

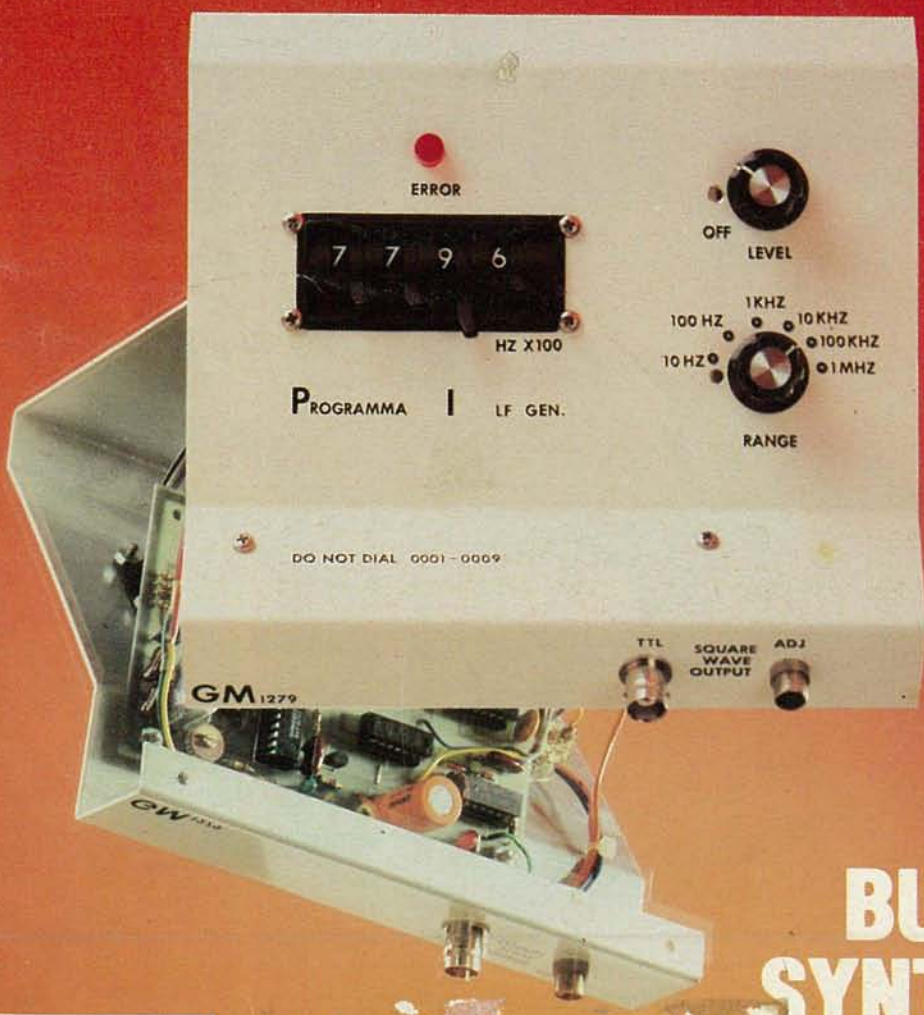
Radio- Electronics

**YOUR OWN COMPUTER
40-PAGE BUYERS GUIDE**

\$1.25 OCTOBER 1980

**Assembling the Unicorn-1 robot
IC's for LED bar-graph displays
Nikola Tesla—the pioneer**

**How to use flasher LED's
Hafler's super hi-fi amplifier kit
One-IC digital panel meter**



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"I made it despite myself."

Success Forces

Can you be successful despite yourself? Here's how I did it.

By Joseph Sugarman, President
JS&A Group, Inc.

It's a joke. I'm considered one of America's top copywriters and mail order entrepreneurs.

I never finished college, never took a course in business, advertising or creative writing, and even flunked English.

On top of that, I failed at almost everything I did. My list of failures would fill an encyclopedia.

Now you probably expect me to tell you that it was failure after failure until I hit upon the "wealth formula" or the "secret to success" or some other trite expression. Not true.

ONLY SIX REASONS

What I've found about success is quite opposite the formulas you've read about or the misconceptions you've heard.

I simply took my few successes and many failures and discovered six reasons why I failed and six reasons why I succeeded.

The reasons I succeeded seemed like forces. Whenever I followed them, I achieved success. Whenever I didn't follow them, I failed. I soon called them Success Forces.

I used Success Forces to build my business from the basement of my home into America's largest single source of space-age products. I was successful. But was it a coincidence or was it a direct result of Success Forces? I really didn't know.

MATERIAL THINGS

If you measure success by material things, I achieved quite a bit: several cars, airplanes, snowmobiles, motorcycles, four beautiful homes—all the material things I imagined I'd ever want.

And I had recognition. My success story was written up in several magazines. But it wasn't until after I revealed my Success Forces in a few speeches that I realized my concept would work for others.

I was getting letters from people who told me how one of my Success Forces had changed their lives. Others told me of how they used Success Forces to make extra money or achieve greater happiness. Still others who always thought of themselves as failures, became successful despite themselves.

But the whole thing seemed strange to me. Was Success Forces original? Something like it had to be in some other success book. So I read. I bought every success book I could find. I studied Chinese philosophy. I bought every motivational cassette that was offered. And I thoroughly studied the material.

I then discovered why my concept was indeed different. Success Forces lets you be yourself, and guides you towards making simple choices that can ultimately change your life. If you make the right choices, you are literally forced into success.

MY \$2,000 SEMINAR

Although I was convinced that my concept was different, I wanted to be absolutely sure it would work. I decided to conduct a seminar with a select group of 16 people who would be willing to pay handsomely to learn my philosophies. My five-day seminar cost each participant \$2,000 and I held eight of them. All were sold out.

The success stories resulting from each seminar are already history. I taught a Texas farmer, a New Zealand rug merchant, a lady from Australia. There were people from all walks of American life, many of whom paid their last \$2,000 to attend.

Not all of the participants succeeded. But so many did become successful and so many told me later how I literally changed their lives, that I was convinced Success Forces should be available for everybody to use.

NOW AVAILABLE

I am now making my concept available in a hardbound book entitled "Success Forces." It contains examples from my speeches and the philosophies from my seminar that participants paid \$2,000 to hear.

A few of the Success Forces you may already know and have been subconsciously following for years. Others, you may have been fighting, thinking that you would fail when all along you would have succeeded. A few of my Success Forces require action—the type of action that everybody can take and that requires no special skill.

This is not a step-by-step book on how to get into a business that promises "A Lazy Way to Riches," or a way to "Quit Your Present Job." It does not matter if you are in business nor whether you want to work hard, take it easy, or just plain be successful.

TEACH HIM TO FISH

There's a saying: "You can feed a man a fish and he'll eat for a day. But teach a man to fish and he'll eat for a lifetime." My book will help you for a lifetime.

I'm not somebody who writes a book on how to make a fortune and then makes my fortune from the sale of the book. I've already made it. Nor am I going to send you a cheaply printed thin paperback. That's not my style. My book is a 200 page hardcover volume that I guarantee you will both enjoy and benefit from. In fact, I will go one step further. After you read it, wait one year. If you have not noticeably benefited from reading Success Forces, return your book to me and I will refund your money in full. Success Forces must give your life additional meaning within one year or your money back. It's that simple. This one-year return offer applies only to those individuals purchasing my book via mail order.

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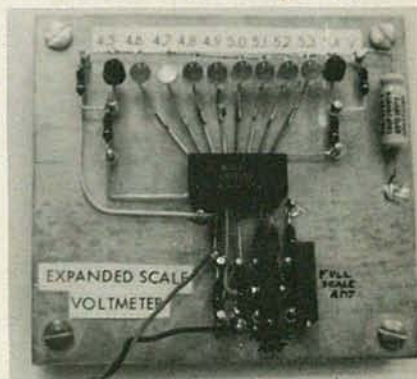
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A synthesized pulse generator that goes from 0.1 Hz to 1 MHz. All CMOS design, this device is ideal for putting logic circuits through their paces and for use as an AF and RF signal generator. Synthesizer allows exact selection of frequency and guarantees repeatability. Construction details begin on page 87.



SPECIAL COMPUTER SECTION covers recent developments in the personal computer field. Find out what's for you, starting on page 45.



LED DISPLAYS are showing up in more and more designs. Learn how to design your own on page 96.

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looking ahead

Staking a claim: Sony made the unusual move of demonstrating a "new product" four to five years before its introduction when it recently showed a hand-held combination video camera and VCR designed to replace the super-8 film camera. At press conferences in New York and Tokyo, Sony's Chairman, Akio Morita, and its President, Kazuo Iwama, urged the electronics industry to get together on a single standard before introduction to avoid a situation similar to the Beta-VHS fiasco.

The camera-recorder combines a CCD color camera with a metal-tape helical-scan VCR in a package weighing 4.4 pounds, including a rechargeable 9-volt battery. The single-chip camera has 570 × 490 picture elements that provide a 250-line horizontal resolution, a 3-1 zoom lens and through-the-lens viewfinder. The two-head recorder uses a cassette resembling a micro audio cassette in length and width, holding 8-mm tape, which will record for 20 minutes.

The battery operates for 40 minutes on a charge. For playback, Sony showed a "home editor," which accommodates the entire camera (except the battery-pack handle) in a special compartment. The editor's output is fed directly to a television set for playback or to any home VCR (Beta or VHS) for home editing. Morita said that the system should sell for under \$1,000, cassettes \$10 each. Sony says its aim is the standardization of cassettes, so they may be purchased anywhere in the world, in the same manner as super-8 film.

Sony's competitors were caught off guard by the demonstration. Comments from Matsushita, Toshiba, and JVC all indicated that they, too, are working on similar single-piece units. Eastman Kodak, believed to be preparing to take the plunge into electronic photography, was silent. Now that Sony has gone public with a top-secret project that has preoccupied the industry, you can expect to see more advance demonstrations of the home-movie machine of the future.

BASF gives up: Germany's BASF has abandoned its plan to make its Linear Video Recorder (LVR) in the United States, and all plans to produce anywhere the model that was first demonstrated as a pre-production prototype a year ago have been called off. The LVR plant in Fountain Valley, CA, has been closed and put up for sale. Under development for at least five years, BASF's LVR was a product whose time had passed. The pre-production prototype recorder used a rapidly-reversing single-reel 8-mm tape with 72 longitudinal tracks. The prototype recorder weighed 11 pounds, a remarkable feat three or four years ago, but not much lighter than some of today's VHS recorders. BASF says it is still working on a miniaturized version—perhaps similar to the four-pound mockup it displayed privately at last year's Berlin International Radio & TV Exposition.

Toshiba's LVR (in this case, standing for Longitudinal Video Recorder) has also been postponed, as noted here last month. Toshiba's version also uses a single-reel cassette, this one containing ¼-inch tape with 300 longitudinal tracks. The tape doesn't change direction, but the head moves from one track to the next after playing, in a manner similar to the eight-track audio cassette. Toshiba

now indicates that LVR will be introduced in two specialized versions before being placed on the general consumer market. The first will be a random-access data recorder, and the second a video recorder capable of taping two shows simultaneously on different tracks, with a recording time of at least two hours, or one hour per show.

Videodisc competition: With two videodisc players now on the market in selected areas, competition is beginning to come into play. At presstime, Magnavox's Magnavision was officially available in eight U.S. markets (and unofficially in some others, as the result of transshipping by some dealers) and Pioneer's Laserdisc in four markets. Both play the same MCA optical discs. The suggested list price of the Magnavision player is \$775, of the Pioneer \$749 (wireless remote random access is a \$50 option). The competing players meet head-to-head in the Dallas-Fort Worth and Minneapolis-St. Paul markets. A quick survey of dealers in those areas shows the Magnavision selling in most stores there at \$695 to \$699, the Laserdisc at list price. In other Magnavision markets, dealers are adhering to the suggested list price. Magnavox says there has been no price reduction, indicating that "aggressive dealers" are merely meeting local market conditions.

Projection update: General Electric has introduced that three-tube projection-TV system forecast in our July column. The company seems to have gone out of its way to make up for the deficiencies of its single-tube version. The new Widescreen 3000, like the old 2000, is a rear-projection unit with a 45-inch translucent screen. The new version, however, has an extremely bright picture with very wide wide-angle viewing—meaning that viewers don't have to sit directly in front of the set to see the optimum picture. It lists at about \$3,500, as compared with \$2,800 for the earlier version. As reported here, Panasonic and Quasar also are selling three-tube rear-projection sets, and Sylvania plans to enter the market. In other projection-TV news, new brighter three-tube front-projection sets are expected this fall from Mitsubishi and Sony. Kloss Video's Novabeam projection system, the least-expensive high-quality three-tube system on the market, has been increased from \$2,500 to \$2,995.

New sports display: Attendees at this year's All-Star Baseball Game at Dodger Stadium in Los Angeles were treated to the latest in stadium giant picture displays—the premiere of a new Mitsubishi system to replace the old light-bulb-type display. Diamond Vision uses 1 × 1.25-inch cathode-ray tubes instead of lightbulbs, in groups of three—one for each primary color. The Dodger Stadium display measures 20 by 28 feet, is clearly visible in full daylight, and will be enlarged next year to 25 by 33 feet. Among the claimed advantages are higher resolution, better brightness and motion, and longer life for the cathode ray tubes as opposed to light-bulbs.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

NOW! A MINIATURE TELEPHONICS SYSTEM
EVEN MA BELL DOESN'T MAKE AVAILABLE.

FINGER FONE™

The unique Finger Fone brings you advanced solid-state wizardry, with total hands free conversation, speak and listen without lifting a finger. The total communications instrument for home and office.

Imagine you're a design engineer. You've just been assigned to come up with a smaller, simpler-to-use, more streamlined telephone with basic memory that can handle 99% of the ways people actually use a phone on a day-to-day basis.

You have a research laboratory with a support staff at your disposal. Plus access to the latest transistors, memory chips, and microprocessors. And you are given only one limitation: Keep the consumer's cost under \$100.

Now, since you're something of a maverick, your mind is not trapped in the right way/wrong way syndrome. And you were too independent to take that job with the Bell System a while back. Because you didn't want all your ideas to come out "Bell-shaped."

THE ANATOMY OF DESIGN

So you set to work — but not with wires, bells and whistles. Because your approach is different: You're going to discover how people actually use a telephone today and then design the instrument from the outside in, basing your conception around real communication needs in a way quite unlike anything ever before achieved.

INTRODUCING THE FINGER FONE

When you're finished, you realize you've come up with a minor revolution in design! Your new instrument is actually a miniature telephone: the entire unit measures a scant 2¾" wide, 8¾" long, and 2¾" high (at the speaker end), scarcely any bigger than the handset on an ordinary phone. Your Finger Fone has a nearly standard alphanumeric keyboard plus a couple of special benefits we'll get to in a minute. It also has an omnidirectional microphone, volume selector key, automatically control the volume of incoming voices, with four LED indicator lamps to display each volume level, and even a bright red on-off light.

What's more, it plugs into the new miniconnector Ma Bell provides for all its phones these days — with no additional wires for any other power source (which make the Finger Fone unlike those other multi-wire "speaker-phones" that sell for more but do less).



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Finger Fone: modular, sophisticated, smarter than your present telephone. Comes with an ivory fascia.

WHY PICK A PHONE UP EVERY TIME IT RINGS?

Let's face it, your hands are often occupied when the phone rings. So to answer, you've got to stop at least half of what you're doing. With a Finger Fone, all you do is reach out and tap the "On" key with one finger. And since you needn't pick the instrument up, you can place it conveniently on a desk, counter, or table — or hang it on the wall.

MORE FINGERTIP CONVENIENCE

When Finger Fone announces an incoming call with its pleasant electronic chirp, tap the "On" key and begin speaking. If the caller is someone the whole family wants to hear, simply tap the volume control key and select one of the four sound levels and your caller's voice will be audible to everyone in the room. This benefit is great for the office as well, making it possible to replace an ordinary telephone, separate speaker-telephone, and their complicated controls.

If you wish to speak with complete privacy, press the volume control key for low level volume. Yes, for strictly private calls you'll have to hold Finger Fone up to your ear. You won't mind, however, because the entire unit is a mere 11¼ ounces, just a featherweight more than ordinary telephone handsets.

YOU HEAR THEM, THEY DON'T HEAR YOU

Need to put your caller on "hold" for a moment? Easy. Tap "hold" key. All five LED indicator lamps will be blinking, indicating your caller is on hold. The other person won't be able to hear you, but you'll be able to hear him or her. We recommend you tell people about this so they don't make unguarded comments they think you can't hear. When you're ready to resume your call, simply tap "off" key, the LED lights will stop blinking, and you can continue.

BUSY SIGNAL? FORGET IT!

Because Finger Fone automatically remembers the most recently dialed "busy" number. When you want to call that number again, tap the "RE" (Recall) key once. Finger Fone dials the number for you, as often as needed until you get a clear line.

WHY WAIT FOR PUSH BUTTON DIALING?

Finger Fone is compatible in areas of the country where push-button dialing is already in use. But if you live in the 30% or so of the country where only rotary-dial phones can be used, wait no longer. Finger Fone automatically converts from musical tones to rotary-dial signals. This way, you can have the speed and advantages of push-button dialing without waiting for your local phone company to install central equipment.

NOW AVAILABLE AT INCREDIBLE LOW COST

Finger Fone costs only **\$79.95** compared with prices of similar-looking telephones (but not similar in performance) costing \$109, \$130 or more. Want two? Then it's only **\$74.95** each. Three? Save even more at **\$69.95** each. Add a \$2.50 charge to your total order for insured shipping, and if you live in New Jersey, include 5% tax.

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You can try one or more Finger Fones in your own home for 30 days, protected by our unconditional money-back guarantee. If you're not satisfied with Finger Fone for any reason, simply return it (insured) for a full refund, no questions asked. Finger Fone is also covered by a 1-year parts and labor guarantee.

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OCTOBER 1980

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what's news

New console for two-way interactive cable TV

Described as a "major milestone" in the evolution of two-way interactive cable television, the QUBE III home computer console (known as the Pioneer BT-1300) was introduced by Warner Amex Communications, Inc., and Pioneer Communications of America in May. The BT-1300 is half the size of present QUBE consoles; it can accommodate up to 110 program channels, and has the capacity to provide any home service, data information retrieval, or video-entertainment programming currently available, as well as those likely to develop in the next decade.



THE NEW QUBE III home console looks like a pocket calculator, but it can access up to 110 video channels. It can support eight numeric digits of variable-length data to and from the terminal; that enables subscribers to tie in with a wide variety of home service applications. (Photo courtesy Warner Amex QUBE.)

By pressing buttons on the console, subscribers will be able to interact directly with programs they are watching: They can register opinions, vote on issues, participate in games, shop from their homes, and take educational courses. There are eight narrowcast channels for education and other services, and twelve interactive response buttons on the home console.

Home applications include financial management, whereby a subscriber can make bank deposits or withdrawals by simply punching in a digital code on the console that would tell the computer which home terminal is requesting a service and that the service is banking. The computer will check to make certain that all figures are correct and a final verification of the transaction will go back to the subscriber. The users will also have instant access to mate-

rial from data-information banks and services such as electronic libraries. Bob Matsumoto, President of Pioneer Communications of America, said: "The unique BT-1300 console represents the most advanced, sophisticated interactive system available in the industry today. There is not another system that can approach it in terms of performance both now and several years hence."

Latest "schoolboy mystery" causes international foul-up

Unauthorized access to several Canadian computer systems has been traced back to a New York City school whose students range from the fourth to the twelfth grades. (The headmaster suggests "It's possible that someone outside is using a phone that's been traced back to a school line.")

The Dalton school has a computer that is used to teach its students. But the computer is getting into systems operated by 21 Canadian business and other organizations—systems to which the school does not even subscribe.

In one case, the unauthorized communications seized control of the systems used by Canada Cement La Farge, and destroyed some of its data in the process. In another, the operation of Scott Hart and Associates' computer system was disrupted.

All things are possible to a student, some teachers of long experience believe, and this highly unexpected development could be the result of a struggling youth trying to solve a routine problem. It is only slightly more probable that some student or staff member may have developed a way to break security codes previously considered invulnerable. The Federal Bureau of Investigation, citing a possible scheme to defraud, obtained a search warrant and seized two plastic bags containing computer printouts and a terminal log sheet; results have not been reported.

New Zenith TV's have two non-TV features

Zenith has taken one step more toward making the TV an integral and necessary part of the home, with two new features, the *Space-Phone* color TV that doubles as a remote-operated extension telephone, and the *Video Sentinel System*, a TV receiver, home-surveillance system, and door-answering convenience all-in-one.

The *Video Sentinel System* consists of a 12-inch black-and-white TV receiver with special circuitry for the video monitor and intercom functions, a closed-circuit TV camera with stand, and a doorbell intercom unit, with connecting cables.

By pushing a TV button on the top of the set, the ordinary program is brought in.

Pushing the CAMERA button brings a picture from the camera location (front porch, back yard, nursery, or elsewhere). The TALK button permits talking and listening to a front door caller.

The suggested price of the system, with all its equipment, is under \$400.

The Zenith Space Phone is a TV set that receives incoming telephone calls when the set is connected to an ordinary telephone line jack. The viewer answers the call from his easy chair with the Space Command button on his TV remote control, then uses the set as he would a speakerphone. The caller is heard through the TV's audio system, and a microphone in the set transmits voices in the room to the caller. The Space Phone can also be used on outgoing calls, after the connection is made on a conventional telephone.

FCC reconsidering Magnavox AM stereo decision

The FCC, in a move that did not come as much of a surprise, is having second thoughts about which AM stereo system it will approve. Its original Report and Order, as announced in April of this year, was to have given the OK to the Magnavox system.

Radio-Electronics was in the course of preparing a report on that system for this issue when, at the end of July, the FCC announced that, in the process of preparing the Report and Order, it had realized that it required more information than it possessed. Consequently, a Further Notice of Proposed Rulemaking will be issued to obtain more facts about all the systems originally proposed. This means that the five contenders for this market—Belar, Harris, Kahn, Magnavox and Motorola—are all back in the running.

Sony and Studer agree on digital audio recording

At a press conference held at the recent Audio Engineering Society convention in Los Angeles, the Sony Corporation and Willi Studer, prominent audio equipment manufacturer of Switzerland, announced that they have reached an agreement to support a common format in stationary-head digital audio recording. Studer will have access to Sony's advanced digital tape recorder technology.

Sony has been conducting its own research and development in digital audio recording and playback. The company at present has a full line of digital equipment, including pulse-code-modulation (PCM) digital audio processors and editing systems for professional sound recording.

Digital recording technology represents the best attainable form of sound recording and promises to usher in a new era of music and audio enjoyment. **R-E**

Facts from Fluke on low-cost DMM's

Our new 4¹/₂-digit bench/portable: You've never seen anything like it.

Take a close look at the face of this instrument. Notice anything new? If you just realized you've never seen *words* on a low-cost DMM display before, you're on the right track.

This is the new 8050A from Fluke, the *lowest* priced 4¹/₂-digit multimeter available that uses microprocessor technology.

The legends on the LCD are clues to what makes the 8050A unique.

dB: You're right. The 8050A delivers direct readouts in dBm, referenced to any of 16 impedances. Use the "REF Z" button to scroll through the memory and locate the zero dBm reference you need,

then set it and forget it. No more tedious calculations or conversions.

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For technical data circle no. 46

satellite tv news

Less expensive satellite equipment

Cheaper satellite private terminals—and more of them—will continue to become easier to find. That was the message during two recent expositions, both of which underscored the growing popularity and interest in backyard earth stations.

First in Chicago, at the Consumer Electronics Show, small-dish antennas made their first formal appearance, with three distributors showing off their equipment. The units were in the \$5,000 and \$10,000 range—and the purpose of the Chicago display was to interest electronics dealers from around the country in selling the devices in their stores. From all indications, the companies were successful—and more stores nationwide will soon be selling and installing equipment.

A couple of weeks later in San Jose, California, the semiannual Satellite Private Terminal Seminar attracted more than 600 people—and for that group of do-it-yourselfers, the price of equipment shown was in the \$2,500 range. For the California event, nearly three dozen equipment suppliers showed their wares, including a number of new and exotic small antennas. At the low-end of the scale was a \$495 16-pound umbrella antenna developed by Bob Luly of San Bernardino, California. The price of LNA's also continues to fall, with some units now in the \$800 range. In addition, an 80° parametric amplifier selling for about \$500 was demonstrated. Sat-Tec, a Rochester NY subsidiary of Ramsey Electronics, demonstrated its \$995 R2 satellite receiver, which requires a 120° low-noise amplifier, and features continuous tuning for all U.S. domestic satellites, Intelsat, and Russian Molniya.

Of the companies showing complete TVRO packages at the Consumer Electronics Show, the lowest-price offering was a \$5,000 set-up jointly presented by Helfer's Antenna Service (23 Brookside Place, Pleasantville, NY 10570) and American Value Inc. (PO Box 96, Rolling Meadows, IL 60008). Helfer's built and demonstrated the equipment, which American Value is selling. The package has only one LNA and the low price is for a 10.5-foot dish; with a 12-foot dish, the price rises \$500.

Third Wave Communications (3618 Elizabeth, Ann Arbor, MI 48103) a company that takes its name from Alvin Toffler's popular new book, uses Microdyne hardware. President Jim Cassily is looking forward to the 1990's when he expects that 12/14 GHz satellites will make the current generation of equipment obsolete. With that in mind, Third Wave is working with technologists to see if current 3-to 5-meter dishes can be converted into solar satellite collectors for future energy-retrieval applications.

Channel One, Inc. (Willarch Road, Lincoln MA 01773), one of the pioneering TVRO distributors, added a new feature to its CES display: a fiber-optics cable to carry the satellite feed the last 1,500 feet from the convention hall parking lot into a video exhibit on the display floor. It was the first time that fiber optics have been used for such a long drop, and users were pleased about picture quality—immune from RF interference, which was rampant within the electrified building.

"SPACE" signing up members

SPACE, the Society for Private and Commercial Earth Stations, held its first formal meeting during the Satellite Private Terminal Seminar (see above). It signed up more than 140 members and elected Stanford University Professor Taylor Howard as President. The group's first thrust will be to respond to proposed legislation that would prohibit private reception of

pay TV programming. SPACE opposes any payments for private use of satellite signals and wants assurances that backyard-terminal owners will not be denied access to satellite signals. However, an informal poll at the SPACE meeting indicated that commercial users would be willing to establish a "reasonable payment" for programming (such as at apartment complexes). SPACE has established three classes of membership: individual (\$25), corporate (\$100), and sustaining (\$500). The group's membership is now about evenly split between manufacturers/suppliers and satellite users (SPACE, 1527 O Street NW, Washington, DC 20005.).

Washington trying to stop unauthorized reception

With the growing use of private satellite terminals, it was inevitable that Washington officials would begin to examine the business. In fact, a bill was recently introduced in Congress (HR 7747) to prohibit "unauthorized interception" of pay-TV programming from satellites and other microwave systems. The proposed law would establish penalties, including a \$100-per-day liability to the program provider and fines of up to \$25,000 and/or one year in jail. Moreover, retransmission of such signals for commercial purposes (such as distribution within an apartment or hotel building) could carry a \$1 million fine. Washington observers aren't certain how the legislation will fare when—or if—it ever comes up for a vote.

Meanwhile, over at the Federal Communications Commission recently, there was a brief discussion of signal piracy. After a short examination, the Commission decided it will file a "friend of the court" document in a California case involving alleged piracy of a microwave pay-TV signal; and at least one commissioner is pushing for the FCC to adopt a formal "anti-piracy" stance.

To confuse things a bit more, let's take a look north of the border. The Canadian Radio-Television Commission (equivalent to our FCC) wants to prosecute owners of illegal receivers; but at least one leading public official there has issued a statement: "Hands off the earth stations of northern Ontario."

Ontario Communications Minister James Snow supported the use of TVRO's, especially in outlying areas, because they "reduce the isolation" caused by lack of media outlets.

Around the satellite circuit

The FCC has formally opened the books on plans and proposals for Direct Broadcasting Satellites in preparation for the 1983 western hemisphere World Administrative Radio Conference. That international meeting will decide what frequencies and power are to be allotted for DBS in North and South America; so the FCC plans to spend about two years getting ready for that session. If you want to file comments or ideas (especially about service requirements, orbital positions, or specifications) in the preliminary FCC examination (General Docket No. 80-398), submit them by October 10, 1980 to the FCC, 1919 M Street NW, Washington, DC 20554.

Japan's "Yuri" experimental direct-broadcasting satellite dropped out of service recently when its remaining traveling wave tube amplifier ceased functioning. The failure means a premature halt to the DBS efforts which had begun last year, using one-meter receive antennas. Another Japanese DBS satellite is already under construction.

GARY H. ARLEN
CONTRIBUTING EDITOR

Brainchild

Yesterday — Remember the first Heathkit Analog Computer (1957)? Or the Heathkit Single-Sideband Transmitter (1958)? How about the Heathkit Multiplex Adapter for FM stereo reception (1960)?

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letters

OOOOOPS . . . AGAIN!

I think there's an error in the foil pattern for the Automotive Voltage Regulator that appeared in the June 1980 issue. Pin 1 of IC1 does not go directly to ground, as it does on the schematic, and it appears to me that the circuit will not work without this ground. Am I correct?

JOHN F. BRIDGE
Worthington, OH

You're right! (And the same mistake appears in the correction on page 72 of the July issue.) The solution is to run a very short piece of resistor lead from the pad at the pin-1 end of R6 to the ground land immediately to its right (on the foil side of the board). The current production run of those boards does not contain this error and purchasers of earlier-production boards have been advised of this mistake and given the opportunity to exchange their "old" boards for the "new" ones—Editor.

RADAR DETECTORS

First of all, I would like to say that this letter reflects only my personal opinion and is in no way a policy statement of the R.C.M.P. or any other police force for that matter. I am a member of the R.C.M.P. in Canada and have been for the past five years. I am also an electronic audio tech.

For some time I have been listening to the radar and radar detector arguments with amusement. Firstly let me speak on the radar.

My writing has been prompted by the Feb 80 letter "Radar Detectors vs The Law". The writer points out that radar has come under severe attack recently—especially moving radar—because of situations that can cause false readings. I have operated radar for the past four years and I agree with the writer on that point.

However, picking out a speeder in a group is quite simple—he is the one whose car is going the fastest. As for "batching", ghost readings, and large speeding trucks behind unsuspecting motorists, the radar operator is instructed in the use of the radar and is supposed to be able to recognize those problems and sort them out from the true readings. However, modern technology has yet to perfect the "idiot proof" instrument. Radar is not "idiot proof".

I should mention after watching the flow of traffic for five years that an officer can judge the speed of a vehicle quite accurately, with only the use of his eyes and sense of timing.

Now on the subject of radar detectors. I do not feel anything wrong with a person owning and operating a radar detector if he can afford it and the law permits it in the area he lives. But let's be honest with ourselves and others, and admit what is usu-

ally the real reason for radar detector use.

Many people quote such notable persons as mayors, traffic control techs, and electronic engineers as saying, "Radar detectors promote safe driving by making drivers aware of their speed, thus slowing them down, and slower speeds reduce accidents."

