Solana Beach, CA 92075

Model RC-5
Frequency: to 10 MHz **Period:** 500 nanoseconds to 10 milliseconds
Interval: 250 nanoseconds to 10 milliseconds **Event count:** to 99,999;
Frequency ratio: to 10 MHz at A, 2.5 MHz at B **Price:** \$144
CIRCLE 99 ON FREE INFORMATION CARD

NOISE

JOSEPH M. GORIN

THE GOAL OF HIGH-FIDELITY IS TO MAKE the listener feel as if the music is being created live in front of him. The state of the art is continually advancing towards that idealistic goal.

Sound is a mechanical phenomenon: the plucked string, the struck diaphragm of a drum, the resonance of human vocal cords—all send vibrations into the air. The ear picks up those vibrations, and we have true high-fidelity—a direct-to-ear non-recording. Unfortunately, that can only happen live and in only one place. To allow greater access to excellent, (and therefore rare) music, we record and broadcast it. In the process, it goes through changes in form from acoustical, to electrical, to magnetic (tape), to mechanical (discs), then back to electrical, to acoustical. By the time the music comes out of that complex system, it sounds different. The balance (frequency response) becomes changed by the system (especially the listening room). The music sounds flat because it's all coming from the speakers in front of you. The dynamic range (the ratio of the loudest to softest sounds) becomes squashed in the recording process. Unnatural noises are added. The illusion, though potentially very pleasing, could be much better and more realistic.

Although almost all of the problems induced in the chain described above are mechanically produced, there are electrical remedies available to the hi-fi or electronics enthusiast. Frequency balance can be restored with graphic equalization. The perceived relationship between the room and the listener can be changed with a rear-channel delay unit (ambience synthesizer). The dynamic range can be improved with a dynamic range expander. Surface noises on records, and hiss on tapes, can be reduced with a dynamically-variable



CARVER C-4000 autocorrelation preamplifier.

noise filter. Of all those *signal processing* accessories, to my ears, the expander and filter provide the greatest increase in realism.

I will begin this four-part series of articles by explaining the principles of operation of dynamic range expanders and show how they have been implemented commercially. Next month, I will do the same with noise filters. The following two parts will contain a construction article on a combined expander/noise filter that you can build from scratch, or from a kit, for a fraction of the cost of an assembled unit.

Why expand dynamic range?

Part of the excitement of live music (and part of the musician's intentions) lie in the range of loudness of the parts of the music. Expanding the dynamic range makes the loud sounds louder and the soft sounds softer. Most recordings are compressed intentionally so that the softest sounds are not obscured by the noise level of the recording medium (tape hiss and disc surface noise), and that the loudest sounds

do not overload the medium. (In tape systems, an overload causes tape saturation and distortion; in discs, overload can mean a burned-out cutter-head, excessively-wide grooves, backcutting, or untrackable passages.) In radio broadcasting, compression is almost always applied to give the station a "louder, clearer" sound and to overcome road noise for the motorist-listener. Peak limiting is always available in the system to prevent illegal over-modulation. Those signal-processing activities are the reason that your favorite record almost always sounds better on your own turntable than on the strongest radio station in the area.

Another reason for compression and expansion is for noise reduction. If the noise is only audible for low-level signals, and the low-level signals are attenuated, then the apparent noise will also be attenuated. Thus, the compression applied to the recorded signal can be beneficial.

There are even signal sources that have not been compressed but which benefit from expansion. Live music is

MXR's dynamic expander.



RG DYNAMICS' pro-20.



REDUCTION TECHNIQUES

The music that comes out of the speakers of your sound system has usually been processed more thoroughly than cheese spread. The dynamic range expander provides one means of restoring much of the naturalness to your program material.

frequently compressed by the musician to overcome surrounding noise.

By restoring the dynamic range of music, noise filters and expanders (and especially the combination) can create a dramatic improvement in your system—but beware: they are addictive!

How expanders operate

All expanders follow similar straight-forward block diagrams with differing details of implementation. As shown in Fig. 1, the work of the expander is done by a device frequently called a VCA (Voltage-Controlled Amplifier), in which the gain is controlled by the voltage (or current) applied to the control terminal.

All the manufacturers of expanders (listed at the end of this installment) have differing implementations of the blocks shown in Fig. 1, each for its own reason. There are three main classes of expanders. First, we have the fixed expanders, as exemplified by the expansion portions of the Heath, Phase Linear, and Carver expanders. They use a conservative, fixed amount of expansion (7, 7.5, and 3.6dB, respectively) as a

portion of their noise-reduction units. Then there are the variable expanders, such as those made by RG Dynamics. They have a variable amount of expansion, and often other controls for different parameters (input/output expansion-slope control, decay time, etc.). A third type is the expander portion of a compressor/expander system intended for noise reduction in tape systems, such as those manufactured by dbx, inc. That type is not optimized for single-ended use (playback of unencoded material) and is thus not applicable to the present discussion. Of

course, the variable-type expanders are more flexible, more expensive—and easier to use to excess (too much expansion always sounds unnatural and too little expansion is of negligible value).

Channel coupling

Most expanders control the gain of both channels together. That reduces the cost of the control circuitry by not requiring two of everything; also, it assures that, regardless of the instantaneous amount of expansion, an instrument placed between the two speakers

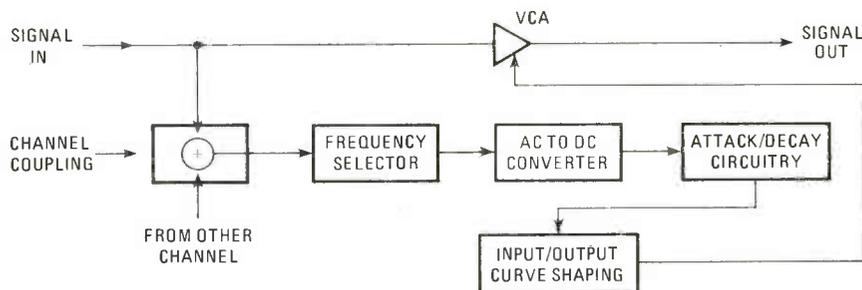


FIG. 1—DYNAMIC RANGE EXPANDERS use a VCA to “ride gain” on the incoming signal.

RG-2 dynamic processor from Pioneer.



MODEL 1BX from dbx.



will not "wander around" because the ratio of its level in each channel will remain constant. If the channels are independent, a strong signal in the left channel can raise the gain of that channel and "pull" a center-stage instrument. Also, if a single instrument is "panned" across the stage, the increased expansion on the dominant side causes an effect very much like increased separation. An advantage of independent channels, though, is that a loud signal in one channel will not change the noise level in the silent channel—an effect that will most likely be noticed only on headphone listening to multi-track recorded music.

Frequency selection

The frequency-selection filter determines which signals affect the expansion most. All the filters attenuate rapidly below 30 Hz to reduce the effect of rumble and other subsonic information. Filtering ultra-sonic signals is also desirable in order to remove FM pilot tones, tape-bias oscillator interference, and other non-musical signals. Typically, however, those are at a very low level and some manufacturers elect not to filter the high end. Besides such obvious criteria, however, there are a number of schools of thought on the shape of the frequency-selection filter. The dbx people are of the broadband school and they suggest that a long, sustained tone will be undesirably modulated by music of changing frequency (but not amplitude) if the frequency filter is not flat. Of course, that situation does not occur often, and it would be hard to detect in an expander of subtle operation (low slope of expansion). Moreover, most musical instruments vary their amplitude with each note. Robert Grodinsky, who designed the products of RG Dynamics, as well as Pioneer's RG-1 (recently updated to the RG-2), believes that the filter should be sensitive to the frequencies where most musical harmonics lie. That will allow more gain when the compressed source is supposed to be loud (lots of harmonics) than when it is soft (fewer harmonics), thus giving more accurate expansion.

AC-DC conversion

Almost all the expanders use precision full-wave detectors to convert the

level of the AC signal to a DC signal suitable for expansion control. A typical circuit is shown in Fig. 2. An explanation of that circuit appears in the February 1980 issue of *Radio-Electronics*. (See "Audio Power Level Meter.") Interested readers are referred to the detailed explanation that is given there. The device is termed "precision" because it is extremely insensitive to the parameters of the diodes, since they are in the feedback loop of the operational-amplifier IC1. The detector is full-wave because it responds identically to peaks of either polarity. That is important if the expander is to respond to rapid asymmetric signals (almost all audio signals are highly asymmetric). The Carver preamp is the only expander to be of the non-precision (passive) half-wave type. At dbx, they use a combination full-wave detector and RMS (Root-Mean-Square) detector.

Attack/decay circuitry

A typical attack/decay circuit is shown in Fig. 3. Voltage V_{IN} is the output of the detector. If a large, fast transient comes along (and music is full of such signals), capacitor C1 will charge up rapidly to a voltage close to the peak value through D1-R2. (Diode D1 is often enclosed in a feedback loop for precision.) Even if the signal is removed, however, C1 must discharge through R1, which is much larger than R2 and allows only a slow discharge rate. That is desirable because the initial edge of a transient should be expanded for enhanced impact. (It is also very likely to have been compressed.) The ear, fortunately, cannot sense the presence of noise immediately following a high-level passage of music, and thus doesn't mind a slow decline in gain. The slow decline prevents the gain from varying rapidly enough to be unpleasant or cause distortion.

RG Dynamics has a special circuit for attack/decay shown in Fig. 4, and used in series with the more conventional type. In that circuit, R2, R3, and C1 are chosen so that C1 charges more slowly than the circuit shown in Fig. 3. Thus, C1 charges up on longer loud passages. Then, at the end of such a passage, the gain declines slowly (about four seconds) so that the reverberant characteristics of the concert hall in which the record-

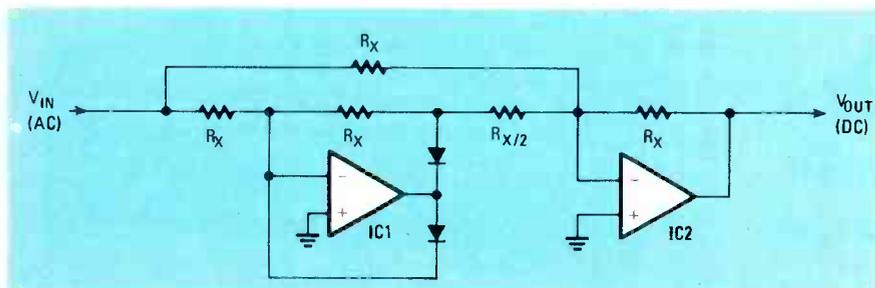


FIG. 2—PRECISION FULL-WAVE detector is first step in generating control signal for VCA.

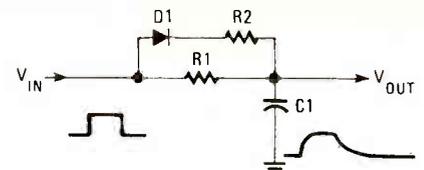


FIG. 3—ATTACK/DELAY CIRCUIT discharges "slowly" to compensate for effects of compression.

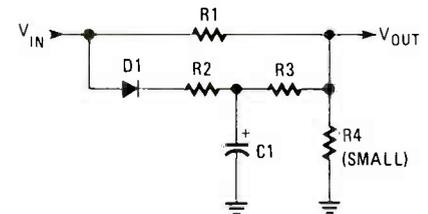


FIG. 4—CIRCUIT USED BY RG DYNAMICS offers longer decay time to long, loud passages.

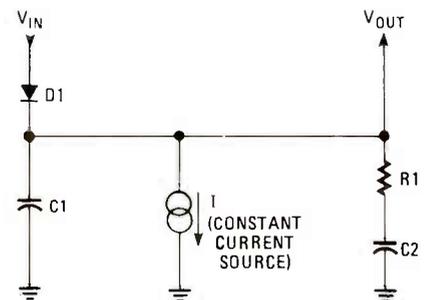


FIG. 5—TWO-STAGE attack/delay circuit is used by dbx for greater flexibility.

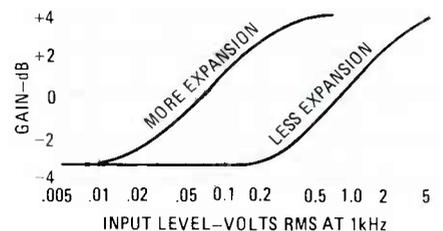


FIG. 6—SLOPE OF EXPANSION should be kept to a minimum to avoid rapid changes in volume.

ing was made are not obscured. If the loud passage is not very long, neither C1 nor the reverberant field of the hall will be expanded. The diode isolates that circuit from the normal path through R1.

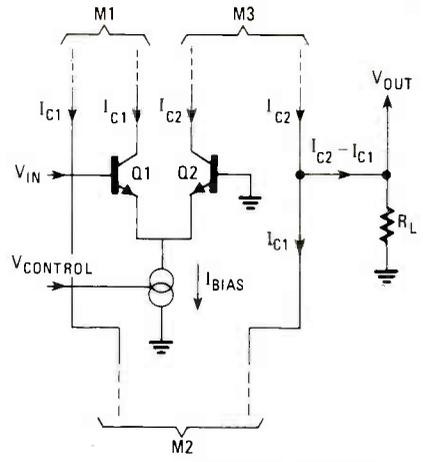
The dbx model 1BX also has a special auxiliary circuit that is shown in Fig. 5. It is designed so that a short high-level signal will charge up C1, but not C2; and when the signal dies down, the gain returns to normal (determined by the voltage on C2) rapidly. However, a long, high-level passage will charge up C2, and the gain will decrease slowly because the value of C2 is large (seven times as large as C1). That allows expansion of percussive sounds without varying the expansion of the underlying long-term signal.

Input/output curve shape

In most designs, the shape of the expansion curve (expansion vs. input level) is determined by the implementa-

tion of the other blocks of the circuit, although special shaping circuits can be constructed easily. All the expanders, except the Carver unit, have relatively straight slopes of expansion vs. level. An example is shown in Fig. 6. A slope should be as shallow as possible, be-

cause that minimizes audible gain changing. Also, a modest-size total variation in maximum to minimum gain is desirable for good noise reduction. The way to get the greatest variation with the smallest peak slope is with a straight line. The shape of that curve is



$$V_{OUT} = (I_{C2} - I_{C1}) \times R_L$$

$$\frac{V_{OUT}}{V_{IN}} \approx \frac{I_{BIAS}}{2} \times \frac{1}{25mV} \times R_L$$

FIG. 7—CURRENT MIRROR PRINCIPLE is illustrated in CA3080 transconductance amplifier.

probably the designer's most basic tool; the shallower it is, the less audible any possible side effects will be. (For example, "breathing", where changes in gain when signals are small cause audible variations in the noise level, and "pumping", where changes in the gain are obvious.)

Voltage-controlled amplifiers

The work of an expander is done by the voltage-controlled amplifier (VCA). Most of the units described use a "transconductance" technique, as shown in Fig. 7. That is typified by RCA's CA3080 operational-transconductance amplifier. A control voltage changes the bias current to differential pair Q1-Q2. The collector current of Q1 goes through current mirrors M1 and M2 (a current mirror "reflects" the input current to its output), and the collector current of Q2 is reflected by M3. The gain of that circuit is due to the transconductance (the ratio of I_{OUT} to V_{IN}) of Q1-Q2 times the load resistance, R_L . Since the transconductance of Q1-Q2 is proportional to I_{BIAS} , the gain is easily controlled.

The drawback of that, and all other VCA's, is that the control element has to be non-linear and it therefore generates distortion. In addition, it will be noisy. (If it were perfectly quiet, the input signal level could be lowered so that the distortion could be dramatically reduced.) The Carver preamp varies the bias on diodes to vary their impedance and change gain, and the Phase Linear 1000 uses FET's as voltage-variable resistors.

Now that you know about what expanders do and how they do it, I expect that you will find my implementation of an expander you can build very interesting. Next month, we will discuss the varied world of dynamic noise-filters.

R-E

ADDRESSES OF MANUFACTURERS

<p>Carver C-4000 Preamp—\$900 P.O. Box 664 Woodinville, WA 98072 CIRCLE 88 ON FREE INFORMATION CARD</p>	<p>Phase Linear 1000 Series II*—\$400 20121 48th Ave. West Lynnwood, WA 98036 CIRCLE 92 ON FREE INFORMATION CARD</p>
<p>dbx, inc. 1BX—\$260 71 Chapel Street Newton, MA 02195 CIRCLE 89 ON FREE INFORMATION CARD</p>	<p>Pioneer RG-2—\$200 85 Oxford Drive Moonachie, NJ 07074 CIRCLE 93 ON FREE INFORMATION CARD</p>
<p>Heath AD-1304*—\$200 Kit Benton Harbor, MI 49022 CIRCLE 90 ON FREE INFORMATION CARD</p>	<p>RG Dynamics PRO-16—\$300 Skokie, IL 60076 CIRCLE 94 ON FREE INFORMATION CARD</p>
<p>MXR Dynamic Expander—\$300 247 N. Goodman Street Rochester, NY 14607 CIRCLE 91 ON FREE INFORMATION CARD</p>	<p>SSS ASRU**—\$100 Kit 912R Knobcone Place Loveland, CO 80537 CIRCLE 95 ON FREE INFORMATION CARD</p>

* Includes dynamic noise filter—see next month's article.
** This unit is the final subject of this article series.

MANUFACTURERS OF EXPANDERS

Manufacturer	Channel Coupling	Frequency Selection	Attack/Decay Circuits	Expansion Fixed Variable	VCA Technique	Features
RG Dynamics	Partial	Midrange "harmonic"	See Text	Variable	Transconductance RCA CA3080	Max. expansion, slope both variable.
MXR	Together	Wideband w/high-treble emphasis	~1.5mS/variable decay	Variable	Transc. Signetics NE571	User variable decay time.
dbx, inc. 1BX	Together	Wideband	See Text	Variable	Transc. Custom dbx circuit.	
Pioneer RG-2	Partial	Midrange	Similar to RG Dynamics	Variable	Unknown	
Phase Linear 1000 Series II	Independent	1.5 kHz and up	Currently being changed.	Fixed—7.5 dB	JFET variable resistor	
Heath	Together	Midrange	3 mS/300 mS for large changes	Fixed—7 dB	Transc. CA3080	
Carver	Together	70 Hz-2.8 kHz low-level; wide-band high-level.	30 sec/.25 sec low-level; 7 mS/180 mS high-level	Fixed—3.6 dB	Diode dynamic resistance	
SSS	Together	Midrange	.3 mS-150 mS for large changes	Fixed—9 dB	MOSFET variable resistors	

DESIGNING With

The threshold-logic family is a relatively unknown one that deserves more attention than it gets. Among its characteristics are the ability to emulate other types of logic gates and to make decisions based on the number of inputs at a given logic level.

JOHN E. CUNNINGHAM

HOW WOULD YOU LIKE A SINGLE integrated circuit that could perform all of the logic-gating functions that you have ever heard of, as well as a few that you have probably never heard of? How would you like a gate that would tell when the majority of the inputs assumed a certain state without regard as to which inputs were involved?

Not only can you get such a gate but you can get two of them in a single dual-in-line package which sells for a low price. It is the type MC14530 Majority Logic Gate, made by Motorola.

That IC has been available for several years, but for some reason it seems to have escaped the notice of most experimenters and technicians.

Majority logic is actually a branch of a more general class of logic known as *threshold* logic. Threshold logic is analogous to the response in an animal or human nervous system where the response seems to be based on whether or not a stimulus crosses over a certain threshold. As such, it has been known for many years but has never enjoyed widespread application.

What is majority logic?

Figure 1 shows a sketch of a majority-logic gate. It has five inputs and the output is high whenever any three or more of the inputs are high. It doesn't matter which of the inputs is high—any three will do.

Figure 2 shows a block diagram of the MC14530 Dual 5-input Majority Logic Gate, together with its pin connections. The device is available in a

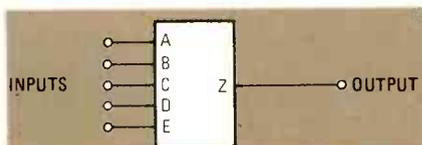


FIG. 1—WHEN the majority of the inputs (A-E) assume a given logic level, so does the output (Z).

16-pin dual-in-line plastic package. The electrical ratings are given in Table 1.

That IC uses CMOS technology and therefore, draws very little current. It can easily be battery-powered. It has the typical CMOS high-noise immunity and can be used in environments where the electrical noise level is high. Like all other CMOS devices, the IC is susceptible to damage from static charges, but it does contain circuitry to protect its inputs.

As shown in Fig. 2, each half of the MC14530 consists of a majority gate of the type shown in Fig. 1 followed by an EXCLUSIVE NOR gate. One input of the latter is brought out to a pin.

The function of the EXCLUSIVE NOR gate is to invert the output of the majority gate by means of a signal applied to input W (pin 6). Thus, if input W is tied to a logical high level, the circuit of Fig. 2 will be a 5-input majority gate. Its output will be high whenever any three or more of the inputs are high. On the other hand, if we connect input W to a logical low level (ground), the circuit will act like what we might call a "minority-logic gate." The output will be *low* whenever three or more of the inputs are high. The truth table for the EXCLUSIVE NOR gate is shown at the

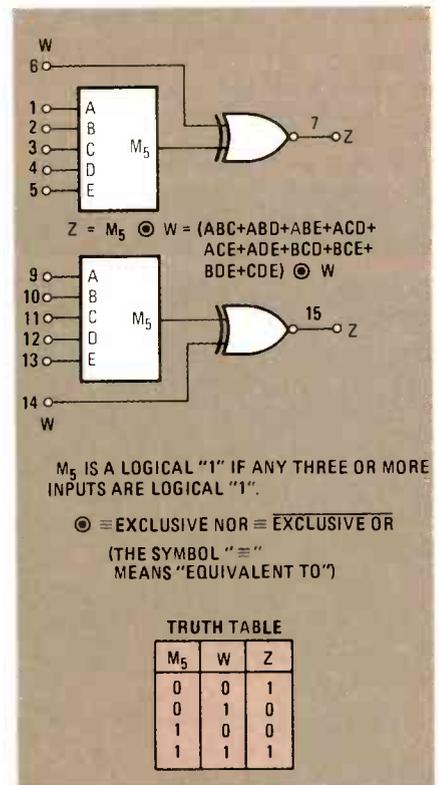


FIG. 2—THE MC14530 consists of two 5-input majority-logic gates, each followed by a NOR gate.

TABLE 1

MAXIMUM RATINGS (Voltages referenced to V_{SS}, Pin 12)

RATING	SYMBOL	VALUE	UNIT
DC Supply Voltage	V _{DD}	+18 to -0.5	VDC
Input Voltage, All Inputs	V _{in}	V _{DD} to -0.5	VDC
DC Current Drain per Pin	I	10	mADC
Operating Temperature Range	T _A	-55 to +125	°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

MAJORITY-LOGIC

bottom of Fig. 2. Figure 3 shows the truth table for the circuit shown in Fig. 2.

There is no reason why a majority-logic gate must have five inputs. We can easily connect it to act as a 3-input majority gate as shown in Fig. 4. When the gate is connected as shown in Fig. 4-a with input W high, the output Z will be high whenever any two of the three inputs A through C are high. With pin W low, as shown in Fig. 4-b, the output will be low whenever any two of the three inputs are high.

Simulating conventional gates

The MC14530 IC can be used not only as a majority-logic gate, but it can also be made to behave as a 2- or 3-input OR, NOR, AND, or NAND gate. Figure 5 shows how connections are made to make the device behave like any conventional 3-input gate. All that is required is that two of the inputs be permanently connected to predetermined levels. For example, in Fig. 5-a, two inputs are permanently connected to a high-logic level. Now, inasmuch as any two of the five inputs are already high, if any of the remaining inputs go high the output will go high. That is exactly how a 3-input OR gate behaves, so our circuit will behave like a 3-input OR gate.

In Fig. 5-b, input W is connected to ground. That, as we saw earlier, inverts the output so the circuit will now behave like a 3-input NOR gate.

In Fig. 5-c, two of the five inputs are tied to ground. The only way the output can go high is for all of the remaining inputs to go high. That is exactly what happens in a 3-input AND gate. To turn the circuit into a 3-input NAND gate, simply tie input W to ground as shown in Fig. 5-d.

Now we have ways to make the basic circuit behave like any 3-input logic gate. We don't have to stop here. We can also make it behave like any 2-in-

TRUTH TABLE

INPUTS A B C D E	W	Z
FOR ALL COMBINATIONS OF INPUTS WHERE THREE OR MORE INPUTS ARE LOGICAL "0"	0	1
	1	0
FOR ALL COMBINATIONS OF INPUTS WHERE THREE OR MORE INPUTS ARE LOGICAL "1"	0	0
	1	1

FIG. 3—OUTPUT STATE of the NOR gate is determined by the status of "W" and of the five inputs.



FIG. 4—TYING ONE OF THE five inputs high and one low leaves a 3-Input majority-logic gate.

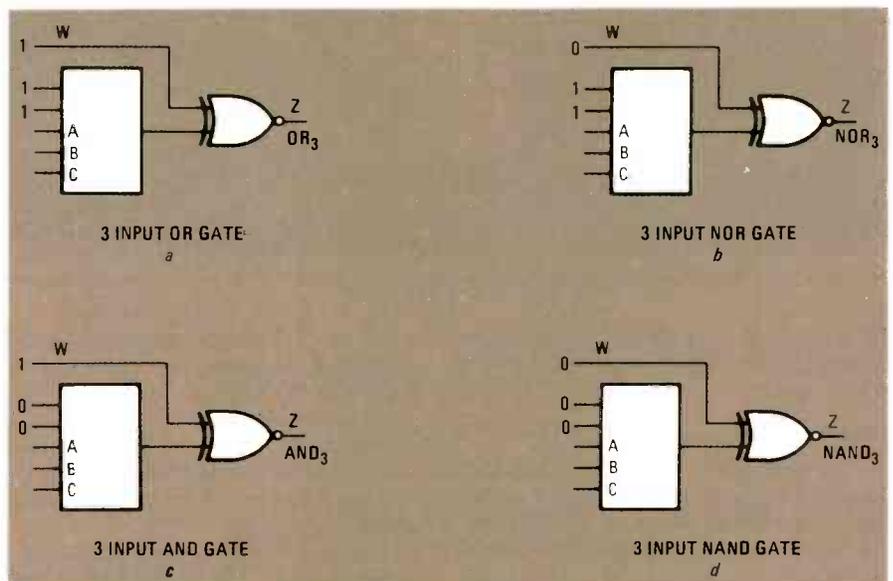


FIG. 5—VARIOUS 3-INPUT logic gates can be formed from a 5-input majority-logic gate.

put gate. The connections are shown in Fig. 6.

In Fig. 6-a, we have simulated a 2-input OR gate by tying two inputs permanently high and grounding another input. If either of the remaining inputs should go high, the output will go high. Thus, we have a 2-input OR gate. To make it into a 2-input NOR gate all we have to do is to ground input W, as shown in Fig. 6-b.

In Fig. 6-c, we have simulated a 2-

input AND gate. Here we have tied two of the inputs low and one of them high. The only way the output can go high is for the remaining two inputs to go high. That, of course, is the AND function. Again to convert the circuit into a NAND gate, all we have to do is to ground input W as shown in Fig. 6-d.

Since the logical function of the gates shown in Figs. 5 and 6 is determined by the logic levels applied to some of the pins, we can change the function of a

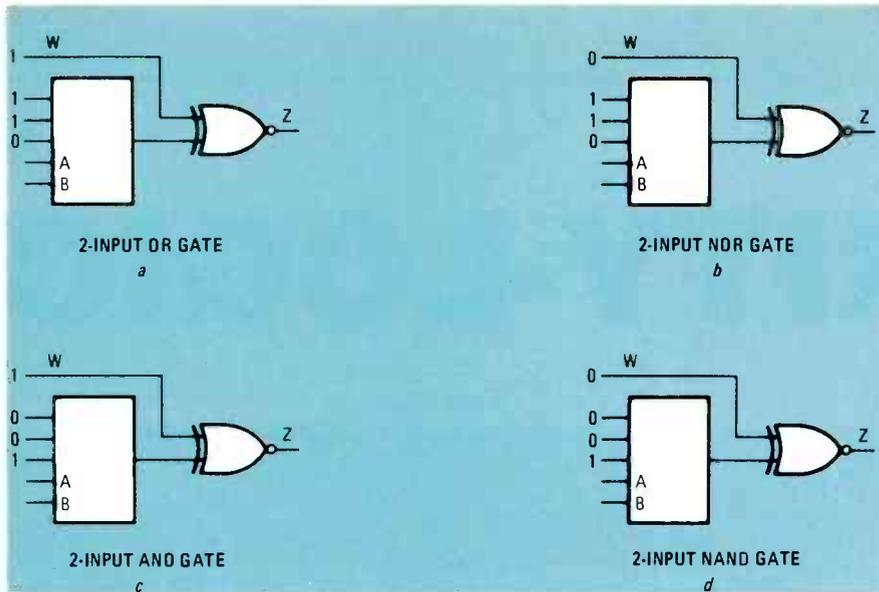


FIG. 6—LOGIC FUNCTION is determined by the logic levels of the "unused" pins.

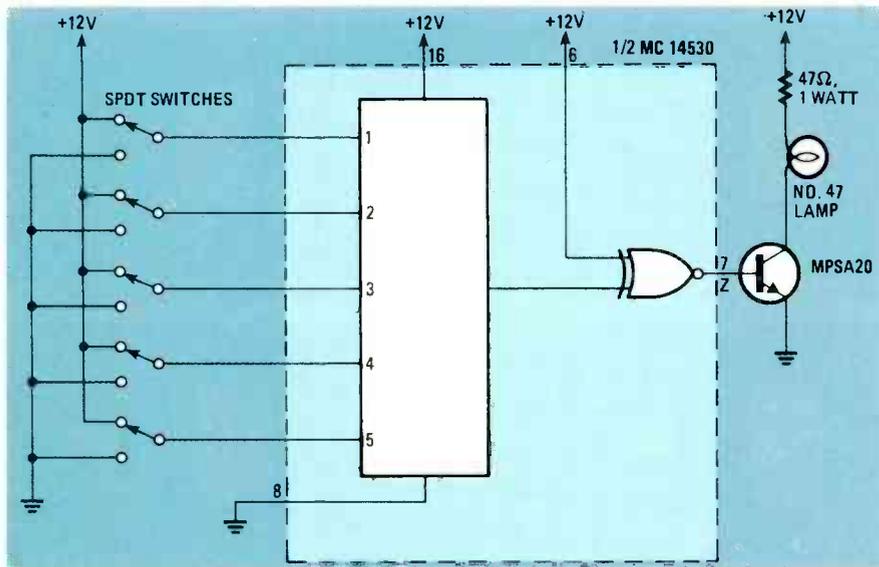


FIG. 7—THE PRINCIPLE OF majority logic is easily applied to a vote where a simple majority rules.

gate while it is in the circuit by simply changing the logic levels applied to those pins.

Majority-logic applications

To make good use of majority logic, most of us have to adopt a new way of thinking. When we think of logic systems and digital circuits, we usually think in terms of the more conventional OR, NOR, AND, or NAND gates. We don't think in terms of majority gates, simply because we haven't been exposed to them.

Many logic-circuit problems can be solved easily using majority logic. Figure 7 shows a secret voting machine for five voters. Each of the voters has a single-pole double-throw switch. When the switch is in the up position it connects one of the inputs of the logic gate to a high logic-level. When the switch is in the down position it connects the input to a low logic-level. Whenever the

majority of the voters set their switches to a high position, the output of the logic gate will go high. Thus, we know that the majority have voted that way, but we have no way of knowing which three (or more) of the five did. The circuit also has possibilities as a simple game.

Figure 8 shows the application of a majority gate to a foolproof security system. One of the most annoying features of intrusion alarms is that they can be tripped by things other than an intrusion, such as failure of a component. The result is false alarms that are annoying and sometimes even dangerous.

The circuit of Fig. 8 minimizes the probability of a false alarm by requiring two out of three intrusion detectors to be tripped before the alarm will sound. Any type of intrusion detector may be used with the system; all that is required is that the output of the alarm

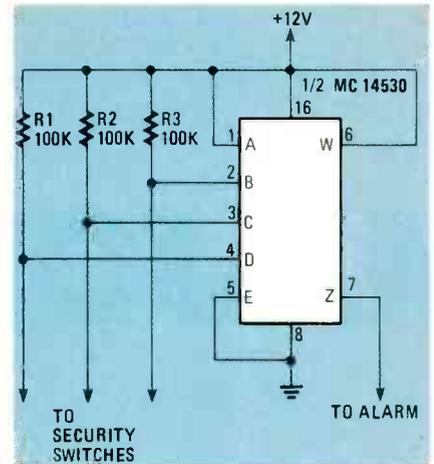


FIG. 8—"FOOLPROOF" SECURITY SYSTEM requires that more than one alarm device be tripped.

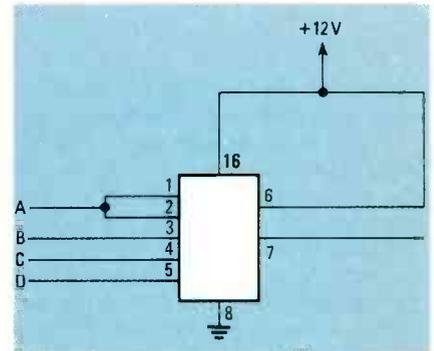


FIG. 9—MAKING TWO INPUTS into one gives that input twice the importance of the others.

be a switch or relay that keeps the output grounded until an intrusion occurs. The intrusion detectors are arranged so that normally an intruder will trip all three upon entering the protected area.

The circuit of Fig. 8 is a 3-input majority gate. The output will go to a high state whenever any two of the input circuits is opened. Thus, if one of the intrusion detectors should fail, it will not cause a false alarm. Similarly, an intruder who skillfully avoids tripping one of the alarms, will sound the alarm upon tripping the other two.

Weighting an input

Another interesting feature of the majority gate is that an input can be "weighted" or made more important than the other inputs. Figure 9 shows a circuit where input A is weighted so that it is twice as important as the other inputs. That is accomplished by simply connecting input A to two of the input pins of the gate.

The output of the circuit of Fig. 9 will go high when inputs B, C, and D go high, or when input A and any one of the other inputs go high. Thus, as far as the circuit is concerned, input A is twice as important as any of the other inputs.

A circuit of that type can be used where one part of a system, such as an intrusion alarm; is more reliable than other parts.

R-E

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National Aeronautics and Space Administration
Patent #4,052,648

If you think your electric bills are high now, brace yourself. They'll be even higher next year, and for years to come—even if your use of electricity remains constant—due to utility company rate increases.

Right now, it's probably costing you \$120 to \$160 a year to run a refrigerator...about \$130 for a freezer...and other outrageous sums to power your attic fan, washing machine, sump pump, electric typewriter and/or trash compactor. Even a gas clothes dryer uses expensive electricity (to rotate the drum).

So it makes a lot of sense to use a lot less electric power. And now you can do just that—without cutting down on your use of electric appliances!

INTRODUCING THE WATT SAVER

Our exclusive new Watt Saver is based on an invention developed and patented by the National Aeronautics and Space Administration. "The NASA/Nola power saver," wrote a **Popular Science** senior editor, "was developed by Frank Nola at NASA's Flight Center in a program to reduce power consumption in spacecraft motors. Nola calls it a PFC—power-factor controller. I prefer to call it a power saver, however, because that's what it does."

NASA TESTED IT

According to NASA documents, "The device has been tested at Marshall Center on over 40 types of motors, with power savings ranging up to 60%, depending on the loading. The motors tested were both single-phase and three-phase, ranging from 1/2 H.P. to 5 H.P. Most motors will show up to 40-50% savings when running lightly loaded or unloaded, and some will show 5-to-7% savings at rated load."

NASA's Technical Support Package showed that "The Power Factor Controller applies to induction type electric motors—the most commonly used type in all major home appliances and the most commonly used in industry." Such as those in refrigerators, freezers, washing machines, dishwashers, trash compactors table saws, drill presses, electric typewriters, gas dryers (without electric ignitors), fans, grinders, food processing machines, lathes and various types of pumps (e.g., heat, sump, swimming pool).

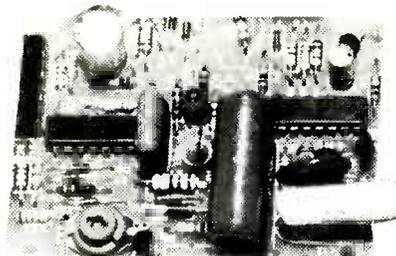
HOW IT SAVES POWER

Popular Electronics explained it this way: "AC induction motors characteris-

tically run at a nearly constant speed that's fixed by power-line frequency and independent of load and supply voltage. When heavily loaded, the motor draws line current that is nearly in phase with the applied voltage....Under light load conditions, the motor develops less torque by allowing more lag between the voltage and the current. This reduces the power factor while leaving the current essentially the same in magnitude." (The wasted power is given off as heat.)

"To minimize this waste, Nola's device monitors the motor's power factor, and when it detects light load conditions, it reduces the supply voltage....The current, now more nearly in phase with the voltage, therefore does as much useful work as before, but it and the voltage are smaller, resulting in a net savings of electric power."

Besides saving power, the Watt Saver also allows motors to run cooler—which lengthens their life—and quieter.



Inside the Watt Saver: electronic components work automatically, microsecond by microsecond, to make sure an electric motor receives no more voltage than what's needed to handle the load at any given instant...to save you money!

IT'S SIMPLE TO USE

The Watt Saver—made in the U.S. under license from NASA—is housed in a sturdy metal case (just 5 1/4" W x 3" H x 2" D) with an electrical outlet and a 2-foot cord. Simply plug the cord of your appliance into the Watt Saver, then plug the Watt Saver's cord into any electrical outlet. You can move the Watt Saver to various locations as needed or, better yet, get two or more.

(For air conditioners, order the wired-in model and if you are electrically inclined no electrician is necessary to connect it.)

Whenever the appliance is used, the Watt Saver goes to work instantly. There are no buttons to push, no gauges to watch. The Watt Saver works automa-

tically, to reduce the amount of electric power used and (therefore) to reduce your electric bills—without reducing the efficiency of your appliances!

LOW COST—AND A TAX CREDIT

Although we're the only company in the world offering the Watt Saver, the cost is modest—only **\$39.95** for the 110V, 15-amp model that handles motors up to and including 1 H.P. Want two? They're just **\$37.95** each. Or splurge and get three at **\$34.95** each. Specify plug-in or wired-in models.

We also offer a 220V, 15-amp model for motors up to and including 2 1/2 H.P. The price is **\$49.95** for one; **\$47.95** each for two or more. Specify plug-in or wired-in.

No matter which model you order or how many units you order, the postage/handling charge is just \$2.50 per order.

And next year, when you fill out your tax return, you can deduct a 15% energy tax credit—for additional savings.

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Try the Watt Saver for as long as 60 days. If not completely satisfied, return it (insured) for a full refund.

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CIRCLE 46 ON FREE INFORMATION CARD

A look at another easy way to make circuit boards.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

IN THE AUGUST 1980 ISSUE, WE DISCUSSED the *E-Z Circuit* adhesive materials for making "instant" PC boards. You know that I am impressed with that system, produced and distributed by Bishop Graphics (P. O. Box 5007RE, Westlake Village, CA 91359). This month I want to be sure that you know about two more PC systems that are also covered in their EZ-102 manual/catalog.

The first is called *Cut 'N' Peel*. It is nothing more than a board with a special copper covering. To use *Cut 'N' Peel*, you must first sketch the circuit on the copper. Then, unwanted copper is cut with an *X-acto* or other very sharp knife and simply peeled up off the board.

Of course, with the unwanted copper gone, you are left with your circuit. There you have it—an instant PC board. You are ready to drill the board, and to mount and solder components.

The cutting and peeling may be quite difficult with a complex circuit but it *can* be done—steady hand, patience, and all that.

In my opinion, that system is well suited to relatively simple circuits. For

others, I'll stick with adhesive copper patterns (pun intended!). In any case, there are two easy, clean, and reliable methods of making prototype one- or two-of-a-kind PC boards, and those methods can even be combined on one board.

What's that?—you need more copies of your board? Then, you may as well get out the etchant. *And* you'll need master artwork. That can be made in a variety of ways. My preference is to use preprinted opaque patterns on clear film (Fig. 1). That system is quick and easy; it not only gives professional-looking results but, perhaps best of all, is forgiving of placement mistakes.

Bishop Graphics offers a complete array of patterns for making original artwork for PC boards. All you have to do is to press them down on clear film in the required configuration and then run traces with the opaque tape. With just a little care, you can come up with a perfect original.

You know, one of the secrets of making a good PC board is to develop a good design (layout) in the first place. Depending upon the circuit, a lot of sketching

and re-sketching may be necessary in order to get the number of jumpers down to a minimum.

Eventually, however, a scale drawing should be made to aid in the actual placement of patterns—either opaque on film, or adhesive copper on a board. Bishop's scale templates are almost indispensable in making those final drawings.

Altogether, the *E-Z Circuit* line is quite comprehensive. Use of those materials can save you a lot of "fussin' and cussin'" when fabricating PC boards.

Pine Wood Derby

Back in March I asked your help for Bill Wisel who was looking for a way to take the "heat" of disputes out of his Cub Scout's Pine Wood Derby heats. Your responses have been both gratifying and intriguing.

Apparently, many of you are or were Scout leaders. There have been more ideas and circuits on that topic than any other since *Hobby Corner* began. In fact, they are *still* coming in. Please accept our thanks and "well done" to each of you who has written.

Unfortunately, all that has come about too late for the 1980 Derby but there is plenty of time for '81. So, let's take a look at some of the responses.

Your answers to Bill's question ranged from the very simple to the very complex—mechanical to IC's; two-lane to six-lane; winner-only to each lane timed; arbitrary timing interval to one-thousandth-of-a-second accuracy! Since the number of circuits we can print is limited, we'll take a look first at the major differences in approach.

Most packs (and leaders!) have limited finances. In spite of using surplus and salvaged parts, an accurately timed, multi-lane finish line is going to be rather expensive. For many readers, however, that is *not* the prime consideration in deciding basic approach.

In determining the number of lanes, several respondents pointed out that those youngsters spend a lot of time building their cars. In order to have the reward of more racing, even for the losers, you have only two lanes and the "best-two-out-of-three heats" rule.