I cannot dispute that slower speeds reduce accidents, but we will most likely read the statistics in the future and see that there were few, if any, accidents in the vicinity of traffic officers operating radar. However, what about the stretch of highway where there is no officer operating radar. What will remind drivers of their speed there? Hardly anything!

If we are honest with ourselves we will realize that, for most drivers on the road owning radar detectors, the primary reason is to escape detection when they wish to exceed the speed limit.

For the last several years a device has been marketed that satisfies all the claims of radar detector owners and distributors. It is called *cruise control*. It helps you keep a constant speed and prevents your speed from "creeping" when going downhill. It also gives you a better average speed over a long distance, and any professional driver knows that this will save you gas and time in the long run. (On a steep downgrade, your car can exceed the Cruise Control speed setting. So you must still be cautious.—*Editor*

For your own protection, from salespeople marketing radar detectors, you should know that a detector only detects a radar beam when it is present. Modern radar units have a microwave lock-off switch that allows the operator to turn off the radar beam until you are well within its range. When the beam hits your car your detector will go off. Being so close to the transceiver, you are also being clocked. Chances are you'll get your speeding ticket, lose your detector, and get an additional fine for having a detector in your possession. All the while a detector distributor is counting your hard-earned dollars and waiting for you to come back to buy another. There are no detectors on the market, nor will there ever be, that can detect a radar *set*—they only detect a radar *beam*.

For your own protection, you are better off to buy and use a cruise control. However, if you wish to use a detector, make sure that your State or Provincial laws allow it or you could lose your investment. Lastly, don't use your detector so that you can speed undetected. With the widespread use of microwave lock-off switches, and officer-awareness of detector operation, the only people making money will be the State or Provincial traffic boards and the radar detector distributors.

R. BROWN, Cst.
St. Albert, Alberta, Canada

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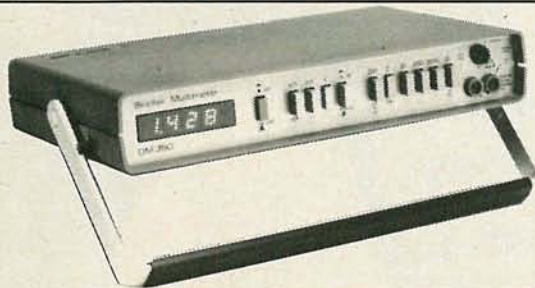
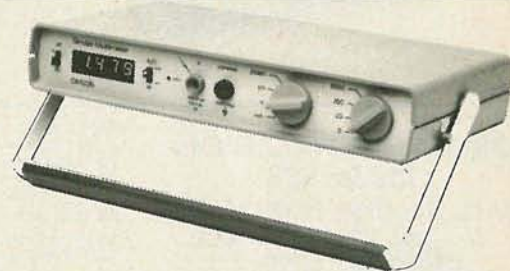
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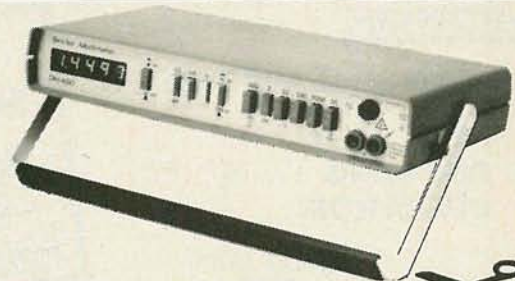
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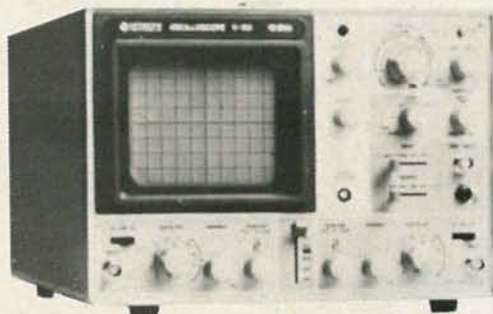
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ous pieces of equipment. If inflation has made your wallet look thinner and thinner lately, then you may wish to consider the least expensive unit that will meet your needs and offer you the best value for your dollar. That conclusion will quickly narrow the field down to but a few prospects.

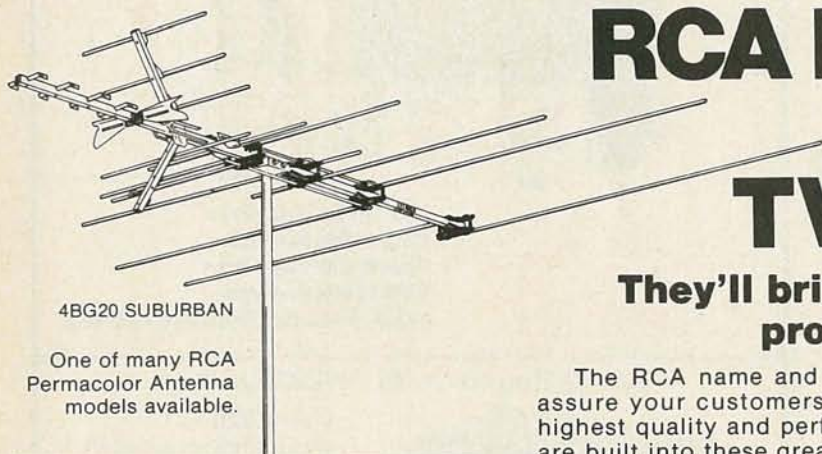
Among those prospects you will discover one unit that offers much of what the more expensive meters offer but at a fraction of the price. The C-Probe II, manufactured by International Instrumentation, Inc., Box 3751, Thousand Oaks, CA 91359, is able to meet those rigid requirements, while keeping the price low, by separating the display device from the actual meter. In fact, you make use of a standard digital frequency counter as the readout for the tester. The company is proud to explain that if you do not now own a frequency counter, the low cost of the C-Probe II will allow you to purchase good 7-digit (30 MHz) counter and the C-Probe II for less than the cost of many capacitance meters alone.

In use, the compact C-Probe II can be operated on its own self-contained rectangular 9-volt battery or from the power line by using a standard charger/eliminator unit that can be

plugged into the rear of the C-Probe's case. Other power sources may also be used and can vary between 6.5 and 16 volts. The circuit uses a 78L08 as an on-board voltage regulator to compensate for the wide range of supply voltages. The AC adaptor connects to the battery (electrically) through a small LED (Light Emitting Diode) mounted near the charger input jack. That LED glows when in the charging state. A bright glow indicates the battery condition as low. As the battery becomes more fully charged, the glow diminishes. Of course, the AC adaptor must be connected to the line and to the C-Probe II for the foregoing indications to be possible. An optional nickel-cadmium battery makes an ideal power source for this tester.

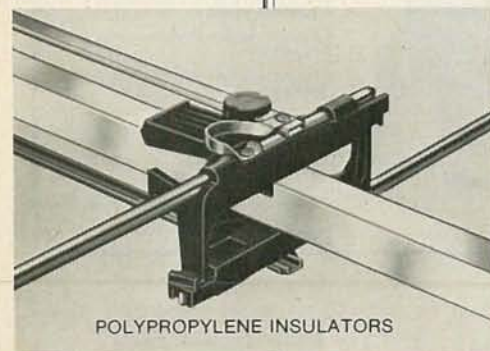
Since the accuracy of any piece of test gear is no better than the calibration of the unit, this little unit has a unique method of assuring the calibration accuracy. Inside the C-Probe II is a test point that is derived from the timebase crystal operating at 3.579545 MHz. If your frequency counter and the C-Probe II both agree, and you read 3.579545 MHz, then the accuracy of the measurements will be within

continued on page 20



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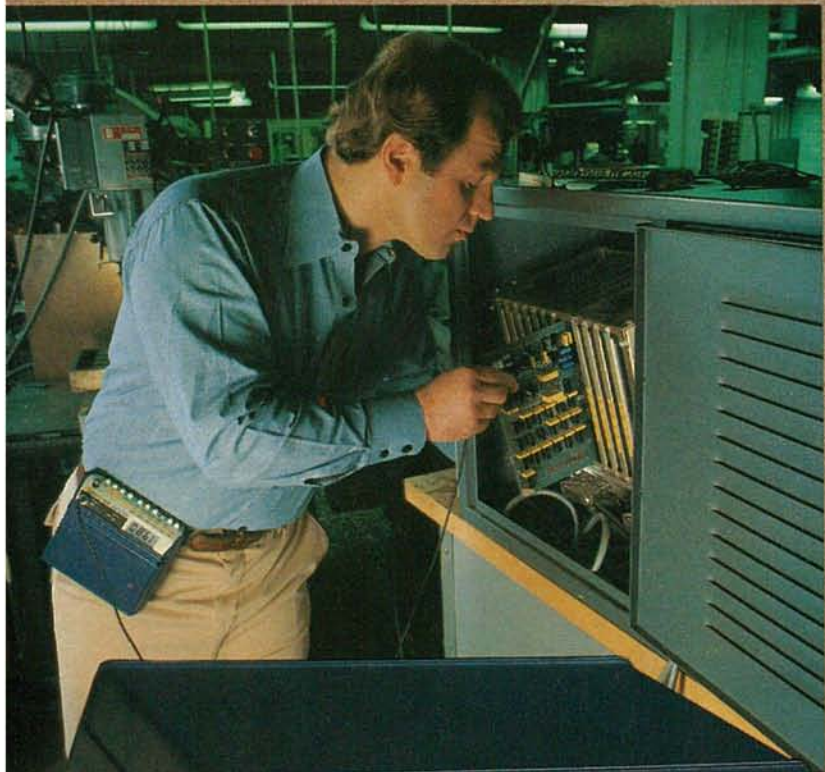
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We believe the MX333, with the VARI-PITCH™ and LOGI-TRAK™ functions, to be the greatest time saving tool in electronics today. It has all the functions, ranges and accuracy you expect from the best along with the two additional features which will save enormous amounts of troubleshooting time. And the MX333's 20Ω range gives you 10 milliohm resolution for those critical low resistance tests. Both MX series DMM's have 0.1% basic accuracy plus a 10A range, plus the intelligent case styling that has the size of a hand held, but the shape of a better idea. With either unit you get more performance per dollar than with competitive models. And the MX333 gives you more, much more, than you ever thought possible! *Effort cutting innovations that will save you hours by the second!*



EXCLUSIVE VARI-PITCH

Not just a beep... not just instant ohms. MX333's VARI-PITCH audible tone changes frequency proportionate to the reading so you can literally troubleshoot by ear! The higher the pitch, the higher the reading. No need to take your eyes off the probe or wait for a readout to settle. VARI-PITCH responds instantly, proportionally and accurately in all voltage, current, resistance and diode test ranges. It even provides analog-like audible response to variations for quick and easy adjustments and nulling.

FAST LOGI-TRAK (5 nsec fast)

Combines the features of a high performance logic probe and voltmeter in one convenient function. Use any standard 10:1 high frequency scope probe to find high and low logic levels and positive or negative pulses as narrow as 5 nsec without taking your eyes off the circuit! The VARI-PITCH output tells it all. *And*, unlike ordinary logic probes, LOGI-TRAK spots ground shorts, supply shorts, opens, marginal or ambiguous logic states and infrequent pulses instantly! Then, without changing anything but the direction of your glance, it's easy to verify actual voltage on the digital readout!

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MX333 and MX331 are the first digital multimeters designed from the ground up for LCD technology. The display's 45° angle is easy to read at any viewing point; from directly above to straight on. Powered by a single 9 volt battery, their compact size and unique shape make them ideal for all portable applications.

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EQUIPMENT REPORTS

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the tolerances specified by International Instrumentation, Inc. If you don't care to "mess up" the timebase in the counter, or you're sure it is accurate, then just adjust the trimmer capacitor in the *C-Probe II* to your counter. Even if your counter is out of calibration, so long as both are reading correctly with each other, it will operate just fine.

The front panel of the meter contains three pushbutton switches that provide selection of all functions. The left-most switch is the on/off switch, the center switch selects the μF or pF range, and the third switch offers a ten-times increase in resolution to the displayed value. In addition, a BNC-type output jack is located on the front panel.

The capacitor to be tested is inserted into a universal type of spring-loaded connector on the top of the case. That unusual connector will accommodate test leads and wires up to 12 gauge. The placement of the input jacks was chosen to keep the test capacitor as far removed from the front-panel switches as possible, to lessen the effects of the hands on the test sample. The lead connected to the capacitor to be tested is merely inserted into the hole provided when the lever on the connector is pressed. Releasing the lever clamps the lead securely in the input jack.

The *C-Probe II* is said to operate directly with counters made by B&K-Precision, CSC, Dana, Data Precision, Davis, Fluke, Heathkit, HP, Leader, NLS, Phillips, Polypak, Radio-Shack, Sabtronics, Sencore, Simpson, Tektronix, or any other counter having regular repeating gate times of .1, 1, or 10 seconds. We

didn't check all of the above, but we did operate the *C-Probe II* with a B&K-Precision and a homebrewed unit. Both operated as specified. To accommodate various gate times used by counters, the *C-Probe II* has an internal adjustment (jumper) that can be changed to match your particular counter. Not all counters on the market can be used with the *C-Probe II*. The Hickok series which count for .1 or 1 second and then perform housekeeping functions for 30 μs before repeating the count cycle is said to be one of the few standard frequency counters found that cannot be used with the *C-Probe II*. It would be advisable for you to check your counter's duty cycle before ordering the *C-Probe II*.

The *C-Probe II* emits a pulse train which contains a number of pulses per gate time that is directly related to the value of the capacitor being tested. Just as an example, using a counter that operates with a 1-second gate interval, the *C-Probe II* will emit 68 pulses per second when the test sample inserted in the input jacks is a .0682 μF capacitor and the pushbuttons are adjusted to the μF range and the $\times 1$ multiplier is selected. The counter will display .068—the value of the capacitor as a direct readout. Pressing the resolution button will now show the resolution in the $\times 10$ range by causing the *C-Probe II* to emit 682 pulses-per-gate interval with the resulting readout of .682. In that position it is necessary to shift the decimal one place to the left mentally, showing an actual reading of .0682 μF .

During the testing of our *C-Probe II*, we made use of a few calibration capacitors with the following results. A 56 pF unit measured 56 in the $\times 1$ resolution while it checked as

continued on page 22

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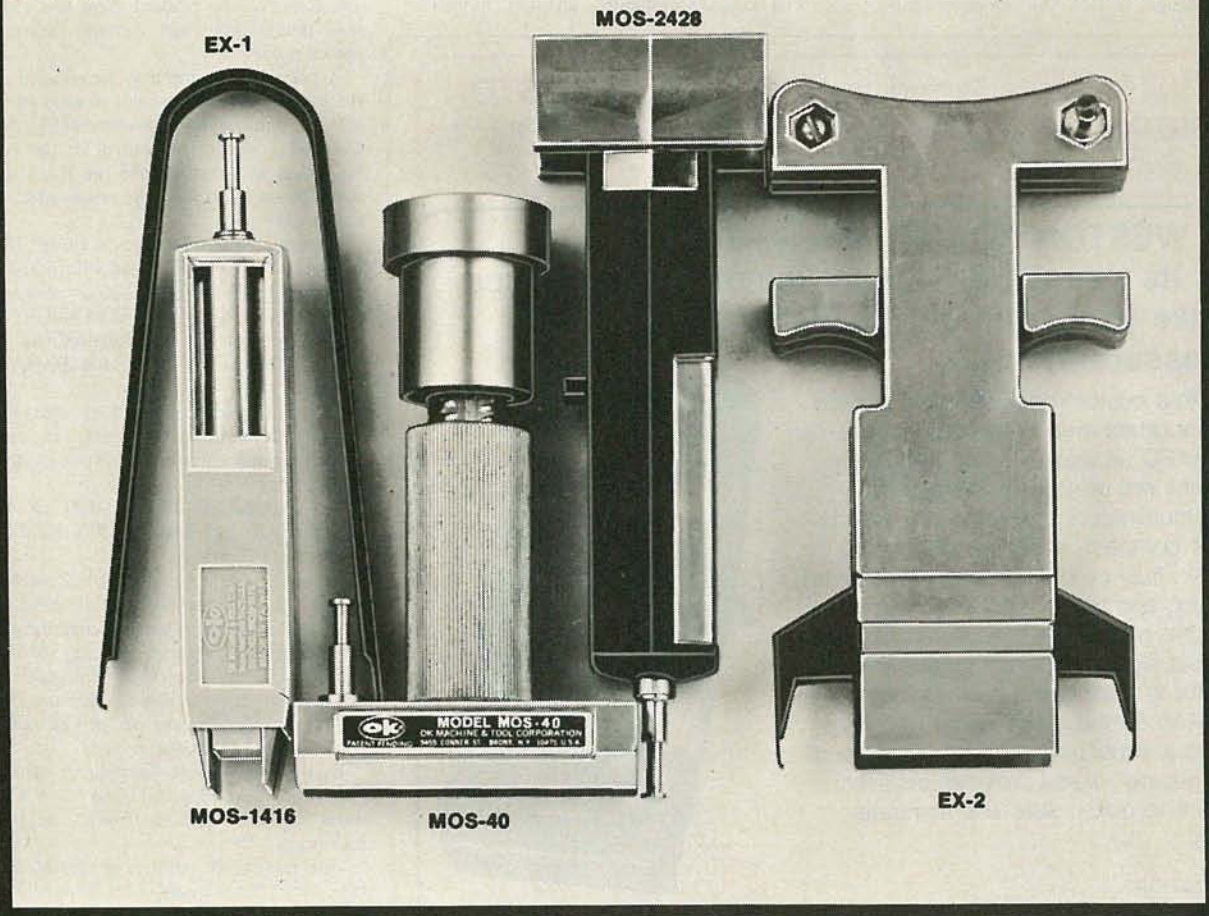


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EQUIPMENT REPORTS
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55.5pF when placed in the $\times 10$ mode. A 1.5 μ F, 20% unit measured 1.48 μ F in the direct mode and indicated a value of 1.4884 μ F in the $\times 10$ resolution range. A .33 μ F capacitor checked out to be .334 directly and at a resolution of $\times 10$, it indicated .3336 μ F.

After using this little unit, measuring only 2.5 \times 4 \times 5 inches, it can be said that it should provide the service technician and serious experimenter with all the resolution needed in the shop or lab. Total weight (including the battery) is just 6.5 ounces. According to International's manual, the accuracy is stated simply as .25% of the capacitor value in the pF range and .5% of the capacitance value in the μ F range. In fact, the company claims

that when one reads the fine print of some competitive testers, the *C-Probe II* really turns out to be more accurate. The *C-Probe II* has a suggested retail price of \$79.95. **R-E**

**Regency Model M-100
Programmable Scanner**

FEATURING A MUCH SMALLER FRONT-PANEL profile than its predecessors, the Regency Model M-100 programmable scanner offers flexibility and operational simplicity.

The M-100 memory includes ten channel capacity, indicated by a bright fluorescent display. Two brightness levels are switch-selectable, or the display may be switched off entirely with the radio still operating.

The display indicates channel numbers



CIRCLE 102 ON FREE INFORMATION CARD

while in scan mode as well as received frequency when a signal is being monitored. Other characters on the readout show loss of power, scan delay, individual channel lockout, and search mode.

A priority function may be selected so that the listener will be sure not to miss an important transmission. Conventionally enough, Channel 1 will seize control of the receiver regardless of mode should the frequency become active (assuming the priority function is activated).

Tuning-frequency ranges include: 30 to 50 MHz, 144 to 174 MHz, and 440 to 512 MHz. Sensitivity is specified as 0.25 μ V on low band, and 0.45 μ V on the high band and UHF. All sensitivity figures are measured for 12-dB SINAD (Signal + Noise And Distortion) at tuneup.

Scanning rate is a rapid 15 channels-per-second; audio output is 2 watts—entirely adequate for noisy environments such as in mobile applications.

The physical size of the M-100 is a compact 5 $\frac{1}{4}$ wide \times 2 $\frac{1}{8}$ high \times 9 $\frac{1}{4}$ inches deep. Weight is 3 $\frac{1}{2}$ pounds.

Although the top-mounted internal speaker is ideal for home use, some volume loss may be expected in certain mobile mounting situations; adequate reserve volume should well make up for any decrease in acoustic sound level. A mobile mounting bracket and DC cord are supplied for mobile use, as well as the AC cord for fixed installation.

Dual power cords (supplied) enable the receiver to be used with 110 to 130 VAC at 18 watts RMS, or 11.5 to 15 VDC at 10 watts maximum.

One innovative feature of the M-100 is a beep tone that signals every time the touch-entry key pad is pressed. This assures the user that his command has registered.

The keyboard is of the pressure-pad variety, so the beep is reassuring since there is no accompanying "snap" feel to the command when the key is depressed.

Our field test

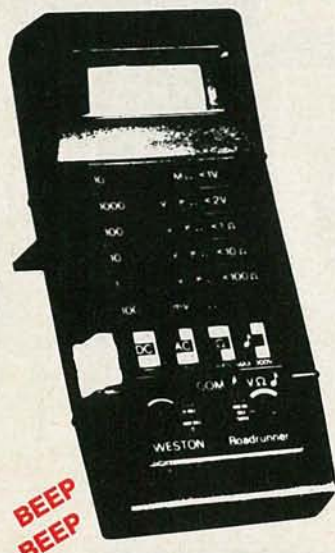
We selected a unit at random from a dealer's shelf to perform our evaluation of the M-100. We were impressed by the functional styling as well as cosmetic appearance of the receiver. The keyboard simplicity was a welcome relief after sampling other high-technology programmables. Needless to say, not everyone needs the sophistication offered in the more expensive scanners, and the M-100 helps to fill that void. Low-band sensitivity was as good as that found in the more expensive programmable to which it was compared. The high band was nearly as sensitive, and at UHF the performance was only slightly less than that of the comparison receiver.

continued on page 24

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200mV, 2V, 20V, 200V, 750V		.75%
DC CURRENT		
2mA, 20mA, 200mA, 2000mA		1%
AC CURRENT		
2mA, 20mA, 200mA, 2000mA		1.5%
RESISTANCE		
200 Ω , 2k Ω , 20k Ω , 200k Ω , 2000k Ω , 20M Ω		.5%

Weight: 1 lb. Dimensions: 7.5 in. x 3.4 in. x 1.9 in.
Power: Single 9V battery
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RCA VIDEO CASSETTE RECORDER SELF-STUDY SERVICE COURSE

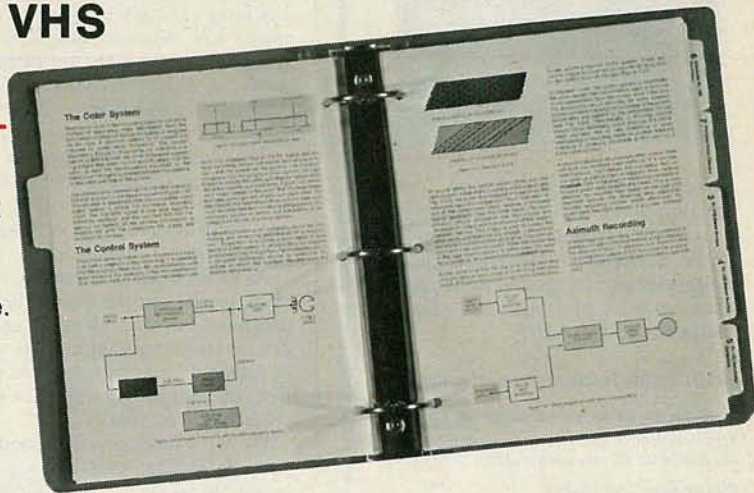
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To meet the need of television technicians who intend to enter the field of VCR service, RCA developed this basic and in-depth home-study course. It consists of six instructional units, an appendix and two video training tapes. Each instructional unit is comprised of a study guide, reference material, workbook and quiz. Program content includes the basic concepts of video recording, mechanical and electronic system analysis and servicing considerations in addition to complete information on mechanical and electrical adjustments. The two video tapes, with a combined viewing time of one hour and forty-two minutes, visually demonstrate mechanical adjustment procedures.

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EQUIPMENT REPORTS

continued from page 22

We would deduce sensitivity of the *M-100* to be perfectly adequate for metropolitan listening purposes.

Audio quality was excellent—the unit uses a voice-shaped passband for maximum intelligibility. Audio level was certainly adequate for nearly any imaginable application. Squelch threshold was tight, allowing response to the weakest recoverable signals.

Our unit had two malfunctions: occasional key bounce (double integer-entry from one key press) and incorrect low-band search range (wouldn't search what we programmed). We judged these malfunctions to be a fault in that particular microprocessor IC and not a problem with the basic receiver design.

The fluorescent display was adequate for bright room lighting; although the *M-100* was not tested in a mobile installation, we would not expect any problems in viewing the display except in direct sunlight.

As with earlier *Touch* products from Regency, a special routine allows the *M-100* to be programmed to search and scan outside of its normal frequency range. Some alignment will be required for great excursions away from the frequency ranges for which the scanner comes preset from the factory.

We were favorably impressed with the *M-100*. Its styling, ease of programming, and bright display are certainly important improvements over earlier models. The Regency *M-100* programmable scanner sells for \$299. It is manufactured by: Regency Electronics, Incorporated, 7707 Records Street, Indianapolis, IN 46226.

B&K-Precision Model 3020 Sweep/Function Generator



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THE B&K-PRECISION CO., A DIVISION OF DYNASCAN, 6460 W. Cortland St., Chicago, IL 60635, has introduced a small instrument that will do more different things than I've ever seen in only one little box. This is their *model 3020* Sweep/Function Generator. It's a function generator (sine, square and triangle waves); an audio to RF sweep generator (from sub-audio up to 2.0 MHz.); a pulse generator (anything from TTL to ramps, sawtooth, etc.) and a tone-burst generator (rapidly coming into favor for hi-fi audio tests and others). It will do so many things that it has a great number of uses in both analog and digital electronics. Anywhere from the research lab to the service shop.

It starts with a VCG (Voltage Controlled Generator) that produces precision waveforms over a range from 0.02 Hz to 2.0 MHz. All of these have continuously-variable DC offset so that signals can be fed to any circuit at the

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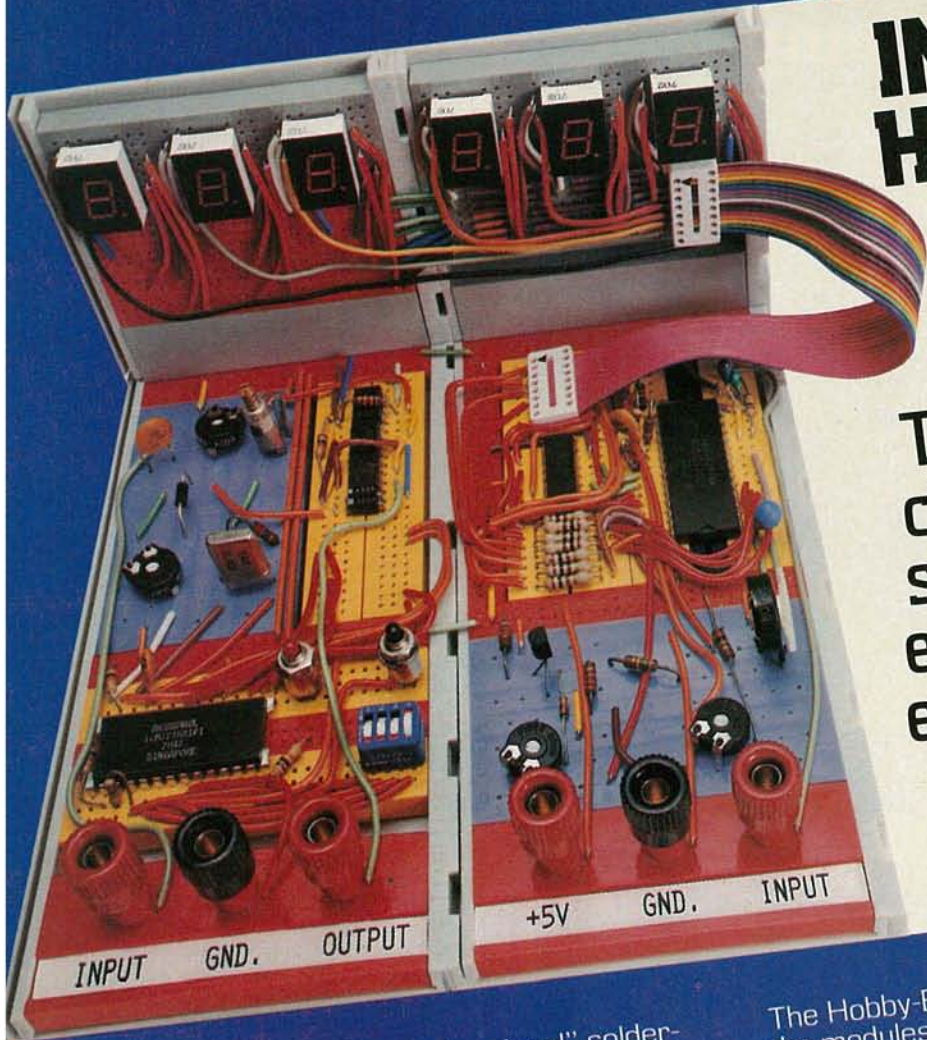
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At the core of the system are two expandable starter packs (priced under \$7.00), one for discrete component projects, the other for integrated circuit projects. Each comes with a number of Hobby-Blox modules that fit into a tray and an illustrated project booklet. In addition, the system includes 14 separate component packs you can purchase individually — terminal, distribution and bus strips, speaker panels, binding posts, etc. — priced from \$1.29 to \$3.59.

The Hobby-Blox system is easy to use because the modules are color-keyed and letter/number indexed. It's time-saving, because they're solderless. It's compatible with DIP's of all sizes and a wide variety of discrete components. And you save money, because the parts can be reused again and again.

How far can you go with the Hobby-Blox system? Take a look at the example above. Then you'll know why we say, "your only limit is your own imagination!"

For a free catalog and the name of your nearest Hobby-Blox dealer call toll-free (800) 321-9668.

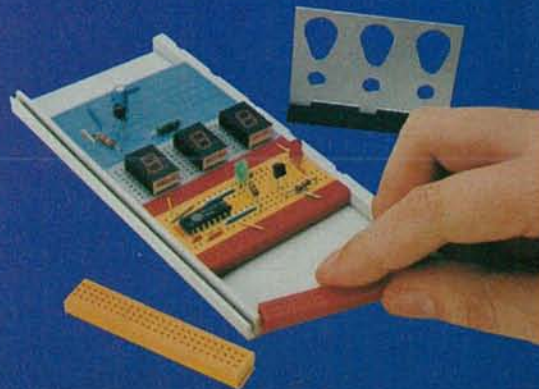
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EQUIPMENT REPORTS

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correct bias level, positive or negative. Since this is a voltage-controlled circuit, it can also be made to sweep any given band of frequencies by feeding a ramp, sawtooth or sine wave voltage into the GCV jack (Generator Control Voltage).

Sweep can be done with either the internal or external control voltage. Scope setup for display of frequency response is simple. The control voltage (internal) is brought out to the GCV OUT jack, and this can be used for the horizontal deflection of the scope. Linear or logarithmic sweep can be used, by pushing the switch button. Sweepwidth is variable up to a 1000:1 frequency ratio. One continuous sweep can cover the entire audio frequency band from 20 Hz to 20 kHz. The sweep is flat; better than 0.3 dB up to 2.0 MHz, with sine waves. Any of the three waveforms can be used in the sweep mode, but the sine wave is more or less of a standard.

Tone-bursts are also getting very popular for some tests, and necessary for others. In this mode, an external signal gates the output into alternate on-off periods. Any frequency or waveform can be used, and the on-off ratio can be adjusted. Special circuitry makes the bursts of signal start with an even half-cycle, either the negative or positive. This makes locking on a scope much easier, and also eliminates transients and odd harmonic components that might cause problems.

Using an external AC modulating signal, you can generate an AM signal at any modulation percentage. The modulation is set by a control on the panel. Only 1.5 volts of signal is needed to get full 100% modulation. The 3020 can produce a full double-sideband signal, with any amount of carrier-suppression. The carrier suppression is set by a front panel control. You can kill the carrier entirely and see only the sidebands.

A variable-symmetry control is provided. This control can make a triangle into a sawtooth or ramp, adjust a square wave to make positive or negative going pulses of any width, or make a "slewed sine wave" which is a really weird waveform! Frequency of pulses, ramps, etc. is controlled by the main tuning dial and the multipliers.

You can make tone-bursts by using an external gating signal. The oscillator frequency can also be controlled by a DC voltage. Feeding an AC voltage in here will give you frequency modulation. A ramp voltage here sweeps the frequency over any desired range. Maximum voltage needed for full-range sweep is 10 volts.

All outputs are 50 ohms. The amplitude of the output is controlled over a range of 0-10 volts peak-to-peak into 50 ohms. There is a variable attenuator with a range of 0 to -20 dB, and three step attenuators, -10 dB, -10 dB and -20 dB; this gives you a total of up to -60 dB of attenuation if needed.

Controls are simple, plainly marked and easy to use. There are ten control knobs on the front panel that will give you any of the outputs you need. The most-often used outputs are controlled from the front, with jacks for the generator control voltage output, control voltage input, a TTL output at a fixed amplitude (frequency set by main dial) the AM IN jack for external modulation, and the GATE IN jack for external control of tone bursts, on the rear panel. All of these are "phono" jacks; the

continued on page 28

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EQUIPMENT REPORTS

continued from page 26

main 50-ohm output on the front panel is a BNC. There are ten pushbutton switches on the front panel. These control the waveform selection, attenuation, and the other functions, like linear or log output, CW/AM, normal/inverted (for reversing polarity of pulses if needed), and the external-internal control switch. All ten of these controls are push-on, push-off types.

All of this comes in a small box only three inches high and less than a foot wide. All of the controls are "man-sized" and spaced so they're easy to get at. Frequency is controlled by a variable dial calibrated from 0.2 to 2.0, and a seven-step multiplier switch, from $\times 1$ to $\times 1000$. For uses needing a very precise frequency, a counter can be used. Normal frequency accuracy is given as $\pm 5\%$ of full-scale reading.

Let's look at just a few of the things you can do with this instrument, previously either very difficult or darn near impossible. We won't have space to cover them all. You can sweep-align the IF stages of any AM radio. You can sweep-align the AM broadcast band, including RF stages, etc. Discriminators on FM communications receivers with a 455-kHz 2nd IF can be aligned. Digital logic circuits of all kinds can be checked out.

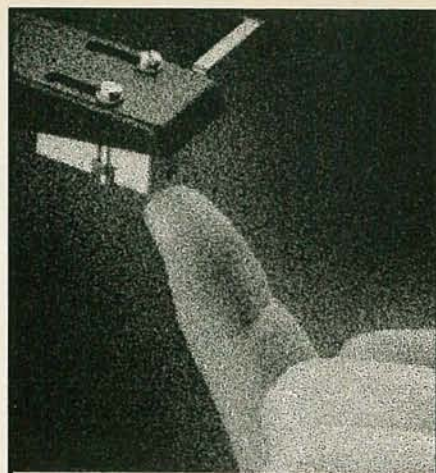
You can test tone-burst decoders at any frequency. In these, a given frequency must be received for specific lengths of time to make it work. (2250 Hz for 120 milliseconds, etc.). The frequency can be set accurately with a counter and the burst-length set up quickly on the scope.

Here's the one that impressed me. With the model 3020, you can check the modulation-limiter on any CB radio in a matter of seconds. Just feed in a tone burst at any frequency in the set's audio range. Display the input signal on the top trace of a dual-trace scope. Feed the limiter output to the lower trace. Set the duration of the burst so that it is slightly longer than the specified attack time of the circuit. (Attack time: time between the arrival of the signal and when the full compression is effective.) This is very easy to see on a calibrated scope. You can NOT do this with a continuous tone signal. Any frequency within the audio band can be used.

You can check everything in audio circuitry; amplifiers for frequency response, linearity, flatness, clipping, you name it. Speaker systems can be tested for frequency response, and the impedance of the speaker or network found quite easily. For clipping tests, there is nothing that can beat a triangle wave. Even the slightest tendency to clip will show up by the "blunting" of the sharp peaks.

I would also like to hand the writers of the instruction manual a large bouquet! It's 68 pages long, and covers a great many specialized tests in great detail. Every detail is shown, including illustrations of exactly how the equipment is hooked up, and what the output should look like. No room to list them all, but this is a very good handbook on the uses of such a versatile instrument. It's one of the best instrument-operating manuals that I've ever run across, and I've seen quite a few. This is quite a lot of instrument for a modest price, and one that should make servicing a lot easier; we can all use something like that: The B&K-Precision model 3020 has a suggested retail price of \$350. **R-E**

more reports on page 32



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ABOUT THE AUTHOR

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

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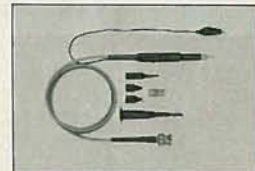
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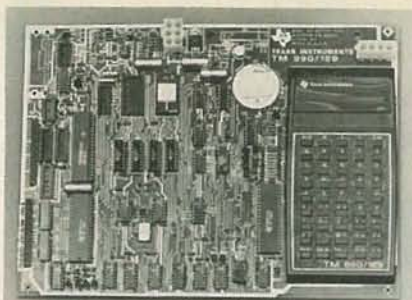


EQUIPMENT REPORTS

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THIS SINGLE-BOARD MICROCOMPUTER IS A COMPLETE system that includes ROM, RAM, input and output devices, and uses the TMS9980 microprocessor. It is one of the most sophisticated of "learning modules" because of an unusually comprehensive operating system that includes the *Unibug* monitor and a line-by-line assembler. A 45-key calculator-like terminal is the primary input/output device. A piezoelectric speaker and four LED's that are wired to the lower four bits of the user



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I/O port are additional on-board output indicators.

Besides the full complement of firmware and versatile alphanumeric terminal the

TM990/189 University Module is supported by over 800 pages of documentation. Two thick books are part of the package: one a user's guide and the other a microprocessor text intended to be used in combination with the computer for a university course. Very few instructional systems give you the same sense of confidence imparted by the University Module. Virtually every question can be answered by referring to the text, tables or schematics. Data sheets describe the EPROM, RAM, ROM, the TMS9901 programmable systems interface (PSI), the TMS9902 asynchronous communications controller and the TMS9980 microprocessor which are either part of the system or can be added as options.

Emphasis is placed on the memory-to-memory architecture that, when skillfully applied, gives fast computation and efficient memory-space use. There is no accumulator as such in this microprocessor family. When adding or performing arithmetic or logical functions, two words in memory can be operated on and the result stored in one of the memory locations, all under the control of a single instruction. The TMS9980 processor used on this board is a limited version of its big brother and is mounted in a smaller 28 pin package that can address only 16384 bytes of memory (compared to 65536 bytes for the TMS9900). Incidentally, when dealing with a 16-bit computer you must be careful to distinguish between words and bytes since bytes are 8 bits long but words 16 bits.

The on-board terminal includes keys for the full alphabet and punctuation marks, although several are difficult to identify because of the limitations of a 7-segment LED display. Although the board can be interfaced to an RS-232- or TTY-type terminal, the only advantage this approach offers is a permanent hard-copy record. The built-in terminal gives full system control in contrast to the partial control implemented by many single-board systems.

Output can be directed to the terminal's ten-digit LED display, an external terminal, the piezoelectric speaker, or the four single-element LED's. The companion text has a Morse code program that produces speaker output tones in response to pressing the alphabetic keys. Amazingly short, this program is an excellent example of the power of the 16-bit processor.

Programs can be stored on audio cassette tape using the on-board interface circuitry. Level detectors and amplifier stages are included to produce reliable recording on standard cassette recorders that have auxiliary input and earphone output jacks.

The *Unibug* monitor responds to 15 commands that let the user save and load programs, call the assembler, and read and modify memory, pointers, registers and the program counter. Programs can be executed up to a specified breakpoint.

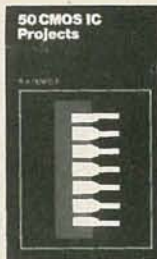
The ROM-based assembler converts assembly language mnemonics to machine code. Two-character symbols can be defined and backward references are satisfied as sufficient information is gathered. The assembler can be reentered at will without destroying the symbol table.

The standard 1K RAM user memory is expandable to 2K on-board, and up to 8K external memory can be added. Sockets are included for a TMS9902 and other parts to implement an EIA RS-232C or TTY serial interface port. The board includes space for a cassette recorder motor relay that is controlled

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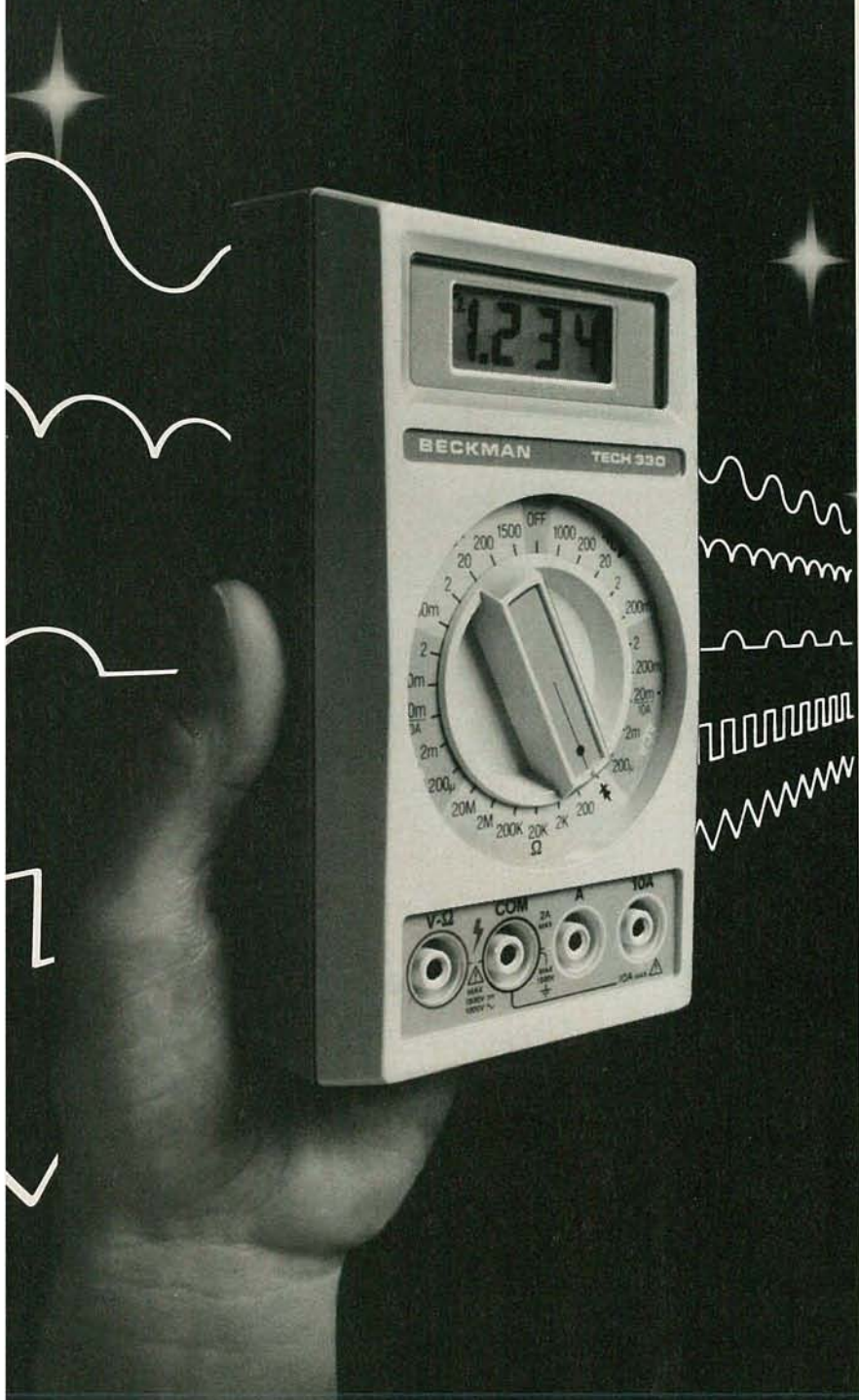
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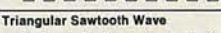
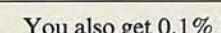
Now you can measure the exact power content of *any signal* — regardless of waveform. Beckman delivers the new TECH™ 330 multimeter with true RMS capability and many more fine performance features for just \$200.

Unlike the common average responding multimeters calibrated to measure only sine waves, the TECH 330 with true RMS capability gives you accurate readings of both sine and non-sine waveforms.

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 	0.707V	0.707V	0.707V
Full Wave Rectified Sine Wave 	0.298V	0.707V	0.707V
Half Wave Rectified Sine Wave 	0.382V	0.500V	0.500V
Square Wave 	1.110V	1.000V	1.000V
Triangular Sawtooth Wave 	0.545V	0.577V	0.577V

You also get 0.1% basic dcV accuracy, instant continuity checks, 10 amp current ranges, a separate diode test function, 22 megohm dcV 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 \$110.

To find out which of our 500 distributors is nearest you, call: (714) 993-8803 or write Beckman Instruments, Inc., Electro-Products Group, 2500 Harbor Boulevard, Fullerton, CA 92634.

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You've probably seen advertisements from other electronics schools. Maybe you think they're all the same. They're not!

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We don't promise you the moon. We do promise you a proven way to build valuable career skills. The CIE faculty and staff are dedicated to that. When you graduate, your diploma shows employers you know what you're about. Today, it's pretty hard to put a price on that.

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At CIE, we believe theory is important. And our famous Auto-Programmed® Lessons teach you the principles in logical steps.

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Our specialists offer you personal attention.

Sometimes, you may even have a question about a specific lesson. Fine. Write it down and mail it in. Our experts will answer you promptly in writing. You may even get the specialized knowledge of all the CIE specialists. And the answer you get becomes a part of your permanent reference file. You may find this even better than having a classroom teacher.

Pick the pace that's right for you.

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For some electronics jobs, you must have your FCC License. For others, employers often consider it a mark in your favor. Either way, it's government-certified proof of your specific knowledge and skills!

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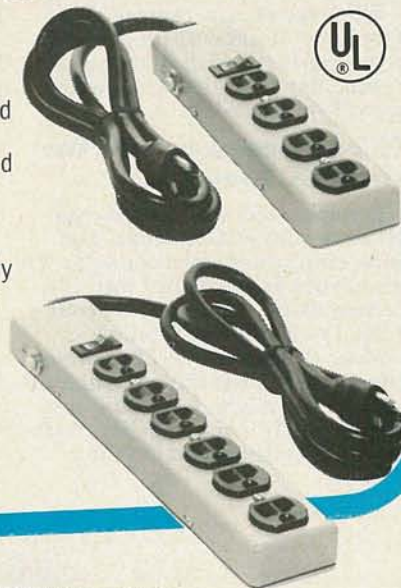
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EQUIPMENT REPORTS

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by the ROM operating system when loading and saving programs. Replacing the processor with a higher performance unit, and changing the crystal and some other components, increases the clock frequency from 2 to 8 MHz.

The *TM990/189* University Module is priced at \$299 and the optional power supply is \$65. The *TM990/189* is one of the better evaluation/learning modules available for those really serious about learning microprocessors from the ground up, starting at the machine and assembly language level. It can be expanded as a development board for those limited in capital, but more sophisticated systems are available for those interested in developing real applications for the 9900 processor series. Texas Instruments Incorporated, P.O. Box 1443, M/S 6404, Houston, Texas 77001. **R-E**

VIZ Model WR515B Color-Bar Signalyst



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THE MODEL WR515B COLOR-BAR GENERATOR from the VIZ Manufacturing Company (335 E. Price St., Philadelphia, PA 19144) is called the Color Bar Signalyst and is really a versatile instrument. It will provide all of the test signals you need for analyzing the signal circuits of any color TV receiver. This includes an RF output on Channel 3 or Channel 4, an IF output and a video output. In result, signal-injection can be used in any section of the set. A switchable 4.5 MHz sound IF carrier is also used, unmodulated.

The *model WR515B* can generate an amazing variety of test patterns. You can get the 10-bar gated-rainbow pattern in three different versions, each with its own special use. In the standard 10-bar pattern, the 6th bar (blue) is marked for instant identification. Next is the same 10-bar pattern, but with no burst. This lets you set up color sync circuits for zero without hooking up a lot of jumpers, or testing this without even taking the back off the set. Last is the bar pattern, with the Y, or luminance, signal added.

There are three solid-color rasters; red, green and blue. The red can be used for checking and adjusting purity on the older sets, and the green for the later models with in-line tubes. Still another raster, called a Color Trio, has fully-saturated sections of each primary color; good quick-check for picture tube suspected of having one weak gun.

For video circuit tests and similar adjustments, there is a black-and-white Gray Quad; the four quadrants of the screen are white, light gray, dark gray and black.

For convergence, there's a hatchdot pattern which consists of a crosshatch with dots around the outer edges and one in the center. For those who still have good eyesight, the old familiar dot pattern is here with the center dot

continued on page 40

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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Level "A" is a complete operating system, perfect for beginners, hobbyists, industrial controller use. \$129.95



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 on-board. • 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 F800, leaving 8000 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)... channeled 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 on-board 4K RAM expansion selectable in 4k blocks... address decoding for on-board 8k EPROM expansion selectable in 8k blocks... address and data bus drivers for on-board 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 F800 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 2k x 8 RAM IC's (allowing for up to 12k of on-board RAM).

DISK DRIVE SPECIFICATIONS

- 8" CONTROL DATA CORP. professional drive.
- LSI controller.
- Write protect.
- Single or double density.
- Data capacity: 401,016 bytes (SD), 802,032 bytes (DD), unformatted.
- Access time: 25ms (one track).

DISK CONTROLLER I/O BOARD SPECIFICATIONS

- Cont.ols up to four 8" drives.
- 1771A LSI (SD) floppy disk controller.
- Onboard data separator (IBM compatible).
- 2 Serial I/O ports
- Autoboot to disk system when system reset.
- 2716 PROM socket included for use in custom applications.
- Onboard crystal controlled.
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DISK DRIVE CABINET/POWER SUPPLY

- Deluxe steel cabinet with individual power supply for maximum reliability and stability.

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Beginner's Pak (Save \$26.00!) — Buy Level "A" (Terminal Version) with Monitor Source Listing and AP-1 5-amp Power Supply; (regular price \$199.95), now at SPECIAL PRICE: **\$169.95** plus post. & insur.

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EQUIPMENT REPORTS

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blanked for centering purposes. The last pattern is called the Superpulse. This is a black screen, with a large white rectangle centered in it. This checks video-circuit high and low frequency response, contrast and other things. On the scope, this shows a very sharp square wave pulse, useful for signal-tracing and locating troubles in these stages.

In normal operation, all patterns are non-interlaced; this gives a more stable picture, especially when the convergence patterns are in use. In some of the later receivers, interlaced scanning must be used. All of the WR515B patterns can be interlaced; just turn the pattern-selector switch to START PLACE and let go; it's spring-return. When the power is turned off, the instrument goes back to non-interlace scanning.

The RF, IF and video levels are all variable. RF from 5 microvolts up to 100 mV into a 75-ohm input, and 10 microvolts up to 200 mV into 300 ohms. The IF signal level can be had up to 100 mV. The video output goes from 0 to 1.7 volts peak-to-peak, and this can be set for either positive- or negative-going sync.

The RF/IF and video outputs may be used at the same time. One good use for the simultaneous output feature is to feed the video signal into the upper trace of a dual-trace scope and then feed the RF into the set antenna terminals. Monitoring the video detector output will show any problems in tuner/IF/AGC, etc. The demodulated signal should be exactly the same as the video on the top trace. Any of the patterns may be used for this purpose. For stable patterns, both horizontal- and vertical-sync trigger pulses are provided from jacks on the front panel. Some patterns are hard to lock on a conventional scope. The bar pattern, for example, makes a comb trace with 10 peaks of the same amplitude. Using the sync and the trigger signal from the WR515B, the waveform will be rock steady.

The instruction manual is detailed, well illustrated with raster patterns and scope waveforms. Sections of the manual give detailed instructions, waveforms, etc., for making many tests in color TV sets. This is a very compact and useful TV test instrument and one that will make many more tests that can come in very handy! The model WR515B has a suggested retail price of \$275. **R-E**

IGM Model BAX-1 Broadband Amplifier

FOR YEARS, ICM (FORMERLY KNOWN AS THE International Crystal Manufacturing Company) provided simple kits for amateurs and experimenters. Most of those were crystal oscillator kits.

More recently, ICM has been producing accessory RF circuitry such as mixers and amplifiers. The model BAX-1 broadband RF amplifier is one, so we decided to look at it.

Basically, the model BAX-1 is an untuned direct-coupled wideband amplifier, designed to increase all signal levels from audio to VHF. Its rated specifications are as follows: 20 Hz-150 MHz. Maximum gain occurs near 1 MHz (30 dB) and the gain drops off gradually into the VHF region so that at 150 MHz it is 6 dB. Working impedance is from 50 to 500 ohms. Maximum input level, 0.01 volt AC. At

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For over a year now, in magazines and newspapers the world over, there have been enthusiastic write-ups on a remarkable new device that can cut your electric bill while helping the U.S. save huge quantities of fuel.

"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*

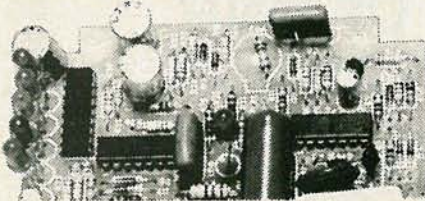
about \$60 for an air conditioner used during summer months. That's what you're paying to run just **one** of these appliances per year.

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.

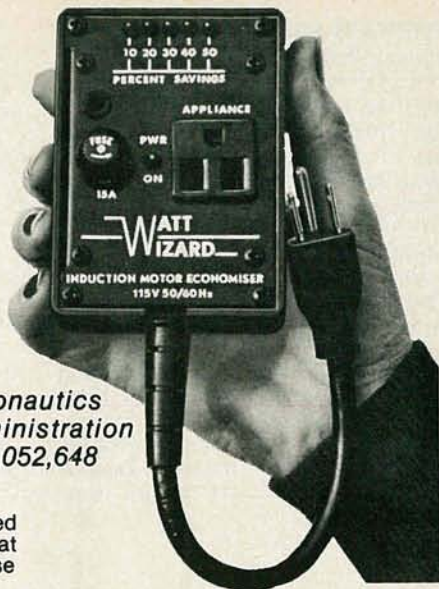
SIMPLE TO USE

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, MasterCharge, 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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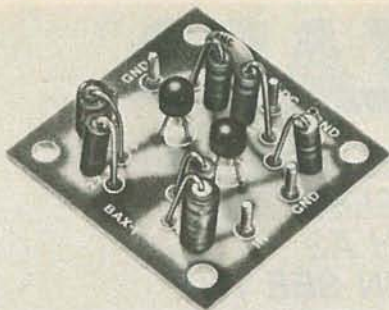
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EQUIPMENT REPORTS
continued from page 40

1 MHz, the maximum output level is 0.1 volt across 50 ohms (or 0.5 volts across 500 ohms).

The noise level is less than 10 microvolts at RF levels and it is under 0.5 millivolts at audio levels. All that is accomplished with a DC operating power of 9 to 15 volts at only 10 milliamps.

The specifications looked good, so we assembled the kit. That was a snap since the kit contains only two transistors, three capacitors and five resistors. Total assembly time, about 15 minutes. The tiny 1/2-inch square PC board is well marked with silk-screened parts identifications. Assembly instructions are adequate and clearly stated. Accompanying diagrams



CIRCLE 106 ON FREE INFORMATION CARD assist in both accurate assembly and practical applications.

Although there was a slight discrepancy between the callout value for the two electrolytic capacitors and their actual value, substitu-

tion is obvious and should cause no confusion. Make certain to keep the leads short to insure the upper-frequency response of the amplifier.

A package of hardware is included for mounting the completed board.

The completed *model BAX-1* amplifier board was connected to a 9-volt battery, and current was measured as the specified 10 mA. Shortwave amplification was checked by connecting the board to a CB receiver. Signals were brought up from barely readable to extremely strong; we were impressed.

Next, we tested VHF applications. The *model BAX-1* also helped improve FM broadcast signals. A mobile radiotelephone signal monitored near 152 MHz was raised from noisy audibility to nearly full quieting. The signal strength of NOAA weather broadcasts at 162.55 MHz was also increased, but not as much. It was clear that the amplifier gain was deteriorating rapidly in the mid-VHF board. Out of curiosity, we attempted to monitor a signal at 500 MHz with and without the *Model BAX-1* in line. At the 500-MHz frequency the amplifier became an attenuator—signals were way down! That was to be expected, and it became clear that the unit responded faithfully to its specified parameters.

It must be kept in mind that this is *not* a low-noise amplifier. A wideband amplifier will substantially boost the noise floor of the system right along with the signals. It is therefore recommended that the frequency limits of any amplifier, including the *model BAX-1*, be narrowed with some type of tuning. Only when extreme frequency agility will be necessary should the upper and lower limits be left wide open. We also recommend that the *model BAX-1* be enclosed in some sort of shielding to reduce the amplification of any stray signal pickup.

It became evident after only a few simple tests that the imagination of an inveterate tinkerer could run wild with this device. Here are some possible applications:

1. **VLF antenna preamplifier**, connected at the antenna to overcome the capacitive losses associated with coaxial feed of a short antenna at low frequencies.
2. **A signal generator booster**. The high gain could provide a considerable increase in output for marginal applications.
3. **A shortwave preamplifier**. Such a unit could provide the equivalent of up to five-S-units improvement on received signals. But you must remember that if it is untuned, the result could be a signal overload of the receiver's front end.
4. **A loop antenna preamplifier**. Used in conjunction with a broadband direction-finding loop, the *model BAX-1* can provide stronger signals to the receiver for monitoring purposes.
5. **An instrumentation amplifier**. Some signals are too small to provide meaningful inputs to oscilloscopes and other test instruments; the *model BAX-1* amplifier should help.
6. **An active bandpass filter**. A variety of bandpass shaping techniques at audio and RF signal levels would be possible with feedback loops and tuned circuits connected to the *model BAX-1*.

Best of all, the cost of the *model BAX-1* amplifier is extraordinarily low (\$6.67). It would be hard to duplicate separate parts and PCB board for the same price. It is manufactured by ICM, P. O. Box 32497, Oklahoma City, OK 73132. **R-E**



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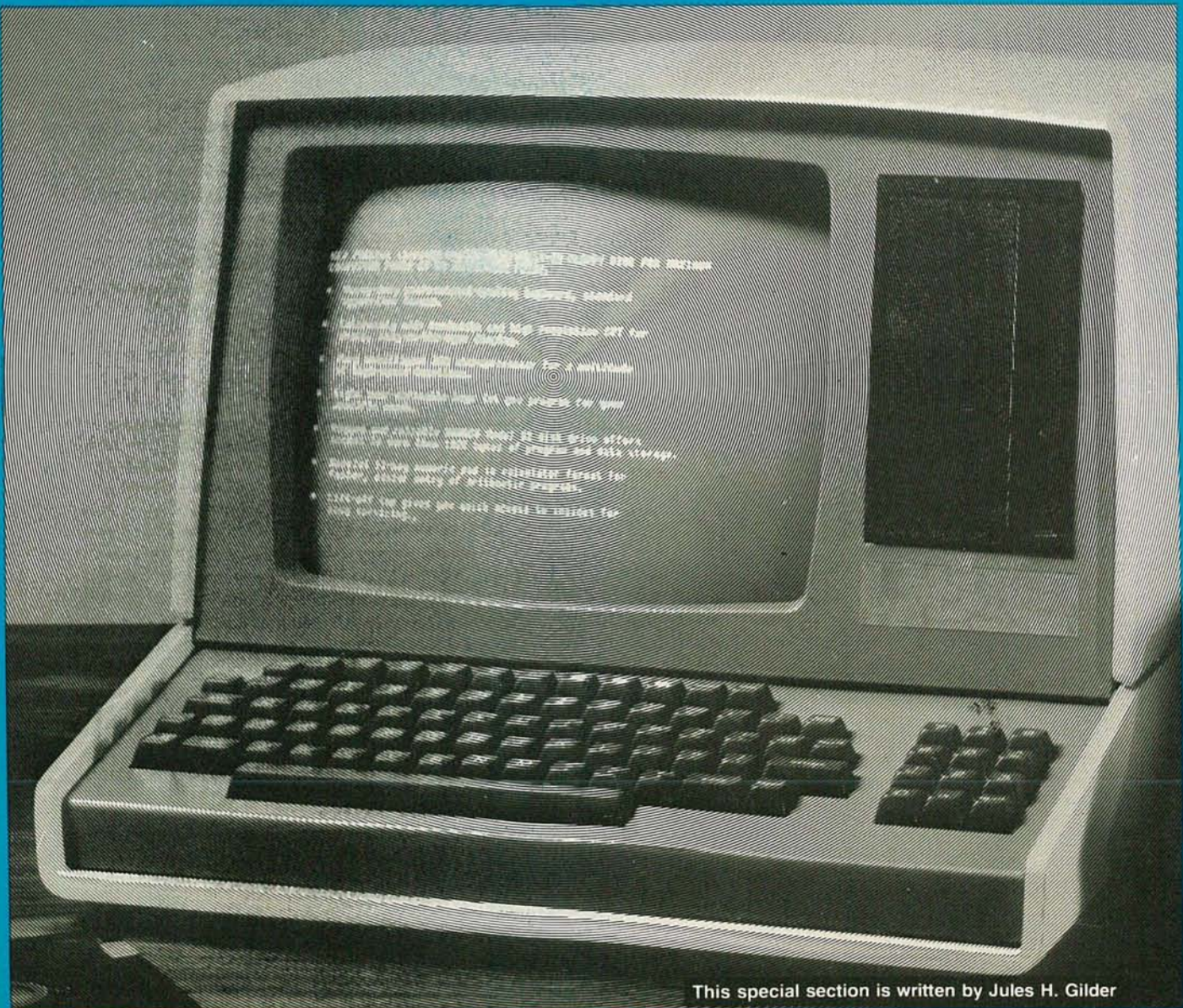
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Radio Shack's TRS-80



Radio Shack's TRS-80 is not perfect but a quarter-of-a-million owners find this computer to be the right piece of equipment at the right price. Some of the TRS-80's strengths and weaknesses are discussed here.