Carl Malmquist of Vestal, NY makes a very good point for *not* actually timing the cars. It is difficult to explain the logic and justice to a youngster who loses one race while having a faster time than the

continued on page 70

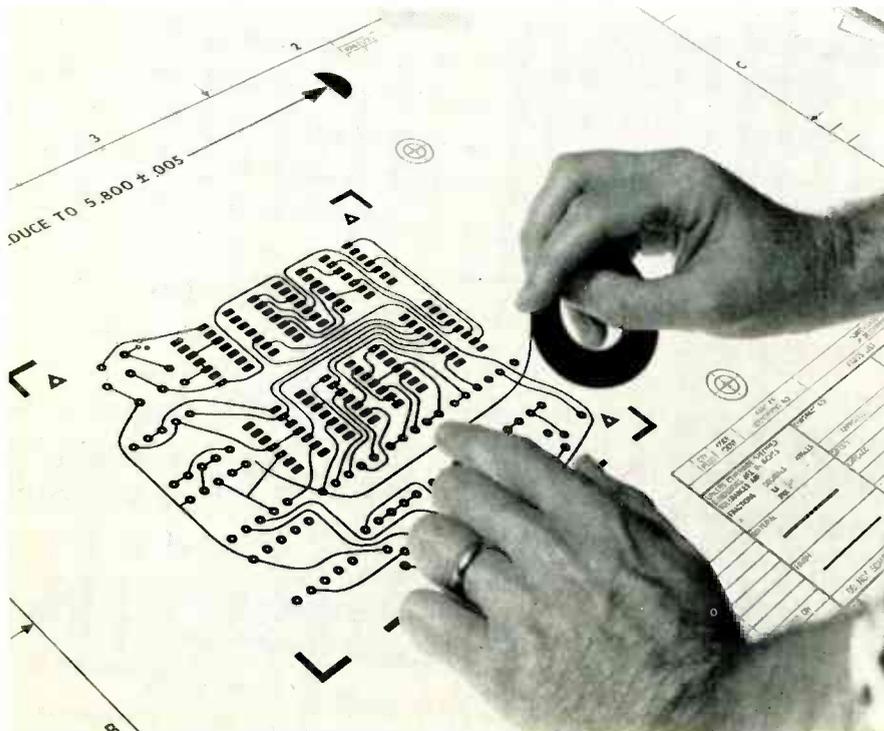


FIG. 1

Start learning and computing for only **\$129.95** with a Netronics 8085-based computer kit. Then expand it in low-cost steps to a business/development system with 64k or more RAM, 8" floppy disk drives, hard disks and multi-terminal I/O.

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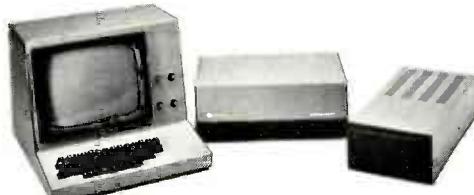
Special! Full 8" floppy, 64k system for less than the price of a mini! Only **\$1499.95!**

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Imagine — for only \$129.95 you can own the starting level of Explorer/85, a computer that's expandable into full business/development capabilities — a computer that can be your beginner system, an OEM controller, or an IBM-formatted 8" disk small business system. From the first day you own Explorer/85, you begin computing on a significant level, and applying principles discussed in leading computer magazines. Explorer/85 features the advanced Intel 8085 cpu, which is 100% compatible with the older 8080A. It offers on-board S-100 bus expansion. Microsoft BASIC in ROM, plus instant conversion to mass storage disk memory with standard IBM-formatted 8" disks. All for only \$129.95, plus the cost of power supply, keyboard/terminal and RF modulator if you don't have them (see our remarkable prices below for these and other accessories). With a Hex Keypad/display front panel, Level "A" can be programmed with no need for a terminal, ideal for a controller, OEM, or a real low-cost start.



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Full 8" disk system for less than the price of a mini (shown with Netronics Explorer/85 computer and new terminal). System features floppy drive from Control Data Corp., world's largest maker of memory storage systems (not a hobby brand!)



Level "A" With Hex Keypad/Display.

LEVEL "A" SPECIFICATIONS

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an advanced 8155 RAM I/O... all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, plus generous prototyping space.

PC Board: Glass epoxy, plated through holes with solder mask. • I/O: Provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader... cassette tape recorder input and output... cassette tape control output... LED output indicator on SOD (serial output) line... printer interface (less drivers)... total of four 8-bit plus one 6-bit I/O ports. • Crystal Frequency: 6.144 MHz. • Control Switches: Reset and user (RST 7.5) interrupt... additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard. • Counter/Timer: Programmable, 14-bit binary. • System RAM: 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems... RAM expandable to 64K via S-100 bus or 4k on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F900, leaving F000 free for user RAM/ROM. Features include tape load with labeling... examine/change contents of memory... insert data... warm start... examine and change all registers... single step with register display at each break point, a debugging/training feature... go to execution address... move blocks of memory from one location to another... fill blocks of memory with a constant... display blocks of memory... automatic baud rate selection to 9600 baud... variable display line length control (1-255 characters/line)... channelized I/O monitor routine with 8-bit parallel output for high-speed printer... serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Keypad/Display Version): Tape load with labeling... tape dump with labeling... examine/change contents of memory... insert data... warm start... examine and change all registers...

single step with register display at each break point... go to execution address. Level "A" in this version makes a perfect controller for industrial applications, and is programmed using the Netronics Hex Keypad/Display. It is low cost, perfect for beginners.

HEX KEYPAD/DISPLAY SPECIFICATIONS

Calculator type keypad with 24 system-defined and 16 user-defined keys. Six digit calculator-type display that displays full address plus data as well as register and status information.

LEVEL "B" SPECIFICATIONS

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards, and includes: address decoding for onboard 4K RAM expansion selectable in 4k blocks... address decoding for onboard 8k EPROM expansion selectable in 8k blocks... address and data bus drivers for onboard expansion... wait state generator (jumper selectable), to allow the use of slower memories... two separate 5 volt regulators.

LEVEL "C" SPECIFICATIONS

Level "C" expands Explorer/85's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and card are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card, gold plated S-100 extension PC board that plugs into the motherboard, just add required number of S-100 connectors.



Explorer/85 With Level "C" Card Cage.

LEVEL "D" SPECIFICATIONS

Level "D" provides 4k of RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the origi-

nal 256 bytes located in the 8155A). The static RAM can be located anywhere from F000 to EFFF in 4k blocks.

LEVEL "E" SPECIFICATIONS

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for 2 x 8 RAM IC's (allowing for up to 12k of onboard RAM).

DISK DRIVE SPECIFICATIONS

- 8" CONTROL DATA CORP professional drive
- LSI controller
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- Single or double density
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- Access time: 25ms (one track)

DISK CONTROLLER I/O BOARD SPECIFICATIONS

- Controls up to four 8" drives
- 1771A LSI (SD) floppy disk controller
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Special! Complete Business Software Pak (Save \$625.00!) — Includes CP/M 2.0, Microsoft BASIC, General Ledger, Accounts Receivable, Accounts Payable, Payroll Package (regular price \$1325), yours now at SPECIAL PRICE: \$699.95.

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- Explorer/85 Level "A" kit (Hex Keypad/Display Version)... \$129.95 plus \$3 post. & insur.
- 8k Microsoft BASIC on cassette tape... \$64.95 postpaid.
- 8k Microsoft BASIC in ROM kit (requires Levels "B", "D" and "E")... \$90.95 plus \$2 post. & insur.
- Level "B" (S-100) kit... \$49.95 plus \$2 post. & insur.
- Level "C" (S-100 6-card expander) kit... \$39.95 plus \$2 post. & insur.
- Level "D" (4k RAM) kit... \$69.95 plus \$2 post. & insur.
- Level "E" (EPROM/ROM) kit... \$5.95 plus 50c p&h.
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- Fan For Cabinet... \$15.00 plus \$1.50 post. & insur.
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- 32k RAM kit... \$299.95 plus \$2 post. & insur.
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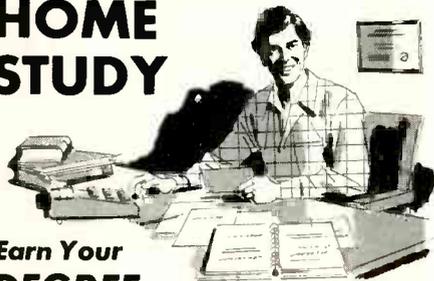
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HOBBY CORNER

continued from page 68

winner of another.

Two methods of triggering the circuits predominate. About half of the respondents use photocells or phototransistors to detect the car's passage over the finish line. D. R. Fair of Center Valley, PA indicates that a pencil-shaped car may not consistently activate such a trigger. Paul Bradley (Sterling Heights, MI) sent a circuit with trimmer pots on each photo device to adjust them for ambient light conditions.

Mechanical switches are used to trigger circuits by many of you. In some cases, leaf-actuated switches are imbedded in the track. Anthony Saxton of Burnsville, MN mounts his micro-switches behind rubber pads at the end of the track.

As mentioned, the actual circuits varied from mechanical relays to 60-device electronic masterpieces. They can give first place only, first three places, arbitrary or accurate time.

Quite obviously, choices must be made about each of these variables. I suggest to Bill and others that cost and complexity be secondary considerations. Decide first what you *need* and what you *want* in terms of final result. Then plan and build accordingly.

I hope that the discussion above will give you plenty of ideas and food for thought. Space will permit only one reader circuit now. I'll include one or two more soon. By then, you should be ready to start construction. The circuits presented will be chosen to illustrate some of the different approaches, not *necessarily* because they are better than all the others that were sent in.

Perhaps the simplest circuit was one sent in by Saxton. He uses mechanical switches and relays to pick winner only. Anthony says it has the dual advantage of sufficient accuracy and no overkill.

Figure 2 shows two double-pole relays in a two lane system. Figure 3 shows how three 3-pole relays are connected for a three-lane system. In that same manner, you can expand the setup for any number of lanes. For example, six lanes would require six 6-pole relays. (Any surplus telephone relays out there?) Let's see how Anthony's circuit operates for two lanes (Fig. 2) and then you can figure out any larger one you want.

Suppose the car on Lane 1 flips that momentary switch first. The circuit is complete through lamp L1 and through the coil of relay RY1 via the closed RY2-b contacts. Thus, relay RY1 is energized and that does two things: It closes contacts RY1-a to keep current flowing through L1 and relay RY1 and it also *opens* contacts RY1-b. In that manner, lamp L1 comes on and stays on.

Now, the second car hits the momentary switch in Lane 2. The circuit to coil

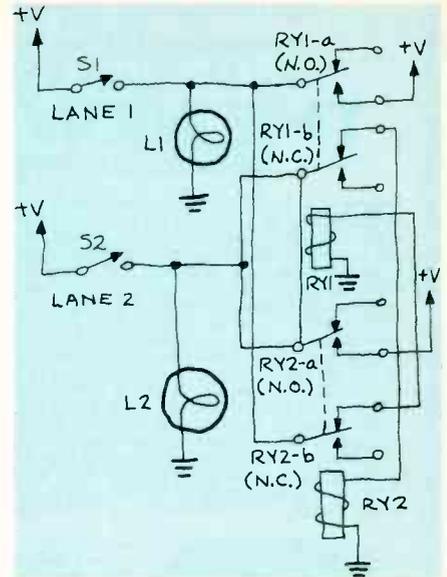


FIG. 2

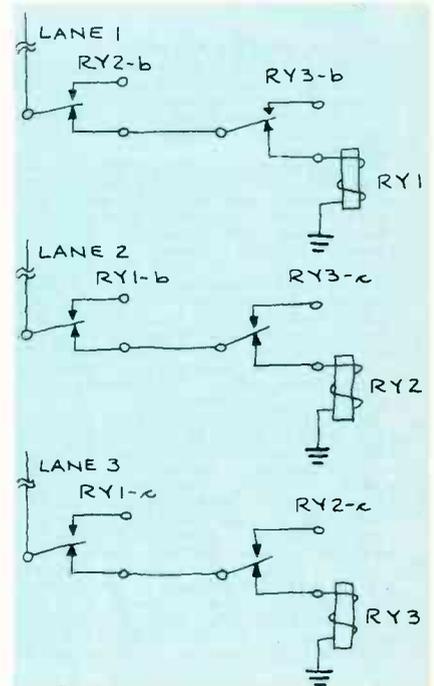


FIG. 3

of relay RY2 is *not* completed because the RY1-a contacts are now open. Thus, relay RY2 does not energize and contacts RY2-a stay open. Since contacts RY2-a are open, lamp L2 does not stay on—it only flashes briefly when the Lane-2 switch is hit.

Of course, if the Lane-2 car is faster, the sequence of events is opposite and lamp L2 lights to the exclusion of L1. A three (or more) lane setup works in the same way and indicates the winner only.

I have given no values for supply voltage, relays, or lamps. The only requirement is that they match. You can even use AC and avoid the need for a power supply.

Next month we'll look at an electronic solution to the problem and talk about some other uses for these circuits. **R-E**

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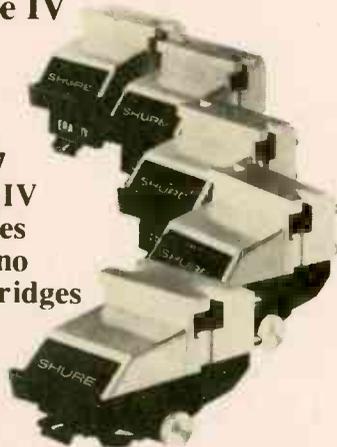
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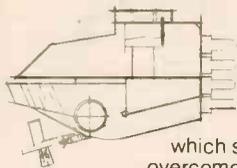
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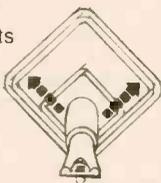


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new products

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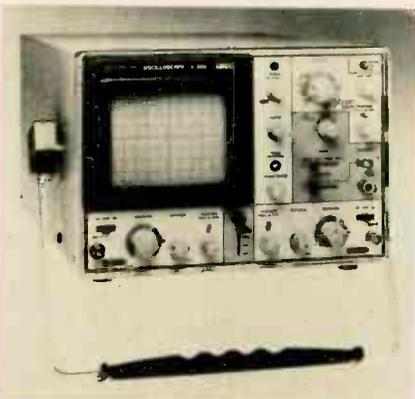
ARCHERKIT ELECTRONIC BICYCLE SPEEDOMETER, is a kit designed to fit most bikes and has 1/2-inch dual-scale 0 to 60 kilometers-per-hour and 0 to 30 miles-per-hour indication. The unit operates on one 9-volt battery. The speed-



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ometer has a rugged 4 X 2 1/2 X 2-inch molded housing and comes complete with mounting bracket, hardware, and step-by-step assembly instructions. Price is \$14.95.—**Radio Shack**, 1300 One Tandy Ctr., Fort Worth, TX 76102.

OSCILLOSCOPE/COMPONENT TESTER, model HM307, is a compact, lightweight single-trace oscilloscope designed for both field service and laboratory applications. It has a built-in component tester that tests common semiconductors and passive components in circuit. (Transistors, diodes, resistors, capacitors, and most other components can be checked.) The model HM307 changes from an oscilloscope to a component tester with the press of a single button while the oscilloscope settings are left undisturbed.



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The component tester applies ±8.6 volts RMS maximum to the device with current limiting to 28 mA; the resulting V/I display instantly reveals most bad semiconductors. No drift compensation is needed, and the model HM307 will trigger on signals as small as 3mm up to 30 MHz. Vertical sensitivity ranges from 5 mV to 20 V/cm in 12 calibrated steps. The time base is from 2 seconds to 0.2 μsec/cm with auto and external triggering

that ranges from 2 Hz to 30 MHz.

All critical DC voltages are regulated. The input AC transformer can be connected to operate from 110 to 237 volts AC, 50 to 60 Hz. The built-in 1 kHz, 0.2-volt (±1%) squarewave generator is used for checking probe compensation. The model HM307 comes housed in an all-metal low-profile case—4.5 X 8.3 X 10.4 in.—designed for rugged field-service use. There is a handy carry handle and retractable tilt-up stand that pulls down from under the unit. Accessories include X 1 probes, X 10 probes, X 100 probes, demodulator probes, test cables, viewing hood, carrying case, and scope chart. Price \$405.00 —**Hameg, Inc.**, 191 Main Street, Port Washington, NY 11050.

MINIATURE SPEAKER, model S100RA, measures 1 X 3/8 in. and weighs 15.2 grams. The fully-enclosed Alnico magnet weighs 0.209 oz. Nominal power is 0.2 watt and frequency response is 750-10,000 Hz. Voice-coil impedance is 8 ohms but may be varied upon special request.

The S100RA is designed for small-space applications such as in beepers, mobile telecommunications devices, portable medical equipment,



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walkie-talkies, and headphones. Cone material is paper and the frame is cadmium-plated steel. Price \$1.00.—**Intervox Speakers**, International Components Corporation, 105 Maxess Road, Melville, NY 11747.

PHASE METER, model 200, has a 0-360° mode for lagging test signals or a ±180° mode for signals whose phase relationships vary around zero. The input-voltage range is 35 mV to 250 volts RMS. Input impedance is 1 megohm for all input levels. Frequency range for a 35-mV RMS signal is 20 Hz to 300 kHz, with ±2° accuracy over that range. Front-panel calibration controls can also



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be used to offset any phase shift in the test setup. Display is three digits, plus sign. An analog output provides 10 mV per degree. Price \$325.—**FSI**, 1894 Commercenter W. No. 105, San Bernardino, CA 92408.

R-E

PLANT WATER GAUGE

THIS PLANT WATER GAUGE CAN EASILY BE constructed on a small piece of perforated construction board. Its case is made from a piece of Styrofoam with a section carved out to hold the nine-volt battery, and a small recess is made into which the underside of the board is pressed. The probes are stuck right through the center of the foam and glued in.

Assemble the gauge following the schematic in Fig. 1 and the drawing in Fig. 2. Be sure to tin the probes with solder to keep them from corroding.

To calibrate the gauge, connect the battery and press the probes gently into a pot containing a plant that is just on the verge of needing water (stick it in so that only an inch of the probe is left visible at the top). Turn the potentiometer until the "OK" LED lights and then turn it back to the point where that LED goes out and the "W," or "Water," LED just comes on. The device should now be properly adjusted.

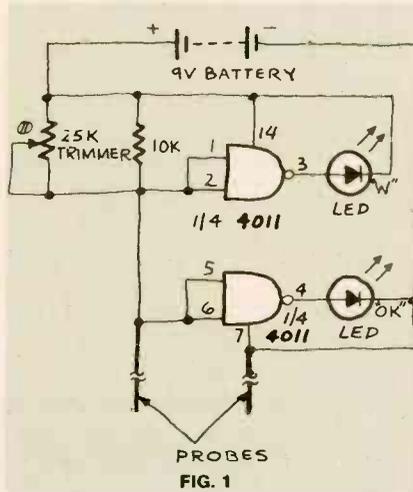


FIG. 1

Use this gauge anywhere for indoor plants and you will find it very useful in determining when to water and in preventing overwatering, since it reaches much farther down into the soil than you possibly can with your own fingers.—*Bob Mostafapour*

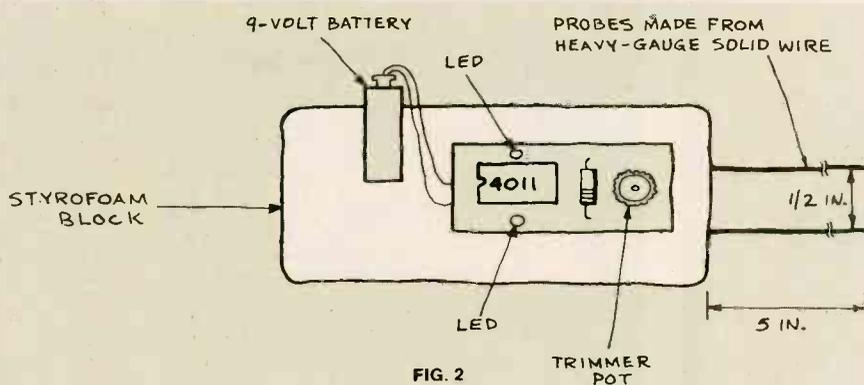
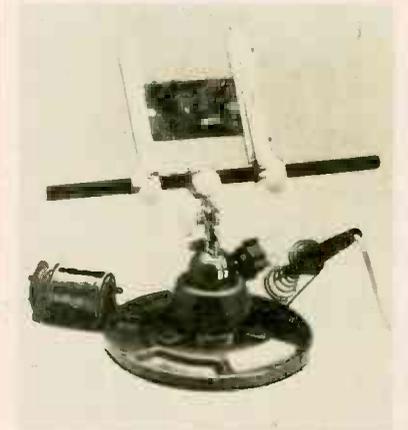


FIG. 2

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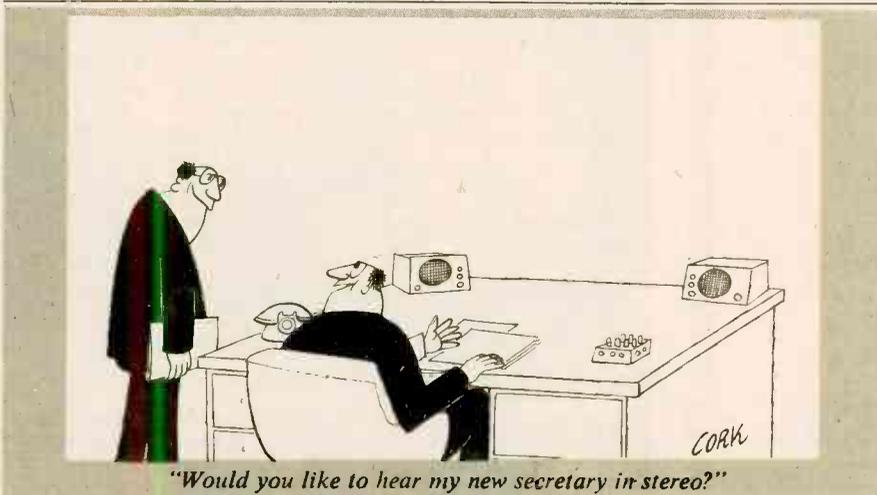
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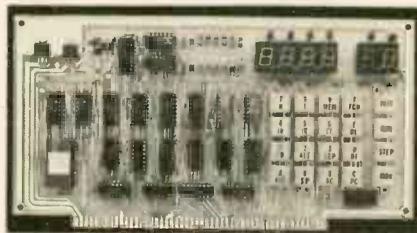


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gram provided with this model, on tape or disk, interacts with Level II BASIC, Level III BASIC and Disk BASIC. Price is \$225.00.—Scientific Engineering Laboratories, 11 Neil Dr., Old Bethpage, NY 11804.