SHORTLY AFTER THE PET COMPUTER APPEARED ON THE SCENE, in the early days of personal microcomputing, The Radio Shack division of the Tandy Corporation announced their entry, the TRS-80 for \$595. The price was right; it was competitive with the PET, then the only other take-it-out-of-the-box, plug-it-into-the-wall computer.

Radio Shack put on a strong promotional campaign and succeeded in selling its TRS-80 with Level I BASIC. But Radio Shack had a few things going for it. First, it had a tremendous distribution network which Commodore Business Machines, makers of the PET, couldn't come close to matching. Second, people knew who Radio Shack was, while Commodore was more of an unknown quantity. Third, Commodore was so impressed with its own achievements, that it demanded that anyone who wanted one of their computers pay in advance—and delivery time stretched to three or four months (and in many cases even more). Fourth, and worst, Commodore's attitude towards its customers was bad and support was bad.

Well, with all of these things going for it, the TRS-80 couldn't help but be a success. The tremendous demand really caught Radio Shack by surprise. Initial estimates were for selling a few thousand computers. Sales to date, three years later, are estimated to be over 250,000. Of course, along the way, Radio Shack learned that its Level I BASIC just wouldn't make it and it came out with Level II BASIC, from Microsoft; but the price of the machine also went up. Today, the 4K Level I machine is virtually a thing

of the past and has been replaced in popularity by the 16K Level II unit. Also, Radio Shack has come out with a more business-oriented computer known as the Model II. Shown above are the three latest additions to the Radio Shack line of computers. At the top left is the TRS-80 Color Computer. It provides color graphics and features instant-load Program Pak software. At the top right is the TRS-80 Model III. It's priced from \$699 for the 4K version expandable to 32K plus disk storage for \$2495. Also shown is the TRS-80 Pocket Computer. It weighs a mere 6 ounces and is less than 7-inches long. You'll be hearing more about these units soon.

System is modular

The basic TRS-80 Model I (as the original TRS-80 is now called) computer is a modular unit that consists of four individual pieces; a 12-inch black-and-white video monitor, a 53-key keyboard/CPU unit that contains Microsoft BASIC in ROM and 4K to 16K of RAM, a power supply for the keyboard console, and a cassette tape recorder.

With all those different units, you need three electrical outlets to set up your computer system. The problem becomes still more acute if you add on an expansion interface and two disk drives: that will require another three outlets for a total of six. It quickly becomes apparent that one of the drawbacks of the TRS-80 design is its rat's nest of wiring. And all of these stray wires can only spell trouble for the high-speed digital circuits found in computers. Worst yet, none of the AC power cords are of the three-wire grounded

TABLE I—BASIC COMMANDS for Model I and Model II TRS-80's

ABS	ASC	ATN	CDBL	CHR\$	CINT	CLEAR
CLOCK	CLOSE	CLS	COS	CSNG	CUD	CUI
CUS	DATA	DATE\$	DEFINT	DEFN(X)	DEFSNG	DEFSTR
DELETE	DIM	DIR	EDIT	END	EOF	ERL
ERR	ERROR	FIELD	FOR	FRE	FRE\$	GET
GOSUB	IF-THEN-ELSE	INKEY\$	INPUT	INSTR	INT	KILL
LEN	LET	LEFT\$	LIST	LIST	LLIST	LOAD
LOAD	LOC	LOF	LOG	LPOS	LSET	MERGE
MID\$	MKD\$	MK\$	MKS\$	NEW	NEXT	ON ERROR
ON..GOSUB	ON..GOTO	OPEN	POS	PRINT	PRINT@	PUT
READ	REM	RENAME	RESET	RESTORE	RESUME	RETURN
RIGHT\$	RND	RSET	RUN	SAVE	SGN	SIN
STOP	STR\$	STRING\$	SQR	SYSTEM	TAB	TIME\$
TROFF	TRON	USR(N)	VAL			



THE ORIGINAL TRS-80 with Level I BASIC and 4K of memory.

type, although the video monitor power plug is polarized to prevent inserting it the wrong way.

Once you successfully save a program on a cassette tape, you face several problems. The first is verifying it, or checking to see that it was properly recorded. To help you in that process, *TRS-80* BASIC has a command called **LOAD** which will compare what has been recorded on a tape to what is actually in memory. Most of the time it works nicely, but recently I have found that it doesn't *always* work. I have loaded tapes into memory and then tried to verify the recently loaded program, with the one that is on the tape. The result was always **BAD**, even though a byte-by-byte check showed that both programs were the same.

Once you do get your program recorded onto tape, you're going to want to load it back in one day. With most computers, if a tape is not being read in correctly, an error message is generated right away. That is not always the case with the *TRS-80*. More often than not, you'll sit and load a long program for three minutes, with everything appearing to go along smoothly. But then when you run the program an error message is generated. Listing the program at that point shows that you have loaded in three minutes worth of garbage, because your volume setting was not exactly set right.

Having gotten those problems straightened out, a new one surfaced, this a lot more serious because it could occur randomly and wipe out my data. It occurs only in disk systems and manifests itself by the disk suddenly rebooting itself, wiping out any program that was in memory at the time. I have been told that it is caused by power-line spikes

and surges and that I should get a constant-voltage transformer to clean that up.

Adding a floppy-disk system to your *TRS-80* provides you with an additional 50K of storage on your first disk and 86K of storage on diskettes in additional disk drives. Assuming that everything in your disk-based system is working fine, you can still encounter difficulty and ruin a good diskette in a snap. All you have to do is to try to turn the system power on or off while your diskette is in its drive, or try booting up your disk while a parallel printer is connected to your system, but not turned on. Any one of those actions could promptly wipe out your diskette. (*Some other computers will also "crash" disks if the system is turned on or off while they are in the drive. It's a good idea to remove disks from their drives during these operations, unless your manual specifically states otherwise—Editor.*)

Expanding a basic 16K-system to more memory or disk-drive capability is expensive. In either case, you must purchase an expansion interface, which costs \$300. Additional memory is sold by Radio Shack at \$149 per 16K, which is 33% to 50% more than you can get it for by yourself. The reason that the expansion interface is so expensive is that it comes with a disk controller capable of handling up to four disk drives. And you get it whether you want it or not. It also comes with a built-in parallel printer interface and a real-time clock which can be helpful in programs where it is necessary to keep track of time.

Need help?

While Radio Shack probably has a larger distribution network than any other personal computer manufacturer, you can't go into any one of them for technical help. If you need help, try and get to a Computer Center store. I have found that, in general, they have people who are quite knowledgeable and helpful.

They keep making changes

One annoying feature about Radio Shack, is that they keep making changes to the hardware without telling anyone, making independently-purchased hardware and software incompatible with the new versions. For example, early versions of the *TRS-80* CPU brought out the 5-volt supply to the external connector. Later models eliminated that. Thus anyone designing an accessory that was to use that supply now had to provide his own power supply. A more recent change was in the ROM's supplied with the system. That can play havoc with the existing software on the market, because now some of the internal subroutines are not located where they were. In fact, some people have told me that the new ROM's have even resulted in problems



A NUMBER of printers are available to run with the TRS-80.

TABLE II

ERASE—Cancels a dimensioned array and frees its memory space.

HEXS—Converts a decimal number to a hexadecimal string.

NULL—Sends blanks at the end of a line (communications).

OCTS—Converts a decimal number to an octal string.

RENUM—Renumbers program lines.

RESET—Restores default system settings for all devices.

SPACES—Prints a specified number of blank spaces.

SPC—Prints spaces on video display.

SWAP—Exchanges the values of two named variables.

WIDTH—Sets line width for video display.

ADDITIONAL OPERATORS: MOD, IMP, EQV, XOR (Integer Division).



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For business applications, consider the Model II

In May 1979, Radio Shack decided to make a concentrated effort to capture a large part of the business-computer market and introduced the vehicle it was going to use to do that—the *TRS-80 Model II*. In its most basic configuration, the *Model II* comes with 32K of RAM and a single, built-in, 8-inch floppy-disk drive. The cost of that system is \$3450. The processor used is a Z80A, which is a 4-MHz version of the processor used in the *Model I*. It is possible to add on an additional 32K of RAM for another \$449.

While the basic computer comes with only one disk drive with 500K of on-line storage, that can be expanded to two megabytes of on-line storage by adding three more disk drives at a cost of \$2350.

Radio Shack calls the BASIC it provides with the *Model II* Level III BASIC; that can be confusing, because Microsoft sells what it calls Level III BASIC for the *Model I*, and the two are not the same. Radio Shack's Level III BASIC is almost identical to the Level II BASIC—there are some exceptions. The BASIC in the *Model II* has 23 more commands than the BASIC in the *Model I* machine. A list of the commands in both BASIC's is shown in Table I, while those added to Level III BASIC are shown in Table II. What is not shown on those tables is a serious omission in Level III BASIC, in which the PEEK and POKE and INP and OUT commands from Level II BASIC are no longer available. Radio Shack claims that those commands are no longer needed, but already several companies are advertising short little machine-language programs for sale that restore the PEEK and POKE commands to Level III BASIC.

There are some differences in the DOS (Disk-Operating System) on the *Model II* as well. The principal one is that the DOS responds with positive feedback. If, for example, you tell the computer to "KILL 'file name'", the computer will respond with "'file name' KILLED" or "'file name' NOT FOUND", so you always know what is happening. In addition, when duplicating a diskette, it is necessary to know the master password.

There is a huge variety of equipment and accessories for the *TRS-80*. So before you go any further you really want to get a copy of the Radio Shack Computer Catalog. **R-E**



with some Radio Shack-supplied software, which will no longer run in the new machines. And nowhere is the change documented, except for a short note in the *new* user's manual that states there will be two fewer bytes of free memory and the sign-on message will be different for the new ROM's.

Radio Shack has made some welcome changes too. The first, and most needed, was the switch to a new type of keyboard that doesn't bounce (produce extra letters every time a key is pressed). Another change involving the keyboard, was the addition of a numerical keypad. That is particularly useful if a lot of numbers are going to be entered. It comes free on new computers. You can add it to older units, that didn't come with it, for \$99.

Another hardware modification now available is a lower-case adapter. That board, which plugs into the keyboard unit, costs \$99 and allows you to display lower-case letters on the video monitor.

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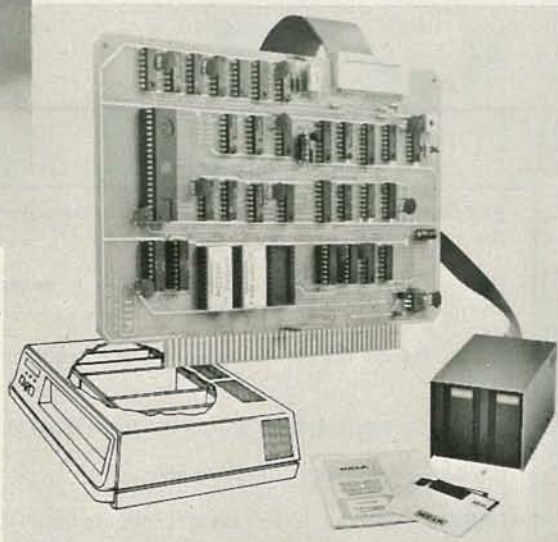


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Low Cost
Mini-Disk Storage
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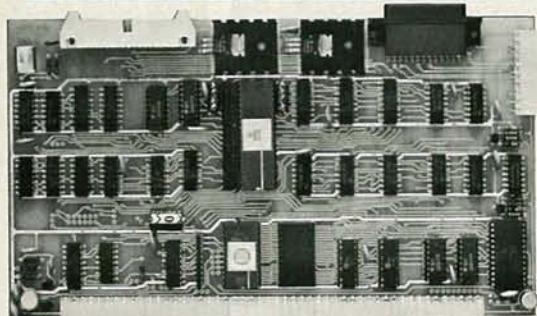
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Versatile Mother Board, Full-Feature Prototyping Boards

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The SBC/9™. A "10" By Any Measure.

The Percom SBC/9™ is an SS-50 bus compatible, stand-alone Single-Board Computer. Configured for the 6809 microprocessor, the SBC/9™ also accommodates a 6802 without any modification. You can have state-of-the-art capability of the '09. Or put to work the enormous selection of 6800-coded programs that run on the '02.

The SBC/9™ includes PSYMON™, an easily extended 1-Kbyte ROM OS. Other features include:

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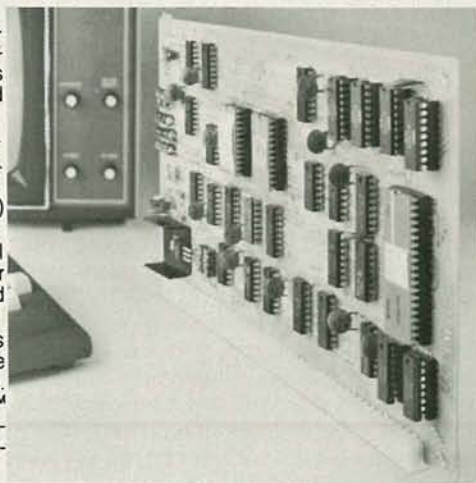
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Memory residency and outstanding software control of display format and characters make this SS-50 bus VDC card an exceptional value at only \$249.95. Other features:

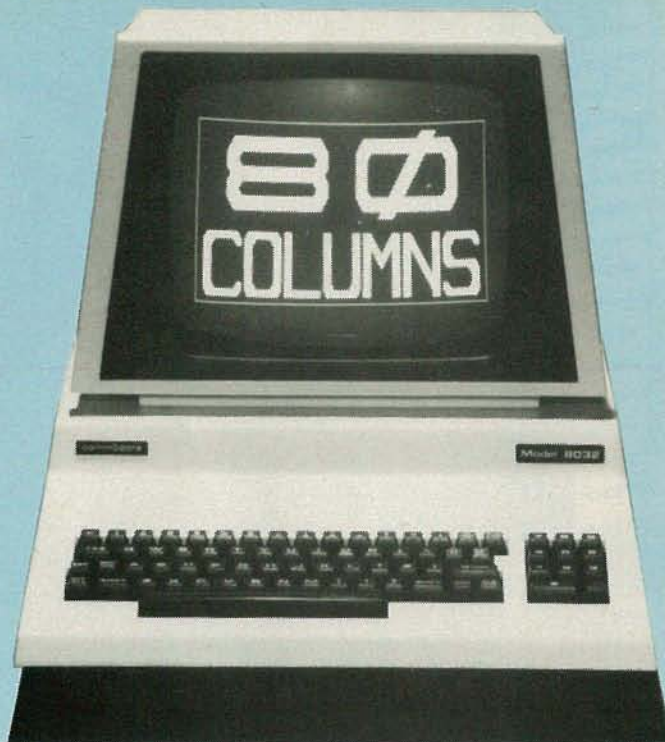
- Generates 128 characters including all ASCII displayable characters plus selected Greek letters and other special symbols.
- Well-formed, easy-to-read 7x12-dot characters. True baseline descenders.
- Character-store (display) memory included on card.
- Provision for optional character generator EPROM for user defined symbols.
- Comprehensive users manual includes source listing of Driver software. Driver — called WINDEX™ — is also available on mini-diskette through the Percom Users Group.



Products are available at Percom dealers nationwide. Call toll-free, 1-800-527-1592, for the address of your nearest dealer, or to order direct.

PET Personal Electronic Transactor

Commodore's PET was the first all-in-one personal computer. Since its introduction it has undergone many changes. The toy has evolved into a business machine.



IF THERE IS ONE COMPANY THAT IS RESPONSIBLE FOR THE personal computer revolution and the development of plug-in-out-of-the-box computers, it is Commodore Business Machines. And if there is one person that is responsible for it, his name is Chuck Peddle: It was he who had the foresight to realize that what the world needed was a ready-to-use home computer that didn't have to be assembled. And the first company to announce such a computer was Commodore.

When the first news articles on the *PET* computer appeared in the technical press five years ago, it seemed too good to be true. They described a full-blown computer with a CRT display and an ASCII keyboard for only \$600. Oh, sure—there were a lot of computer kits available at that time for about the same price; but none of them had the same capability.

The kits gave you a CPU, power supply, and a box to house it in. One or two manufacturers even offered some memory. But you, the purchaser, still had to toil long hours to build and debug the unit—and after that you still couldn't use it, because it required a host of peripheral interfaces and, of course, an I/O device, such as a teletypewriter.

Then came the announcement from Commodore that they were going to supply the entire thing, assembled and ready to run BASIC at the flick of a switch. And all that would cost less than most of the basic kits. Along the way, the \$600 *PET* fell by the wayside, as did most of the Do-It-Yourself computer kits. The 4K *PET* gave way to the 8K *PET*, and the cost went up to \$800, but it was still a bargain. Seeing the interest that was generated by that ready-to-use computer, it didn't take long for other manufacturers to jump on the bandwagon.

But look at that keyboard!

One of the most controversial aspects of the *PET* that was first announced was its keyboard. It consisted of 73 keys that were arranged in an ASCII block of 53 keys and a 20-key numeric and control key block. Unlike the keyboards on its subsequent competitors, those on the *PET*

were made with calculator-type pushbuttons. The keys were not arranged in the standard staggered configuration found on typewriters and they were also considerably smaller than typewriter keys. All of that led to complaints about the keyboard and how it wasn't possible to touch-type with it. While most of those complaints were probably justified, as evidenced by the fact that eventually Commodore came out with a *PET* that had a standard-sized keyboard, at the time the issue was really insignificant. Here was a company that was offering a complete computer system for only \$800, a price that only two years before would have been scoffed at. The complaint, however, was a good way for Commodore's competitors to make points, and so the controversy raged.

Another advance from Commodore, that was related to the keyboard, was that the *PET* was the only computer to offer the full upper and lower case ASCII character set, 64 graphics character and 11 special function keys. Among those "special function" keys was a key to enter the value of the math constant (π); keys to control the cursor (up, down, left, and right); a key to clear the screen and home the cursor; a key to insert and delete data; a reverse field key, and even a key to cause a program to be loaded automatically and run, or to stop program execution. In addition, a slow-list capability was provided by holding down the RVS key while a program was listed.

Getting physical

For those of you who never saw the original *PET*, discontinued last year, here is a quick description of it. It is a one-piece factory-assembled computer that weighs 44 pounds and measures 14 inches high by 16.5 inches across, and is 18.5 inches deep. It has a built-in 9-inch CRT display and a built-in semiautomatic tape-storage system. I call it semiautomatic because the user must place it in the RECORD or PLAY mode, and it does not automatically FAST FORWARD or REVERSE. However, the integral file-handling system that is built into the *PET* does tell the user which mode to place the recorder in (and when) and it does start and stop the



HIGH-QUALITY WORD PROCESSING can be achieved using a printer such as the NEC Spinwriter.

tape automatically under computer control.

Last year, Commodore succumbed to the pressure it was receiving from users and came out with a new version of the *PET* that had a full-sized keyboard. It is housed in the same case as the original *PET*, so its dimensions are the same, but because the keyboard is much larger, the tape recorder had to be made an external accessory, and to get it you had to pay an extra \$95. The new keyboard has added some features that were sorely lacking in the early *PET* computers. To begin with, it contains a SHIFT LOCK key. But why should the lack of a SHIFT LOCK key be considered such a big disadvantage for the *PET*? After all, many other computer keyboards don't give you this function either. That's true, but most other computers also do not provide the wide selection of characters that are available on the *PET*. And the lack of a SHIFT LOCK was very annoying whenever a lot of graphics or lower-case letters were being entered.

When the new keyboard was added, the motherboard inside the computer was redesigned so that up to 32K of dynamic memory could be used. In the original *PET*'s, expansion had to be done externally. Also, static memory was used; it's easier to design with, because no refresh circuitry has to be included, but it generates a lot of heat. In addition, MOS Technology, a subsidiary of Commodore, was the only company that made the memory IC's, and as a result, replacements were very expensive.

With the addition of the new keyboard, Commodore decided that it would increase the basic machine from an 8K machine to a 16K machine, since most people wanted more memory anyway. The base price of the new *PET* was also raised, by \$200, and it now costs \$995 (plus the cassette recorder). The price for a 32K machine, which is identical in every way to the 16K machine except for the extra memory, is \$1295. That means you're paying \$300 for 16K of RAM, an outrageous price.

When it first came out, perhaps one of the biggest selling points, aside from price, was the *PET*'s ability to "speak" BASIC as soon as it was turned on. That's fairly common today, but four years ago it was a real innovation.

Another handy feature that was (and still is) found in *PET* computers, is a very good screen editor that makes it easy to correct mistakes. With the editor, you can move the cursor wherever you want to on the screen and then insert or delete characters or whole words with no difficulty. And, unlike the case with other screen editors, you do not have to re-enter the entire line that is being corrected. All you do is to make your correction and then press RETURN;

the computer automatically enters the corrected line.

It has a file system, too

As mentioned earlier, the *PET* is capable of reading and writing programs and data files to cassette tapes. The tape recorders used cost \$95 each, which is about two to three times the price of a decent cassette recorder that can be used with most other computer systems. Although the tape unit uses a commercial audio-cassette drive mechanism, the electronics are custom-made so that only that special recorder can be used. I have heard however of a company that sells an adapter, which will permit you to use a conventional cassette recorder with a *PET*, but I haven't seen it. And with such an important task to perform, it's probably better to pay the extra money—or better yet, go to a disk-based system.

The tape system in the *PET* is very reliable. The system records data at 1000 baud, which at first glance makes one think that it is rather fast. However, to insure data reliability, it records everything twice, and when it reads back data, it reads both recorded versions to verify that what it has read is correct. Thus the effective baud rate is only 500 baud, the same as the *TRS-80* Level II.

Unlike other tape systems which require low-noise tapes and meticulous adjustment of volume-control levels, the *PET* system can use just about any kind of tape, and no adjustments whatsoever are needed. I have tried a wide variety of tapes and found that even the cheapest kind available can be used successfully.

A handy feature of the tape system (missing from some of the popular systems) is the VERIFY command. After using it, I can't see how any computer can be without it. That nifty little command allows you to check and see if the program you recorded on tape was recorded without errors. I have yet to find a program that wasn't recorded properly.

In systems without that feature, notably the *Apple*, the only way to check whether the program was recorded properly is to load it into the computer. But that destroys the original program that is in the machine; so if your tape has dropouts on it, or the battery voltage of your tape recorder is low, loading the defectively-recorded program into your computer will wipe out the original program, and several hours worth of work can go down the drain.

Another plus for the *PET* tape system is that it works with named files. That means that you can give each program or data file a name, which is stored on the tape as a program header. Then you can tell the computer to load a program with a particular name, and it will ignore all others on the tape and only load the one with the desired name.

Commodore designers have made the *PET* a little more personal by including routines that keep the user posted about what is going on. For example, while it is looking for a particular file, the computer will let you know, not only that it is making the search, but it will also tell you which files it has passed on the tape while it was looking for the

one that you specified. That makes the *PET* more useful. About the only thing that is missing in the way of basic features, is the ability to use the BELL feature (ASCII character 7) of the ASCII keyboard.

Thanks for the memory

When it first came out, the least expensive version of the *PET* was the 4K system, which sold for \$595 and offered the user 4000 words (each digital word represents one character) of random-access memory (RAM). But that wasn't all—you also got 14K of read-only memory (ROM), which contained an 8K BASIC interpreter, a 4K operating system, a 1K monitor program, and a 1K diagnostic program. It was the 14K of ROM that put the *PET* way ahead of all other systems on the market at that time. Now most personal computers have similar features.

Since the *PET* was first introduced, the system ROM's have undergone several revisions. The original ROM's had a bug in them that would occasionally cause the cursor to be lost. That would require that the computer be shut off and turned on again in order to recover. Obviously, any program in the computer would be lost. Commodore acknowledged that bug and replaced the defective part free to anyone who reported problems. The next set of ROM's to be made available were the new ones that were developed for the 16K and 32K *PET*'s. That was not just a simple replacement of a single ROM, but an entirely new set. The changes in those ROM's are many and most of the machine-language routines have been shifted around so that programs using machine language calls from the original ROM set cannot be used without modification on the new set. Commodore is now about to announce an even newer ROM set, BASIC 4, which makes interfacing to the disk drive a lot easier. That set was originally developed for the latest computer to be added to the Commodore line, the 80-column CBM computer. And still another ROM set is in development, this one called BASIC 5. This ROM set will have a lot of utilities built into it such as renumber, append, and many others. The BASIC also includes an additional command called PROTECT, which, when invoked, prevents the user from accessing the source code or making a copy of the program.

While many people complain about the frequent and incompatible ROM changes, I see it as a good point for the Commodore computers. It shows that Commodore is constantly seeking to improve their products, which is really nice to see.

New 80-column computer available

Recently, Commodore has announced a new computer, aimed squarely at the business market. Known as the *model 8032* CBM computer, it features a 12-inch CRT and a full business keyboard with numeric keypad. The BASIC in the 8032 is Commodore's latest—version 4.0—and it works with the new disk-operating system, DOS 2.0. The new BASIC corrects several errors in the previous basic and adds some enhancements.

Externally, the 8032 is similar to the 16K/32K *PET*'s, except that the shape of the cabinet has been changed slightly to accommodate the larger video monitor. Included in the 8032 is an electronic bell that can be accessed via ASCII character 7. In addition, the bell is used as an end-of-line warning device, much like the bell on a typewriter. It sounds when the cursor passes column 75 on the screen.

PET checks itself out

From the repair point of view, the *PET* is a serviceman's dream. For the old *PET*'s, with the aid of a special connector, the *PET* can check itself out. Once the source of a fault has been located, repairing the system is simple. Each of the three boards can be snapped out quickly and replaced with another, so that the system can be up and

running in no time. For the new *PET*'s, Commodore has a special boot-strap loader that clips onto the 6502 microprocessor chip and loads in the diagnostic program. The reason that is necessary is that the new ROM's have no room for the diagnostic routines. Once the diagnostic program is loaded, servicing is as before.

Microsoft BASIC is used

The BASIC that is in the *PET* ROM's is a Microsoft BASIC and as such is fairly compatible with the BASIC's that are found in most home computers. Of course it contains the PEEK and POKE commands that have become popular with the microcomputer revolution. In addition, it contains some special commands that are designed specifically for use with the IEEE bus.

Also part of the repertoire are tape-file handling commands, such as OPEN, INPUT#, PRINT# and CLOSE. *PET* BASIC also contains a GET command that inputs a single character from the keyboard without printing it, making it possible to hit the RETURN button without stopping the program.

PET BASIC has one more very useful command: TI. That is not an oblique reference to one of Commodore's competitors, but rather a time command; it's used in conjunction with the *PET*'s built-in clock. It can be used to time programs or even set up a time-of-day program in the computer.

Plenty of peripherals are available

In the way of mass storage, Commodore has two-disk systems announced and a few more on the way. The first is the 2040 dual-drive minifloppy system. It uses Shugart 390 drives and the system is accessed in the same way as the cassette-operating system.

The 2040 costs \$1295, has access to 340K of data on the two drives, and it doesn't use double density and double tracking techniques. The density is achieved by using two microprocessors (a 6502 and a 6504) and five memory IC's that are built into the disc unit itself. But the real key to the high density is an encoding scheme that packs the data so that less storage space is needed.

The information needed for encoding data to be stored on the disk is contained in 2K of ROM located in the disk unit. Also included is an 8K ROM-based disk-operating system. In addition, the 2040 contains 4K of static RAM.

Only two connections are needed for the disk system; an AC power cord to supply it with 50 watts of power and an IEEE interface cable to connect it to the *PET*. The diskette itself is a soft-sectored one that is formatted by the drive. It has 35 tracks, with a constant recording density. The number of sectors-per-track, however, varies—from 17 for the innermost tracks to 21 for the outermost. Track 18 of the diskette is used for the directory of programs that are on the disc.

For those who require even more data-storage capability, Commodore has just announced a new dual-disk drive system known as the 8050. That system provides three times the storage capability—512 kilobytes-per-diskette or 1 megabyte-per-dual-drive-system—for only 1/3 more money (\$1695).

In the area of hard copy, Commodore has two printers. One is the CBM 2023, which is a matrix, impact printer that has a pressure feed and takes 10-inch-wide roll paper. It prints at 80 characters per second and costs \$695. The second printer, the CBM 2022 is similar to the 2023, except that it is a tractor version and costs \$100 more. Both printers connect to the *PET* via the IEEE bus.

Commodore has two more peripherals available that may be of interest: a voice synthesizer for \$395 and an acoustically coupled modem for \$395. The modem is a half- and full-duplex modem that features asynchronous operation at 300 baud.

THE APPLE COMPUTERS

The first Apple computer was the brainchild of two young men working out of a garage. The young men are now rich, and the Apple a resounding success.

ONE OF THE VETERANS OF THE PERSONAL-COMPUTER REVOLUTION is Apple Computer Company. In 1975, when micro-computers first appeared on the scene, Apple Computer was the first company to offer a single-board computer. The price, for what was then known as the *Apple I*, was \$666. That included an onboard ROM monitor and a built-in video interface.

About eight months after the *Apple I* appeared on the market, the Cadillac of home computers made its debut, *Apple II*. The *Apple II* represented a giant step forward in home computing then and, except for its newly introduced brother, the *Apple III*, it is still the best buy in personal computers around.

Like its predecessor, the *Apple II* has built-in video circuitry that allows it to interface directly to a color-video monitor, or to a television set through an add-on modulator. *Apple II*'s now come in two varieties, the *Apple II* and the *Apple II Plus* (often referred to as minus by experienced Apple owners). The difference between the two machines is in the BASIC that you'll find resident in the computer at the time of purchase.

On the *Apple II*, the computer comes with Integer BASIC resident in ROM. The term "integer" refers to the way the computer performs mathematical operations. In Integer BASIC, for example, $5 \div 2$ would yield 2 instead of the expected 2.5, because 2.5 is not an integer. While that seems strange and hardly useful, such is not at all the case. Integer BASIC is very fast and as a result lends itself well to application in games programs.

For those who wish to have the floating-point capability (where in the above example you'd actually get 2.5) it is possible to purchase an additional firmware board with Applesoft BASIC in it; that is the BASIC that is available on most computers. In addition, older Apple systems were supplied with Applesoft on disk so that those with a lot of memory and an integer machine could have Applesoft available to them.