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wipes clean the recorded signals. Measures 5 X 3 1/2 inches and weighs 4 lbs. The model 24-001 operates from a power source of 110 to 120 volts AC and is designed for intermittent duty. The suggested retail price is \$58.50.—Robins Industries Corp., 75 Austin Blvd., Commack, NY 11725. R-E

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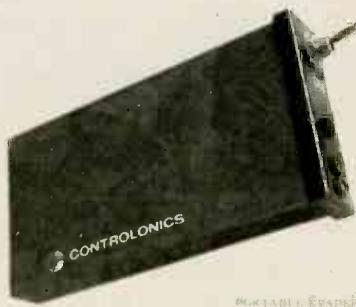
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radio products

More information on radio products is available. Use the Free Information Card inside the back cover.

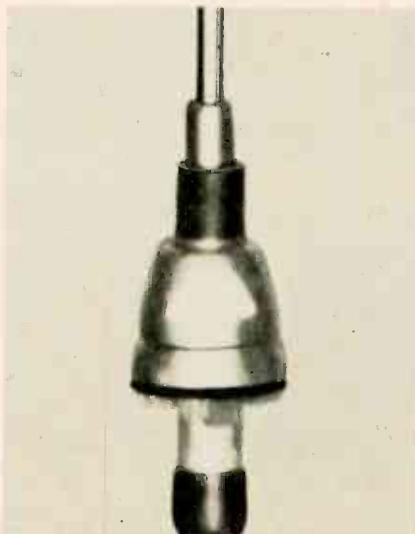
PORTABLE SCRAMBLER, the *Evader*, ensures privacy in two-way radio voice communications. A primary security-level scrambler, the portable *Evader* is compact and mounts directly on the radio using "hook-and-loop" pads. The rugged, water-resistant unit operates from the radio's



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power supply. A standard-designation code module is internally wired. The scrambler principle used is audio-band inversion with the code module selecting the inversion frequency. This portable unit is compatible in all codes with all basic *Evader* models. Price is \$547.—**Controlonics Corp.**, 410 Great Road, Littleton, MA 01460.

CUSTOM ANTENNA, FM-91, fits all General Motors and narrow-fender cars. The antenna has a single stainless-steel mast 31 inches long and a 72-inch cable. Shown is a close-up of the anten-



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na's body-mount. Price for the *FM-91* is \$7.37.—**Harada Industry of America, Inc.**, Dept. P, W. Artesia Blvd., Compton, CA 90220.

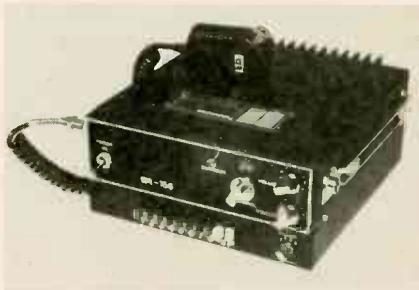
COMPACT AM/SW RECEIVER, the model *EP-8*, measures only 45 mm X 73 mm X 25 mm (1.77 X 2.95 X 0.98 inches) and weighs only 96 grams



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(3.5 oz.). The receiver tunes the standard AM broadcast band and shortwave frequencies from 3.9 to 12 MHz. Controls include a BAND SELECT switch, tuning dial, and a volume control coupled with an on/off switch. Power is supplied by two hearing-aid-type batteries (included). The *EP-8* has built-in Ferrite rod antennas for both bands. Audio output is by means of an earphone. Price is \$24.95.—**Radios International**, P.O. Box 6053, Richardson, TX 75080.

VHF/FM TRANSCEIVER, model *WR 156*, is a front-mount radio with a frequency range of 150-174 MHz and a frequency spread of 12 MHz. Twelve channels of any TX or RX frequency combination can be programmed with the 12-MHz spread, with full specs eliminating the need for



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two separate radios. The performance of each channel in this model is equal to that of a single channel radio. Options available for the *WR-156* include a 12-channel priority scanner, CTCSS encode/decode, DTMF, and time-out timer, plus any signaling system desired. Price range is from \$1,395 to \$2,350.—**W R Communications**, 1165 Harrison St., Seattle, WA 98109. **R-E**

stereo products

More information on stereo products is available.
Use the Free Information Card inside the back cover.

SPEAKER-SELECTOR SWITCH, The Controller, is a lightweight, compact unit that allows hookup and independent control of up to five pairs of stereo speakers. Any one pair or up to all five can be played simultaneously. Features include two headphone jacks, built-in amplifier protection, and barrier-type terminals for amp and speaker connections to help prevent short circuits. *The Controller* is compatible with all hi-fi amps, receivers, and headphones that operate into 4-ohms impedance; with a rating of 50 watts contin-



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uous per channel, its power is unlimited with the load switch off. Suggested retail price is \$49.50.—GC Electronics, 400 So. Wyman St., Rockford, IL 61101.

CLEANING KIT, model TX250, is designed for cleaning audio-tape heads, and features *Audio Cleaning Pens*—one for pressure rollers, and one for heads. Each pen holds a *Clean-Wick* that can be cut to the shape needed for each task. The kit



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also contains the solvent, ten replacement *Clean-Wicks*, a cutter, a device that elevates the pressure rollers for cleaning, and a rack for the kit materials. Good for about 900 cleanings, the kit is priced at \$27.50.—Texwipe Co., 101 West St., Hillsdale, NJ 07642.

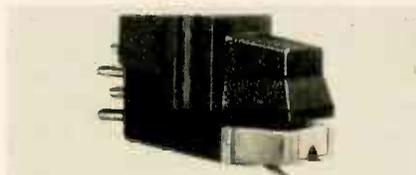
NOISE-REDUCTION SYSTEM, model SAE 5000A, removes impulse noises from records. The *SAE 5000A* is capable of removing even smaller pops and clicks than its predecessor while providing a cleaner sound than was previously attainable. Sophisticated logic circuits continually monitor the program material for those audio defects and automatically shut down the audio system upon detection of the impulses. A reconstruction circuit replaces the impulse noise with information extrapolated from the music appearing immediately before and after the impulse so that musical continuity is maintained. Since the entire process takes place in less than



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$\frac{1}{1000}$ of a second, the listener remains unaware of it. Both THD and IM in the *SAE 5000A* are rated at less than 0.1%. Signal-to-noise ratio is greater than 90 dB and frequency response is 20 Hz to 20 KHz \pm 1 dB. Suggested retail price of the *SAE 5000A* is \$225.—Scientific Audio Electronics, Inc., 701 E. Macey St., Los Angeles, CA 90012.

STEREO CARTRIDGES, model M72EJ and model M72B, feature a new stylus assembly with a reduced tip mass that results in high-trackability performance. The cartridges have a tracking-force range of from $1\frac{1}{2}$ to 3 grams, and are compatible with most turntables. The *model M72EJ* (shown), with bi-radial elliptical stylus is priced at \$51.00; *Model M72B* with spherical stylus is



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\$45.70. Prices for stylus assembly alone are: *N72EJ* \$17.45; *N72B* \$14.05.—Shure Bros., Inc., 222 Hartrey Ave., Evanston, IL 60204.

RECEIVER, the STA-2000, offers quartz-locked digitally synthesized AM/FM *Dolby* reception. It can scan the entire FM or AM band, stopping automatically, perfectly tuned, at each station. Its fluorescent readout displays the exact station frequency and also serves as a digital clock when the receiver is not in use. Any six FM and any six AM stations may be entered in the receiver's memory for instant access at the touch of a button. A *SCAN* button makes the microprocessor sample the programming on each station in the



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memory for a few seconds, and stops at the touch of the *HOLD* button. The *STA-2000* is rated at 60 watts-per-channel and carries a price tag of \$599.95.—Radio Shack, One Tandy Center, Fort Worth, TX 76102. R-E



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CIRCLE 55 ON FREE INFORMATION CARD

Catastrophic failures in solid-state circuits can be a troubleshooter's nightmare.

JACK DARR, SERVICE EDITOR

MOST OF US ARE ALL TOO FAMILIAR WITH the catastrophic failure in solid-state TV's, where some part blows up, and takes the horizontal output transistor and several others with it. That problem isn't limited to TV. I just ran across the identical problem in not one, but *two* high-power hi-fi amplifiers. This material was sent to me by Ric Church, the "Hi-Fi Doctor" of Bowling Green, KY. (To be frank, Ric did all the work; I'm just writing it up!)

Catastrophic failure can be a serious problem, and we both thought that it should be brought to the attention of readers so they'd have some ideas about where to start should they have the misfortune to run into it.

The basic problem was the same in both: a Sansui AU20,000 audio amp and a Marantz 2325 receiver. By coincidence, it made its presence known in the left channel on both of them.

The symptoms for both were the same: At very irregular intervals, the units would make a very loud bang out of the left-channel speaker. Along with the bang went the final stage transistors and the woofer of the speaker system went with them. (Even more of a catastrophe than

TV, considering the price of a good woofer!) In Ric's first letter, he gave me a clear description of the problem. I wasn't able to give him too much direct aid, to be honest. I did make some suggestions as to possible causes, tests, and so on. Later, he wrote back, saying he had solved it.

The bang was always at the same volume. That ruled out the preamps. The DC power supply was also eliminated since the problem was only in one channel. Switching the driver boards made no difference, so those were eliminated. The Sansui amplifier contains six transistors in the output stage which has an NPN side and a PNP side. (Marantz is almost the same but only four transistors.) When the bang occurred, it blew only two of the six transistors. The Sansui amplifier would continue to play with the four remaining output transistors and with no bangs. The Marantz blew all of the finals.

I suggested checking at reduced power with a variable-voltage line transformer (and a resistive load to save expensive speakers); also, using heat, cold, and physical jarring to see if the problem could be forced to show up. The reason-

ing was that anything in the signal path or bias circuitry that caused a very sharp transient would do damage when the transient was amplified. It should have been in the input circuits to the finals in order to get the gain needed to do the dirty work. These tests didn't show up anything at all for quite a while.

He finally found it! In the Sansui, it was caused by biasing transistor TR01, a 2SC1364. (See Fig. 1.) Since that is located on the power-output board, swapping other boards did no good. The actual cause was a *momentary* breakdown, which then *healed itself* and the amp went on working. A very rare bird indeed! The component apparently senses output levels and controls bias on the output stages. The breakdown itself caused the transient.

In the Marantz, the problem was basically the same, but the cause was a pair of bias diodes. Same thing; the diodes affect the bias on the high-power output stage. Now, I remember a very similar case, quite a long time ago, in a much smaller amplifier. All of a sudden . . . bang, no output transistors! I found the cause by moving the bias diode, which promptly broke in two in the middle and blew up the two new output transistors I'd just put in. Frankly, at that time I was quite green in dealing with solid-state audio amplifiers and I didn't think that an open bias diode would blow the outputs. Take my word, (and Ric's) for it now, that it *will*.

The Hi-Fi Doctor's recommended cure for that—and one with which I agree—is to locate the parts that could be suspected (bias diodes, bias transistors, etc.) and replace them! The bad parts heal themselves. When making replacements, go through the specs and pick a transistor or diode that *exceeds* the rating of the original part. **Do not** use the same part number or the problem will be back. Since that involves only a very few and comparatively inexpensive parts it would be a logical remedy.

I'll throw this one in from much experience—look the whole area over very closely for any signs of a bad solder joint on the PC boards. A bad joint could easily cause that type of transient; they're noted for it. Also, it would be a very good idea to use high-wattage resistive loads when making tests, instead of the expensive speakers.

Thanks again to Ric for all of the good work, and good luck to all of you if you fall over this kind of problem. **R-E**

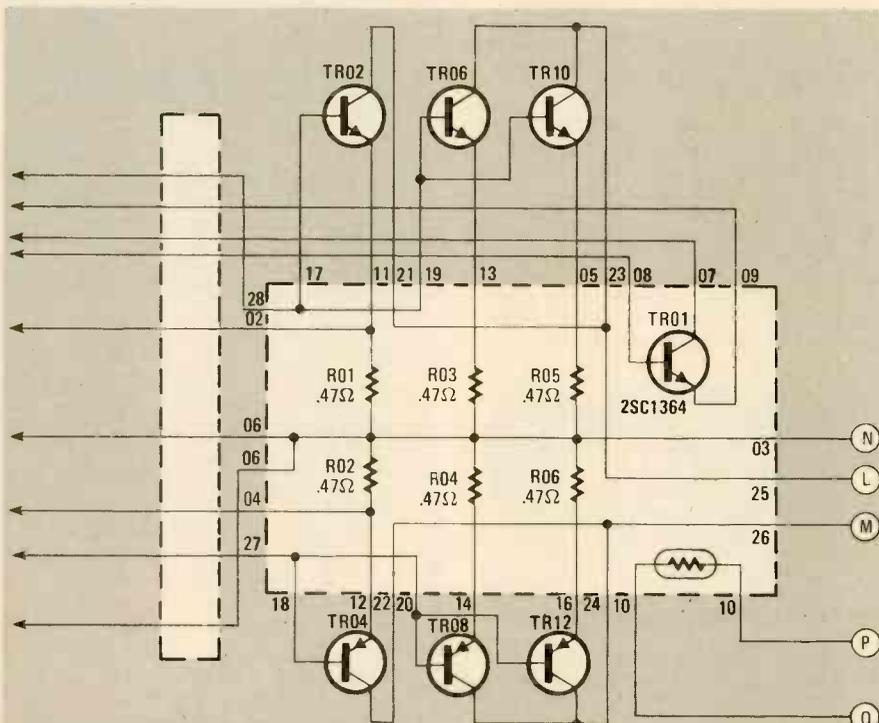


FIG. 1

service questions

COLOR BAR GENERATOR PROBLEMS

Edwin Menendez Inclan of Mexico City sends this feedback note: "I had two problems with my Sencore CG-141 color bar generator. The raster was short, vertically, on all patterns. (On TV signals, raster filled the screen). The other was the complete loss of the single horizontal line or dot pattern. You originally suggested checking or changing TR7, the vertical oscillator transistor. Although the original did not show any leakage, a new one did make the patterns fill the screen. They were vertically unstable, though.

"After much searching, I found that there was a slightly leaky capacitor in the collector circuit of TR7 (.05 μ F at 600 volts). Also, by using a resistance substitution box, I found that a resistor in the same circuit must have changed value. By setting the sub-box to a value that made the line/dot show up, I got it working properly again!"

Thanks, Edwin.

ALL WET

I've got a Panasonic CT-702 that was bought by a friend at a flea-market. Looks as if it had been out in the rain for some time! No sound, no raster. Found a bad SCR and couple of transistors on S-board. No luck. Finally took S-board out and cleaned all the plug-in contacts. Got raster but no sound or picture. Cleaned all contacts on A-board, and got them back. Now, the only problem is that some of the controls don't work properly, such as the Pana-Brite, etc. ABL control doesn't work right. On the S-board, D811 had come in two. Can't find it on the parts list under "diodes."—A.K., Struthers, OH.

Are you sure the guy that bought that thing was really a friend? Anyhow, you've done all the right things; I'd suggest pulling *all* of the plug-in boards and giving them a good cleanup and contact tightening. That can't do anything but good.

D811 is called a diode but it isn't. It's apparently a VDR (Voltage-Dependent Resistor), and is listed only by part number. It is a shunt across TR851, the APF Output, which is just the voltage-regulator transistor. You should be able to get a replacement from Panasonic.

VERTICAL OSCILLATOR TIME-CONSTANT

This Zenith 19CC19's vertical oscillator is running too fast (rolling down). All parts seemed to be in tolerance. Changed C222, .01 μ F; no luck. When I bridged it with another .01 μ F the oscillator locked in. However, the vertical hold now has no

effect at all! What's going on here?—R.A., N. Miami, FL.

The vertical-oscillator frequency here, and in lots of other TV's, is determined by an R-C time-constant developed in the oscillator-input circuitry. You doubled the size of a capacitor; that should indicate that, somewhere in there, one of the resistors in the circuit is off-value! The time-constant is entirely an R-C thing; the value of the resistors and capacitors set it.

Incidentally, the capacitor in question is in the feedback loop from the vertical-output tube plate, so its charging time would set the time of the oscillator stage's "firing" (from the sync). Check or re-

place some of the few resistors in the same circuit; don't overlook any of the other capacitors either!

PARTS WANTED

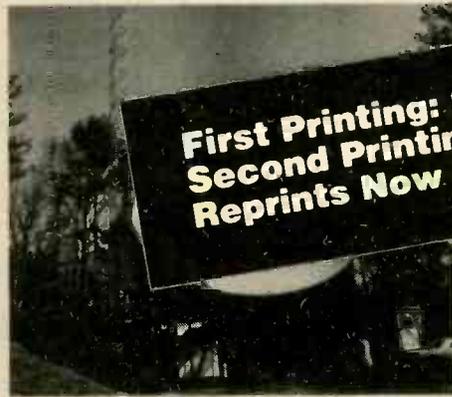
I need help in finding a flyback for a Broadmoor 6199C color TV. I think the company went out of business some time ago. Can you help?—T.W., Madison, WI.

I've had requests for this sort of thing before, and in a very few cases been able to find something by checking part numbers. Not in this case, unfortunately. If anyone out there has found a source for Broadmoor parts and data, I'd really appreciate getting the information, and so would a whole lot of others.

R-E

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COMPUTER TV

continued from page 50

resistors R8 and R9, is not critical. I found that I could use values ranging from 2K to 10K for R8, and from 5K to 10K for R9, with essentially the same results.

Power supplies

Two separate power supplies are required if the computer-side and the TV-side of the interface are to be completely isolated from each other. The TV-side requires only +5-volts DC. Most TV sets have 12 volts DC available internally somewhere, and that can be reduced to five volts by means of IC6, a 7805 regulator. The TV chassis is used as ground for this end of the circuit.

The computer-side of the interface requires both +5-volts and approximately -8-volts. A simple power supply to deliver those voltages is shown in Fig. 3. A transformer with an output of around 100 mA is adequate for the circuit. The transformer's center-tap should be used as the ground for the entire computer-side of the isolator. Use heat sinks on both of the five-volt regulators to keep them running cool.

Installation and use

The best place to locate the interface board is inside the TV set's cabinet, where accidental contact with the TV's chassis ground will be impossible. Switch S1 can be mounted inconspicuously on the TV set's cabinet. (Make certain that none of its metal

parts are in contact with any of the TV's.) That switch allows you to use the TV set either as a monitor or for its intended purpose.

As suggested by the schematic, the best place to inject the composite video signal from the interface is at the TV's first video-amplifier stage. Refer to your set's schematic or to a Sams Photofact folder. An excellent source of TV-interfacing information is Don Lancaster's *TV Typewriter Cookbook*, published by Howard W. Sams and Co., Indianapolis, IN 46268.

The total cost of this project, including the power supply, should be under \$25. It would be hard to find a monitor at that price! **R-E**

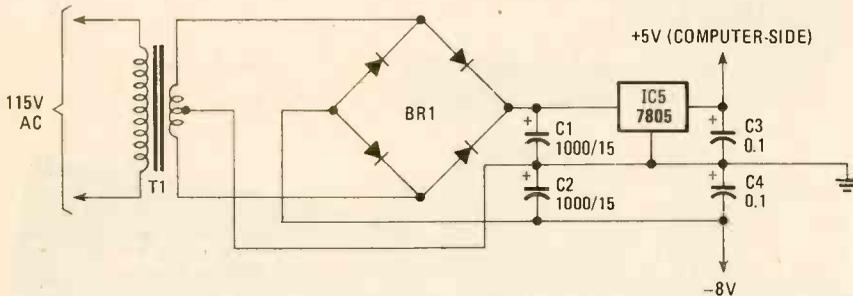


FIG. 3—BIPOLAR POWER SUPPLY is used for the comparators. The -8-volt line need not be regulated.

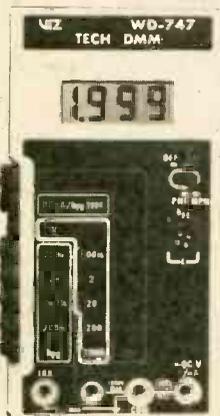
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What's coming?

At least one manufacturer is in the early-development stages with a 100-bit-wide bit-slice microprocessor. That would allow a great number of operations, both internal and I/O (Input/Output), to happen simultaneously. It allows high throughput at relatively moderate processing speeds.