The second type of Apple, the *Apple II Plus*, comes with Applesoft as the BASIC that is resident in ROM in the machine. When Apple Computer Co. made this version of the computer available, they also changed one of the system ROM's to add some additional features. Unfortunately, when something is added, something else must always be taken away and in that case it was the built-in mini assembler. Also, Apple Computer Co. decided to give the system the capability of being a turn-key system so that programs could be run as soon as power was applied, if a disk drive were used. Finally, the reset circuitry was modified so that it was software-controllable. All of those features

have pluses and minuses, but owners of the *Plus* see only the minuses, hence the nickname. By the way, all of the features taken away from the *Apple II Plus* are restored to the computer when the Integer firmware card is installed.

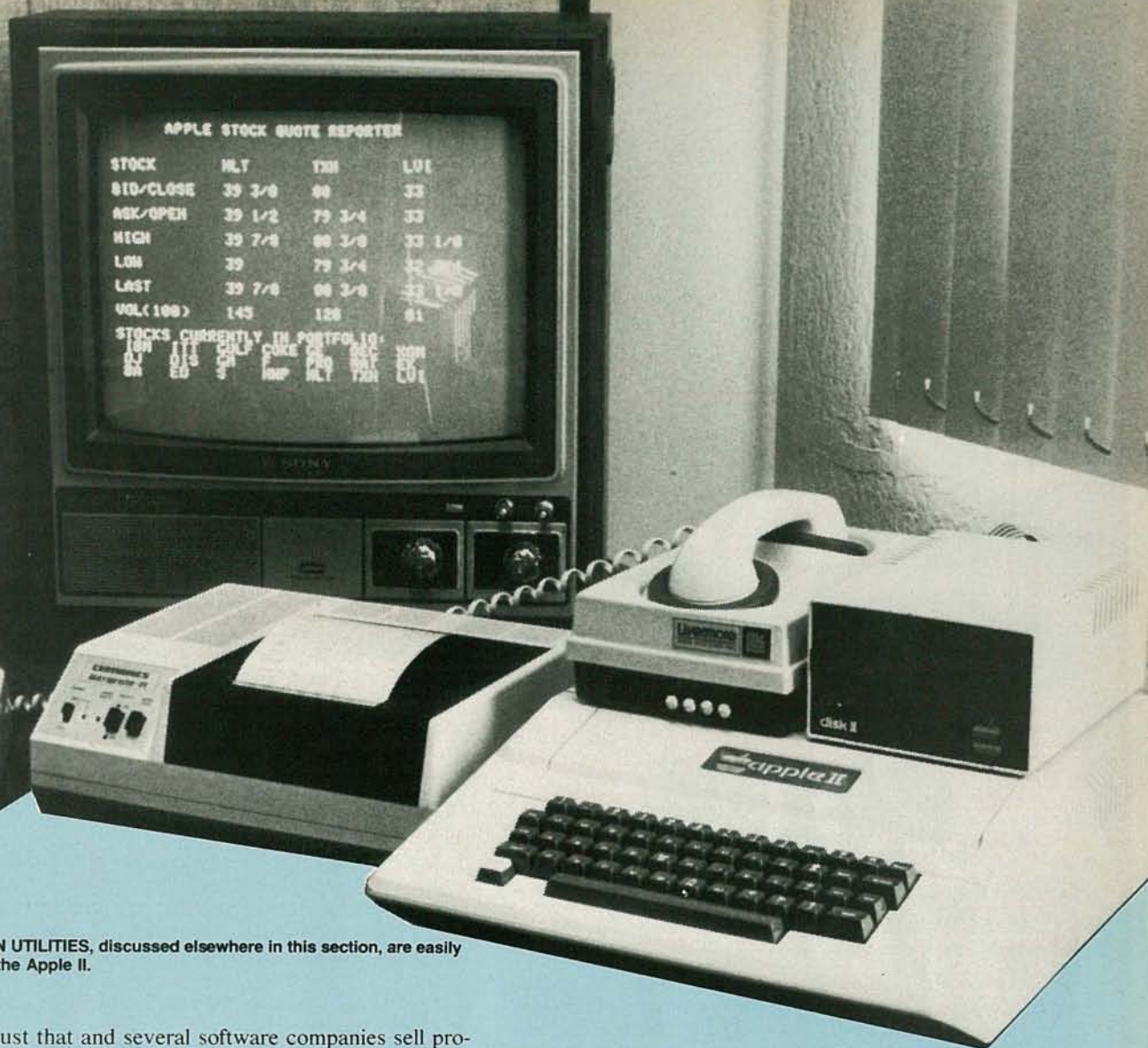
The low end *Apple II*, be it the regular or the *Plus*, contains 16K of random-access memory and has sockets that allow the user to expand it to 48K just by plugging in the extra IC's. The 16K *Apple II* lists for \$1200, but can be gotten, by carefully examining the ads in computer magazines, for as low as \$950. For that price you get one type of BASIC, a built-in speaker, a standard 52-key typewriter-quality keyboard, an 8-slot expansion bus that is widely supported by independent manufacturers, a built-in video interface, two paddles for interactive games, four built-in analog-to-digital converters, a variety of demonstration programs, and a machine that will give you hours of fun. The built-in speaker can be used to produce music, warning 'beeps', or even play back digitized speech.

Five display modes available

The computer has five display modes. The first, and most frequently used, is the all-text display mode. Then there are two low-resolution, full-color graphics display modes: one that combines the 40-x-40 low-resolution graphics with four lines of text and the other that is all graphics. The same holds true for the high-resolution graphics mode. There is one that permits four lines of text on the bottom of the screen and the plotting of points on a grid 280 wide x 160 high. In the all graphics mode the resolution increases to 280 x 192. There are six colors available in the high-resolution mode, including black and white. The resolution in that graphics mode is so fine that it is possible for the user to define his own character set. Apple Computer has a program in its contributors library



APPLE II DISK DRIVE uses uniquely-designed controller card.



INFORMATION UTILITIES, discussed elsewhere in this section, are easily accessed by the Apple II.

that does just that and several software companies sell programs that do it too.

Those character-generator programs are popular, because the *Apple II* has no built-in capability to display lower-case letters. Several independent manufacturers, such as Mountain Hardware and Dan Paymar, have overcome that problem with accessory devices, the cheapest of which is the Paymar adaptor for only \$50. One hardware limitation of the *Apple II* is that it only displays lines of 40 characters. Here again, outside manufacturers have been innovative and come up with accessories that increase that to 80 characters per line, but in those cases, the computer must be used with a video monitor.

In the text-display mode, the *Apple II* has programmable text windows, so it is possible to divide the screen up into several distinct sections and access any one of them under program control while the others stay fixed. Each window has its own scrolling capability, and each can be cleared individually. In addition, characters on the *Apple II* can be displayed in one of three modes. The first—and most often used—is the normal white-on-black display. The next is an inverse mode where letters are displayed black on white. Finally, they can be displayed in a flashing mode. Using Applesoft BASIC, it is simply necessary to invoke the NORMAL, INVERSE or FLASH commands to display the text appropriately. In Integer BASIC the same things can be accomplished by POKEing a particular location in memory with various values. That versatility in handling text makes it possible to produce interactive programs that are both attractive and easy to read.

In addition to the main computer unit, Apple has several accessories available for it. The most important is a disk

drive. Apple disk drives cost \$495 if purchased from Apple Computer and \$395 if a compatible drive is purchased from an independent manufacturer. The drive-controller card, which can handle two drives, sells for \$100. Apple has done some pretty innovative things with their disk system. They use the standard SA400 drive from Shugart, but they don't use the Shugart digital controller card that comes with the drive. Instead, they replace it with their own. Aside from reducing the parts count on the card, which increases reliability, they've made the card smart, so that it can calculate the acceleration and deceleration of the drive and compensate for it when accessing the disk.

The standard Apple disk drive is capable of storing 116 kilobytes of data. However, Apple has developed two new ROM's for its controller card which make it possible to increase storage to 143 kilobytes per diskette, and that upgrade kit, along with a new version of DOS (*Disk Operating System*) to support it (DOS 3.3) should be available by the time you read this article.

It understands Pascal too

Apple Computer Co. is quick to recognize desires of the public and when it became apparent that the computer language Pascal was becoming popular, it set about developing a method of implementing it on the *Apple II*. As a result, about a year ago, Apple came out with an accessory known as the Language System. That \$500 system makes it possible to run the popular UCSD Pascal language on the *Apple II* computer.



THE WHOLE COMPUTER weighs only seventeen pounds.

The Language System consists of a card that plugs into one of the slots in the Apple. The card contains an extra 16K of RAM, support circuitry, and a ROM that will permit the Apple disk to boot up automatically when power is applied. A reasonable price for the board alone would be \$100 to \$150. The extra money for the system is for the software that comes with it, the UCSD Pascal system which includes an editor, compiler, linker, and utility programs. The system also includes a 6502 assembler. Finally, two ROM's are included, which must be used to replace ROM's that are on the standard disk-controller card. Those ROM's set up the disk drive to work with 16-sector disks, as opposed to the standard 13-sector ones. The increase in sectors accounts for the increase in density from 116K to 143K that is associated with the Language System.

Although the Language System is commonly referred to as the Pascal card, that is really not accurate since Apple is planning on having other languages available for it soon. Already announced are FORTRAN and Pilot.

Apple III is coming

In May of this year, Apple Computer Co. introduced its next-generation computer, the *Apple III*, which should be on your dealer's shelf by the time you read this article. Basically, the *Apple III* has everything *Apple II* owners wished they had in theirs and went out and bought accessories for. The *Apple III* has a built-in mini-disk drive; printer interfaces for serial and parallel printers; a real-time battery-powered clock-calendar that will run for three years and keep track of time to within 1 ms; standard IBM keyboard with a numeric key pad with automatic repeat of any key; a 2-inch speaker, a fixed frequency 'beep' generator, a 1-bit squarewave generator, and a 6-bit digital-to-analog converter. The basic unit comes with 96K of memory; that is expandable to 128K.



THE NEW APPLE III, aimed primarily at the business market.

Like the *Apple II*, it uses a 6502 microprocessor, but it has been enhanced in two ways. Firstly, a 2-MHz version of the CPU (known as the 6502A) is used. That immediately makes the *Apple II* two times faster. Secondly, external logic has been added to enhance the 6502 instruction set. Additional CPU features include a relocatable base-page register and a relocatable stack.

A nice feature of the new computer is that the character generator is stored in RAM. That means that all characters are software-defineable and that any type font can be generated. So, in addition to defining new character sets, such as Greek and Hebrew, it is possible to generate high-resolution figures in the text mode. Another result of that is that scrolling can occur one dot row at a time, resulting in a smooth, non-jerky movement.

Perhaps the smartest feature of the *Apple III* is its built-in *Apple II* emulator. When activated, that makes the *Apple III* look exactly like an *Apple II*, and all the software that is available for the *Apple II* will work on it. The *Apple III* also has a Language System built in and is thus capable of running Pascal as well.

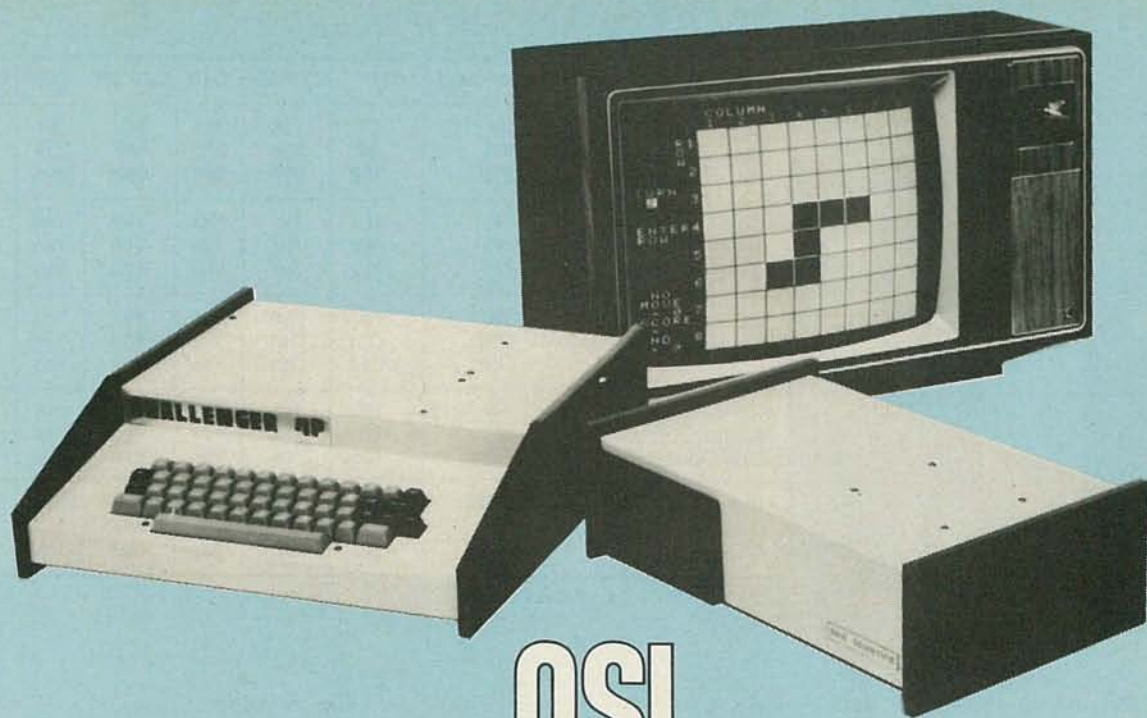
Support is the best around

When it comes to helping out a customer or dealing with a problem, be it malfunctioning equipment or answering technical questions, Apple's support is the best around. Apple's network of service centers is geared to repairing or replacing defective parts within 24 hours. While that goal isn't always achieved, their track record is pretty good. And if you've got a technical question, Apple's hot line (408-996-9868) is always staffed during the business day to provide customers the answer to any question, be it hardware-or software-related.

Having used that hot line quite a bit, I can tell you first hand that it is great; the people manning it are both patient and helpful. If they don't know the answer, they'll find someone who does. The only problem with the hot line is that it is only manned by two people at a time with only two telephones; thus getting through can be difficult at times. No other manufacturer, though, has anything better.

The Apple's popularity extends around the world, and the software and hardware support for it are almost beyond belief. Many games, programs and peripherals first developed for it have been adapted for other systems. It's no wonder that the Apple has become one of the top-selling personal computers!

R-E



OSI

SUPERBOARD & CHALLENGER

These products provide one of the least expensive ways of building up a system.

OHIO SCIENTIFIC, INC., OR OSI, WAS ONE OF THE EARLY ENTRIES in the home computer market, dating back to the "old" days of 1975. Their present line of computers ranges from simple one-board computers to sophisticated rack-mounted computers and consists of four product lines; the *Challenger I*, *Challenger III*, *Challenger 4* and *Challenger 8*.

The *Challenger I* series, which includes several models, is aimed at the student and hobbyist with prices ranging from \$279 to \$995. For the higher performance needs of the professional and educational user, there are several models in the *Challenger 4* and *Challenger 8* series that range from \$698 to \$2597 price bracket. The small-business computer series, *Challenger III*, starts above \$4000 and will not be detailed here. A comparison chart detailing the key features appears in Table 1.

Beginners can start "naked"

The first member of the OSI family of personal microcomputers is the *Superboard II*, a "naked" microcomputer, without power supply (5 volts at 3 amps required) and cabinet. The *Superboard II* includes a full 53-key ASCII character keyboard, a 30-row by 30-column video-display interface for use on a video monitor or home television via an RF modulator, and a cassette tape interface that will work with most home cassette recorders. Also included on the board is an 8K BASIC in ROM and 4K or 8K of RAM.

The *Superboard II* is directed toward the computer neophyte who can start getting into this fascinating hobby with an inexpensive basic system that works reasonably well and can be expanded to include other peripherals such as a floppy disk drive. The *Superboard II* with 4K of memory

costs \$279 while the 8K version costs \$348.

Add a power supply and an enclosure to the 8K *Superboard II*, and it becomes a *Challenger CIP*, designed to be used with a standard television set (via a separate RF video modulator). An optional 12-inch OSI black-and-white video monitor is available for another \$115. The *Challenger CIP* offers upper and lower case characters from the keyboard. On the video screen, it will display up to 30 lines of 30 characters each in the text mode. In the high-resolution graphics mode, it will display dots within a 256-by-256 grid.

As is the case with most of the popular personal computers, except for the TRS-80, the OSI computers use the 8-bit 6502 microprocessor. The bare-bones *Challenger CIP*, without the audio cassette recorder and without the video monitor, is \$399.

The next step up is the *Challenger CIP MF* which includes 12K of RAM, the 8K BASIC in ROM, and either one or two 5-1/4-inch mini-floppy disk drives. With disk drives, data retrieval can be achieved in seconds rather than the minutes required when a cassette storage system is used. The cost of a *CIP MF* with 12K of RAM, the 8K ROM BASIC, and one mini-floppy disk drive is only \$995. That price makes it the cheapest disk-based personal computer available anywhere. Need more memory? The *CIP MF* can be expanded up to a total of 32K of RAM. With 20K or more of memory, small-business applications can be handled through OSI's powerful OS-65D V3.0 operating system that supports sequential as well as random access data files directly from BASIC.

Peripherals available for the *Challenger CIP MF* include an electrostatic or impact printer (\$695 and \$1250 respec-

TABLE I

Feature	Superboard	C1P	C1P MF	C4P	C4P MF	C8P	C8P MF
Min. RAM	4K	8K	12K	8K	24K	8K	32K
Max. RAM	8K	8K	32K	32K	48K	32K	48K
Base Price (\$)	279	399	995	698	1695	895	2597
Color Graphics	No	No	No	Yes	Yes	Yes	Yes
Joystick Int.	No	No	No	Yes	Yes	Yes	Yes
Keypad Int.	No	No	No	Yes	Yes	Yes	Yes
AC Remote Int.	No	No	Opt	Yes	Yes	Yes	Yes
Modem Interface	Opt	Opt	Opt	Yes	Yes	Yes	Yes
Printer Int.	Opt	Opt	Opt	Yes	Yes	Yes	Yes
Home Security	No	No	No	No	Yes	No	Yes
Audio Output	No	No	No	Yes	Yes	Yes	Yes
D/A Converter	No	No	No	Yes	Yes	Yes	Yes
Video Display	30x30	30x30	30x30	32x64	32x64	32x64	32x64
Real Time Clock	No	No	Yes	No	Yes	No	Yes
GT Option	No	No	No	No	Opt	No	Opt

tively), a 300-baud modem (\$199), and a home controller (\$175). The AC Remote Control System, or home controller, together with a real-time clock, enables the computer to operate lights and appliances automatically under program control. The AC-control interface permits the computer system to inject control signals on the AC power line circulating throughout the home, and turn lamps or appliances on and off. Also available is a home security system, including smoke and door/window burglar-alarm sensors. Should an entry be attempted, or smoke be present, the computer would be informed immediately, and the appropriate devices would be activated.

Do it better with a C4P

The *Challenger C4P* is a cassette-based system and includes the 8K ROM BASIC, just like the *C1P*. But the *C4P* has some additional features. It has over three times the display capability of the *C1P* and is capable of displaying 32 lines of 64 characters each, in up to 16 colors. In the graphics mode, the screen resolution is 256-by-512 points.

Also included in the *C4P* is a 200-Hz to 20-kHz programmable tone generator, an 8-bit companding digital-to-analog converter (DAC) for voice and music generation, two 8-axis joystick interfaces for interactive games, two 10-key keypad interfaces, and an AC remote-control interface for appliance and home control systems. The basic *C4P*, selling for \$698, may be expanded to hold up to 32K of RAM through the use of two expansion slots in the keyboard chassis. The RAM used in the computer is all static and therefore requires no system refreshing; it can easily be backed up using a battery supply. With as little as 24K of RAM, the *C4P* will handle 5-1/4 inch mini-floppy disk drives which cost \$450 each.

If you decide in advance that mini-floppies are the way to go, then the *C4P MF*, at \$1695, provides the same features as the *C4P* but includes 24K of RAM and a single mini-floppy disk drive. In addition, the *C4P MF* contains a real-time clock and countdown timer, a modem interface, 16 parallel lines for additional control interfaces, an accessory bus for an external 48-line I/O board, and a home-security system interface. The system can be expanded to 48K of RAM and two mini-floppies.

The computer features a "foreground-background" capability that allows it to monitor a home-security system and turn appliances on and off while at the same time it is running another application program. The *C4P MF* is the only home computer that has that capability built into it.

According to Ohio Scientific, the *C4P MF* normally operates twice as fast as an Apple II or PET and three times faster than a TRS-80. However, if you need even more speed, it is possible to double that speed by getting the GT option, which is a special ion-implanted 6502, along with faster RAM. The option can only be ordered at the time of purchase and costs an extra \$950.

For more expandability try the C8P

The top-of-the-line in personal computers for Ohio Scientific is its *Challenger C8P* series of computers. The *C8P* contains eight expansion slots, only five of which are available to the user. The others are used for the basic configuration. That means that the *C8P* has more than three times the expansion capability of the *C4P*. The basic *C8P* is a cassette-based machine with 8K BASIC in ROM and 8K of static RAM. That can be expanded up to 48K of RAM. To increase program storage, the *C8P* can be interfaced to two 8-inch floppy disk drives. The basic *C8P* costs \$895 with 8K of RAM.

If you need more memory, it can be upgraded to a *C8P DF*, which costs \$2597. That gives you 32K of RAM (expandable to 48K) with dual 8-inch floppy disk drives that are capable of storing up to 250 kilobytes of data. The *C8P DF* offers the same features as the *C8P* plus the Home-Security System. An optional Universal Telephone Interface can dial any telephone number via rotary dial or Touch-Tone (TM) techniques. By combining the Universal Telephone Interface with OSI's Votrax voice I/O board here's what you'll get: A computer system that can dial any number and communicate via voice output, leaving messages, and answering anticipated questions. Add to that combination the home-security system, and the *C8P DF* can automatically dial the police or fire department, and by voice message communicate its emergency needs. A dedicated alarm dialler, however, would probably be more cost effective. Another possibility is that the computer owner can dial home from some remote location and tell the computer to turn specific appliances on and off.

Like the *C4P*, a GT option is available for the *C8P DF* too. If desired, it must be ordered at the time of purchase and costs an extra \$1825.

Software, including Pascal and FORTRAN for 48K systems with at least two mini-floppies, for the Ohio Scientific computers is available on both tape and diskette, with prices ranging from \$6 to \$200.

R-E



HEATH H89:

Kit or Assembled

Originally, all personal computers were available only as kits. Now, just the opposite is true. Heath, though, still lets you build your own.

IT'S NOT EASY TO LOCATE A PERSONAL COMPUTER SYSTEM that includes a smart terminal plus a floppy disk for under \$2000. But, if you are familiar with basic electronic kit assembly and construction, you can buy a relatively sophisticated computer that uses not one but two Z-80 microprocessors, a smart video terminal, 16K of random access memory (RAM), and a 100K minifloppy-disk storage system. All of that will cost you only \$1695. And with a reasonable degree of patience and confidence, it will work when first turned on.

When personal computers first appeared five years ago, almost all were kits. Today it is just the opposite: almost all are assembled and ready to use. But Heathkits have always been popular and have a reputation for working well the first time. Nonetheless, if kits don't "turn you on," you can still enjoy the Heath computer by purchasing a *WH89* (W for wired) *All-In-One* computer, factory-assembled and tested. Whichever model you get, the *H89* is a fully integrated desktop computer with many built-in features plus a wide variety of external peripherals available.

The 8-bit *H89* includes a computer, 12-inch black-and-white video display, 5¼-inch minifloppy-disk drive, 16K of RAM and an ASCII keyboard with a numeric keypad. In actuality, the *H89* is really an *H19* Smart Video Terminal into which the computer, floppy disk, and interface boards have been assembled.

Two Z-80 microprocessors used.

There are two Z-80 microprocessors used in it, one for the computer and one for the smart terminal; each unit can thus operate independently to allow the *H89* to process data at a high speed.

The basic unit comes with a 2-MHz Z-80 microprocessor and 16K of RAM, but is expandable to 48K. Expansion is very easy, because the Heath designers apparently tore a page out of the Apple's designer's book and provided empty sockets already in place in the computer. Thus all that is needed to expand the memory is to buy extra chips and plug them in. It should not take more than 15 minutes.

With 48K of memory space dedicated to user RAM, and since the Z-80 can address 64K of memory, another 16K

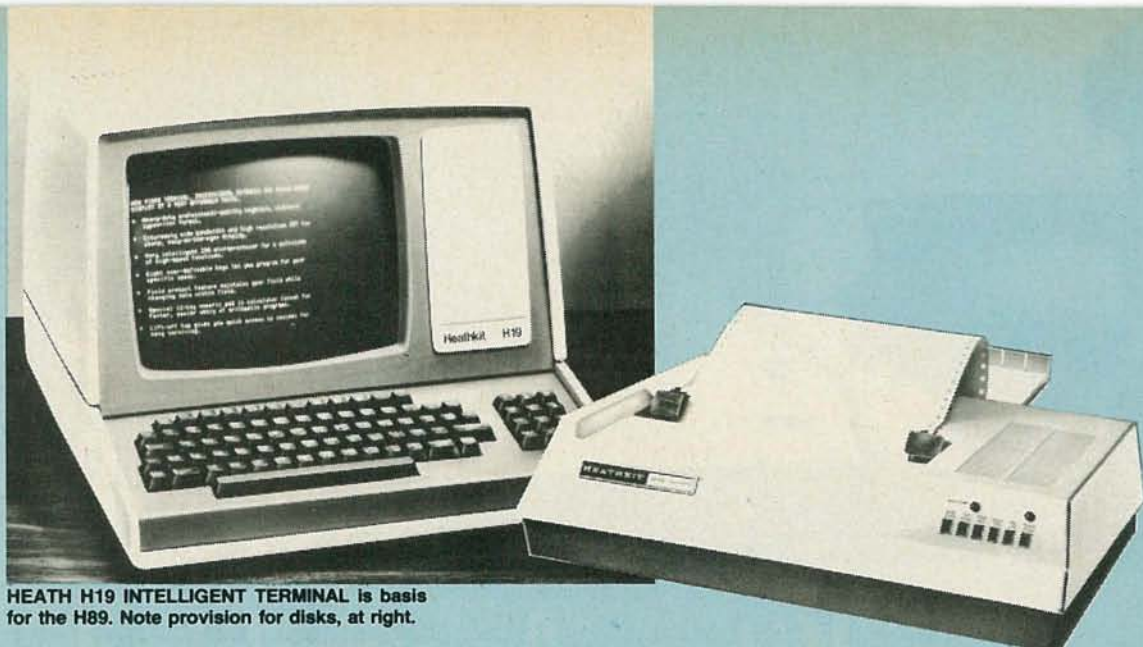
of memory must be accounted for, and it is. Two 8K sections of memory are reserved for system use. The first 8K section is located in low memory. Of that, 3K is used for system ROM and 1K for system RAM. The remainder is not currently used. The other 8K block of memory that is reserved is in high memory and it is currently not being used.

The display is presented on a bright 12-inch CRT that contains a P4 phosphor. The screen format is 25 lines by 80 characters, for a total of 2000 characters. One disadvantage of the display is that it is not a memory-mapped display and thus it is not possible to access individual locations on the screen by *POKE*ing a value into a specific memory location. In displaying information on the screen, several different dot matrix formats are used. To display upper case letters, a 5 × 7 dot matrix is used, while a 5 × 9 dot matrix is used to display lower case letters with descenders. And, to display graphics characters, an 8 × 10 dot matrix is used.

The terminal part of the *H89* will operate at twelve different, keyboard selectable, baud rates up to 9600 baud. The Z-80 that is included in the terminal adds some versatility to the terminal so that some desirable features are available. Among those are the ability to insert and/or delete characters or full lines of information. It also makes possible a graphics capability. Another handy feature is reverse video. That allows the user to emphasize any particular section of the screen by printing black letters on a white background.

As any true terminal must have, the *H89* has a full ASCII keyboard. The 84-key heavy-duty keyboard consists of a 72-key standard typewriter keyboard and a 12-key numeric and control-function keypad. In addition to providing access to the full 128 ASCII characters, the keyboard also provides access to 33 predefined graphics characters and it has eight keys that are reserved for user-defined functions. To simplify and speed the entry of numerical data, a 12-key pad is provided. And if the shift key is used with several of the keys on the pad, control of the cursor for insertions and deletions is provided.

Borrowing another design idea from the *Apple II* com-



HEATH H19 INTELLIGENT TERMINAL is basis for the H89. Note provision for disks, at right.

A NUMBER of peripherals, such as the H14 printer, are available from Heath.

puter, the *H89* contains a small loudspeaker which is used to generate an audio "beep" that is used whenever the BELL character (ASCII character 7) is printed. That is important, because in good interactive programs, the bell can be used to warn the user of an impending change of state or overflow condition. Also, the speaker can be used to generate various tones and crude music under software control.

Hard-sector floppies used

A WANGCO/Siemens *model 82* minifloppy-disk drive is used in the *H89*. That particular drive requires the use of hard-sector diskettes that have 40 tracks-per-diskette, 1 sector-per-track and 256 bytes-per-sector. That provides slightly more than 100K of data storage per diskette. The data transfer rate to and from the disk drive is at 128 kHz.

For applications where 100K of on-line data storage is not enough, an optional *H77* Floppy-Disk System can be added, for only \$595. That adds another 100K of storage to the system. And for still more storage, an *H17-1* (\$345) floppy-disk drive, can be added to the *H77*. That will give you 300K of on-line storage.

For the economy-minded, who feel they can get along without a disk drive (and those people are few and far between), Heath offers the *H88-5* audio-cassette interface. That system operates at 120 bytes-per-second and uses a 2.4-kHz signal for its mark tone and a 1.2-kHz signal for its space tone.

System documentation included

Unlike some personal computers, the *H89* comes with a 260-page Operation/Service Manual to teach the basics of microcomputers using the *H89* as an example. The book includes detailed circuit explanations, digital timing sequences and trouble-shooting tips. In addition, a Software Reference Manual, 440 pages long, discusses five systems-software packages that are available. Another 110-page book provides all of the information required for the optionally available Microsoft BASIC.

The five major systems-software packages available for the *H89* consist of the Monitor, HDOS, Dbug, Edit, ASM, and Benton Harbor BASIC. The Monitor is supplied as 2K of ROM firmware and is activated when the system is turned on. It allows the user to display and change data in RAM, load and run programs from cassette tapes, and boot the disk if one is present. Heath's Disk Operations System (HDOS) keeps track of data written to and read from the disk drives. Benton Harbor BASIC is a lan-

guage that was originally written for the *H8* computer, but was carried over to the *H89* as well, to provide upward compatibility. That, by the way, is something that Heath is very conscious of. In fact, when talking with outside software manufacturers, Heath has required that when machine-language programs are written for their computers, all programs must be in 8080 code so that they will be compatible with all Heath computers, the older *H8*'s and the newer *H89*'s.

Microsoft BASIC now available

Recognizing that Microsoft BASIC was fast becoming a *de facto* industry standard, and that it also was quite a good BASIC, Heath has also arranged for it to be available on the *H89*. The *H89* Microsoft BASIC contains 116 commands and functions, compared to the 73 in Benton Harbor BASIC. It also features a built-in program editor so that individual lines can be edited without retyping the entire line.

For those hardy souls who prefer to program in machine language, Heath offers a 3-module set of programs to edit, assemble, and debug programs. Again, clinging to their desire to maintain compatibility with the old and the new, Heath has chosen to provide an assembler that works in 8080 code. In the Edit mode, the user can type in text to form source files for assembler programs. Once a source file has been created, the command ASM is invoked to put the assembler into operation. The assembler takes the mnemonic version of the assembly-language program (the source) and converts it into the hexadecimal digits that represent machine language (object code). And if you're not perfect, then after you try to assemble your program, you'll have plenty of use for the Dbug program.

The Dbug program allows the user to single-step through a machine-language program and to inspect the contents of memory locations and data registers, making alterations wherever he wants to. Another convenience of the Dbug program is that it makes it easy to load and dump assembled programs onto diskette.

Here are the prices

The *H89* is available, in kit form, with 16K of RAM and an audio-cassette interface for \$1695. A fully assembled *H89* (known as the *WH89*) with 48K of RAM and a serial interface, with a built-in minifloppy disk drive, but without the audio cassette interface, is \$2895. The *H89* can be purchased without the built-in disk drive, but with an audio cassette interface, as the *H88* for \$1295. **R-E**



HERE COMES TI

It isn't that great a leap from calculators to computers. Texas Instruments, having captured one market, now enters the other with the Model 99/4 personal computer.

TEXAS INSTRUMENTS (TI), INITIALLY A MAJOR MANUFACTURER of semiconductors, became a leading supplier of consumer products when they launched their digital watches and calculators on the world market. TI's first entry into the field was not overly impressive, but they have moved from that low point to become the major U.S. manufacturer in the calculator market. Throughout 1979, rumors abounded that TI was going to announce an entry into the home-computer market and existing manufacturers feared that the Texas giant would come out with a product that would quickly dominate that market also. At the Consumer Electronics Show in Chicago, June 1979, the suspense ended. TI showed their home computer—the TI Model 99/4—and the industry heaved a sign of relief. Its \$1150 price (since raised to \$1400) non-standard keyboard, and limited capabilities meant that TI's entry would pose little threat to other computers already on the market.

By and large, that first industry reaction has proven to be accurate. A year after its introduction, the TI 99/4 is still not well accepted in the marketplace. But don't count TI out yet. After a slow start in the calculator market they surged ahead to dominate it and they may do the same with computers.

The basic TI 99/4 consists of a 40-key keyboard, 16K of random access memory (RAM), 26K of internal read-only memory (ROM), and a separate 13-inch color monitor display. The heart of the computer is a TI 16-bit microprocessor chip, the TMS 9900—and the 99/4 is the *only* home computer on the market that has a 16-bit processor in it. While that could give it a tremendous advantage over all the other 8-bit computers (it means that more memory is directly addressable by the microprocessor, and machine language instructions in 16-bit micros are generally more efficient than those in 8-bit units), Texas Instruments has decided to keep the user from accessing the full value of that capability. Much of it just amounts to potential advantages hidden in the machine.

The system provides some nice features, such as color graphics, music, and programmable sound effects. The graphics, which can have a resolution as high as 192 × 256 pixels in 16 colors, can be really great, especially since the computer comes with a high-resolution Zenith

color monitor. But here again, TI thought only about their own interests and not those of the consumer. The high-resolution color graphics are only available from programmed ROM cartridges, and the ROM cartridges are only available from TI. Even if you buy the cartridges from another company—such as Milton Bradley, which has produced some games for the 99/4—the cartridges are still manufactured by TI. After all, their major business is semiconductors. If the user wants to write programs that use graphics, he is stuck with low-resolution graphics that don't come close to the real capabilities of the computer. That is because TI chose not to allow the user to access memory directly. For example, the high-level computer language known as BASIC normally provides PEEK and POKE commands that permit the user to access specific memory locations. TI's BASIC has no PEEK or POKE commands.

Keyboard is too small

The keyboard layout on the TI 99/4 is in the standard staggered key format, but the keys are smaller than the standard typewriter keyboard and extra care is required if it is to be used by someone who knows how to touch-type.



PLUG-IN COMMAND MODULES contain programs in ROM.



ACOUSTIC COUPLER allows the 99/4 to talk to other computers.

In addition, the keys are calculator-type switches, not the standard keyboard-type switches, and if you place your hands on the keyboard in the standard touch-typing configuration, you realize that there are keys missing on the right-hand side of the keyboard. Commodore was the first company to make the mistake of using a nonstandard keyboard when they introduced the PET computer and they got a lot of flak for it—so much that in the next model they came out with a standard keyboard. It's a pity that TI didn't learn from Commodore's mistake.

The 99/4 has the ability to address up to 72K of memory in its present configuration. That consists of 16K of RAM (random access memory), 26K of internal ROM (read only memory) and up to 30K of ROM in the form of solid-state command modules. The internal ROM contains 13-digit floating-point TI BASIC, which is billed as being fully compatible with ANSI Minimal BASIC. That can be misleading however; just about every BASIC available today is compatible with the ANSI standard, because it is so narrow in its scope. Even with that compatibility with the standard, many are incompatible with each other. Since TI BASIC is not compatible with Microsoft BASIC, the *de facto* industry standard, novice users may find the book, "Introduction to TI BASIC", by Inman, Zamora, and Albrecht, useful. (The authors wrote the manual supplied by TI with the computer.) It is published by Hayden Book Co. Inc. and sells for \$9.95.

In addition to its 13-digit accuracy, TI BASIC includes commands to handle color graphics, and sound and music generation over a full five-octave range. Altogether, TI BASIC contains 24 BASIC statements and 14 commands. Sounds and music are generated by a built-in programmable music synthesizer that features three voices and white noise. The frequency range covered is 110 Hz to 40 kHz (five octaves) and the duration of each note is variable and programmable from 1 ms to 4275 ms. The volume is adjustable up to 30 dB. Another capability of the com-

puter, also in the area of sound, is speech synthesis. That is not available in the basic unit, but in an accessory device. The solid-state speech synthesizer costs \$149.95, which is fairly inexpensive compared to other speech synthesizers. It comes with a 200-word vocabulary and allows the user, under program control, to have the computer give verbal prompts. Also, the quality of speech is quite good. Additional vocabulary modules with different words will be made available.

Included in the available accessories is a 360-degree, multiposition joystick with a side-mounted "fire" button. The joystick is connected via a 4-foot cable and two of them can be connected for real time competitive games.

Software

Software for the TI 99/4 is available in two forms: cassette tapes and solid-state Command Modules. The Command Modules plug into a slot in the keyboard console and each one can contain up to 30K of programming. TI has several modules available on different subjects. In the area of educational aids there are grammar, math, and early reading. Business-related programs are also available such as investment analysis, statistics, personal record keeping, and tax aids. Games that are available in modules from TI are video chess and football.

In an interesting marketing marriage, TI and games manufacturer Milton Bradley have arranged for a number of Bradley's games to be available in software modules. Specifically, Yahtzee (a dice game), Hangman (a word game), Zero Zap (a pinball game) and Connect Four (a strategy game) have been made available. Command modules both from TI and Milton Bradley range in price from \$19.95 for video graphics to \$69.95 for video chess.

Peripherals

The TI 99/4 keyboard console includes a number of connectors for adding peripherals to the system. In addition to the speech synthesizer, peripherals available from TI include a 5.25-inch mini-disk drive (\$499.95), a disk drive controller (\$299.95), a thermal printer (\$399.95), a telephone modem (\$224.95) and an RS-232 serial interface (\$224.95). Also available is an RF modulator for \$75. That is grossly overpriced and potential 99/4 owners would do better buying modulators from an outside source at 1/4 to 1/2 the price.

One measure of how successful a personal computer is on the market is the number of independent vendors that support the computer. It is interesting to note that even after a year on the market, to this author's knowledge, there is not a single hardware manufacturer supporting the 99/4 and less than a handful of software vendors producing programs for it. In fact, chances are that if you walk into half a dozen computer stores in your area, you'll be hard pressed to find one that carries any software for the 99/4, aside from that supplied by TI.

R-E



COMPUTERS COMPUTERS COMPUTERS

You'd be surprised at who's getting into the computer field (or maybe you wouldn't). Here's information on some products that have been around awhile—and on some interesting newcomers.

WITH PROSPECTS OF PERSONAL COMPUTER SALES EXCEEDING 500,000 units by the end of this year, more and more companies are entering the market. Since the Altair 8800 was made available in kit form from MITS, Inc., five years ago, personal computer interest has soared. In 1976, the Apple was introduced by the Apple Computer Co., Inc. and was shortly followed to the market place by Commodore's (Personal Electronic Transactor) PET and Radio Shack's TRS-80.

Those three companies represent the major influences on personal computer sales in 1980. But other computer manufacturers, such as Ohio Scientific and Cromemco Inc., intend to increase their share of the market with new and exciting products.

More significantly, several of the world's largest manufacturers of toys and electronic games—Exidy, Mattel, Atari and APF Electronics—see the personal computer market as a natural extension of their home entertainment and education markets. Thus each of those firms has dedicated considerable funds to develop computers that would serve that market adequately. Some, such as Exidy and Atari, have developed a basic computer that will work well strictly in programming applications or for use as a video game. Others, such as APF and Mattel, have developed a sophisticated video game component, to which a keyboard can be added later to produce the final computer.

With the latter approach, the marketing strategy seems to be to capture the interest of the consumer first with a high-level "toy" that can be a powerful learning tool as well as a talented opponent in home games. After the initial investment in the game component, the owner—or more likely the owner's parents—can later add the keyboard component and thus have a relatively powerful computer with a wide variety of educational, business, and financial software available.

Compucolor II

Compucolor, a division of Intelligent Systems Corp., made a bold decision when it introduced its Compucolor II personal computer in 1978. Rather than entering the market with a computer without a cassette (as some others had done), or a mini-disk drive (as most others had done), or a color monitor (as all others had done), Compucolor offered a self-contained, two-piece, deck-top unit that included a keyboard chassis connected via ribbon cable to a high-quality color monitor. The unit also contained a built-in 51K minifloppy disk drive. Not only was the system unique in that the owner went directly to a diskette, rather than



COMPUCOLOR II can combine business with excellent color graphics.

upgrading from a cassette, but the owner was saved from the frustrations of arguing about who could use the family color television set during prime viewing time.

Several models available

The Compucolor II computers all have the same central processor, an 8-bit 8080A. The *model 3* comes with 8K of RAM, the 51K minifloppy disk drive, and a high-resolution color-video monitor. All of that costs \$1595. The *model 4*, comes with 16K of RAM and sells for \$1795, while the *model 5* has 32K of RAM and sells for \$2095. Finally, a special 16K Compucolor computer with an oversize 25" screen is available for schools for \$2895.

An extended version of Microsoft BASIC is used in the Compucolor computers. Special commands have been added to it to accommodate the color-graphics capabilities of the machine. Two other language capabilities are available as well. For \$75, FORTRAN IV can be purchased for the machine; and for only \$24.95, an assembler.

Disks have a few disadvantages

Until recently, owning a Compucolor computer had one big drawback: You had to buy blank diskettes from Compucolor, because a special formatting is used on the diskettes and Compucolor wouldn't tell anyone else how to do it. They were the only source for those diskettes, which, consequently, cost more than they should have. The result was that Compucolor owners balked at their involuntary continued connection with Compucolor, but Compucolor had a perpetual market for its blank disks. Worse than that, commercial software manufacturers refused to support that machine, because they, too, were required to purchase formatted diskettes from Compucolor. (Compucolor's price was higher than what commercial software houses could buy diskettes for elsewhere, so prices for software would have to go up considerably.) To my knowledge, even today, Compucolor is the only source for programs to run on the Compucolor computer.

Recently, the disk situation has changed and a formatter program that will format blank diskettes properly for use on the Compucolor computer is now available. Another problem with the Compucolor disk system is that a formatted diskette will only hold 51K of program or data. That is the lowest amount of data being stored on 5¼-inch minifloppy diskettes that I know of. The company claims that the diskettes they supply can be used on both sides. But that's

no better than having two separate diskettes, because on-line storage is limited to 51K per drive. The reason is that while programs *can* be stored on both sides of a diskette, the drive used can only access one side of the disk at a time. By the way, if additional disk storage is desired, an extra drive can be purchased for \$395. Compucolor is working on two advances in disk storage, an 8-inch drive and a 25 megabyte hard disk.

There are three different keyboards offered for use with the Compucolor computer. The least expensive one, which is standard with the basic unit, is a 72-key ASCII keyboard. For an additional \$135, the expanded keyboard can be substituted for the standard one. That unit features numeric and color-coded keys that can be used to specify color graphics when desired. For the person who wants to go first-class all the way, a deluxe keyboard can be substituted for the standard one for only \$200 more than the base price. That deluxe keyboard also offers a numeric key pad and has 16 additional function keys.

While input for the computer normally comes from the keyboard, output from it normally goes to the 13-inch color-video display. The screen can display characters in two modes. In its most dense mode it is possible to get 2048 characters on the screen in a 64-character per line, 32-line per screen format. If larger characters are desired, it is possible to double the size and get 16 lines of text on the screen.

In addition to its text-display modes, the Compucolor computer has a 128 × 128 point graphics-display mode in which it is possible to display 8 foreground and 8 background colors. A nice feature of the graphics mode is that it is possible to mix graphics with text, with characters capable of blinking, if desired.

Exidy Sorcerer

Exidy, a major manufacturer of coin-operated video games, entered the personal computer market in 1978 with the *Sorcerer* computer. The 13-pound keyboard console, which does not include a video display or a cassette tape recorder, contains a 63-key ASCII keyboard that allows you to access the full 128-character ASCII set, as well as 128 programmable graphics characters. The keyboard also contains a 16-key numeric key pad.

On the right side of the keyboard console, is a removable plug-in cartridge that physically resembles a standard 8-track stereo cartridge. Many people believe that it is; however the cartridge is really a ROM PAC that contains 8K of read-only memory. When the *Sorcerer* first came out, it was equipped with a BASIC ROM PAC that contained Microsoft 8K BASIC. Nowadays, that costs extra.

The original *Sorcerer* was available in 8K, 16K and 32K versions. However, because of many problems with the original circuit board, it was redesigned and at that point provision was made to add an extra 16K of memory, so that later units now are capable of being expanded up to 48K.

It had great potential but...

When the *Sorcerer* first came out, it looked as if it were going to give the *PET*, the *TRS-80*, and even the *Apple* a run for their money. It promised a lot and seemed to take the good points from all of those machines and combine them into one. It had the standard *PET* graphics character set, but allowed the user to define his own graphics characters and assign them to any key. It had a "real" keyboard, which the *PET* didn't. It had a Z-80 microprocessor like the *TRS-80*—and like the *TRS-80*, had the longer 64-character line. Like the *Apple*, it had a very fast cassette-tape interface—1200 baud as opposed to the 300- and 500-baud interfaces of the *PET* and the *TRS-80*—but it also permitted programs to be read and stored at 300 baud if desired. And it featured higher-resolution graphics than the *Apple* (240 × 512 dots), making it possible to get unbelievably beautiful graphics.

Graphics, however, were limited to black and white. The *Sorcerer* has some other nice features, too. It has an expansion box that is compatible with the S-100 bus, making a raft of accessories, both hardware and software, available for use with it. It also has a Centronics compatible parallel printer interface built in, as well as an RS-232 serial interface and a dual-cassette interface.

With all that going for it, how could the *Sorcerer* help but be a big hit? It's simple. The human interface, both to the machine and the company, was terrible. One of the biggest drawbacks of the *Sorcerer* is that it has no screen editor. For the uninitiated, that means that if you make a mistake when entering a program and you notice it after the line has been entered into memory (in other words after you press the RETURN key), it is not possible to list the line on the screen and then move your cursor to it and correct it. Instead, you must retype the entire line in again. While that may seem insignificant, its importance is quickly realized after a few long programs have been written. Exidy's answer to that was that if you bought the word-processor cartridge, which sells for \$199, you can overcome the problem. That's a lot to pay for a feature that should be standard (and is on most other machines).

Another problem with the BASIC is that it is not possible to list a particular line or a range of lines. You can only list a program from the beginning, or from a particular line number, to the end of the program. And if you wish to stop the listing, you have to type a CONTROL-C. There are many other problems with the *Sorcerer*. It is altogether too easy to wipe out the program you are working on by exiting to the monitor and coming back to BASIC. While a warm-start return to BASIC is provided, this is still a situation that arises all too often.

What is one of the biggest problems with the *Sorcerer* is its absolutely atrocious documentation. It comes with two manuals but even after reading both of them you still don't know what all the capabilities of the machine are or how to implement them. An additional manual, originally produced by a *Sorcerer* user, is now being made available by Exidy. That clears up a large number of the questions left unanswered by the other manuals, but not all of them.

If you have a problem and try to call Exidy for a solution, don't be too hopeful. While there is someone who fields such phone calls, that person is not always available and, when available, is frequently less knowledgeable than the caller. In my particular case, several phone calls that got me connected to several different people, resulted in the expected—several different answers. The particular question is not important, but the response is. One response was: "I don't understand what you're talking about." Another was: "It can't be done." Still another was: "I think someone here wrote a program that can do that but I don't remember who." The question was never answered satisfactorily.

But all is not lost for the *Sorcerer*. Exidy's latest plans call for getting away from the hobbyist and aiming the *Sorcerer* at business applications. Let's hope that the quality of Exidy's service department grows along with its aspirations.

The *Sorcerer* with 16K of RAM sells for \$1295; with 48K of RAM, the price is \$1495. A 12-inch black-and-white monitor is available for the outrageous price of \$499. For users requiring fast mass storage, a floppy-disk subsystem, using 5¼-inch minifloppy-disk drives that can store 120 kilobytes of data on a diskette, is available for \$1150. That includes the controller. Additional drives cost \$795. A combination video-monitor/disk-drive subsystem, which will store 308 kilobytes per drive and comes with two drives, is available for \$2995.

APF Imagination Machine

APF Electronics' *Imagination Machine*, also known as the *IM-1*, is a home-entertainment center for fun and games and also an effective personal computer for serious activities such as education. The *IM-1* features music output,

games in color, and a built-in dual-track cassette recorder that permits voice to be played back on one track, and machine-readable data on the other.

The *IM-1* consists of two components, a computer console (\$500) and an *MP 1000* game controller (\$130). The console includes a 53-key typewriter-style keyboard, 8K of RAM, a built-in dual-track cassette recorder, an audio section with a sound synthesizer, microphone input, volume control, and loudspeaker. A helpful feature on the keyboard console is the printed instructions for single-key entry of the 24 BASIC commands available.

The *MP 1000* game console, which contains its own 11K of RAM, has been marketed for quite a while by itself as a stand-alone TV game. It contains two 4-directional joy-



IMAGINATION MACHINE, from APF, makes a good introductory computer.

sticks with numerical keypads and "fire" buttons. The *MP 1000* fits into a cutout in the keyboard console and is connected to it by means of a sturdy "U" connector.

The two-component combination, or *IM-1*, offers 9K of RAM and 10K of ROM and has a video-screen format of 32 characters per line, by 16 lines. Output is sent to an ordinary black-and-white or color television set via a built-in RF modulator.

Software for the APF computer is available in two forms, ROM and cassette tape. Among the programs available on cassette are Typing Tutor, Math Tutor, Budget Manager, and Artist & Easel. The solid-state ROM cartridges provide such games as Blackjack and Backgammon as well as APF's 12K BASIC, which is not a Microsoft BASIC.

Musical entertainment is possible by applying a series of symbols after the MUSIC command is entered; tunes with a musical range of up to three octaves can be played with the built-in synthesizer and speaker. Another form of art available on the *IM-1* is computer-generated graphics. In the "low" resolution mode, up to 16 shapes—in up to 8

colors—can be displayed in 512 cells of 32 columns by 12 rows. In the "high" resolution mode, up to 128 × 192-dot resolution is possible.

Accessories recently introduced for the *IM-1* include a printer, modem, minifloppy-disk drive system and a memory-expansion unit. That last one is the most serious shortcoming of the *IM-1*. Currently, it is only expandable to a maximum of 16K of RAM. While that should be sufficient for most applications, it is desirable to be able to go farther.

Cromemco Z-2 computer

Cromemco Z-2 computers, for the most part, are directed towards the most serious business, engineering, and scientific professionals. At the high end of its product span, the Z-2 system includes 11 megabyte hard-disk drives, a multi-user system capable of handling up to eight users and memory expansion up to 512K. But at the low end of their line, they do indeed supply small systems that fall within the budget of the personal-computer/small-business owner.

First, Cromemco computers are not packaged in flashy, color-molded cases. Instead, they are housed in standard 19-inch-wide cabinets, suitable for rack mounting. The basic Z-2 unit contains slots for 21 memory and I/O boards plus room for two minifloppy-disk drives. With 4K of RAM, and no disk drives, the basic Z-2 costs \$1290. When a mini-disk drive is added, the system becomes a Z-2D. A Z-2D, with 64K of RAM sells for \$3785 and with two drives it costs \$3990.

Basic input and output to a Z-2 computer must be done through a terminal, preferably a CRT terminal. Cromemco offers one, the 3102 CRT Terminal, for \$1995. It features a 116-key ASCII keyboard with 20 user-definable keys and a 14-key numeric pad. It also has a 12-inch CRT display that will show 1920 characters on 24 lines of 80 characters each, using a 7 × 9 dot matrix display.

Since the Z-2 is designed to support the S-100 bus, there are a host of other peripherals available for it. Software that is available includes several versions of BASIC, FORTRAN, COBOL, CP/M, and a Z-80 Relocatable Macro Assembler, to name a few packages.

Atari 400 and 800

Atari, well known for its sophisticated home and arcade games, offers two personal computers, the Atari 400 and the Atari 800. The Atari 400 is in the \$600-price class and includes a touch-sensitive, 57-key, flat keyboard (here's another company that didn't learn from Commodore's mistake) with upper and lower case letters, graphic sym-



ATARI 400 is one of two computers offered by this manufacturer.

bols, and full screen-editing functions.

The basic machine comes with 8K of memory that translates into only 5K for the user, because the computer uses the other 3K for internal operations. That 5K however winds up being more like the equivalent of 3K because of the inefficient way in which BASIC programs are stored in memory. That is another BASIC that was not written by Microsoft, but by Shepardson Microsystems; it is also a BASIC that is going to give its owners a lot of problems. Aside from its wasteful use of memory, it handles strings entirely differently from the way Microsoft BASIC handles strings. As a result, 90% of the programs that appear in the hobby-computer magazines will not be usable as they are, and will probably require significant alteration to get them to run on an Atari computer.

A single-cartridge slot is available for plug-in software. That is normally occupied by the BASIC ROM cartridge. While the 400 comes with only 8K of RAM, it is possible to send it back for upgrading to 16K of RAM. That is the maximum amount of RAM possible in the 400. Because of its memory limitations and nonstandard keyboard, the 400 will probably die a fairly rapid death as those people who absolutely must have an Atari computer opt for the 800.

The Atari 800 is priced from \$1000 and boasts a full-size typewriter-type keyboard. It comes equipped with 8K of RAM, 8K of internal ROM and 8K of BASIC in a ROM cartridge. Unlike the 400, however, the 800 has room to place memory-expansion modules that can contain 8K or 16K of additional RAM. Be careful how you insert them, however. While the instructions in the manual tell you how to put them in by referencing the printed material on the top of the memory cartridge, some cartridges have been produced with that information upside down. Thus, trying to insert the cartridge according to instructions could possibly result in damage. Internal ROM can be expanded to 26K.

As far as mass storage is concerned, up to four minifloppy-disk drives can be added to the computer. Each drive is capable of storing 92 kilobytes of data on a diskette, resulting in a maximum on-line capacity of 368K.

Among the recent peripherals announced for the 400 and 800 are the Atari model 825 80-column, dot matrix,



WIDE RANGE of accessories is available for the Atari 800.

impact printer; the Atari *model 830* Modem and the Atari *model 850* Standard Interface. That interface permits connection of RS-232 and other peripheral devices to the Atari computer.

To tackle the potential problem of nationwide service, Atari has entered into an agreement with Control Data Corp. to provide service to 400 and 800 owners through 200 service centers across the country. In addition, Atari will market Control Data's powerful Cyberware business investment programs which will run on the 800 only.

Mattel's Intellivision

Mattel Electronics has invested more than three years of design effort into *Intellivision*, an integrated personal computer that is connected to the user's TV set through a built-in RF modulator.

Mattel's approach to the home computer market is similar to APF's, where there are two components, a video game, and a keyboard unit. The game part of the system is available and is known as the Master Component. It comes with two hand controllers, or keypads, with 12 keys each and four action buttons. The second part of the system, the Keyboard Component, will have a 60-key tactile keyboard, which will display 40 characters per line and 24 lines per screen. Characters will be upper and lower case. Also included are a built-in cassette recorder and an 8-bit 6502 microprocessor.

The keyboard unit has given Mattel a lot of headaches and its introduction has been delayed several times. Lab prototypes, which surface at shows, contain Microsoft BASIC, but final units are expected to contain Mattel's own BASIC. Let's hope it is compatible with Microsoft's.

In the graphics mode, 15 colors can be displayed in a 30,720-point array (160 × 192). In addition, 8 moving foreground symbols are available. To add excitement to TV



INTELLIVISION from Mattel will do more than just play games.

games, a synthesizer chip is included in the Master Component to generate cheers when a goal or a win is scored. In the Keyboard Component, the audio channel of the cassette recorder can furnish music or sound effects.

Mattel is currently marketing the Master Component and expects to have the Keyboard Component out by early 1981. At that time, a 40-column printer and modem are also scheduled for release. The cost for an *Intellivision* system will range from \$300 for a system with 2K of RAM, to \$800 for a system with 18K of RAM.

To satisfy those consumers who consider prompt service an important factor in determining which computer to buy, Mattel has arranged for hundreds of General Electric (GE) service centers across the country to operate as authorized *Intellivision* repair centers.

R-E

PERIPHERALS AND ACCESSORIES

That Expand Your Computer

When you've made the decision to purchase a computer, you've only just begun to build a system.

OWNERS OF STEREO COMPONENT SYSTEMS AND OWNERS OF personal computers have one restless desire in common: the urge for change. Rare indeed is the stereo-component buyer who has not "upped" his system with an improved turntable, or added a graphic equalizer or Dolby tape deck. The same for the serious computer hobbyist. After his initiation into the exciting world of computer applications, it is natural to reevaluate his needs for a printer to provide permanent, or "hard copy" output, a floppy-disk system to add considerably more memory storage than his cassette can conveniently provide, or a modem to permit him to communicate with other computers and access "information utilities" (see page 74 this issue). Then there are speech and music synthesizers to add more excitement and fun to the computerized games he plays, AC controllers to permit his computer to control lights and appliances in his house, and a host of other devices.

Peripheral devices permit the basic computer to communicate with the outside world. Hundreds of peripherals are available from a growing number of manufacturers anxious to penetrate the rapidly growing personal computer market. Most personal computer manufacturers themselves offer a wide line of peripherals for their own equipment.

There are a large number of peripherals that might be desirable to add on to personal computers, yet they are not available from the computer manufacturers, but from independent manufacturers. When the computer owner decides to purchase such a peripheral, it becomes his responsibility to see that the device is plug-in compatible (meaning that it is hardware- and software-compatible) or else face the task of matching the peripheral to his computer. Quite often, a particular peripheral can be obtained at a lower cost by buying from a peripheral manufacturer instead of the computer manufacturer. Also, it is not unusual for a computer manufacturer to delay the introduction of a peripheral device until it is sure that there's a large enough market for it. The reason is that frequently computer manufacturers don't make their own peripherals, but purchase them from independent suppliers. In order to get a good price they must purchase in large quantities. Often it is possible to purchase the same device easier, and at a cheaper price, from the independent.

Peripherals can cost more than the personal computer they serve. It is thus important for the user to analyze both his current and probable future needs carefully before making an additional investment. If you buy more than you really need, you will never get a bargain. On the other

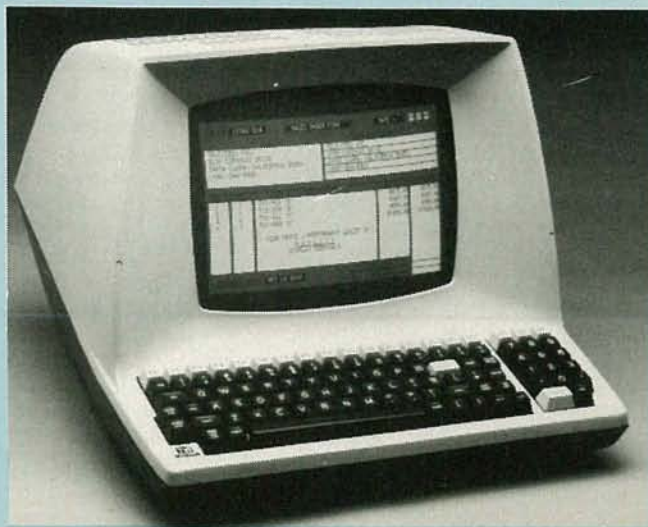
hand, if you buy less than you need, you'll probably have to upgrade in a short time, losing again.

CRT terminals

In the early days of personal computing (only five years ago), hobby computers were most often equipped with a series of front-panel switches and LED indicators. More convenient input and output required the use of an external terminal, generally a CRT terminal. Today's computers generally have a keyboard and video interface built in, generally eliminating the need for an external CRT terminal. There are however, instances when those external terminals are quite desirable. Most often that occurs with computers that are limited to 40-column displays and have to be used in applications where 80 or more columns are required. A particular example of that is the Pascal system offered for use with the *Apple II* computer, which is designed for 80-column operation.

Well over 500 models of terminals are on the market today, and most use the interface standard set up by the Electronic Industries Association (EIA) known as RS-232. That standard defines the voltage levels, control signals, connectors, and pinouts required. Most display terminals use cathode-ray tubes (CRT's) as displays, although a few use flat-panel plasma displays.

Terminals come in three levels of sophistication; dumb, smart, and intelligent. A dumb terminal is basically a key-



CRT TERMINAL is a necessity for many computer systems.

board plus a CRT display. Add some hardware to provide a programmable cursor (next letter-position indicator) and the user can now do more than just see what is taking place. That is a smart terminal and permits the user to do such editing chores as inserting and/or deleting letters or words. Finally, an intelligent terminal not only allows editing, but is programmable. Tasks such as moving the top lines up and off the screen as new lines are entered and later recalling them are possible. An intelligent terminal needs memory to handle its varied tasks and thus usually has its own RAM and ROM. In addition, it usually has local-storage capabilities on its own cassette or disk systems.

Get it in writing

Using a personal computer to play the various games that are available is a lot of fun. When you're finished, you turn off the computer and that's that. But if you are using your computer for serious business tasks, or to complete your income tax, you must finish the job and write out your results before you turn the computer off—or lose the information.