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There's more to automotive electronics than engine controls and digital dashboards. Next month, we will take a look at bells and whistles—things that make driving more pleasurable. R-E

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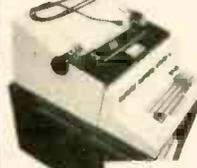
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1.5 6.2 27 110 470	2.0K	8.2K	36K	150K	620K	2.7M	*10M
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1.8 7.5 33 130 560	2.4K	10K	43K	180K	750K	3.3M	*12M
2.0 8.2 36 150 620	2.7K	11K	47K	200K	820K	3.6M	*13M
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2.4 10 43 180 750	3.3K	13K	56K	240K	1.0M	4.3M	(* 1/2w only)
2.7 11 47 200 820	3.6K	15K	62K	270K	1.1M	4.7M	
3.0 12 51 220 910	3.9K	16K	68K	300K	1.2M	5.1M	
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10.5	12.7	15.4	18.7	23.7	28.7	34.8	42.2	51.1	61.9	75.0	93.1
10.7	13.0	15.8	19.1	24.3	29.4	35.7	43.2	52.3	63.4	76.8	95.3
11.0	13.3	16.2	19.6	24.9	30.1	36.5	44.2	53.6	64.9	80.6	97.6
11.3	13.7	16.5	20.0	25.5	30.9	37.4	45.3	54.9	66.5	82.5	101.0
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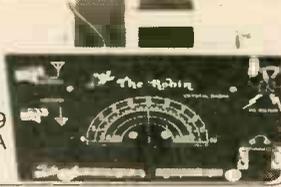
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GOVERNMENT surplus receivers, transmitters, snooperscopes, parts, fantastic 72 page catalog 25c. **MESHNA**, Nahant, Mass. 01908



Zilog NEW LOW PRICES				MICROPROCESSOR CHIP SETS									
Z80-CPU	2.5 MHz	8.45	Z80-SIO/0	2.5 MHz	22.45	Part No.	Price	Part No.	Price	Part No.	Price	Part No.	Price
Z80A-CPU	4.0 MHz	9.45	Z80A-SIO/0	4.0 MHz	28.56	8080A CPU	5.45	8228	4.98	6800 CPU	5.95	6502 CPU	9.45
Z80-PIO	2.5 MHz	5.98	Z80-SIO/2	2.5 MHz	22.45	8085 CPU	9.95	8251	6.95	6802 CPU	11.65	6504 CPU	9.45
Z80A-PIO	4.0 MHz	7.65	Z80A-SIO/2	4.0 MHz	28.56	8212	2.50	8253	9.95	6810	3.50	6505 CPU	6.45
Z80-CTC	2.5 MHz	5.98	Z80-SIO/9	2.5 MHz	16.85	8214	3.65	8255	5.95	6821	3.50	6506 CPU	6.45
Z80A-CTC	4.0 MHz	7.65	Z80A-SIO/9	4.0 MHz	21.54	8216	2.50	8257	10.95	6850	3.50	6522	9.95
Z80-DMA	2.5 MHz	18.65	Z80-DART	2.5 MHz	14.45	8224	3.45	8259	12.95	6852	3.50	6532	13.95
Z80A-DMA	4.0 MHz	22.95	Z80A-DART	4.0 MHz	17.60	8226	2.50					6551	13.95

SCR's and TRIAC's

C106D	.34	SCR	5 amp	400V	TO-220
TIC116B	.97	SCR	8 amp	200V	TO-220
TIC126B	1.09	SCR	12 amp	200V	TO-220
TIC216B	.99	Triac	6 amp	200V	TO-220
TIC226D	.95	Triac	8 amp	400V	TO-220
TIC236D	1.45	Triac	12 amp	400V	TO-220
TIC246D	1.45	Triac	16 amp	400V	TO-220

Bi-Fet OP AMPS

TL064CN	2.75	Quad low power
TL071CP	.59	Low noise
TL072CP	1.19	Dual low noise
TL074CN	2.35	Quad low noise
TL081CP	.49	J-FET input
TL082CP	.99	Dual J-FET input
TL084CN	1.95	Quad J-FET input

74S SCHOTTKY

74S00N	.48	74S37N	1.29	74S134N	.76	74S168N	4.98	74S241N	4.95	74S373N	3.95
74S02N	.52	74S38N	1.29	74S135N	1.56	74S169N	4.98	74S244N	4.95	74S374N	3.95
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74S04N	.52	74S51N	.52	74S139N	1.18	74S175N	1.29	74S253N	7.65	74S470N	7.95
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74S30N	.52	74S132N	1.48	74S162N	4.45	74S225N	9.65	74S283N	3.99		
74S32N	.89	74S133N	1.89	74S163N	3.95	74S240N	4.95	74S299N	6.98		

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Subject to prior sale

NEW 1981 EDITION

2 volumes — 3200 pages
now available
regular price \$82.50

Introductory Offer: \$75.00
New section on custom I.C.'s and microprocessor development systems

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LM301AN-8	.34	LM324N	.52	LM741CN-8	.32
LM304CH	.89	LM339N	.52	LM747CN-8	.59
LM307N-8	.29	LM348N-14	.99	LM748CN-8	.39
LM308N-8	.89	LM358N-8	.79	LM1458N-8	.42
LM308CH	.85	LM358N-8	.79	LM1488N-14	.69
LM309K	1.56	LM565CN-14	.49	LM1489N-14	.69
LM310CH	1.49	LM723CH	.89	LM3045N-14	.99
LM311N-8	.59	LM723CN-14	.48	LM3302N-14	.55
LM317T	1.36	LM725CN-8	1.75	LM3303N-14	.89
(TO-220)		LM733CN-14	1.59	LM3900N	.49
LM318N-8	1.45	LM739CN-14	1.29	LM4136N-14	.99
LM318CH	1.75	LM741CH	.65	LM2003AN	.89

DUAL-IN-LINE—LOW PROFILE—I.C. SOCKETS

CONTACTS	PRICE	CONTACTS	PRICE
8 PIN	.07	22 PIN	.21
14 PIN	.11	24 PIN	.23
16 PIN	.13	28 PIN	.27
18 PIN	.17	40 PIN	.39
20 PIN	.19		

• LOWEST PRICES ANYWHERE FOR THE HIGHEST QUALITY. AN UNBEATABLE COMBINATION.

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TIP29B	.38	TIP41C	.59	TIP125	.72
TIP29C	.39	TIP42A	.57	TIP126	.72
TIP30A	.39	TIP42B	.59	TIP127	.84
TIP30B	.42	TIP42C	.64	TIP144	1.44
TIP30C	.42	TIP110	.54	TIP141	1.64
TIP31A	.38	TIP111	.57	TIP142	1.84
TIP31B	.42	TIP112	.64	TIP145	1.96
TIP31C	.45	TIP115	.55	TIP146	1.98
TIP32A	.42	TIP116	.59	TIP147	2.25
TIP32B	.45	TIP117	.64	TIP2955	.83
TIP32C	.48	TIP120	.64	TIP3055	.70
TIP41A	.55	TIP121	.68	FT3055	.59

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CD4011BE	.24	CD4035BE	.96	CD4078BE	.32	CD4532BE	1.12
CD4012BE	.24	CD4040BE	.84	CD4081BE	.24	CD4539BE	.84
CD4013BE	.36	CD4041BE	1.79	CD4082BE	.24	CD4543BE	1.98
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CD4020BE	.84	CD4050BE	.42	CD4510BE	.76	CD4585BE	.85
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CD4023BE	.25	CD4053BE	.98	CD4514BE	1.89		
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LED222	T-1 3/4 5 mm Green	.24
LED224	T-1 3/4 5 mm Yellow	.12

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74S288	\$3.95	256 bit, 16 PIN
74S188	\$3.95	256 bit, 16 PIN
93417/MB7052	\$3.95	1K, 16 PIN
93446/MB7053	\$4.95	2K, 16 PIN
93436/MB7058	\$4.95	2K, 16 PIN
93453/MB7122	\$9.95	4K, 18 PIN
82S185/7128	27.95	8K, 18 PIN
74S478/7132	24.95	8K, 24 PIN
82S191/7138	78.00	16K, 24 PIN

We provide PROM programming.
Please enclose truth table or master PROM.

NOW AVAILABLE FROM ACTIVE ELECTRONICS.
GIFT CERTIFICATES
VALUES: \$10, \$15, \$20, \$50, \$100.
THE PERFECT CHRISTMAS GIFT FOR YOUR FRIENDS AND RELATIVES.

MOS MEMORIES

MOS Static RAM's

Part No.		Price
2101-35	1K (256 x 4) 350NS 22 PIN	3.95
2102-25	1K (1K x 1) 250NS 16 PIN	1.09
P2111-45	1K (256 x 4) 450NS 18 PIN	3.95
P2112-35	1K (256 x 4) 350NS 18 PIN	2.85
2114L	Low Power 4K (1024 x 4) 300NS	3.45
2147	4K (4K x 1) 55NS	9.95
2147	4K (4K x 1) 70NS	8.95

UART's

COM8017/AYS-1013A	Special 3.95
40 KHz Single 5V Supply	

1K CMOS RAM

5101	1K (256 x 4) 450NS 22 PIN Low Power	3.95
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4K CMOS RAM

P6504	4K (4K x 1) 550NS 18 PIN 110MW	7.95
P6514	4K (1K x 4) 450NS 18 PIN 110MW	7.95

SHIFT REGISTERS

3341APC	FIFO 1 MHz	4.98
3347PC	80 bit	3.95

"Memory Specials"

EPROM'S

C2708	1K x 8 450 ns	\$ 4.95
TMS2532	32K (4096 x 8) 450 ns	\$24.95
C2716/TMS2516	16K (2K x 8) 450 ns	\$7.95
(Single 5V supply — Similar to intel version)		
TMS2554	64K (8K x 8) 450 ns	\$195.00

16K MOS DYNAMIC RAM'S (16 PIN)

416-3 (200ns)	\$3.95
416-5 (300ns)	2.95

4K MOS DYNAMIC RAM'S

TMS4080-30	Special 2.95
4K (4K x 1) 300NS 22 PIN	
TMS4080-20	3.95
1K (4K x 1) 200NS 22 PIN	

16K CMOS STATIC RAM

6116 16K (2K x 8) 150NS 16 PIN	\$99.95
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64K MOS DYNAMIC RAM

4164 64K (64K x 1) 200NS 16 PIN	\$99.95
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THIS IS AN UNBELIEVABLE MOS SALE. ALL MAJOR MANUFACTURERS. ALL CURRENT PRODUCTION. ACTIVE ELECTRONICS — YOUR AUTHORIZED SOURCE FOR MAJOR MANUFACTURERS PRODUCTS.

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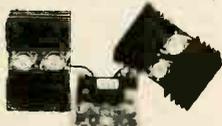
74LS00N	.21	74LS20N	.24	74LS55N	.27	74LS95N	.58	74LS108N	.69	74LS162N	.85	74LS193N	.89	74LS248N	1.69	74LS293N	.96	74LS362N	11.95	74LS395N	1.95
74LS01N	.21	74LS21N	.24	74LS73N	.38	74LS96N	.68	74LS139N	.69	74LS163N	.85	74LS194N	.89	74LS249N	.99	74LS299N	.84	74LS365N	.79	74LS447N	.35
74LS02N	.27	74LS26N	.39	74LS74N	.45	74LS107N	.42	74LS145N	1.25	74LS164N	.64	74LS195N	.68	74LS251N	2.25	74LS293N	.38	74LS366N	.79	74LS490N	1.95
74LS03N	.23	74LS27N	.29	74LS75N	.39	74LS109N	.52	74LS147N	2.45	74LS165N	1.27	74LS196N	1.12	74LS253N	.59	74LS298N	1.19	74LS367N	.79	74LS630N	85.00
74LS04N	.27	74LS30N	.19	74LS76N	.39	74LS112N	.42	74LS148N	1.44	74LS166N	1.87	74LS197N	.99	74LS257N	.84	74LS299N	2.65	74LS368N	.79	74LS631N	85.00
74LS05N	.27	74LS32N	.56	74LS78N	.36	74LS122N	.54	74LS151N	.45	74LS170N	2.75	74LS221N	.88	74LS258N	.68	74LS320N	2.95	74			

100W CLASS A POWER AMP KIT

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

Specifications:

- Output power: 100W RMS into 8-ohm 125W RMS into 4-ohm
- Frequency response: 10Hz - 100 KHz
- T.H.D.: less than 0.008%
- S/N ratio: better than 80dB
- Input sensitivity: 1V max.
- Power supply: $\pm 40V @ 5 \text{ amp}$



TA-1000 KIT \$51.95
Power transformer \$15.00 each

PROFESSIONAL 10 OCTAVE STEREO GRAPHIC EQUALIZER!!



Graphic equalizer have been used for years in sound studios and concert arenas but were too expensive to be considered for home use. Now we offer you the facility at an affordable price. This unit can extend your control of your Hi-Fi system by minimizing the non-linearities of the combined speaker/room system. Fantastic features as follows:

- 10 double slide controls for two channels
- Cut out rumble, surface noise and hiss
- Minimizes speaker/room non-linearities
- Frequency response from 30Hz to 16KHz
- 10 tone controls plus defeat, monitor and tape selector.
- Control range $\pm 12\text{dB}$ in 10 octaves (30Hz, 60Hz, 120Hz, 240Hz, 500Hz, 1KHz, 2KHz, 4KHz, 8KHz, 16KHz.)
- Operating voltage 117V 50/60Hz.

FACTORY ASSEMBLED UNIT, NOT A KIT
SPECIAL PRICE \$69.50 ea.

SUB MINI SIZE FET CONDENSER MICROPHONE



Specification:

Sensitivity: $-65\text{dB} \pm 3\text{db}$
FEQ. Response: 50 Hz 8 KHz
Output Impedance: 1K ohm max.
Polar Pattern: Omni-directional
Power Supply: 1.5V 10V D.C.
Sound Pressure Level: Max. 120dB
EM4RP \$2.50 ea. or 2 for \$4.50

NEW MARK III 9 Steps 4 Colors LED VU

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

IN KIT FORM \$18.50

2 WATT AUDIO AMP

Pre assembled units. All you need is to hook up the speaker and the volume control. Supply voltage from 9~15V D.C. measures only 2" x 3 1/2", making it good for portable or discrete applications. Comes with hook up data.



BUY 2 FOR \$4.99

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

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

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



MARK IV KIT \$31.50

NEW MARK V 15 STEPS LED POWER OUTPUT INDICATOR KIT

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



\$41.50 EACH KIT

BATTERY POWERED FLUORESCENT LANTERN

MODEL 888 R

FEATURES

- Circuitry: designed for operation by high efficient, high power silicon transistor which enable illumination maintain in a standard level even the battery supply drops to a certain low voltage.
- 9" 6W cool/daylight miniature fluorescent tube.
- 8 x 1.5V UM-1 (size D) dry cell battery.
- Easy sliding door for changing batteries.
- Stainless reflector with wide angle increasing illumination of the lantern.

\$10.50 EA

30W + 30W STEREO HYBRID AMPLIFIER KIT

It works in 12V DC as well!! Kit includes 1 PC SANYO STK-043 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 60 watts (30 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100MHz and 10KHz.



\$32.50 PER KIT

5W AUDIO AMP KIT

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

PROFESSIONAL PANEL METERS



- A. 0-50UA 8.50 ea.
- B. 0-30VDC 8.50 ea.
- C. 0-50VDC 8.50 ea.
- D. 0-3ADC 9.00 ea.
- E. 0-100VDC 9.00 ea.

Type MU-52E All meters white face with black scales. Plastic cover.

SPECIAL 0.5" LED ALARM CLOCK MODULE

ASSEMBLED! NOT A KIT!
Features: • 4 digits 0.5" LED Displays • 12 hours real time format • 24 hours alarm audio output • 59 min. countdown timer • 10 min. snooze control.



ONLY \$7.00 EACH
SPECIAL TRANSFORMER FOR CLOCK \$2.50

DIGITAL AUTO SECURITY SYSTEM

4 DIGITS PERSONAL CODE!!
SPECIAL \$19.95



- proximity triggered
- voltage triggered
- mechanically triggered

This alarm protects you and itself! Entering protected area will set it off, sounding your car horn or siren you add. Any change in voltage will also trigger the alarm into action. If cables within passenger compartment are cut, the unit protects itself by sounding the alarm.

3-WAY PROTECTION!

All units factory assembled and tested - Not a kit!

SANYO HYBRID AUDIO POWER AMPLIFIER I.C.



70 WATTS

100 WATTS

Typical ratings
Operating case temp. 85°C.
T.H.D. = 0.5% $f = 20 \sim 20\text{KHz}$
Input resistance $P_o = 0.1W$ 30K Ω
Power band width 20Hz ~ 20KHz
Freq. response 10Hz ~ 100KHz
Output resistance = 8 Ω
With built in protection circuit.
All units come with data sheet.

PART	OUTPUT (W)	SUPPLY VOLTAGE	PRICE
STK040	10W+10W Stereo	$\pm 16V$ D.C.	\$14.50
STK041	15W+15W Stereo	$\pm 20V$ D.C.	\$18.50
STK043	20W+20W Stereo	$\pm 22V$ D.C.	\$22.50
STK054	23 WATTS	$\pm 23V$ D.C.	\$13.50
STK056	30 WATTS	$\pm 22V$ D.C.	\$18.50
STK050	50 WATTS	$\pm 35V$ D.C.	\$26.50
STK070	70 WATTS	$\pm 42V$ D.C.	\$32.50
STK1050	100 WATTS	$\pm 50V$ D.C.	\$40.50

PROFESSIONAL FM WIRELESS MICROPHONE

TCT model WEM-16 is a factory assembled FM wireless microphone powered by an AA size battery. Transmits in the range of 88-108MHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case; mike is 6 1/4" long. With a standard FM radio, can be heard anywhere on a one-acre lot; sound quality was judged very good.

\$16.50



FLASHER LED

Unique design combines a jumbo red LED with an IC flasher chip in one package. Operates directly from 5V-7V DC. No dropping resistor needed. Pulse rate 3Hz @ 5V 20mA.

2 for \$2.20



BIPOLAR LED RED/GREEN

2 colors in one LED, green and red, changes color when reverse voltage supply. Amazing!
2 FOR \$1.60

LCD CLOCK MODULE!

• 0.5" LCD 4 digits display • X'tal controlled circuits - D.C. powered (1.5V battery) • 12 hr. or 24 hr. display • 24 hr. alarm set - 60 min. countdown timer • On board dual back-up lights • Dual time zone display • Stop watch function.

NIC1200 (12 hr) \$24.50 EA.

NIC2400 (24 hr) \$26.50 EA.



SANYO UHF VARACTOR TUNER

For UHF CH 14 ~ 83
Tuning voltage + 1V ~ + 28V D.C. Input impedance 75 OHM. I.F. band width 7 ~ 16 MHz. Noise figure 11.5 dB MAX. Size 2 1/4" x 1 1/4" x 3/4". Supply voltage 15V D.C. Sound I.F. = 58.0 MHz. Video I.F. = 62.5 MHz



All units are brand new from Sanyo.
MODEL 115-B-405A
\$35.00 EACH

FLUORESCENT LIGHT DRIVER KIT



With Case Only
\$6.50 Per Kit

12V DC POWERED
Lights up 8 ~ 15 Watt Fluorescent Light Tubes. Ideal for camper, outdoor, auto or boat. Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board. Light tube not included!

SUPER FM WIRELESS MIC KIT — MARK III



FMC-105
\$11.50 PER KIT

This new designed circuit uses high FEQ. FET transistors with 2 stages pre amp. Transmits FM Range (88-120 MHz) up to 2 blocks away and with the ultra sensitive condenser microphone that comes with the kit, allows you to pick up any sound within 15 ft. away! Kit includes all electronic parts, OSC coils, and P.C. Board. Power supply 9V D.C.

PRESS-A-LIGHT SELF GENERATED FLASHLIGHT



EXCLUSIVE!! \$3.95 ea
Model F-179
Never worry about battery, because it has none! Easy to carry in pocket and handy to use. Ideal for emergency light. It generates its own electricity by squeezing grip lever. Put one in your car, boat, camper or home. You may need it some time!

ELECTRONIC DUAL SPEAKER PROTECTOR



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

KIT FORM
\$8.75 EA.

"FISHER" 30 WATT STEREO AMP



Super Buy
Only \$18.50

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

SPACE WAR SOUND GENERATOR BOARD



Brand new preassembled module for a toy factory. The board gives out 6 different selectable space sound with LED light effect. Sounds include UFO take-off, space gun blast, wave, and space chime. 7 LED on the board will work with the sound. Requires 9V battery to operate. Speaker not included.
SPECIAL \$3.99 EACH SPEAKER \$1.25 EACH

ELECTRONIC PIEZO BEEP BUZZER



Unique surplus $\frac{1}{4}$ " Dia. piezo ceramic disc on circuit board gives a distinct high freq. buzz. Unit contains an I.C., 2 caps, 6 resistors and is already preassembled. Requires 9V battery to operate.
SPECIAL 2 FOR \$2.99

2 BIT COUNTER, WARBLE PULSE ALARM BOARD



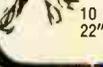
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Color: Red, White, Blue, Green, Black
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N/Close also Available
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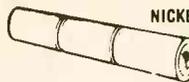
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10 pairs — 5 colors Alligator clips on a 22" long lead. Ideal for any testing.
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2 PK/\$19.00



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"C" SIZE BATTERY PACK



10 C size ni-cd battery in dng pack, gives out 12.5V D.C. 1.8 amp per hour. All fresh code, pull-out from movie cameras. Can be disconnected to use as single c cells. Hard to find \$15.00 per pack of 10 batteries

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SPECIAL \$8.99 EACH
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Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver. All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operates by 9-12 DC. \$13.50

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\pm 4 30V DC 800 MA adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator I.C. Kit includes all electronic parts, filter capacitors, I.C., heat sinks and P.C. board.

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ELECTRONIC SWITCH KIT

CONDENSER TYPE
Touch On Touch Off
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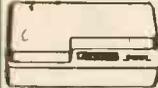
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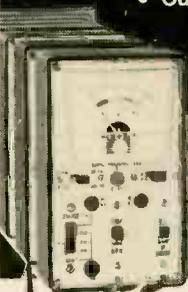
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SG301AN	1.70	1.00	88	SG3403	1.24	25up	100up	SG4189P	2.10	1.60	1.40	SG3597M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
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SG308T	1.70	1.30	1.15	SG3412	1.24	25up	100up	SG4194N	2.10	1.60	1.40	SG3606M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG308M	1.20	90	80	SG3413	1.24	25up	100up	SG4194P	2.10	1.60	1.40	SG3607M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG308AT	4.00	3.10	2.85	SG3414	1.24	25up	100up	SG4195N	2.10	1.60	1.40	SG3608M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG308AM	3.00	2.30	2.00	SG3415	1.24	25up	100up	SG4195P	2.10	1.60	1.40	SG3609M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG309T	1.90	1.45	1.25	SG3416	1.24	25up	100up	SG4196N	2.10	1.60	1.40	SG3610M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG309K	2.30	1.75	1.55	SG3417	1.24	25up	100up	SG4196P	2.10	1.60	1.40	SG3611M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG310T	2.70	2.00	1.80	SG3418	1.24	25up	100up	SG4197N	2.10	1.60	1.40	SG3612M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG311T	2.10	1.60	1.40	SG3419	1.24	25up	100up	SG4197P	2.10	1.60	1.40	SG3613M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG311M	1.50	1.15	1.00	SG3420	1.24	25up	100up	SG4198N	2.10	1.60	1.40	SG3614M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG312T	2.80	2.15	1.95	SG3421	1.24	25up	100up	SG4198P	2.10	1.60	1.40	SG3615M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG317K	3.20	2.45	2.15	SG3422	1.24	25up	100up	SG4199N	2.10	1.60	1.40	SG3616M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG317P	2.00	1.55	1.35	SG3423	1.24	25up	100up	SG4199P	2.10	1.60	1.40	SG3617M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 05T	3.00	2.30	2.00	SG3424	1.24	25up	100up	SG4200N	2.10	1.60	1.40	SG3618M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 05P	1.70	1.30	1.15	SG3425	1.24	25up	100up	SG4200P	2.10	1.60	1.40	SG3619M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52K	1.80	1.40	1.25	SG3426	1.24	25up	100up	SG4201N	2.10	1.60	1.40	SG3620M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52P	1.70	1.30	1.15	SG3427	1.24	25up	100up	SG4201P	2.10	1.60	1.40	SG3621M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52T	1.30	1.00	0.90	SG3428	1.24	25up	100up	SG4202N	2.10	1.60	1.40	SG3622M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52R	1.30	1.00	0.90	SG3429	1.24	25up	100up	SG4202P	2.10	1.60	1.40	SG3623M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52L	1.30	1.00	0.90	SG3430	1.24	25up	100up	SG4203N	2.10	1.60	1.40	SG3624M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52R	1.30	1.00	0.90	SG3431	1.24	25up	100up	SG4203P	2.10	1.60	1.40	SG3625M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52L	1.30	1.00	0.90	SG3432	1.24	25up	100up	SG4204N	2.10	1.60	1.40	SG3626M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52R	1.30	1.00	0.90	SG3433	1.24	25up	100up	SG4204P	2.10	1.60	1.40	SG3627M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52L	1.30	1.00	0.90	SG3434	1.24	25up	100up	SG4205N	2.10	1.60	1.40	SG3628M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52R	1.30	1.00	0.90	SG3435	1.24	25up	100up	SG4205P	2.10	1.60	1.40	SG3629M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52L	1.30	1.00	0.90	SG3436	1.24	25up	100up	SG4206N	2.10	1.60	1.40	SG3630M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52R	1.30	1.00	0.90	SG3437	1.24	25up	100up	SG4206P	2.10	1.60	1.40	SG3631M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52L	1.30	1.00	0.90	SG3438	1.24	25up	100up	SG4207N	2.10	1.60	1.40	SG3632M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52R	1.30	1.00	0.90	SG3439	1.24	25up	100up	SG4207P	2.10	1.60	1.40	SG3633M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52L	1.30	1.00	0.90	SG3440	1.24	25up	100up	SG4208N	2.10	1.60	1.40	SG3634M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52R	1.30	1.00	0.90	SG3441	1.24	25up	100up	SG4208P	2.10	1.60	1.40	SG3635M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52L	1.30	1.00	0.90	SG3442	1.24	25up	100up	SG4209N	2.10	1.60	1.40	SG3636M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52R	1.30	1.00	0.90	SG3443	1.24	25up	100up	SG4209P	2.10	1.60	1.40	SG3637M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52L	1.30	1.00	0.90	SG3444	1.24	25up	100up	SG4210N	2.10	1.60	1.40	SG3638M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52R	1.30	1.00	0.90	SG3445	1.24	25up	100up	SG4210P	2.10	1.60	1.40	SG3639M	2.20	1.70	1.45	SG3782CP	2.20	1.70	1.45
SG320 52																			

National Semiconductor Clock Modules



12VDC
AUTOMOTIVE/
INSTRUMENT
CLOCK

APPLICATIONS:
• In dash auto clocks
• After-market auto/
RV clocks
• Aircraft-marine clks.
• 12VDC oper. Instru.
• Portable/battery
powered instruments.

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

MA 1003 Module \$16.95

MA 1023 .7" Low Cost Digital LED Clock Module 8.95
MA 1026 .7" Dig. LED Alarm Clock/Thermometer 18.95
MA 5036 .3" Low Cost Digital LED Clock/Timer 6.95
MA 1002.5" LED Display Dlg. Clock & Xformer 9.95



National Semiconductor RAM SALE

MM5290N-4 (MK4116/UPD416) .. \$4.95 each
16K DYNAMIC RAM (250NS)
(8 EACH \$39.95) (100 EACH \$450.00/lot)

MM5290J-2 (MK4116/UPD416) .. \$6.95 each
(8 EACH \$49.95) (100 EACH \$550.00/lot)

MM5298J-3A \$3.25 each
8K DYNAMIC RAM (LOW HALF OF MM5290J) 200NS
(8 EACH \$29.95) (100 EACH \$290.00/lot)

MM2114-3 \$5.95 each
4K STATIC RAM (300NS)
(8 EACH \$43.95) (100 EACH \$450.00/lot)

MM2114L-3 \$6.25 each
4K STATIC RAM (LOW POWER 300NS)
(8 EACH \$44.95) (100 EACH \$475.00/lot)

EPROM Erasing Lamp



- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes
- Maintains constant exposure distance of one inch.
- Special conductive foam trim eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVS-11E \$79.50

Jumbo 6-Digit Clock Kit

- Four .630" ht. and two .300" ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6 3/4" x 3 1/8" x 1 3/4"

JE747 \$29.95

6-Digit Clock Kit

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6 3/4" x 3 1/8" x 1 3/4"

JE701 \$19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to $\pm 5V$, $\pm 9V$ and $\pm 12V$ with JE205 Adapter. Includes components, hardware and instructions. Size: 3 3/4" x 5" x 2 1/4"

JE200 \$14.95



ADAPTER BOARD
—Adapts to JE200—
 $\pm 5V$, $\pm 9V$ and $\pm 12V$

DC/DC converter with $\pm 5V$ input. Toroidal hi-speed switching XFMR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3 3/4" x 2" x 9/16"

JE205 \$12.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

IN5800A	CPU	6.50
DP812	8-Bit Input/Output	3.25
DP814	Priority Interrupt Control	3.25
DP816	BI-Directional Bus Driver	3.25
DP818	Clock Generator/Driver	3.25
DP820	Bus Driver	3.25
DP822	System Controller/Bus Driver	3.25
DP824	System Controller	3.25
IN5820	I/O Expander for 48 Series	8.86
IN5820C	Asynchronous Comm. Element	5.95
DP825	Prog. Comm. I/O (USART)	7.45
DP826	Prog. Interval Timer	3.25
DP828	Prog. Peripheral I/O (PPI)	19.95
DP829	Prog. DMA Control	19.95
DP830	Prog. Interrupt Control	19.95
DP832	Prog. CRT Controller	49.95
DP837	Prog. Keyboard/Display Interface	19.95
DP839	Octal Bus Receiver	19.95
DP840	System Timing Element	6.95
DP834	8-Bit BI-Directional Receiver	3.95
DP837	8-Bit BI-Directional Receiver	3.95
DP838	8-Bit BI-Directional Receiver	3.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	19.95
MC6800CP	MPU w/8K Clock and RAM	19.95
MC6800AI	128x4 Static RAM	4.96
MC6801	Peripheral Inter. Adapt (MC6800)	7.45
MC6802	Priority Interrupt Controller	10.95
MC6803L	1024x8-Bit ROM (MC68030-8)	14.95
MC6805	Asynchronous Comm. Adapter	7.45
MC6802S	Synchronous Serial Data Adapter	29.95
MC6800	5400bps Digital MODEM	10.95
MC6802	700bps Modulator	12.95
MC6800A	Quad 8-Bit Trans. (MC6803)	2.25

MICROPROCESSOR CHIPS

Z80 (70C)	CPU (MK3800N) (2MHz)	13.95
Z80A (70-1)	CPU (MK3800N) (4MHz)	15.95
CDP1802	CPU	19.95
IN640	MPU	16.95
IN640A	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MC6802	MPU w/Clock (80K Bytes Memory)	11.95
IN5800N-4	MPU—8-Bit (8MHz)	16.95
IN5800N-4A	CPU—Sep. Chip 8-Bit (180bytes RAM)	19.95
IN5800N-4	CPU (256 Bytes RAM)	24.95
IN5800N-4	CPU w/8-Bit Static	24.95
IN5800N-4	CPU w/8-Bit Micro Interpreter	29.95
IN600	CPU	19.95
IN5900	CPU—16-Bit	29.95
IN5900L	MPU—16-Bit	49.95

SHIFT REGISTERS

MM500H	Dual 2-Bit Dynamic	.50
MM500H	Dual 50-Bit Dynamic	.50
MM500H	Dual 100-Bit Static	.50
MM500H	Dual 64-Bit Accumulator	.50
MM1402	756-Bit Dynamic	3.95
MM5012	1024-Bit Dynamic/Accumulator	1.95
MM5012H	30672-Bit Dynamic	1.95
MM5012H	Octal 80-Bit	9.95
MM5012H	Octal 80-Bit	9.95
MM5012H	1024-Bit Dynamic	3.95
2518N	Hex 12-Bit Static	2.95
2520V	Dual 12-Bit Static	4.95
2520V	8-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 256-Bit Static	4.00
2529V	Dual 256-Bit Static	2.00
2529N	Quad 80-Bit Static	4.95
2530N	Quad 80-Bit Static	6.95
13110C	File (Dual 80)	5.95

DATA ACQUISITION

AF1001CN	Universal Active Filter 236	5.95
AF121-1CJ	Touch Tone Low Pass Filter	19.95
AF121-1CJ	Touch Tone Low Pass Filter	19.95
LM339AH	Super Gain Op Amp	1.00
LM339	Constant Current Source	1.00
LM332	Temperature Transducer	1.00
LF324N	JFET Input Op Amp	1.10
LF385N	Sample & Hold Amplifier	3.75
LM399H	Temp. Comp. Prac. Ref. (500mV/C)	4.75
ADC0808L	8-Bit A/D Converter (1.5LSB)	4.25
ADC0808L	8-Bit D/A Converter (0.8% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0808CN	8-Bit A/D Converter (8-Ch. Mult.)	5.25
ADC0811CN	8-Bit A/D Converter (16-Ch. Mult.)	10.95
DAC0808L	8-Bit D/A Conv. Micro. Comp. (0.2% Lin.)	13.95
DAC0808L	10-Bit D/A Conv. Micro. Comp. (0.2% Lin.)	8.95
DAC0808L	10-Bit D/A Converter (0.2% Lin.)	8.49
DAC0808L	10-Bit D/A Converter (0.2% Lin.)	5.95
DAC1228L	12-Bit D/A Converter (0.2% Lin.)	9.95
CD4049	8-Channel Multiplexer	1.19
AV-8-1013	3K Ohm 10-Bit	5.95

RAM'S

1101	256x1 Static	1.49
1001	1024x1 Dynamic	.99
1001 (101)	256x1 Static	1.95
2102	1024x1 Static	1.75
71L02	256x1 Static	1.95
1111 (8111)	256x4 Static	3.95
2112	1024x4 Static MOS	4.95
2114L	1024x4 Static 400ns	5.95
2114L	1024x4 Static 400ns Low Power	6.95
2114L-3	1024x4 Static 300ns	7.49
2114L-3	1024x4 Static 300ns Low Power	7.95
2117	16,384-Dynamic 500ns (housemarked)	4.95
41K (UPD416)	16K Dynamic 260ns	4.95
4096K1	Fast 70ns	19.95
5101	256x4 Static	7.95
MM5361	1024x1 Dynamic Fully Decoded	.99
MM5362	2Kx1 Dynamic	.25
MM5363/2107	4096x1 Dynamic	4.95
MM5363-2108	16K EPROM (UPD416)	6.95
MM5363-2A	8K Dyn. 200ns (lower lg of MM5363)	4.95
7409	16x4 Static	1.75
UPD4164H/4027	16K Dynamic 16-pin	4.95
TM5404-45N	4K Static	1.95
TM5405	1024x4 Static	14.95

PROMS/EPROMS

1702A	2K UV-Erasable PROM	5.95
MM5361	1024x1 Dynamic	9.95
MM52716	16K EPROM (+5V, +5V, +12V)	19.95
2716 (int) (2517)	16K EPROM (Single +5V)	17.95
2732 (int) (2537)	32K EPROM	45.95
7258	1K EPROM (450ns) (Single +5V)	7.50
5203	2048 PROM	14.95
62512 (745188)	2048-Bit Read Only Memory	19.95
625115	4096 Bipolar PROM	19.95
625122 (745288)	32x1 Tri-State Bipolar PROM	4.95
625135	8K PROM	29.95

NMOS READ ONLY MEMORIES

MC68020P	128Kx16 ASCII Shifted w/Track	13.50
MC68020P	128Kx16 Math Symbol & Pictures	13.50
MC68020P	128Kx16 Alpha, Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

M-280	User Manual	7.50
M-CCP1802	User Manual	5.00
M-2650	User Manual	5.00

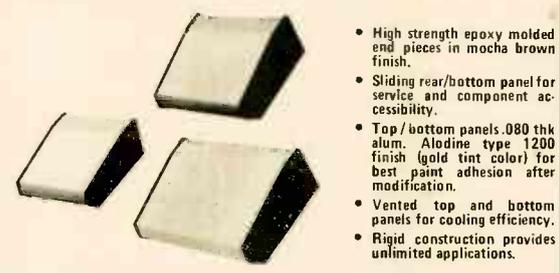
SPECIAL FUNCTION

D5005CN	Dual MOS Clock Driver (5M2)	3.50
D5006CN	Dual MOS Clock Driver (5M2)	1.95
IN5171N-1	Floppy Disk Controller	24.95
IN5171N-1	Communication Chip	19.95
MM58107N	Microcontroller Real Time Clock	5.95
MM58107N	Microcontroller Compatible Clock	11.95
CP0402N	Microcontroller with 64-Digit RAM	6.95
CP0402N	Direct LED Drive	7.49
CP0402N	Microcontroller with 64-Digit RAM & Direct LED Drive w/7 Bus Unit	7.49
CP0402N	32-500 VAC Freq. Invert (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

AV-54910	Push Button Telephone Dialer	14.95
AV-54920	Rotary Dialer	14.95
AV-54930	CMOS Clock Generator	4.95
AV-5235	Keyboard Encoder (16 keys)	11.95
HD0365-5	Keyboard Encoder (16 keys)	7.95
HC922	Keyboard Encoder (16 keys)	5.49
HC923	Keyboard Encoder (20 keys)	5.75
MM5190N	Push Button Pulse Dialer	7.95
MM5190N	96/144-Key Serial Keyboard Encoder	8.95

DESIGNER'S SERIES Blank Desk-Top Electronic Enclosures



- High strength epoxy molded end pieces in mocha brown finish.
- Sliding rear/bottom panel for service and component accessibility.
- Top/bottom panels .080 thk. alum. Alodine type 1200 finish (gold tint color) for best paint adhesion after modification.
- Vented top and bottom panels for cooling efficiency.
- Rigid construction provides unlimited applications.

CONSTRUCTION: The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to 1/4" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.

Enclosure Model No.	Panel Width	PRICE
DTE-8	8.00"	\$29.95
DTE-11	10.65"	\$32.95
DTE-14	14.00"	\$34.95

\$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage — Add 5% plus \$1 Insurance

Spec Sheets — 25¢
Send 4¢ Postage for your
FREE 1981 JAMECO CATALOG

Jameco ELECTRONICS
PHONE ORDERS WELCOME
(415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
1355 SHOREWAY ROAD, BELMONT, CA 94002
PRICES SUBJECT TO CHANGE

JOYSTICKS



JS-5K 5K Linear Taper Pots \$5.25
JS-100K 100K Linear Taper Pots \$4.95
JVC-40 40K (2) Video Controller in case \$5.95

AC and DC Wall Transformers

Part No. Input Output Price

AC 250 117V/60HZ 12 VAC 250mA \$3.95
AC 500 117V/60HZ 12 VAC 500mA \$4.95
AC 1000 117V/60HZ 12 VAC 1 amp \$5.95
DV9200 117V/60HZ 9 VDC 200mA \$3.25
DC 900 120V/60HZ 9 VDC 500mA \$3.95

CONNECTORS

DB25P D-Subminiature Plug \$2.95
DB25S D-Subminiature Socket \$3.50
DB9/1226 Cover for DB25P/S \$1.75
P.C. Edge (22/44 Pin) \$2.95
UG88/U BNC Plug \$1.79
UG89/U BNC Jack \$3.79
UG9175/U UHF Adapter \$.49
SO239 UHF Panel Recp. \$1.29
PL258 UHF Adapter \$1.60
PL259 UHF Plug \$1.60
UG260/U BNC Plug \$1.79
UG1094/U BNC Bulkhead Recp. \$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
* 8 ea. MM5290 (UPD416/416) 16K Dyn. Rams (1NS)
* Documentation for Conversion

TRS-16K2 *150NS \$49.95
TRS-16K4 *250NS \$39.95

JE610 ASCII Encoded Keyboard Kit

The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and -12V @ 10 mA for operation. Features: 60 keys generate the 125 characters, upper and lower case ASCII set. Fully buffered. Two user-definable keys provided for custom applications. Caps lock for upper case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16 pin dip or 18 pin edge connector. Size: 3 3/4" H x 14 1/4" W x 8 1/2" D

JE610/DTE-AK (as pictured above) \$124.95
JE610 Kit 62-Key Keyboard, PC Board \$ 79.95
K62 62-Key Keyboard (Keyboard only) \$ 34.95
DTE-AK (case only — 3 3/4" H x 14 1/4" W x 8 1/2" D) \$ 49.95

JE600 Hexadecimal Encoder Kit

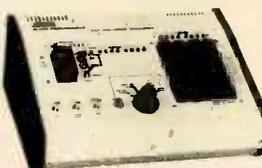
FULL 8 BIT LATCHED OUTPUT 19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-definable keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3 3/4" H x 8 1/4" W x 8 1/2" D

JE600/DTE-AK (as pictured above) \$99.95
JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (No case) \$59.95
K19 19-Key Keyboard (Keyboard only) \$14.95
DTE-HK (case only — 3 3/4" H x 8 1/4" W x 8 1/2" D) \$44.95

SN7400N	25	SN74156N	79
SN7401N	20	SN74157N	69
SN7402N	25	SN74160N	89
SN7403N	25	SN74161N	89
SN7404N	25	SN74162N	89
SN7405N	29	SN74163N	89
SN7406N	29	SN74164N	89
SN7407N	35	SN74165N	89
SN7408N	29	SN74166N	89
SN7409N	29	SN74167N	2,79
SN7410N	25	SN74170N	1,95
SN7411N	29	SN74172N	4,95
SN7412N	25	SN74173N	1,39
SN7413N	29	SN74174N	99
SN7414N	69	SN74175N	89
SN7415N	59	SN74176N	79
SN7416N	25	SN74177N	79
SN7417N	25	SN74178N	1,49
SN7418N	25	SN74180N	69
SN7419N	45	SN74181N	2,25
SN7420N	29	SN74182N	2,95
SN7421N	29	SN74183N	2,49
SN7422N	45	SN74184N	2,49
SN7423N	29	SN74185N	2,49
SN7424N	29	SN74186N	1,25
SN7425N	29	SN74187N	1,25
SN7426N	29	SN74188N	1,25
SN7427N	29	SN74189N	1,25
SN7428N	29	SN74190N	1,25
SN7429N	29	SN74191N	1,25
SN7430N	29	SN74192N	89
SN7431N	29	SN74193N	89
SN7432N	29	SN74194N	89
SN7433N	29	SN74195N	89
SN7434N	29	SN74196N	89
SN7435N	29	SN74197N	89
SN7436N	29	SN74198N	89
SN7437N	29	SN74199N	1,49
SN7438N	29	SN74200N	1,49
SN7439N	29	SN74201N	1,49
SN7440N	29	SN74202N	1,49
SN7441N	1,10	SN74203N	1,49
SN7442N	1,10	SN74204N	1,49
SN7443N	1,10	SN74205N	1,49
SN7444N	1,10	SN74206N	1,49
SN7445N	1,10	SN74207N	1,49
SN7446N	1,10	SN74208N	1,49
SN7447N	1,10	SN74209N	1,49
SN7448N	1,10	SN74210N	1,49
SN7449N	1,10	SN74211N	1,49
SN7450N	1,10	SN74212N	1,49
SN7451N	1,10	SN74213N	1,49
SN7452N	1,10	SN74214N	1,49
SN7453N	1,10	SN74215N	1,49
SN7454N	1,10	SN74216N	1,49
SN7455N	1,10	SN74217N	1,49
SN7456N	1,10	SN74218N	1,49
SN7457N	1,10	SN74219N	1,49
SN7458N	1,10	SN74220N	1,49
SN7459N	1,10	SN74221N	1,49
SN7460N	1,10	SN74222N	1,49
SN7461N	1,10	SN74223N	1,49
SN7462N	1,10	SN74224N	1,49
SN7463N	1,10	SN74225N	1,49
SN7464N	1,10	SN74226N	1,49
SN7465N	1,10	SN74227N	1,49
SN7466N	1,10	SN74228N	1,49
SN7467N	1,10	SN74229N	1,49
SN7468N	1,10	SN74230N	1,49
SN7469N	1,10	SN74231N	1,49
SN7470N	1,10	SN74232N	1,49

JEGOB PROGRAMMER 2708 EPROM PROGRAMMER



3 separate Display Registers & LED's for Hex Key entry. 10 LED's 12" 1" for Address Register and LED's for Data Memory Register. The Data Memory Register displays the contents of the RAM from the EPROM Chip.