So a rather necessary peripheral for the serious computer buff is a printer; and a printer can cost as much as, or even more than, the computer itself. With a printer connected to the computer, the user has the ability to produce a variety of printed material such as program listings, mailing labels, billing, and inventory records to name a few.

Printers can be classified in several ways. First, there are impact printers that operate by transferring a character to paper through an inked ribbon, much the way a typewriter does. In contrast, there are non-impact printers that use such printing technologies as electrostatic and thermal techniques.

Impact printers that produce either complete, typewriter-like characters, or segmented characters formed by a matrix of dots, are available. Fully-formed characters are printed in a single stroke. With matrix printing, a defined series of dots form the character just as a TV picture is created by a series of scanning spots on a television screen. Printers are also referred to as character printers and line printers. A character printer creates one character at a time, and prints it. A line printer prepares a group of characters along the line at the same time and the line appears to be printed at once. The line printer is much faster, but also more expensive.

Which is preferable? That depends on the application. Fully-formed characters printed by devices with a *Selectric* or daisy-wheel type of print head are sharper and clearer than characters printed by a matrix print head. They are particularly pleasing for letters and word-processing applications. Most applications don't require that, so the matrix printers, which are cheaper, are sufficient. For applications that require multiple copies, impact printers are usually to be preferred over non-impact types.

Another key factor in the choice of a printer is speed. The instantaneous printing speed is the rate at which the print head can produce characters. It does not include the carriage return time, which in some printers is minimized by using bidirectional printing techniques. Something else to consider is that the rate at which a printer receives data may be faster than the rate at which it can print it. In such cases, the printer must contain some sort of buffer (extra memory to store the data until it is printed).

One of the earliest, and still frequently used, printers in the low-cost computer market was the *Teletype* cylinder printer, shown in Fig. 1. A complete set of characters is arranged in a series of concentric rings on the printing mechanism. To move the proper character into position, electronic signals direct the motion of the cylinder in a circular, as well as an up-and-down direction. Once the proper character is in position, a hammer strikes the cylinder, causing it to transfer ink from a ribbon to paper.

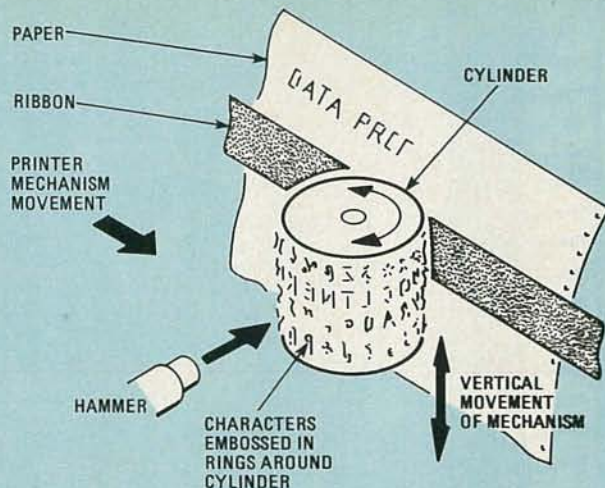


FIG. 1—CYLINDRICAL TYPING ELEMENT is capable of printing speeds of up to 10 characters-per-second. This became the first low-cost printer for the hobbyist market.

Used *Teletype* printers are available from \$200 to \$500, while new ones cost about \$1200.

The *Teletype*, at 10 CPS (Characters Per Second), is very slow and only permits upper-case characters. An improvement in both of those areas was made with the development of printers based on the IBM *Selectric* mechanism, shown in Fig. 2. Here, a type sphere is rotated on its axis until the proper character is selected and then the sphere strikes the ribbon. That mechanism improved printing speed to about 14.5 characters per second. The price tag for such printers is in the \$1000-to-\$4000 range.

Another design for a letter-quality impact printer is the daisy-wheel printer shown in Fig. 3. On each spoke, or petal, is a single character. When the hub is rotated to the correct position, a hammer is energized which causes the letter to strike a ribbon. Both the daisy-wheel and *Selectric*-type print mechanisms have a wide variety of type fonts available, with the *Selectric* balls offering the wider choice. Daisy-wheel printers, such as those produced by Qume, Diablo, and Howard Industries operate at speeds ranging from 30 cps to 55 cps. Prices range from \$2700 to \$7000.

The most commonly used printers in personal computer applications are matrix printers. That is because they are usually the cheapest, generally under \$1000. But high-performance matrix printers can exceed \$9000 in price. In matrix printers, the print head contains a vertical column of small needle hammers that are moved across the page while input is fed from information stored in memory. Print heads usually have seven to nine needles in a vertical row, and a horizontal matrix that is four to seven

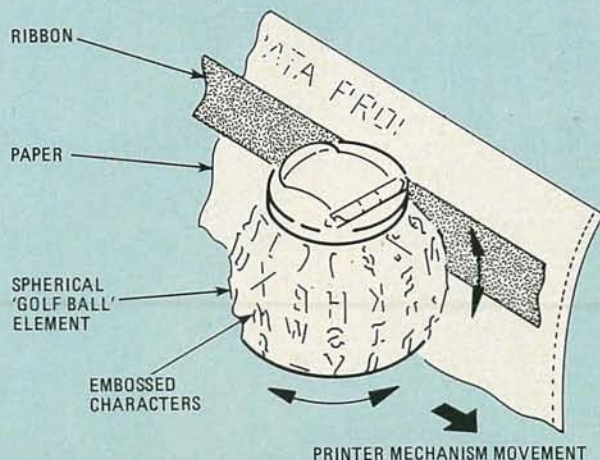


FIG. 2—THE SPHERICAL TYPING ELEMENT, commonly found on *Selectric* typewriters, offers a choice of typefaces and operates at printing speeds of up to 15 characters-per-second.

columns wide, to form a complete image of the character. The larger the matrix, the better the character definition. In fact, some new printers from Sanders Associates, Centronics, and Integral Data Systems, make multiple passes over the same character with the head position moved slightly each time. That produces a character that has more dots and can approach the quality of fully-formed character printers. Character-based matrix printers can print at speeds as high as 330 cps, while line printers can reach speeds of 500 lines per minute.

Non impact printers are generally quieter, cheaper, and faster than the impact types; but they are often less legible and sometimes require a special paper. Also, they do not produce multiple copies on a single pass.

A thermal matrix printer uses a heat-sensitive paper which changes color when heated to 200°F. A typical print head contains a 5-by-7 array of dot-heating elements. The head forms a single character at a time and moves horizontally across the specially coated paper. The speed of such printers range from 50 to 100 cps; speed is somewhat limited by the need for the dot elements to cool down a bit before proceeding to create the next character. Prices for such printers range from \$500 to \$1000.

Electrosensitive printers are somewhat similar to thermal

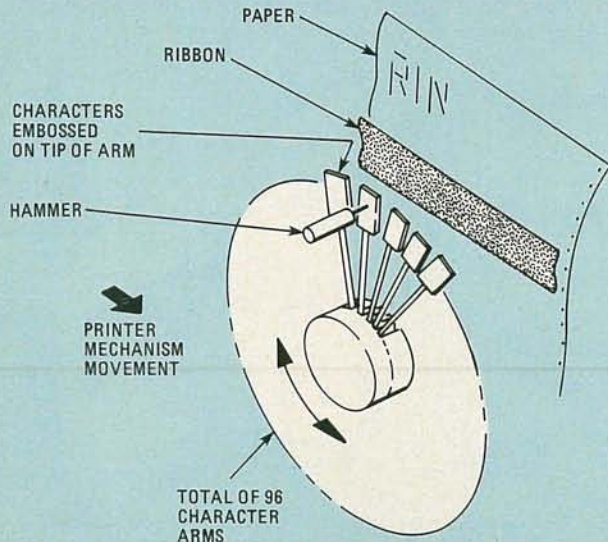


FIG. 3—DAISY-WHEEL PRINTERS are relatively expensive but offer letter-quality printing at speeds of up to 55 characters-per-second. Print wheels can contain up to 96 characters.

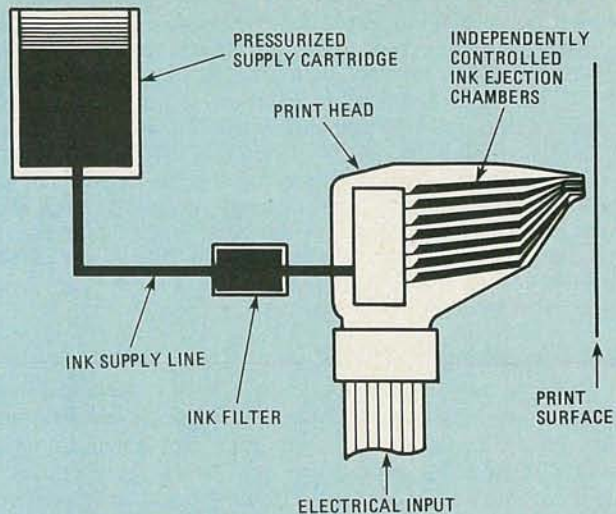


FIG. 4—INK-JET PRINTERS are a relatively new technology and use ink jets to produce matrix characters on paper.

printers in that they also use a specially coated paper, as well as a matrix print head. Instead of having heating elements in the print head, those have small metallic electrodes. A dark paper, coated with a light-colored conductive layer, is pulled in front of the print head. To form a particular character, a series of pulses are applied to specific head electrodes; a voltage breakdown, or arcing, takes place and the conductive coating is destroyed leaving the dark areas exposed to create a character. To form a different character, voltages would be applied to different electrodes on the print head to burn away different areas of the conductive coating.

Another non-impact approach to printing is the ink-jet system, Fig. 4. Here a high-velocity stream of ink, in the form of microscopic droplets, is squirted at the paper. The droplets are given an electrical charge and passed between electrodes whose voltages are varied. The ink droplets are thus deflected, much like the beam of a CRT, and form characters on paper. The printing speed is high and up to 180 lines per minute can be printed.

Here are some typical prices for a variety of printers. A thermal printer (40 cps) for the *Apple II* computer costs \$595; an electrostatic model (150 lines per minute) costs \$695, and an impact matrix printer (60 cps) is available for \$1545. A matrix impact printer (65 cps) for the *PET* costs \$798. Radio Shack markets an electrostatic matrix printer (120 lpm) for \$239 and several impact matrix printers (up to 120 cps) from \$999 to \$1999.

When looking at those prices a few things should be remembered. Not all of the printers have the same capability. Some print only 40 columns across while others go to 132. Some include tractor-feed mechanisms for the paper, while others don't. The prices are not quoted for comparative purposes—not enough information is presented for that—but rather to show a range of prices for currently available equipment.

Need more memory... add a floppy disk

It doesn't take a serious computer hobbyist much time to feel a craving for more memory than his cassette can handle conveniently. The hobbyist also soon becomes impatient with the slow access time of a tape as he rewinds to search for a particular section. A disk is a randomly accessible memory device that is capable of storing and retrieving information considerably faster than a tape system. Of the various types available, the minifloppy disk is the most popular in the home computer market.

The floppy disk was first introduced to the market by IBM and is somewhat similar in appearance to a 45 RPM record; it is more flexible (see Fig. 5), has no grooves, and is permanently sealed in a square plastic jacket. The only exposed area

is in a slot cut in the jacket which provides a place for a magnetic head to make contact with the magnetic media of the diskette. Tolerances in floppy-disk drives are very close and the magnetic head is in intimate contact with the rotating media. In addition, the speed of rotation is quite high (360 RPM), so that even a small speck of dust, fingerprints, or cigarette smoke can cause a read or write error to the disk. Therefore, users are instructed to replace diskettes back into their protective envelopes immediately after use.

IBM's original floppy-disk entry was an 8-inch disk, the 3740, which featured 77 tracks (48 tracks-per-inch), soft sectoring with 26 sectors-per-track, 128 bytes-per-sector, a recording density of 3200 bits-per-inch and a speed of 360 RPM. Since then, minifloppy disks, 5¼-inches in diameter, have appeared in both hard-and soft-sector formats.

What is soft sectoring? It is a method by which codes are used to identify various sectors on the disk (see Fig. 6). It permits a blank diskette to be formatted in any way desired. For example, on the *Apple II*, diskettes were originally formatted as 35 tracks with 13 sectors-per-track and 256 bytes-per sector. A recent improvement now makes it possible for *Apple* disks to be coded as 35 tracks with 16 sectors-per-track, resulting in 24K of additional data storage on the same physical medium. When a soft-sector disk is used, it is formatted first and information is stored on it that defines each track and sector so that when the disk system wants to store data, it can read that information and know exactly where it is all the time.

The second approach to disk storage is hard sectoring. Here, a series of holes, one for each sector, is punched on the periphery of the center-drive hole. A LED-and-photocell combination permits light to pass through the holes as they rotate, causing pulses to be generated. The electronic circuitry in the drive counts those pulses so that the drive always knows where the head is on the disk.

While all floppy-disk systems operate in a similar manner, storage densities vary from 170K for PET diskettes to as little as 51K for compucolor diskettes. Storage capacity is only one of the parameters to consider in disk systems. It refers to the number of tracks, the number of bytes-per-track and the number of recording surfaces (some drives record on both sides of the floppy disk). Others are access time and transfer rate. Access time is the time it takes to position the head to the proper track, plus the time it takes for the diskette to rotate and reach the appropriate sector, plus the time to read or write the data. The transfer rate is determined by the disk-system speed of rotation, recording density, and the number of tracks that can be accessed in parallel.

Recent advances have improved the performance of disks and disk systems. To increase storage capacity, double-density and double-sided systems have been developed. Double-sided systems include a read/write head on each side of the diskette and thus result in twice the storage capacity. Some double-density systems double the number of tracks per side, e.g. on minifloppies from 35 to 77; others simply pack more information into the same number of tracks. By combining both of those technologies, a fourfold increase in storage capacity is possible.

How does it work?

A disk-drive system is a sophisticated combination of servo-mechanisms and control electronics. When a diskette is inserted into the drive, a spindle locates the center hole and a motor brings the speed of the diskette up to 360 RPM. Then the read/write heads are positioned over the first track, 00, by the small index hole in the diskette. The heads are next positioned to whatever location is desired by a seek operation. The heads float over the tracks until the proper position is found; then a head-loading coil pulls the heads down (loads them) to the magnetic surface of the diskette. When the heads must be moved to another location, they are lifted off the media (unloaded), moved, and then loaded again.

There are many applications where it is necessary to store a

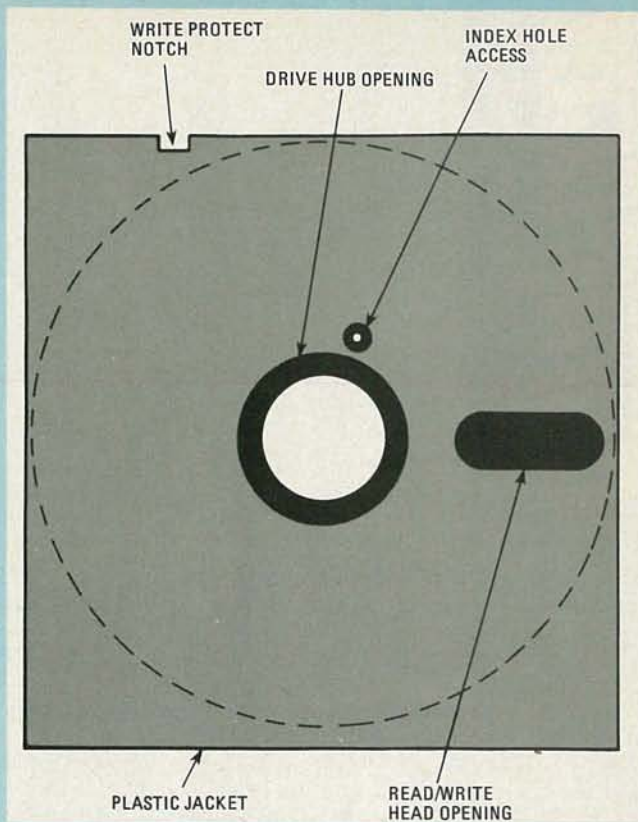


FIG. 5—A FLOPPY DISK is almost fully enclosed in a jacket to protect the surface from dirt and physical damage.

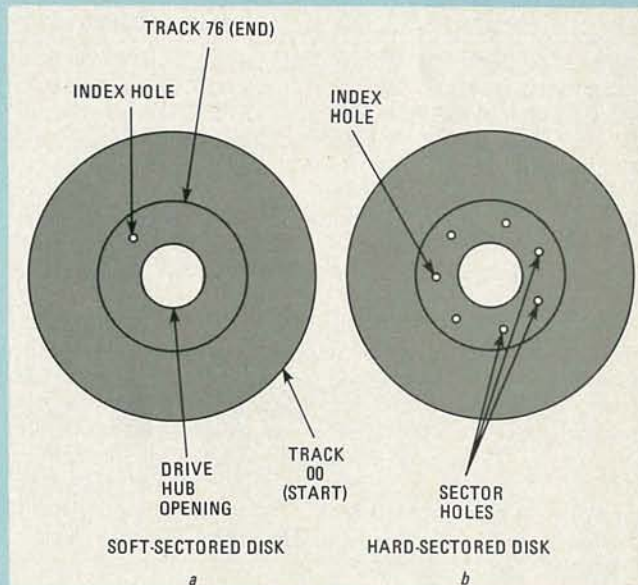


FIG. 6—A SOFT-SECTORED DISK, shown in a, uses one index hole to locate the data on the surface of the disk. A hard-sectored disk, shown in b, uses many index holes for the same purpose and is more efficient because less computer memory is required for the system.

lot of information on disk. Frequently that can exceed the storage capacity of a single diskette. For such applications, there are other types of disk drives that do not have flexible media. Those are called hard disks. A new type of mini hard-disk that uses a technology originally developed by IBM has just recently been announced. Those disks are known as micro-Winchester disks and they provide a phenomenal 6 megabytes of storage on a 5¼-inch hard disk. Prices for the disks are expected to be in the \$1500 range.

Computers can chit-chat...with a modem

Once a user gets used to working by himself at his personal computer, it doesn't take long for him to start thinking of

communicating with other terminals, computers, or "information utilities." At that time, he is ready for a peripheral called a modem (for *MOD*ulator-*DEM*odulator) which permits digital information to be transmitted over long distances via phone lines.

Basically, a modem provides a means for a digital signal to modify an audio signal so that the digital information can be sent over the phone lines. On the sending end, the audio signal is encoded, or modulated, with the desired information and at the receiving end, it is decoded, or demodulated. The modulation is generally done by a technique known as FSK (Frequency-Shift Keying).

Connection of computer modems to telephone lines can be direct or indirect. Indirect connections are done via an acoustic coupler. The acoustic coupler has a cradle that holds a telephone receiver, into which the electronic signals to be transmitted are acoustically coupled. With an acoustic coupler, the user must dial the phone himself and then place the handset in the coupler.

With a directly coupled modem, the modem is connected directly to the phone line and, with the appropriate hardware and software, it is possible for the computer to dial numbers, or answer phones, and then transmit the required data and hang up.

The cost of acoustic couplers is generally about half the price of hardwired modems because the acoustic devices must then be connected to a serial interface, which generally more than compensates for the difference in price. One of the most popular acoustic modems is the CAT by Novation Inc., 18664 Oxnard St., Tarzana, CA 91356. It usually sells for between \$150 and \$199. The most popular direct connect modem for the *Apple* computer is the D.C. Hayes Associates, Inc. (10 Perimeter Park Dr., Atlanta, GA 30341) Micromodem II, which sells for about \$400.

Computers can talk and play music

Computers operate from digital signals, a fact known even to the novice. Thus it is startling to hear a voice or music coming from a computer. Similarly, it is entertaining to watch the reaction of an observer when the owner of a home computer commands his computer to do things with spoken words; yet the observer, using the same words, cannot get any reaction from the computer.

The ability to generate voice or music from digital signals is called speech or music synthesis. Music is easier to generate than speech, since a musical tone contains a fundamental frequency and a series of harmonics. Speech, with its various sounds and inflections, is generally a complex, non-repetitive waveform that is more difficult to synthesize.

To generate a musical note, an algorithm is developed and the computer is instructed on the duration and amplitude of the signal. To form chords, a number of different tones are



MODEMS LIKE THIS allow computers to use the telephone.

combined. To generate speech, a variety of techniques are used. One approach consists of feeding a microphone's output to a computer, where an analog-to-digital (A/D) converter samples the waveform and converts it to digital signals, which are then stored in memory. For adequate reproduction a high number of samples is required, demanding considerable memory storage. For example, to reproduce four minutes of speech properly would require almost 250K of memory—enough to fill an 8-inch floppy disk.

Another approach to speech synthesis makes use of phonemes, basic elements of speech, which do not correspond to words or letters of the alphabet; instead, they are sounds that can be combined to form words. That technique is much more efficient in the use of computer memory. The drawback is the somewhat unnatural sound that is produced. Digitized speech output is available on the *Apple II* computer with the *Super Talker*, which is a speech-output device produced by Mountain Hardware, Inc., 300 Harvey West Blvd., Santa Cruz, CA 95060. The price is about \$400.

The new Texas Instruments 99/4 computer has a solid-state speech synthesizer module that contains over 200 predefined words in its vocabulary. When the operator types SAY "DOG", a bark will be heard from the computer's self-contained audio circuits.

In addition to talking, computers are capable of listening to and understanding spoken words. A speech-recognition system generally includes a microphone, a preprocessor, and a feature extractor. When the operator speaks into a microphone, the preprocessor analyzes the spoken word while the feature extractor investigates any unique or unusual features of the voice. The computer then identifies the word and stores the information leading to the decision. That all takes place during an initializing session called training. Once the system has been trained, it will recognize those words on which it was trained. Since the speech-recognition system has averaged and stored the unique speech pattern of the trainer, it will not always respond to the same words spoken by a different individual. As such, it is possible to use it to identify individuals by voice only.

A variety of other devices used, too

In addition to those major peripherals, computer owners often find need to purchase other devices to improve the operation of their system. Those can range from filters for the power line to accessory devices such as the *Data Dubber* from The Peripheral People in Mercer Island, WA that makes it easier for the TRS-80 to read computer tapes. **R-E**

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SOFTWARE AND DATA VIA TELEPHONE

Even the largest personal computer has its limitations. You can get around these, though, by using the information utilities offered by several services.

THE NEWEST AND FASTEST-GROWING UTILITY TODAY IS THE "information" utility. Many modern philosophers and educators claim that information is power. The more you know, the better you can plan. The faster you can predict will determine your success as a student, businessman and professional.

Top performing corporations have been using large and expensive computers for years to increase their lead over competitors; they make use of their "information utilities" to power their growth. And now, the home computer owner can have access to the same type of computing power so that he can search legal documents, track down news stories, reserve airline or theater tickets, identify stock market prices and trends, research term papers, pinpoint government research projects—all without leaving his home. Low-cost timesharing is available now from Telecomputing Corporation of America's (TCA) *The Source*, CompuServe's *MicroNet* and Lockheed's *Dialog*. The information utilities are here now, at a modest cost, ready for the home computer owner to "plug-in" and draw upon enormous stores of information.

Software is the key

Only five years ago, home computers hardly existed, except in the basements of serious hobbyists. Estimates for 1980 run to \$1 billion in retail sales...that's growth! Although the cost of the computer hardware has dropped considerably, much of the credit for the rapid surge is due to the large number of programs, also known as software, available from a large number of suppliers.

No longer is the home computer market limited to the serious computer buff who can tailor his software to match his hardware limits; now, a novice can purchase a low-cost home computer, spend a half hour with a carefully detailed instruction manual, connect all the pieces together, plug in a tape or disk drive and proceed to run a program. Within hours he can lose all his hangups and fears and write his own simple programs. That's fine—what next?

The new owner of a home computer can store names, addresses and phone numbers of friends, do regular mailings to customers of his small business, prepare his weekly payroll and other business chores. His wife can keep recipes in the computer's memory and balance her checkbook. His children can play games with the computer and use it to learn spelling, math and many other subjects.

Lots of fun, lots of record keeping and lots of choices to keep the new "toy" busy. But what next?

What's next is time-sharing, or the capability to connect the home computer with huge data banks or "information utilities." A home-computer owner can literally plug into a

vast library, a huge newspaper network or other large storage banks of facts, data and information. Until now, only major corporations or large government agencies could afford to store and gain access to such data banks. Now, large-scale computer-systems houses are making their data banks available to the home computer owner during off-peak hours. It makes sense—the data is there anyhow, so why not offer it at low cost during hours when the demand is low?

Furthermore, communications between computers offers an attractive alternative to the faltering U.S. mail service; electronic mail is another service provided by information utilities.

Getting on line

It's not difficult to avail yourself of these information utilities. Assuming that you are already the owner of a home computer, what you must add is a device that will convert digital output signals from the computer into audio tones that can be sent over the phone lines and, in some cases, a serial interface (more about that later) to allow you to connect this device to the computer.

Actually, you do not even need the complete computer, but can get by with just a computer terminal—the separate keyboard and video-display unit used to get information into and out of most large, and some small, computers. Using your own computer, though, does have its advantages.

Because the computer is programmable, you can instruct it to communicate with one of the networks even when you're not around.

To give one example, suppose you want to get the closing Dow Jones averages hot-off-the-wire, but will not be able to do so yourself when the news is fresh. You can instruct *your* computer to call up the appropriate computer at a specific time and ask for that information. When it is received, your computer can either store it in its memory, to await your return and instructions, or can automatically transfer it to a more permanent storage medium, such as a floppy disk, where it will be permanently retained, perhaps as part of a data base you'll use yourself to compile a monthly average of closing prices.

In another instance, you might program the computer to answer the phone when it rang and, if it detected a computer at the other end of the line, to respond to the effect that you were not there at the moment but that it would be glad to take a message for you that the other computer cared to leave. You could even, if you were anticipating a message from someone over one of the networks, have a message waiting for him in your computer's memory, to be transmitted when he called.

The device that actually takes the information from the

computer and sends it over the phone line, or receives the incoming information and translates it into a form that the computer can use, is known as a *modem* (MODulator/DEModulator). Modems can be divided into two categories. There are acoustically-coupled, and all-electronic modems.

The acoustically-coupled kind ties the computer into the phone line without any direct connection to the telephone company's equipment. It is designed to accept a telephone handset and to link the computer with the phone equipment through a built-in microphone and speaker, using sound, rather than electricity as the medium. The other end of the acoustic coupler is connected electrically to a *serial port*—sometimes referred to as an *RS-232 interface*—of the computer.

What's a serial port? Most small computers come with a *parallel* port, generally used to connect to a printer. This is fine, as long as you have at least eight wires—one for each of the eight bits that make up a single ASCII character. Telephones, however, use only one line. Therefore, the bits must be arranged to travel in single file—or serially—rather than in parallel. That is the function of a serial port and, if your computer is not equipped with one, it can usually be obtained through the computer's manufacturer. And, if he does not have one available, there's sure to be someone else who does sell such an interface that will work with your setup.

Acoustic couplers, though, require you to be present to answer the phone and to place the handset into the coupler. There's a more elegant method.

The other type of modem is the all-electronic one which is permanently connected directly to the phone line. This means that it can easily be programmed to work under computer control—to answer the telephone automatically, to determine whether there's a computer at the other end of the line, etc. It can also, in many instances, dial a number under the computer's direction, as would be the case in the Dow Jones example given above.