Development of microprocessor systems by means of a ribbon cable from the programmer panel, not subject to EPROM socket or the microprocessor board.

Read checking verification of programmed data.

When you move data from a master to RAM, you write into RAM with the same data.

Allow manual stepping the readout panel up and down at any address location.

Special EPROM Programming capability.

10-Key Hexadecimal Keyboard assembly. Programmer Board assembly with compact keypad and a LED's Test Panel Board assembly. The Test Panel Board has a 10-key Hex keypad. Power requirements: 115VAC, 50Hz, 500mA.

Compact desk top enclosure. Color coordinated engineer's case with light tan panel and milled and green in-molded bezel. Size: 3.5" x 11.75" x 6.5". Weight: 5 lbs.

The JEGOB EPROM Programmer is a completely self-contained unit which is independent of computer and requires no additional systems for its operation. The EPROM can be programmed from the Hexadecimal Keyboard or from a computer-programmed EPROM. The JEGOB Programmer can emulate a programmer EPROM by the use of memory EPROM. This will allow you to write EPROMs or program a program, for a system, prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that re-writing the entire program will not be necessary. The JEGOB Programmer contains a Programmer Board with 25 IC's including power supplies of -5V, -5V, +5V, +12V and +20V. The Hexadecimal Keyboard and LED's Test Panel Board are separate assemblies within the system.

JEGOB8 KIT \$399.95
JEGOB8A Assembled and tested \$499.95

DISCRETE LEDS

XCS56R .200" red	5/51	MV50 .085" red	6/51	XC111R .190" red	5/51
XCS56G .200" green	4/51	XC209R .125" red	5/51	XC111G .190" green	4/51
XCS56Y .200" yellow	4/51	XC209G .125" green	4/51	XC111Y .190" yellow	4/51
XCS56C .200" clear	4/51	XC209Y .125" yellow	4/51	XC111R .190" clear	4/51
XC22R .200" red	5/51	XC256R .185" green	4/51		
XC22G .200" green	5/51	XC256G .185" yellow	4/51		
XC22Y .200" yellow	4/51	XC256Y .185" clear	4/51		
MV10B .170" red	4/51				

DISPLAY LEDS

C.A. - Common Anode			C.C. - Common Cathode		
Type	Polarity	Ht. Price	Type	Polarity	Ht. Price
MAN 1	C.A.-red	.270 2.95	DL741	C.A.-red	.600 1.25
MAN 2	C.A.-D.M.-red	.300 4.95	DL746	C.C.-red ± 1	.630 1.49
MAN 3	C.C.-red	.125 .25	DL747	C.A.-red	.600 1.49
MAN 52	C.A.-green	.300 1.25	DL750	C.C.-red	.600 1.49
MAN 54	C.C.-green	.300 1.25	DL338	C.C.-red	.110 .35
MAN 71	C.A.-red	.300 .75	FND359	C.C. ± 1	.357 .99
MAN 72	C.A.-red	.300 .75	FND359	C.C. ± 1	.357 .75
MAN 74	C.C.-red	.300 1.25	FND503	C.A. (FND500)	.500 .99
MAN 82	C.A.-yellow	.300 .49	FND507	C.A. (FND500)	.500 .99
MAN 84	C.C.-yellow	.300 .99	HOSP-3401	C.A.-red	.800 1.50
MAN 360	C.A.-orange	.300 .99	HOSP-3403	C.C.-red	.800 1.50
MAN 363	C.A.-orange ± 1	.300 .99	HOSP-3413	C.C.-R.H.D.-red	.300 1.25
MAN 364	C.C.-orange	.300 .99	5082-7620	C.A.,L.H.D.-yel.	.300 1.25
MAN 4610	C.A.-orange	.400 .99	5082-7623	C.C.,R.H.D.-yel.	.300 1.25
MAN 6610	C.A.-orange-DD	.560 .99	5082-7730	C.A.,L.H.D.-red	.300 .99
MAN 6630	C.A.-orange ± 1	.560 .99	5082-7731	C.A.,R.H.D.-red	.300 1.25
MAN 6640	C.C.-orange-DD	.560 .99	5082-7750	C.A.,L.H.D.-red	.430 1.75
MAN 6650	C.C.-orange ± 1	.560 .99	5082-7751	C.A.,R.H.D.-red	.430 1.75
MAN 6660	C.A.-orange	.560 .99	5082-7760	C.C.,R.H.D.-red	.430 1.75
MAN 6710	C.C.-orange-DD	.560 .99	5082-7300	4x7.91 dig. RHD	.600 22.00
MAN 6750	C.C.-red ± 1	.560 .99	5082-7302	4x7.91 dig. LHD	.600 22.00
MAN 6780	C.C.-red	.1 .560 .99	5082-7304	Orange char. (±1) .600	19.95
DL704	C.A.-red	.300 1.25	AN-1	Photo Xistitor Opto-Isol.	.69
DL707	C.C.-red	.300 1.25	LIT-1	Photo Xistitor Opto-Isol.	.69
DL728	C.C.-red	.500 1.49	MOC3010	Optically Isol. Triac Driver	1.25

POTENTIOMETERS

\$2.95 each	\$1.35 each
2 Watt @ 70°C ± 10%	3/4 Watt @ 70°C
7/8" Slotted Shaft	1.5 Turn pot. Linear
Linear Taper	Regr. Printed Circ. pot.
Meets MIL-R-94	

Part No.	Part No.	Part No.	Part No.
CMU 1021 RVANAY SD-102A	1K	830P-500hm	830P-5K
CMU 1022 RVANAY SD-502A	5K	830P-1000hm	830P-10K
CMU 1023 RVANAY SD-102A	10A	830P-5000hm	830P-500K
CMU 2531 RVANAY SD-253A	25K	830P-1000hm	830P-10K
CMU 5031 RVANAY SD-503A	50K	830P-1K	830P-50K
CMU 1041 RVANAY SD-104A	100A	830P-2K	830P-1Meg
CMU 1052 RVANAY SD-105A	1Mg		

LOW PROFILE (TIN) SOCKETS

Pin	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
18 pin LP	.22	.21	.20
18 pin LP	.22	.21	.20
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL (GOLD) STANDARD (TIN)

Pin	1-24	25-49	50-100
8 pin ST	.27	.25	.24
14 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.59	.50	.41
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

WIRE WRAP SOCKETS (GOLD) LEVEL #3

Pin	1-24	25-49	50-100
8 pin WW	.59	.54	.49
14 pin WW	.69	.63	.58
18 pin WW	.79	.73	.67
16 pin WW	.89	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.38	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.79	2.09	1.89

1/4 WATT RESISTOR ASSORTMENTS - 5%

ASST.	1	5ea.	10 Ohm	12 Ohm	15 Ohm	18 Ohm	22 Ohm	50pcs.	\$1.95
ASST. 2	5ea.	180 Ohm	82 Ohm	100 Ohm	120 Ohm	150 Ohm	180 Ohm	50pcs. <td>\$1.95</td>	\$1.95
ASST. 3	5ea.	1.2K	1.5K	1.8K	2.2K	2.7K	3.3K	50pcs. <td>\$1.95</td>	\$1.95
ASST. 4	5ea.	3.3K	3.9K	4.7K	5.6K	6.8K	8.2K	50pcs. <td>\$1.95</td>	\$1.95
ASST. 5	5ea.	56K	68K	82K	100K	120K	150K	50pcs. <td>\$1.95</td>	\$1.95
ASST. 6	5ea.	390K	470K	560K	680K	820K	1M	50pcs. <td>\$1.95</td>	\$1.95
ASST. 7	5ea.	1M	1.2M	1.5M	1.8M	2.2M	2.7M	50pcs. <td>\$1.95</td>	\$1.95
ASST. 8R									\$10.95 ea.

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INTER-SIL

Part No.	Function	Price
70451P	CMOS Precision Timer	14.95
70452P/Kit*	Stopwatch Chip, XTL	22.95
7106CP	3 1/2 Digit A/D (LCD Drive)	16.95
7106EP/Kit*	I.C. Circuit Board, Display	34.95
7107CP	3 1/2 Digit A/D (LED Drive)	15.95
7107EP/Kit*	I.C. Circuit Board, Display	28.95
7110CP	3 1/2 Digit A/D LCD Dis. H.L.D.	18.95
7117CP	3 1/2 Digit A/D LED Dis. H.L.D.	17.95
7201DR	Low Battery Volt Indicator	2.25
7206PG	CMOS LED Stopwatch/Timer	12.95
7206EP/Kit*	Stopwatch Chip, XTL	13.95
7207JPE	Tone Generator	9.95
7206EP/Kit*	Tone Generator Chip, XTL	5.15
7207AIPD	Oscillator Controller	6.50
7207AEP/Kit*	Freq. Counter Chip, XTL	11.10
7208PI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
72151PG	14 Func. CMOS Stopwatch CKT	13.95
7215EP/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216A1J1	8-Digit Univ. Counter C.A.	32.00
7216D1P1	8-Digit Freq. Counter C.C.	21.95
7217J1	4-Digit LED Up/Down Counter	12.95
7218C1J1	8-Digit Univ. LED Drive	10.95
7220L1P1	LCD 4 1/2 Digit Up Counter DRI	16.95
7226A1J1	8-Digit Univ. Counter	31.95
7226AEP/Kit*	5 Function Counter Chip, XTL	74.95
72401JE	CMOS Bin Prog. Timer/Counter	4.95
72421JA	CMOS Divide-by-256 R.C. Timer	2.40
72601JE	CMOS BCD Prog. Timer/Counter	6.00
72601JE	CMOS BCD Prog. Timer/Counter	5.25
75551PA	CMOS 555 Timer (8 pin)	1.40
75551PD	CMOS 555 Timer (14 pin)	2.25
7602CPD	CMOS Op Amp Comparator	5MV 2.5
7612BCPA	CMOS Op Amp Emv.	5MV 2.95
7612BCPA	CMOS Dual Op Amp Cmp.	5MV 3.95
7613CCPD	CMOS Tri Op Amp Cmp.	10MV 5.35
7613CCPD	CMOS Quad Op Amp Cmp.	10MV 7.50
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8069CCQ	50ppm Band-Gap Volt Ref. 10V	2.50
8211CA	Volt Ref/Indicator	2.50
8222CPA	Volt Ref/Indicator	2.50

* INTER-SIL EVALUATION KITS

74C00	74C02	74C04	74C10	74C14	74C154	74C30	74C42	74C46	74C53	74C74	74C86	74C89	74C93	74C95	74C00ZCN	74C01LCH	74C02CPD	74C07CP	74C10ZCP	74C10ZCN	74C14ZCP	74C14ZCN	74C154ZCP	74C154ZCN	74C164ZCP	74C164ZCN	74C182ZCP	74C182ZCN	74C192ZCP	74C192ZCN	74C201ZCP	74C201ZCN	74C210ZCP	74C210ZCN	74C220ZCP	74C220ZCN	74C230ZCP	74C230ZCN	74C240ZCP	74C240ZCN	74C250ZCP	74C250ZCN	74C260ZCP	74C260ZCN	74C270ZCP	74C270ZCN	74C280ZCP	74C280ZCN	74C290ZCP	74C290ZCN	74C300ZCP	74C300ZCN	74C310ZCP	74C310ZCN	74C320ZCP	74C320ZCN	74C330ZCP	74C330ZCN	74C340ZCP	74C340ZCN	74C350ZCP	74C350ZCN	74C360ZCP	74C360ZCN	74C370ZCP	74C370ZCN	74C380ZCP	74C380ZCN	74C390ZCP	74C390ZCN	74C400ZCP	74C400ZCN	74C410ZCP	74C410ZCN	74C420ZCP	74C420ZCN	74C430ZCP	74C430ZCN	74C44
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CPU's & SUPPORT CHIPS

8088A	6.95
8088A	12.95
AMD 2901	13.95
8205	3.95
8215	2.90
8228	4.50
8251	6.95
8259	9.95
8257 (AM9517)	8.95
290A SIA	8.95
8275	34.95
MC6845	24.95
FD1791	34.95

RAM's

2114L-3	4.95
4116-3	4.95
4116-2	6.75
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2102-4	4.95
MK4027-3	3.95
MK4096-11	2.90
TMS4045-25	6.50
MS4050NL	3.95
2101-1	2.45
2107E/5280	3.50
MM5270	3.45
MK4008P	1.95

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4001	35	4027	48	4031	35	74C74	50
4002	35	4029	85	4032	48	74C76	70
4006	1.10	4029	85	4033	35	74C83	1.30
4027	27	4030	35	4039	1.75	74C86	1.40
4008	95	4034	2.25	4501	95	74C86	50
4003	45	4035	97	4510	80	74C90	30
4012	45	4040	1.00	4511	35	74C93	30
4011	35	4042	85	4514	1.95	74C151	1.75
4012	35	4043	85	4516	1.00	74C187	1.75
4013	40	4044	90	4516	1.00	74C192	1.20
4014	40	4045	90	4519	1.00	74C181	1.15
4014	1.00	4049	1.95	4520	1.00	74C183	1.15
4015	45	4050	45	74C02	27	74C183	1.28
4017	1.06	4051	1.10	74C03	27	74C183	1.20
4018	80	4052	1.10	74C04	40	74C172	1.30
4019	45	4053	1.10	74C08	30	74C179	1.20
4020	1.10	4066	70	74C10	27	74C182	1.30
4021	1.10	4069	45	74C14	40	74C201	50
4022	35	4072	35	74C22	1.20	74C201	50
4023	35	4073	35	74C22	1.20	74C201	50
4025	35	4077	35	74C73	45	74C206	6.85
4025	35	4077	35	74C73	45	74C206	6.85

TRANSISTOR SPECIALS

2N1303 PNP GE TO-5	3.81 00
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2N4956 PNP S-SWITCHING	11.95
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2N1420 NPN SI TO-5	3.81 00
2N3787 NPN SI TO-66	5.91 00
2N2222 NPN SI TO-18	4.81 00
2N2907 NPN SI TO-18	4.81 00
2N3905 NPN SI TO-3	1.60
2N3904 NPN SI TO-82	5.81 00
2N3906 PNP SI TO-82	5.81 00
2N5206 NPN SI TO-220	8.55
2N6109 PNP SI TO-220	5.55
2N3138 PNP SI TO-220	5.50
2N3138 PNP SI TO-220	5.55
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UART's

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1602B	3.95
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2.000 MHz 6.144 MHz	16 cond. - .40/ per foot
4.000 MHz 8.000MHz	40 cond. - .75/ per foot
3.000 MHz 10.000 MHz	50 cond. - .90/ per foot
3.57 MHz 18.000 MHz	
5.000 MHz 18.432 MHz	
6.000 MHz 20.000 MHz	

MINIATURE MULTI-TURN TRIM POTS	100, 5K, 10K, 20K, 250K. .75 each ... 3/2.00
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MTA 206 DPDT	... \$1.70
MTA 206 P-DPDT CENTER OFF	... \$1.85
MSD 206 P-DPDT CENTER OFF LEVER SWITCH.	... \$1.85

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200 1.5A 6A 36A 110A	200 1A 10A 25A
400 1.5A 6A 36A 110A	400 1A 10A 25A
600 1.5A 6A 36A 110A	600 1A 10A 25A

FP 100 PHOTO TRANS	... \$.50
RED, YELLOW OR GREEN LARGE LED's .2"	... \$1.00
RED/GREEN BIPOLAR LED's	... \$.55
MLED92 R LED	... \$.75
MRED14B PHOTO DARL. XTOR	... \$.75
TL118 OPTO-ISOLATOR	... \$.80
118 OPTO-ISOLATOR	... \$.80
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MM5314	\$4.75
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1UF 35V 5/81.00	30UF 6V 5/81.00
2.2UF 20V 4/81.00	33UF 20V \$ 60
3.3UF 20V 4/81.00	100UF 15V \$ 70
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	3203 ... \$ 50
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	FND 510 C.A. .5" \$ 85
	HP3400 .8" C.A. \$1.95
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7403	17	7474	42	74164	85
7404	24	7475	49	74165	85
7405	24	7476	45	74166	105
7406	33	7480	45	74167	135
7407	33	7482	50	74170	160
7408	27	7486	75	74173	130
7409	24	7486	42	74174	85
7410	17	7489	160	74175	75
7411	22	7490	50	74176	75
7412	22	7491	55	74177	75
7413	42	7492	50	74180	75
7414	90	7493	50	74181	190
7418	33	7494	50	74179	120
7417	37	7495	75	74191	120
7420	17	7496	60	74192	79
7425	35	74107	35	74193	79
7426	33	74121	35	74194	95
7427	35	74122	35	74195	95
7430	17	74123	42	74196	85
7432	27	74125	45	74197	87
7437	27	74126	45	74279	95
7438	27	74145	75	74285	220
7440	17	74150	110	74366	80
7441	85	74151	65	74367	80
7442	50	74153	55	74390	150
7445	70	74154	110	75325	150
7447	75	74155	75	75451	105
7447	75	74157	65	75492	105
7448	75	74160	65	8798	110

FULL WAVE BRIDGE

PRV	2A	6A	25A
100			1.40
200	1.80	3.20	2.20
400	1.00	1.65	3.30
600	1.30	1.90	4.40

DIP SOCKETS

8 PIN	.17	22 PIN	.30
16 PIN	.22	28 PIN	.40
18 PIN	.25	40 PIN	.60

74LS SERIES

74LS00	28	74LS139	130
74LS01	29	74LS151	130
74LS02	28	74LS153	119
74LS03	28	74LS154	119
74LS04	25	74LS158	125
74LS05	25	74LS159	125
74LS08	35	74LS160	125
74LS09	35	74LS161	110
74LS10	30	74LS162	110
74LS11	35	74LS163	120
74LS12	45	74LS164	120
74LS13	45	74LS165	120
74LS14	45	74LS166	125
74LS15	35	74LS167	120
74LS16	35	74LS173	130
74LS17	55	74LS174	130
74LS18	55	74LS175	160
74LS19	25	74LS181	250
74LS20	25	74LS182	250
74LS21	25	74LS183	250
74LS22	25	74LS184	250
74LS23	25	74LS185	250
74LS24	45	74LS186	250
74LS25	45	74LS187	250
74LS26	45	74LS188	250
74LS27	45	74LS189	250
74LS28	45	74LS190	250
74LS29	45	74LS201	295
74LS30	45	74LS202	300
74LS31	45	74LS203	275
74LS32	45	74LS204	275
74LS33	45	74LS205	275
74LS34	45	74LS206	275
74LS35	45	74LS207	275
74LS36	45	74LS208	275
74LS37	45	74LS209	275
74LS38	45	74LS210	275
74LS39	45	74LS211	275
74LS40	45	74LS212	275
74LS41	45	74LS213	275
74LS42	45	74LS214	275
74LS43	45	74LS215	275
74LS44	45	74LS216	275
74LS45	45	74LS217	275
74LS46	45	74LS218	275
74LS47	45	74LS219	275
74LS48	45	74LS220	275
74LS49	45	74LS221	275
74LS50	45	74LS222	275
74LS51	45	74LS223	275
74LS52	45	74LS224	275
74LS53	45	74LS225	275
74LS54	45	74LS226	275
74LS55	45	74LS227	275
74LS56	45	74LS228	275
74LS57	45	74LS229	275
74LS58	45	74LS230	275
74LS59	45	74LS231	275
74LS60	45	74LS232	275
74LS61	45	74LS233	275
74LS62	45	74LS234	275
74LS63	45	74LS235	275
74LS64	45	74LS236	275
74LS65	45	74LS237	275
74LS66	45	74LS238	275
74LS67	45	74LS239	275
74LS68	45	74LS240	275
74LS69	45	74LS241	275
74LS70	45	74LS242	275
74LS71	45	74LS243	275
74LS72	45	74LS244	275
74LS73	45	74LS245	275
74LS74	45	74LS246	275
74LS75	45	74LS247	275
74LS76	45	74LS248	275
74LS77	45	74LS249	275
74LS78	45	74LS250	275

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9 DIGITS 600 MHz \$129⁹⁵ WIRED

PRICES:

CT-90 wired, 1 year warranty	\$129.95
CT-90 Kit, 90 day parts warranty	109.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC Adapter/Charger	12.95
OV-1, Micro-power Oven time base	49.95
External time base input	14.95

The CT-90 is the most versatile, feature packed counter available for less than \$300.00! Advanced design features include, three selectable gate times, nine digits, gate indicator and a unique display hold function which holds the displayed count after the input signal is removed! Also, a 10mHz TCXO time base is used which enables easy zero beat calibration checks against WWV. Optionally, an internal nicad battery pack, external time base input and Micro-power high stability crystal oven time base are available. The CT-90, performance you can count on!

SPECIFICATIONS:

Range: 20 Hz to 600 MHz
 Sensitivity: Less than 10 MV to 150 MHz
 Less than 50 MV to 500 MHz
 Resolution: 0.1 Hz (10 MHz range)
 1.0 Hz (60 MHz range)
 10.0 Hz (600 MHz range)
 Display: 9 digits 0.4" LED
 Time base: Standard-10.000 mHz, 1.0 ppm 20-40°C
 Optional Micro-power oven-0.1 ppm 20-40°C
 Power: 8-15 VAC @ 250 ma

7 DIGITS 525 MHz \$99⁹⁵ WIRED



SPECIFICATIONS:

Range: 20 Hz to 525 MHz
 Sensitivity: Less than 50 MV to 150 MHz
 Less than 150 MV to 500 MHz
 Resolution: 1.0 Hz (5 MHz range)
 10.0 Hz (50 MHz range)
 100.0 Hz (500 MHz range)
 Display: 7 digits 0.4" LED
 Time base: 1.0 ppm TCXO 20-40°C
 Power: 12 VAC @ 250 ma

The CT-70 breaks the price barrier on lab quality frequency counters. Deluxe features such as; three frequency ranges - each with pre-amplification, dual selectable gate times, and gate activity indication make measurements a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1.0 ppm accuracy - that's .0001%! The CT-70 is the answer to all your measurement needs, in the field, lab or ham shack.

PRICES:

CT-70 wired, 1 year warranty	\$99.95
CT-70 Kit, 90 day parts warranty	84.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC adapter/charger	12.95

7 DIGITS 500 MHz \$79⁹⁵ WIRED



PRICES:

MINI-100 wired, 1 year warranty	\$79.95
MINI-100 Kit, 90 day part warranty	59.95
AC-Z Ac adapter for MINI-100	3.95
BP-Z Nicad pack and AC adapter/charger	12.95

Here's a handy, general purpose counter that provides most counter functions at an unbelievable price. The MINI-100 doesn't have the full frequency range or input impedance qualities found in higher price units, but for basic RF signal measurements, it can't be beat! Accurate measurements can be made from 1 MHz all the way up to 500 MHz with excellent sensitivity throughout the range, and the two gate times let you select the resolution desired. Add the nicad pack option and the MINI-100 makes an ideal addition to your tool box for "in-the-field" frequency checks and repairs.

SPECIFICATIONS:

Range: 1 MHz to 500 MHz
 Sensitivity: Less than 25 MV
 Resolution: 100 Hz (slow gate)
 1.0 KHz (fast gate)
 Display: 7 digits, 0.4" LED
 Time base: 2.0 ppm 20-40°C
 Power: 5 VDC @ 200 ma

8 DIGITS 600 MHz \$159⁹⁵ WIRED



SPECIFICATIONS:

Range: 20 Hz to 600 MHz
 Sensitivity: Less than 25 mv to 600 MHz
 Less than 150 mv to 600 MHz
 Resolution: 1.0 Hz (60 MHz range)
 10.0 Hz (600 MHz range)
 Display: 8 digits 0.4" LED
 Time base: 2.0 ppm 20-40°C
 Power: 110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double duty!

PRICES:

CT-50 wired, 1 year warranty	\$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95



DIGITAL MULTIMETER \$99⁹⁵ WIRED

PRICES:

DM-700 wired 1 year warranty	\$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack + AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include; 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3 1/2 digit, 1/2 inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts: 100uV to 1 KV, 5 ranges
 DC/AC current: 0.1 uA to 2.0 Amps, 5 ranges
 Resistance: 0.1 ohms to 20 Megohms, 6 ranges
 Input impedance: 10 Megohms, DC/AC volts
 Accuracy: 10.1% basic DC volts
 Power: 4°C cells

AUDIO SCALER

For high resolution audio measurements, multiplies UP in frequency.

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

\$29.95 Kit \$39.95 Wired

ACCESSORIES

Telescopic whip antenna - BNC plug	\$ 7.95
High impedance probe, light loading	15.95
Low pass probe, for audio measurements	15.95
Direct probe, general purpose usage	12.95
Tilt bail, for CT 70, 90, MINI-100	3.95
Color burst calibration unit, calibrates counter against color TV signal.	14.95

COUNTER PREAMP

For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer-included.

- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop

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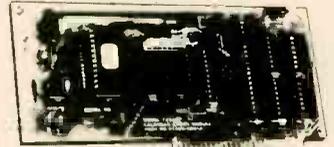
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- Firmware Card... 149⁰⁰
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 - Uses MSM5832 crystal controlled.
- California Computer Systems

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MEMORY ADD-ON KIT INCLUDES INSTRUCTIONS

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- SN7404N .22
- SN7408N .24
- SN7410N .22
- SN7412N .28
- SN7413N .35
- SN7414N .49
- SN7416N .29
- SN7417N .29
- SN7423N .28
- SN7425N .25
- SN7430N .23
- SN7437N .29
- SN7438N .24
- SN7440N .22
- SN7442N .57
- SN7443N .78
- SN7445N .78
- SN74451N .20
- SN74454N .32
- SN74474N .20
- SN74475N .32
- SN7482N 1.05
- SN7492N .50
- SN7493N .48
- SN7495N .60
- SN7496N .70
- SN74122N .39
- SN74136N .95
- SN74141N .69
- SN74151N .65
- SN74153N .65
- SN74154N 1.25
- SN74155N .80
- SN74157N .69
- SN74160N .95
- SN74161N .65
- SN74163N .85
- SN74164N .87
- SN74165N .87
- SN74174N .95
- SN74175N .69
- SN74180N .75
- SN74181N 1.15
- SN74393N 1.89

- 74LS00 .26
- 74LS02 .26
- 74LS03 .26
- 74LS04 .26
- 74LS08 .28
- 74LS09 .26
- 74LS10 .26
- 74LS20 .26
- 74LS21 .28
- 74LS22 .26
- 74LS26 .49
- 74LS27 .26
- 74LS30 .28
- 74LS32 .32
- 74LS38 .32
- 74LS42 .65
- 74LS48 .78
- 74LS51 .25
- 74LS54 .35
- 74LS74 .38
- 74LS75 .60
- 74LS83 .44
- 74LS85 .95
- 74LS86 .95
- 74LS90 .69
- 74LS93 .69
- 74LS107 .45
- 74LS112 .38
- 74LS113 .48
- 74LS122 .48
- 74LS123 .95
- 74LS126 .69
- 74LS138 .69
- 74LS151 .44
- 74LS153 .44
- 74LS155 .115
- 74LS158 .75
- 74LS160 .95
- 74LS161 .85
- 74LS162 .95
- 74LS163 1.60
- 74LS164 .65
- 74LS165 .65
- 74LS170 1.75
- 74LS174 .75
- 74LS175 .75
- 74LS190 .75
- 74LS193 .95
- 74LS195 .95
- 74LS196 .85
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- 74LS240 1.65
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- 74LS244 1.45
- 74LS245 2.25
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- 74LS257 .95
- 74LS258 .95
- 74LS259 2.85
- 74LS279 .44
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- 74LS293 1.85
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The MSM5832 is a monolithic, metal-gate CMOS integrated circuit that functions as a real time clock/calendar for use in bus-oriented microprocessor applications. The on-chip 32.768 KHz crystal controlled oscillator time base is counted down to provide addressable 4-bit I/O data of SECONDS, MINUTES, HOURS, DAY-OF-WEEK, DATE, MONTH, and YEAR. Data access is controlled by 4-bit address chip select, read/write and hold inputs. Other functions include 12M/24M format selection, leap year identification and manual ~ 30 second correction.

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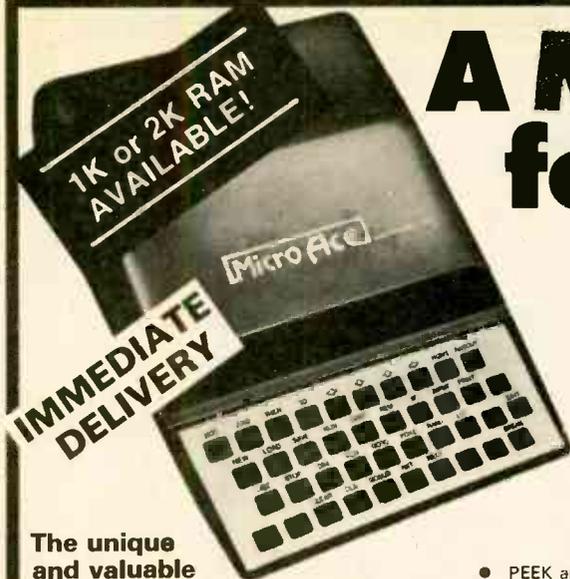
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- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability — takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The MicroAce also has string input — to request a line of text when necessary. Strings do not need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up to 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications
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- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.
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The MicroAce owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the MicroAce 1K byte

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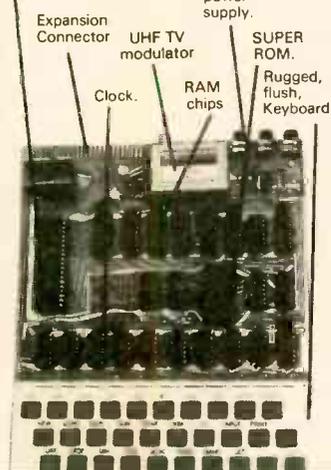
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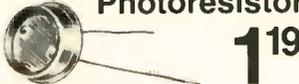
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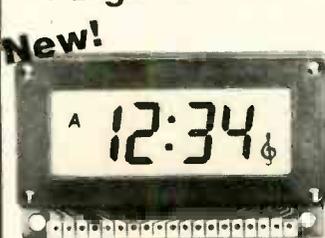


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- 120 volt a.c. CDD
- Used but fully tested

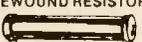


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3 X 5 SPEAKER

3 oz. Magnet
8 OHM Impedance
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Knobs for Slide
Pots 20¢ each
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• 1 1/2" long • 2 1/2" dia. SLIDE

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- Min. Order \$10.00
- Add \$2.00
- Shipping USA
- Calif. Res. Add 6%
- Prompt Shipping

CIRCLE 23 ON FREE INFORMATION CARD

COUNTERS/TIMERS

continued from page 59

impedance change requires some simple conditioning before the UCT can "read" it. Additional conditioning may be required to get accurate measurements if the signals are plagued by such afflictions as contact bounce, noise, or glitches. Low-pass filters or monostables may be enough.

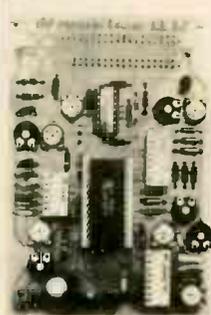
Even when the input signal is purely electronic (such as how many times a microprocessor interrupt-request flag goes up during a particular program run), a situation may demand some conditioning beyond that afforded by the UCT's own input circuitry.

All that is mentioned here in the interest of tracing those devilish problems down to their source—and saving your capable UCT from undeserved criticism when it counts things "funny." It just counts what it sees.

As you get more experience with your Universal Counter/Timer, you'll be able to pick up or invent a few tricks of your own. If you come up with something interesting, share it with us. It helps to keep life interesting. R-E

BULLET ELECTRONICS

Sound Effects Kit \$18.50



The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new Texas Instruments SN76477 Sound Chip, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot, and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3 1/4" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate Explosions, Phasor Guns, Steam Trains, or almost an infinite number of other sounds. The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100mW amp will drive a small speaker directly, or the unit can be connected to your stereo, with incredible results! (Speaker not included). 76477 is included. Available separately for \$3.15 each.

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Most popular transistor for power supplies, audio amps, switching, etc.
Limit 20 per customer 50¢ Each

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SATISFACTION GUARANTEED ON ALL PARTS AND KITS. EXAMINE FOR 10 DAYS IF NOT PLEASED RETURN IN ORIGINAL FORM FOR REFUND. INSURE FOR AMOUNT IF PRODUCT VALUE IS OVER \$10.

BANKRUPT Game Manufacturer Dumps Computer Backgammon Game

The Engineers designed this one too good, making it too costly to be competitive. Result... Chapter XI. We bought all the parts and can offer the unit as a kit for over 60% off retail!

You get:
Double sided glass PC Board
Powerful 8035 Micro Processor Chip
Two 2716 style mask ROMS
RAM Chips, LED readouts,
Keyboard, Instructions
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8035 and program ROMS only with schematics. \$12.00

DISPLAY POINT WILL VERIFY THE NUMBER OF PIECES ON ANY POINT

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CLEAR MOVE ALLOWS TO CLEAR ENTRY TO ALLOW NEW MOVE.

PLUS MUCH MORE!

\$39.95
Includes Case
Does not include player pieces

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SMALL SINGLE HYBRID IC AND COMPONENTS FIT ON A 2" x 3" PC BOARD (INCLUDED) RUNS ON 12VDC GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 5 WATTS COMPATIBLE WITH SE-01 SOUND KIT

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Well made, open frame transformer with mounting ears. Build a +5 and ±12 supply with inexpensive parts. Free schematics of several designs. Primary 117VAC. SEC #1 15VAC @ .5A SEC #2 15 VAC @ .5A SEC #3 8VAC @ 2.5A.

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The Greatest Breakthrough In Electronic Music Ever!

New! The Super Music Maker \$23.50 (Basic Kit)
Does not include speaker switches or 2708 ROM.

Doorbells Car Horns Toys
Store Displays

Forget Electronic Music Kits that are a nightmare of numerous IC's... that use hard to find bi-polar PROM's or are limited to just a few notes! The new per Music Maker Kit from Bullet features a single microprocessor IC that is factory programmed with 20 short songs. With the addition of an optional 2708 ROM, it will play up to 1,000 more notes. Unique addressing scheme allows up to 250 notes per song; up to 100 different songs per ROM (total notes less than 1,000). Quality PC board is designed to make assembly easy. If you can program your own 2708's we give complete instructions. Pre-programmed PROM Albums are available with hundreds of song selections For only \$15.00 each. Lists available.

- * Operates on 12VDC or 12VAC (transformer required)
- * On board 7W power amp drives 8 ohm load
- * Envelope control gives decay to notes

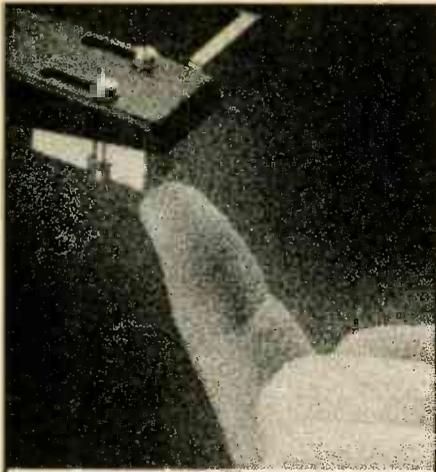
"Next tune" switch allows sequential playing of all songs.

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* 2708 (unprogrammed) \$9.80

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our actual tests showed an overall improvement of about 5%. Different vehicles under different driving conditions will undoubtedly find different results.

Because of limitations on time, gas-economy tests were not checked. The *Tiger* has a reversible plug that allows the user to revert back to the car's original ignition at a twist of the wrist; thus, if failure of the CDI should ever occur, the vehicle will not become disabled. If it should ever be necessary to remove the CDI for service, two simple jumper-wire connections will provide normal operation of the vehicle without having to reconnect the original wiring harness.

Is the installation of the CDI system justified? If the extra few percent horsepower is important, and the additional mileage without replacing points and plugs a major consideration, then the answer may be yes.

The Tiger 500 CDI is available from Tri-Star Corp., PO Box 1727, Grand Junction, CO 81501. The assembled version sells for \$69.95 and the kit version sells for \$59.95. **R-E**

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Brainchild

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Each was a ground-breaking innovation for its day. Each was a Heathkit brainchild.

Today — Today's brainchildren include the popular Heathkit All-In-One Computer, a complete computer system with disk storage, smart terminal, two Z80 microprocessors — all in one compact unit.

Also rising fast, the Heathkit Screen Star, a new projection TV that brings together the best in video technology to create the sharpest color picture ever on a six-foot diagonal screen.

Heath imagination applied to microprocessor electronics created the Heathkit Weather Computer. It monitors current weather, tracks changes, stores data — and puts it all at your fingertips.

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GX-379

CIRCLE 29 ON FREE INFORMATION CARD



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And when you pay more, you expect more!

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The K40 is guaranteed to transmit further or receive clearer than any antenna it replaces. We know it will. We've tested it with 771 CB'ers just like you for one year.

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You can fit your K40 to any mounting surface. It will fit any vehicle you'll ever own! That includes choppers, dune buggies, gutters, mirror mounts, luggage racks, trunks, hatchbacks, through roofs, semis, pick ups and RV's.

MORE QUALITY:

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*Including optional mounts at extra cost.

2. It's made better...



3. It's proven best!

...Here's what the leading CB publications said.

CB TIMES: "... it's not often that a product bursts onto the market scene, dominates and improves CB'ing for everyone. American Antenna and the K40 are doing it—repeated tests showed the K40 could out-perform the major competitive brands."

RADIO-ELECTRONICS: "The results of our tests showed that, in three different positions of the monitoring receiver, the model K40 equaled or out-performed the competitive antenna. Apparently, American Antenna's advertising is not merely Madison Avenue showmanship."

PERSONAL COMMUNICATIONS: "... an impressive 95% of the trials, the K40 out-performed the existing mobile antennas. We had to try one for ourselves. "... in every case, the K40 either equaled or out-performed its competitor."

"No ifs, ands, or buts! The K40 Antenna from American Antenna would have to be just about the best antenna around."

CB MAGAZINE: "Introduced in October, 1977, the K40 quickly became the top seller and in mid 1978, became the number one selling antenna in the nation."

...Here's what CB'ers all across the country said.

ANTENNA SPECIALISTS: "... truck driver and CB'er for 10 years ... 50% further than my M410 'Big Momma'."

—J.H. Collett, 207 McFee, Bastrop, LA

AVANTI: "I'm an electronic technician with a Second Class FCC license ... I was able to transmit 70% further and tune the SWR 75% lower than my Avanti."

—H.R. Castro, VRB, Monserrante D-67, Salinas, Puerto Rico

PAL: "... 20% better in transmission and reception than my 5/8 wave Pal Firestik."

—John A. Blum, Box 446, Zelienople, PA

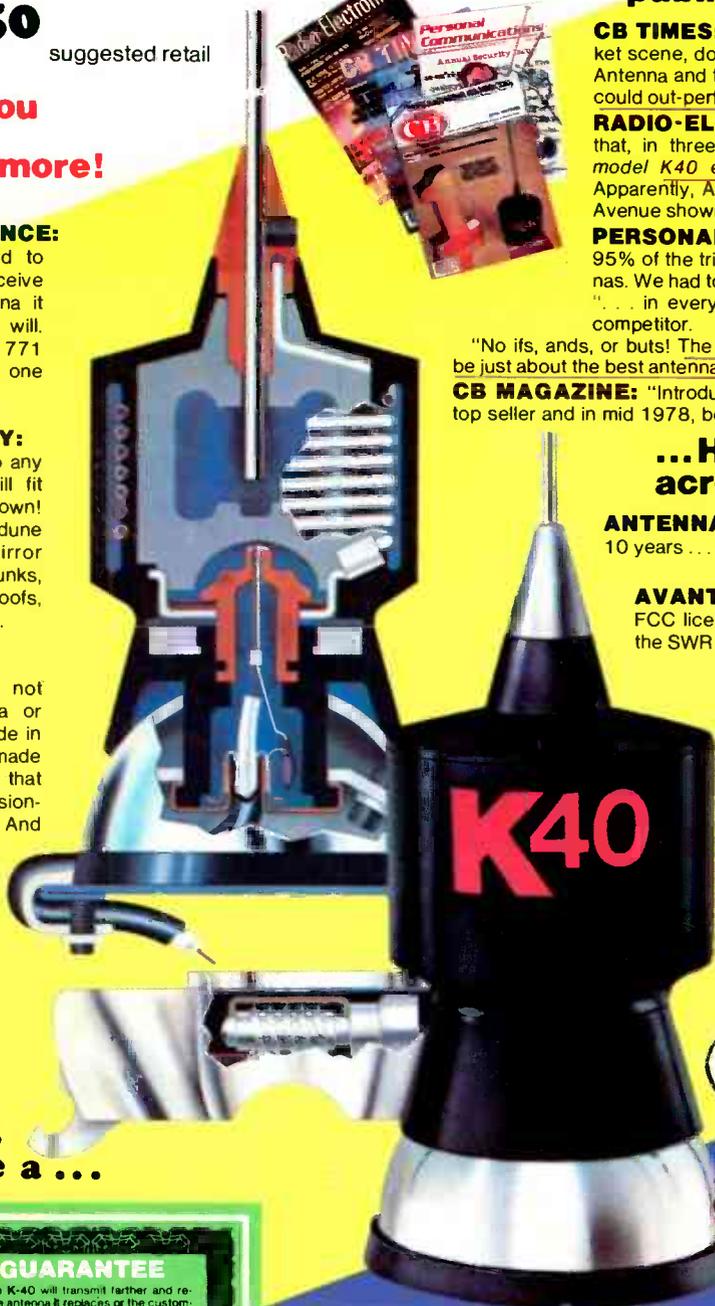
SHAKESPEARE: "... I've been a CB'er for three years and the K40 is the best I've ever had. Better in reception and transmission than my Shakespeare."

—H. Bachert, Jr., 15 King Rd., Park Ridge, NJ

HUSTLER: "Compared to my Hustler XBLT-4, the K40 can consistently transmit 40% further and the reception was better. The K40 is the perfect way to complete a CB system."

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CIRCLE 4 ON FREE INFORMATION CARD