This type of modem is usually connected to the computer more directly than through a serial port, because of the complexity of its functions. Telephone company regulations may also require that a special coupling device be

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>UPI N G DEBAGAN
ENTER STARTING & ENDING DATE - OR PRESS RETURN FOR TODAY

PICK A STARTING STORY NUMBER - FROM 1 (THE EARLIEST)
TO 13 (THE LATEST).
13

READ FORWARD IN TIME (RF), READ BACKWARD (RB),
SCAN FORWARD (SF) OR SCAN BACKWARD (SB)?
SF

13 07-03 03:00 ped=
(9 graf lead, pickup 4th graf: the trip xxx _ carter attacks reagan tax
cut)

PICK A STARTING STORY NUMBER - FROM 1 (THE EARLIEST)
TO 13 (THE LATEST).
13

READ FORWARD IN TIME (RF), READ BACKWARD (RB),
SCAN FORWARD (SF) OR SCAN BACKWARD (SB)?
RB

13 07-03 03:00 ped=
(9 graf lead, pickup 4th graf: the trip xxx _ carter attacks reagan tax
cut)
urgent
previous washington
Carter attacks Reagan tax proposal
By HELEN THOMAS
UPI White House Reporter
LOS ANGELES (UPI) - President Carter today attacked Ronald Reagan's
tax cut proposal as irresponsible, inflationary and impossible to carry
out without cutting federal social services.
For his first public comment on the tax-reduction proposal made by
his probable Republican opponent for the presidency in November, the
president flew to the former California governor's home state.
He told a meeting of the National Education Association, which has
strongly supported Carter's campaign, that Reagan's suggested $36
billion tax cut is "a classic free lunch something for nothing.
That kind of hasty offer can only be called by one word _
irresponsible," the president said.
"It is sheer deception to promise the American people that we can
have this enormously expensive and unfair tax cut that we can
dramatically increase defense spending" and still maintain social
programs, he said.
Carter did not mention Reagan by name but press secretary Jody
Powell made it clear the president was directing his remarks at Reagan
and other GOP tax-cut proponents.
Powell also told reporters Carter has not made up his own mind
about a tax cut, but has agreed to work with House and Senate Democrats,
who want to pass their own _ lesser _ tax cut to rival the Republican
proposal.
Carter was met at the airport by California Gov. Edmund Brown Jr.,
a former rival for the Democratic presidential nomination. Brown praised
Carter's cooperation with California officials and said there is no
hostility between the two men.
Brown has not endorsed Carter. Asked whether he would, Brown
replied: "Not this morning ... It's not the appropriate forum for
that."
The trip, which will be partly paid for by the Carter-Mon
WE ARE IN STORY 13
TYPE "B" "R" "M" "S" OR "G" AND A STORY NUMBER
QUIT

```

THE NEWS, even before it's "hot off the wire," from UPI, via The Source.

added between this type of modem and the phone line, to prevent any possible interference with normal telephone functions. Many modems have such a coupling device built in.

In all cases, special software will be needed—at the very least to enable the computer to communicate via its serial port. Software for the more sophisticated modems is generally available from the modem's manufacturer to work with your particular computer.

The Source

An inexpensive information retrieval system, *The Source*, can be tied to a personal computer through a modem, as just described, and a toll-free telephone line. Whether you own an Apple, Pet, TRS-80, Heath, Exidy, Atari or other computer, you can gain immediate access to United Press International (UPI) newswires, the New York Times Consumer-Data Base, airlines schedules and reservations, restaurant and wine guides, tax tables, computer games and electronic mail—and that's just for openers.

The Source is not a novelty or game to while away leisure time, although games and educational courses are part of the network. It is a low-cost computer service that provides the hobbyist, student and small-businessman access, through time-sharing, to an enormous information network. The system is offered by Source Telecomputing Corp., a subsidiary of Telecomputing Corporation of America, 1616 Anderson Rd., McLean VA 22102.

How cheap is this service? Would you believe only \$2.75 per hour during non-prime time (6 PM to 7 AM, Monday through Friday; all day Saturday and Sunday) and \$15 per hour during prime time? An initial \$100 hookup charge includes a user account number, a secret password (which can be personalized) and a local toll-free telephone number to

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>
>DATA GAMBBP
*** GAMES LIBRARY - NO PRINTER REQUIRED ***

ADVENTURE-EXPLORE COLOSSAL CAVE (SUPER GAME!!!)...PLAY ADVENTURE
BACKGAMMON.....PLAY BACKGAMMON
CASINO STYLE 21.....PLAY BLACKJACK
CIVIL WAR SIMULATION AGAINST THE COMPUTER.....PLAY CIVILWAR
CHECK CHECKERS CHALLENGE.....DATA CHECK
COIN FLIPPING.....PLAY COIN
SHOOT CRAPS.....PLAY CRAPS
STATISTICS CONCERNING A PARTICULAR DATE.....PLAY DATES
TIC TAC TOE IN SPANISH.....PLAY ESTIC
GET THE FARMER, FOX, CHICKEN, AND GRAIN ACROSS.....PLAY FARMER
MONDAY NIGHT FOOTBALL.....PLAY FOOTBALL
GOLF FOR ONE OR MORE PLAYERS.....PLAY GOLF
GUESS THE COMPUTER'S NUMBER.....PLAY GUESS
HANGMAN WORD GAME.....PLAY HANGMAN
GOVERN ANCIENT SUMERIA.....PLAY HMKABI
HORSE RACE GAME.....PLAY HORSE
IQ GAME OF SKILL.....PLAY IQTEST
GOVERN THE ISLAND OF SETAYS OETINU.....PLAY KING
LARGE GAME OF GOLF.....PLAY LGOLF
LIFE (COLONY GENERATION).....PLAY LIFE

LUNAR LANDING SIMULATION.....PLAY LUNAR
COMPANIES COMPETE TO SELL A PRODUCT.....PLAY MARKET
MASTERMIND.....PLAY MIND
ANCIENT GAME OF NIM.....PLAY NIM
ANOTHER NIM.....PLAY NIM2
CARE TO TRY YOUR LUCK ON THE SLOT MACHINE?.....PLAY UNEARM
PICA-CENTRE (NUMBER GUESSING GAME).....PLAY PICA
A NEW ADVENTURE GAME.....PLAY PITS
RANDOM POETRY.....PLAY POETRY
POKER AGAINST THE COMPUTER.....PLAY POKER
SCORE FOUR AGAINST THE COMPUTER.....PLAY SCOREFOUR
RANDOM SHAKESPERIAN SONNETS.....PLAY SONNET
FILL IN THE MISSING LETTERS.....PLAY SPELL
STAR TREK (SUPER VERSION!!!).....PLAY *TREK
PLAY THE STOCK MARKET.....PLAY STOCKS
RULE ANCIENT SUMERIA (A DIFFERENT ONE).....PLAY SUMER
TARGET PRACTICE AS WEAPONS OFFICER ON THE ENTERPRISE.....PLAY TARGT2
TIC TAC TOE.....PLAY TICTACTOE
A REGULAR CASINO OF GAMES FROM LAS VEGAS.....PLAY VEGAS
ROULETTE FOR UP TO SEVEN PEOPLE.....PLAY WHEEL
PATROL THE CITY STREETS.....PLAY WATCHMAN
HUNT THE WUMPUUS.....PLAY WUMPUUS

NOTE:
FOR INFORMATION ON ANY GAME TYPE.....INFO (GAMENAME)
I.E., INFO ADVENTURE; TO VIEW A DEMONSTRATION OF CERTAIN
OF THE MORE COMPLEX GAMES, TYPE DEMO (GAMENAME).

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TO PLAY GAMES from The Source, type "PLAY," followed by the name of the game.

access *The Source* in areas where there are a lot of members. In areas with only a few members, it may be necessary to dial long-distance. To illustrate cost in another way, a user with a 300-baud modem (which sends out 30 characters per second) could get as many as 200,000 characters of data-base information for only five dollars. The subscriber can have billing charged to any one of several credit cards including American Express, VISA, and MasterCard (formerly Master Charge).

Get the news while it's hot

UPI's network extends to more than 7000 news-service customers who print newspapers, magazines and market reports based on timely input. Let's see how a college senior with a personal computer could benefit from *The Source*. Assume that he has to prepare a term paper on the political strain between the U.S. and Iran.

As a subscriber to *The Source*, the student would request UPI and then be queried by the computer on whether he was interested in National (N), Regional (R), State (S) or Federal (F) departments; next whether General (G), Business (B), Sports (S) or Miscellaneous (M) news categories. After National (N) and General (G) selections were made, the screen would request a key word or search phrase to identify the request to review U.S.—Iran news stories. *The Source* would then indicate the number of stories available within a selected time period (week or month) and allow the subscriber to scan the first paragraph of each story; if the entire story is required, just a simple keyboard command would display it on the screen. Thus, within minutes, and without leaving his room, the student could access UPI's filed stories and prepare a factual, timely paper. How timely? A story on a major political move in Iran filed in Teheran would reach a *Source* subscriber within two minutes of its initial transmission. A fast-reaction newspaper would carry the story perhaps hours later. Thus, our college senior could submit a term paper to his professor during an afternoon class and discuss items that might be covered in the next day's newspaper! A clever student could earn many an A with such a masterful ploy.

What's happening back home

A novel form of news coverage offered by *The Source* is called UPI Newshare, to deliver local news items generally considered insignificant for the National, Regional, and State categories.

For example, if your hometown lost the Little League Championship, the story would hardly be picked up by the major UPI network. However, with Newshare, local newspapers will be adding their stories to the UPI computer.

Users of *The Source* would have quick access to local news without waiting days for delivery of their old hometown newspapers. And think how easy it will be to keep up with news of old friends just by tapping a few keys on your home computer.

Neither rain nor sleet...

Have you reached your threshold of tolerance for excessive delays in mail delivery? Electronic mail is just one offering of *The Source*. Not only can time of delivery be considerably compressed, but two-way message exchange is possible at modest costs.

Electronic mail can be "delivered" in three ways. The simplest method allows one subscriber to send a message at 30 characters per second to another subscriber's "mail-box", where the second subscriber's terminal indicates Mail Call. When the second subscriber types MAIL on his keyboard, the message "mailed" to him will appear on the CRT.

A two-way message exchange is possible between two subscribers in the CHAT mode. Finally, a message can be sent from a subscriber to a non-subscriber via *Datapost*, a service competitive with *Mailgram*. *Datapost* is a service of TDX Systems Inc., and receives the messages at its center located at O'Hare Airport in Chicago; the messages are then converted to hard copy and sent on express flights for next-day delivery in cities around the country. Cost? Only 75-cents-a-message additional charge above *The Source* and telephone line fees.

MicroNet

MicroNet, a service of CompuServ Inc., permits personal computer owners in 175 major cities in the U.S. to access their large DEC K1-10 and K1-20 central processors in Columbus, Ohio. The *MicroNet* system offers (1) a variety of computer programs on a time-sharing basis, (2) the ability to expand the potential of the personal computer, (3) a means to buy and sell software through the *MicroNet* Software Exchange, (4) a Feedback feature to contact *MicroNet* headquarters at no charge, and (5) nationwide contact via its National Bulletin Board and Electronic Mail capabilities.

The personal computer service is only available during off-peak hours, 6 PM to 5 AM weekdays and all day Saturday, Sunday and holidays. *MicroNet* may be accessed via local telephone service from more than 175 major metropolitan areas. The service costs \$5 per hour connect-time in over 30 proprietary cities; an additional \$2 per connect-hour surcharge is added for customers using *MicroNet* from *TymNet* network cities. (*TymNet* is a telephone-interconnect network between *MicroNet* and several major cities. Thus, if you live in one of these major cities and you use *TymNet*, you will be billed for local phone calls when accessing *MicroNet*.) The initial fee is \$9; however, the first hour of use is free, thus reducing the cost by \$5.

Among the programs in the *MicroNet* library are (1) BASIC with double precision, linking capability, file-to-file sorting and a debug mode, (2) FILGE (for File Generator and Editor) which has powerful text-manipulating capabilities, (3) FINTOL for solving financial problems, and (4) MicroQuote to provide rapid access to information on securities traded on exchanges and over-the-counter. FORTRAN, APL, and Pascal are also available.

Become a Wall Street wonder

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maturity dates, option information, Moody's ratings and exercise prices.

Cost for the use of MicroQuote is \$5 per hour of connect-time, a per-access fee of \$1 for each use of MicroQuote, plus additional transaction fees based on the amount of information requested. For example, if you requested a list of 25 issues, a 25-cent charge is applied. Daily, weekly and monthly price and dividend sets cost 5, 10 and 25 cents for each set, which supplies date, volume, high/ask, low/bid and close prices. If you wanted to examine a particular stock issue in detail, the charge would be \$1.25.

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MicroNet users are permitted to store up to 64 kilobytes of their own data on the system. However, those files must be accessed at least once every seven days or they will be deleted.

An interesting and innovative service offered by MicroNet is the opportunity to market software via the personal computer through two approaches. The first approach is for software guaranteed by CompuServe, MicroNet's parent. Vendors will sell their tested software to CompuServe on a direct or royalty basis. A user finding this particular software beneficial to his business or interests can test the program on MicroNet and then purchase it using his credit card. The program would then be downloaded from CompuServe's mainframe to the personal computer. In a second approach, users will have an opportunity to test programs available from software retailers. In this case, CompuServe will act as a retail outlet, renting space on its network to software merchants.

A Feedback system is available for subscribers who desire user guides and reference manuals for MicroNet programs that are not self-documenting.

Electronic mail

MicroNet's electronic mail system relies on a bulletin-board format. The user places a message on the bulletin board using his personal computer. But, unlike other bulletin boards, on this one, only the person to whom the message was addressed can receive it. Subscribers using this mode must scan the bulletin board as they enter the system to see whether any messages have been posted for them.

A variation of personal-computer CB is also available from Micronet. A subscriber offers his "handle" or nickname and selects the channel he wishes to participate in. He is then informed of the number of other subscribers on the same channel and can then choose merely to "listen" via his CRT display or to take an active role. Needless to say, a crowded channel on a computer display is as unintelligible as a group chatting over a jammed CB voice channel.

To join the MicroNet set, you add a modem to your personal computer and set it for 300 baud. Request and return a service application to CompuServe's Personal Computing Division, 500 Arlington Center Blvd., Columbus, OH 43220. Your VISA or MasterCard credit card number is requested. You will then receive by return mail a user kit containing a user identification number, a secret password, a local network telephone number (if there is one) and basic documentation of the MicroNet system. Then to make life easier for you and to achieve compatibility between the MicroNet system and your personal computer, a MicroNet Executive program is loaded into your computer at no charge. Billing for connect time, other surcharges, and any software purchases will be done through your charge card.

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SOME OF THE SERVICES offered by The Source to users of personal computers.

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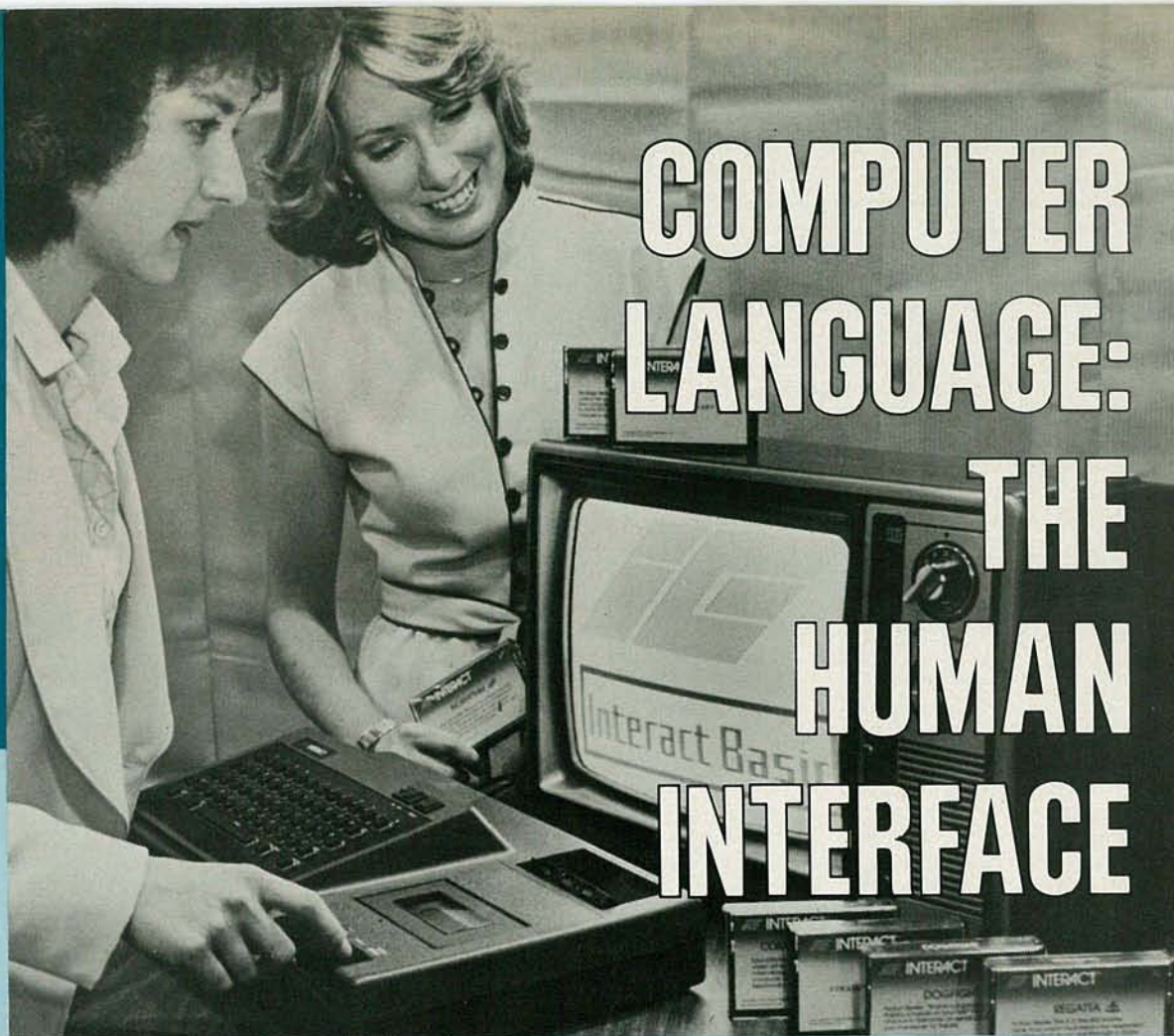
When you think about it, it's a fantastic bargain. The databases include periodicals going back ten years or more, with the most current issues available. Think of the time, gas, and parking fees involved in visiting your local library to search through their files manually. When you locate the specific items, the librarian would require additional time to locate some of the outdated material (if the library is large enough to maintain a lengthy file of the publications you require).

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R-E



COMPUTER LANGUAGE: THE HUMAN INTERFACE

Computers cannot act on their own—they have to be told what to do. Here's a discussion of several of the languages used to instruct them.

IF YOUR RICH UNCLE PASSED AWAY AND LEFT YOU A MULTI-million dollar IBM computer, it probably wouldn't do you any good (unless you sold it). All you would possess would be a well-designed piece of computer hardware unless he also left you the software (programs) to tell the machine what to do.

The computer is a machine. It doesn't understand the English language. Yet it is capable of performing an endless number of tasks, involving lengthy calculations and complex procedures. And the computer can respond to a computer language, so the obvious step is to develop a language that can be understood by humans and somehow converted to the language a computer can follow.

A computer *program* is a set of instructions that tell the computer what to do. A computer *language* defines the rules of grammar and vocabulary for writing instructions. If you don't follow the rules, the computer cannot understand the instructions, and it will be unable to perform its assignment.

A *statement*, or *instruction*, in a computer program, is a string of elements from an alphabet that includes letters, digits and symbols. A set of rules, or *syntax*, establishes the form of each statement which conveys a specific operational meaning or *semantics*. Thus a computer language includes the alphabet, syntax and semantics.

Computer languages in use today can be grouped into three broad categories: machine languages, assembly languages, and problem-oriented languages. Both machine and assembly languages are considered *low-level* languages while a problem-oriented language is concerned *high level*.

Machine language

The most elementary language is machine language since it is the only language that the computer understands directly; any other language is "foreign" to the computer and thus it will not recognize or execute proper commands. Machine language is written with the computer's hardware or design configuration in mind so the programmer must be well aware of how the machine works. Because the vocabulary and grammar rules are rather limited, machine language is considered simple. However, because of the limited vocabulary, a fairly long program is required to lead a computer through a relatively simple assignment.

A machine-language program consists of a list of instructions in binary form to direct the computer to perform an operation or a series of operations such as add, multiply, read, write, or store. For the programmer's convenience, decimal, octal, or hexadecimal numbers may be used and then converted into binary numbers inside the machine. The operation to be performed is given by a code that directs the computer to perform a specific operation and also supplies the operand, which is the quantity to be operated upon. Instructions in machine code are binary numbers, not letters or words. A series of binary numbers representing a very small part of a machine-code program would look something like this:

Operation Code	Operand 1	Operand 2
01011001	01001100	11011010

To perform a simple addition of just two numbers would involve the above listing of 1's and 0's, in the binary lan-

guage that makes the computer perform. Imagine the enormous sequence of 0's and 1's required to perform a complex calculation!

Obviously, the computer programmer who attempts to prepare a lengthy program in machine language will be prone to making errors since it is a tedious and tiresome task. The task is somewhat lessened with the aid of an octal or hexadecimal program that accepts the programmer's inputs in octal or hexadecimal (special numbering systems that are more intelligible to humans than binary) and converts them to binary.

The advantages of machine-language programming are (1) the ability to instruct the computer directly and (2) the low requirement for supporting software or memory. The disadvantages include (1) the need for the programmer to have full awareness of the machine's hardware structure, (2) the lengthy and tedious effort involved in writing the program and (3) the lack of flexibility in using a program written for one computer on another type. For example, a machine-language program written for a Motorola 6800-based computer cannot be applied, without extensive modifications, to a computer using an Intel 8080 CPU.

Perhaps the greatest drawback to machine-language programs is their lack of intelligibility to non-computer users. A detailed machine-language program, with its lengthy series of 0's and 1's—or even their octal or hexadecimal equivalents—has no meaning to the student, engineer, businessman, or layman eager to apply the computer to his specific applications. Indeed, even a professional machine-language programmer has quite a task keeping track of the meanings of the machine code.

Assembly language

To make computer programs easier to comprehend, symbolic languages were developed. Such a language makes use of letters or names for instructions, data and addresses. These names or "mnemonics" refer to the terms they represent so a computer user can, by association, relate the term to the function. An example of mnemonic symbols in everyday use is DOD for Department of Defense and IRS for Internal Revenue Service. Only three letters are used as shorthand identification, yet most people know immediately what they represent.

Not all instructions are as easy to remember as ADD, SUB, or AND. But it is not too difficult for the programmer to associate LA with "load the address" or P to punch a card. Such use of symbolic code rather than a lengthy string of ones and zeros was the first major step to bring computer-programming capability to the non-professional programmer. If we wanted to have the computer calculate $X = A + B$, where $A = 3$ and $B = 5$, in assembly language, we would use the assembler instructions listed in Table 1.

TABLE 1

Location	Operation	Operand 1	Operand 2	Comments
Begin	LDA	REG 6	B	Load B into register 6
	ADD	REG 6	A	Add A to register 6
	STA	X	REG 6	Store register 6 at X

The symbolic instructions listed in Table 1 would be translated into machine-language form by the assembler.

Now a non-professional programmer can write what's known as a source program, using symbolic language, with instructions or statements to guide computer activities. Next, a processing step is required to translate the *source* program (easy for a human to write and understand) into an *object* program, which is a machine-language program that the computer can understand. The program that accomplishes this task is called a *translator*. Its output, the object program, is what the computer requires to direct its operation.

The grammar of assembly language is similar to that of machine language but the vocabulary is different. Since a computer is still being directed, the operations available and the sequencing are unchanged. However, mnemonics, rather than numbers, are used in preparing the program.

Symbolic languages make computer-program preparation easier, since terms, rather than numbers, are used to relate to the problem-solving needs.

A profound advantage of symbolic language is the ability it gives one type of computer to process programs written in many different languages, provided a translator program is included with each language. This means that one computer can handle programs written in either BASIC or FORTRAN (to be described later), as long as a separate translator is available to convert each into the computer's machine-language code.

This first step to make programming a bit simpler is called assembly language, machine-oriented language, or low-level programming language. Although symbolic notation makes program-writing easier than straight binary coding, it takes about as many symbolic instructions to write a program as machine language does. Stated another way, there is a one-for-one conversion of language instructions. Thus, the assembly-language programmer still must write lengthy instructions and must be familiar with all the peculiarities of the computer he is programming. For complex programs, many of the abbreviated mnemonics will not take convenient comprehensive form and will require extensive commentary to keep track of all the definitions of terms.

The translator that converts the assembly-language (source) program into the computer object program is called an *assembler* and is usually located in the computer's memory. As the source program, written in symbolic language, is entered into the computer, the assembler converts each symbol into machine-language form (or the object program). At this stage, the computer is only recording the object program in its memory, or onto punched paper tape, magnetic tape or disk. When the translation task is completed, the object program can be entered in its entirety into the computer; now the computer can understand the instructions and data, and can proceed to execute the program.

Assembly language is an improvement over machine language, but is still machine-dependent. Every type of computer requires its particular assembly language.

Problem-oriented languages

The next step in program design makes the computer hardware (and type of computer) relatively unimportant with respect to the task to be performed. This type of language is known by such names as: "problem-oriented," "procedure-oriented," or, simply, "high-level." It approaches the programming problem from the viewpoint of the goal to be achieved, rather than the specific machine that will achieve it.

Broadly speaking, there are two types of high-level language—compilers and interpreters. Compilers will be considered first.

A compiler allows a program to be written in English-like terms and translates it directly into machine language. With it, a single statement, such as "PRINT," can cause a whole series of machine-language instructions to be executed. From the human point of view, a compiled language is much more efficient than assembly language.

As with an assembler, the compiler first translates the source-language program into an object program before running it. A program, that originally has been written using a compiler cannot be run unless the entire program (or a complete section of it) has first been translated (compiled) into machine code. Here's how a program would be compiled on a large computer system (smaller systems use floppy disks

rather than punch cards):

First the program is laid out, and debugged to the greatest extent possible (getting the bugs out of an already compiled program is not the simplest task in the world), using coding sheets. Then, assuming that a punch-card system is being used, a keypunch operator punches or codes one card for each line on the coding sheet. The complete set of such cards is called the "source deck."

Then, with the compiler already in the computer's memory, the program is fed into the computer one card at a time. After all the cards have been fed in, the program is compiled, and a new set of cards, containing machine-language instructions, is generated. This set is known as the "object deck." Since one "source" card may require several machine-language instructions to be carried out, the object deck contains many more cards than the original source deck.

After compilation, the code from the object deck is loaded back into the computer, and the program can be run.

The other type of high-level language we'll discuss is the *interpreter*. Most of the BASIC's used with small computer systems are interpreters. Interpreters, like compilers, allow programs to be written in an English-like form, but operate somewhat differently internally. The most significant difference is that no compilation takes place and that the source code is always accessible.

An interpreted language translates instructions into machine language as the program executes—in real time—rather than "predigesting" them all at once, as does a compiler. Because an interpreter is constantly "interpreting" (or translating) as well as actually executing the program, it tends to run more slowly than a compiled language. Furthermore, the interpreter retains no memory of what it has interpreted so, even if it has already executed a certain routine a hundred times, it must interpret it anew when it encounters it for the hundred-and-first. This makes for an even greater reduction in speed.

Interpreters have their advantages, though. Because you are always working with source code, it is simple to modify a program should a change be necessary. A program can even be stopped while it is running, altered, and the run continued. This is an impossibility if you are using a compiled language. Also, while a compiled program may occupy much less memory than an interpreted one, the *compiler itself* may take up so much room in a small computer that it would leave little or no memory space for the program it was intended to run.

Machine and assembly languages are designed to match specific computers, and bear no relation to the applica-

tions the computers are intended to perform. Problem-oriented, or high-level, languages disregard the hardware aspects of the computer and concentrate instead on the applications. To simplify programming, it was desirable to develop different languages for different applications. Languages have been developed for mathematical and scientific needs, for business procedures, for text editing, and for other specialized needs. Only one problem-oriented language has been developed as a *universal* language to replace all others: the IBM PL/I or Programming Language/1.

The premise was that scientists, businessmen, engineers, and computer experts could program nearly everything they needed with this language. Unfortunately, the language is so complex that few programmers can handle it. Secondly, a powerful computer is required to use the program. And finally, it turns out that the scientific programmer using PL/I involves himself only with the scientific portion while the business programmer only identifies with the business section. It may well be that the goal of an ideal computer language is not unlike that of a universal language for speech around the world. Wouldn't it be convenient to have one language spoken and written throughout the world? No need for guide books, language-phrase books, language courses for the traveler—but as obvious as the need appears, the prospect of a universal language is far distant. So too, perhaps for a universal computer language.

Advantages of high-level language

What are the advantages of high-level languages? Programs are shorter, easier to write, and debugging (locating errors) is simplified. Programs written for a particular application can be supplied to users around the world, regardless of the computer they have, as long as a compiler or interpreter is available for the language used. And, of course, there is no need for the programmer to be concerned with the inner workings or details of his computer's hardware or machine language.

Then why are low-level assembly- or machine-languages still in use? High-level languages require considerable memory and programs run slower since a translation process is involved between the human-oriented and machine language. Often the compiler is expensive and requires a large amount of memory. If an interpreter is used rather than a compiler, translating each statement and executing it, less memory is required. The tradeoff is a loss in efficiency since translation must be performed every time the user runs the original program.

Which is best? For the non-professional programmer, high-level languages are much simpler to prepare and use; programs are relatively easy to comprehend from the symbols involved. Assembly and machine-language programs, when properly prepared, can make the computer perform faster; also, programmers familiar with the particular strengths of a computer's hardware can make the computer "do tricks" and thus operate more efficiently than would be possible with general-purpose high-level programs. Even today, assembly and machine languages offer efficiency unmatched by high-level languages.

Popular high-level languages

High-level languages, or problem-oriented languages, can be general-purpose, or can be specifically tailored for applications such as engineering, education, banking or process control. Over a thousand languages are in existence, some used only by a handful of specialists and others enjoying widespread use by a large number of computer users.

Among the most popular computer languages are:

ALGOL (*Algorithmic Language*)—a math and science language in common use in Europe.

APL (*A Programming Language*)—a language to handle long strings of numbers or letters with ease.

BASIC (*Beginner's All-Purpose Symbolic Instruction Code*)—a language developed to introduce students to computers; simplicity and ease of use highlight this language. Widespread use with personal computers.

COBOL (*Common Business-Oriented Language*)—the original language designed for the non-professional programmer for business, rather than scientific, applications.

FORTRAN (*Formula Translation Language*)—Probably the most widely used language. Although originally intended for scientists, it is in widespread use for business applications.

LISP (*List Processing*)—a language developed by a group at MIT to handle list processing. Lists are finite sequences that can appear in a large variety of structures in the form of numbers, letters, or even computer words.

Pascal—an extended version of ALGOL developed for teaching structured programming to students.

PL/1 (*Programming Language/1*)—a complex language combining the advantages of COBOL, FORTRAN, and ALGOL. The language contains more features than any other language; however, because of its complexity, it is difficult to learn and apply.

RPG (*Report Program Generator*)—a language for requesting and defining reports.

Languages in detail

Wouldn't it be ideal if all computers understood instructions written in the English language? Yes, it would, but there would always be problems. Human languages are extremely complex and yet imprecise. Words don't mean the same thing to everyone. For example, "watch" may indicate "observe" to one person and "timepiece" to another. With computers, words and instructions must be exact, without ambiguities to confuse the computer.

High-level, or problem-oriented, languages are a good compromise for efficient communications between humans and the computer. It has been estimated that well over 1,000 high-level languages have been developed; perhaps 200 enjoy some form of popularity.

Why so many languages? High-level languages are intended to handle problems and thus deal with a multitude of applications. While many languages have a rather broad appeal and application, there always seems to be a reason for programmers to develop a specific language for a specific need. There are high-level languages, for example, exclusively tailored for numerically-controlled machine tools, electronic circuit design, hydraulic system analysis, graphical analysis and other such specialized applications.

ALGOL

ALGOL (*Algorithmic Language*) was developed in the mid-1950's for scientific and mathematic applications. ALGOL is much more popular in Europe than in the U.S. and is well respected as a powerful language capable of handling very complex programs.

One version of ALGOL of particular significance is the "publication" version which many computer scientists use to describe new programs they have developed. Thus, there are many programs published in ALGOL even though the program authors or potential users do not have the sophisticated hardware to run or test the programs. The publication version of ALGOL is based upon the type faces generally available to printers and thus includes upper and lower case letters, methods to indent lines, and bold-face type.

The language's power and versatility are assets which are hampered by the need for a relatively large, slow, and expensive compiler. Programs in ALGOL are separated into blocks, with smaller called-subroutines or procedures.

APL

In 1960, Ken Iverson of IBM developed APL (*A Pro-*

gramming Language) as a notation for describing algorithms. (An algorithm is a prescribed set of well-defined rules or processes for the solution of a problem in a finite number of steps.) Based on a series of symbols for logical and mathematical functions, APL is easy to learn and requires relatively few characters to define complex operations. It is used in applications ranging from complex mathematical and scientific problems to text editing and computer-assisted education.

APL's major attraction is its powerful problem-solving capability coupled with a high degree of interactivity. This allows top-level managers, such as businessmen and financial analysts with key decisions to make, to "have a conference" with their computers using APL. Since the language is easy to learn and use, these busy managers do not require extensive training nor added staff to handle the program.

APL makes use of several unusual symbols, such as an upside-down T, and thus special terminals are required for APL to put these symbols into the machine. APL is not a scientific language, but is considered more of a manipulative language for handling long strings of numbers or letters; it's ideal for text editing. The text of an article or a book can be fed into a computer using an APL program; the manuscript can be rewritten or altered with spelling corrections or hyphenation, and then retrieved from the computer in its new format. Many modern automated printing and publishing firms use APL for such automatic typesetting applications.

APL, as well as BASIC, are languages based on interpreters rather than compilers. This means that programs can be written, tested and debugged rapidly.

The APL language is used by large firms as a powerful analytic tool for long-range planning.

BASIC

BASIC, *Beginner's All-Purpose Symbolic Instruction Code*, was developed at Dartmouth College in 1965 as a language for introducing students to computer science. The project was supported by a grant from the National Science Foundation and was managed by Professors Kemeny and Kurtz. BASIC was originally intended for use on a time-sharing computer.

The object of the project was to come up with an easy-to-use computer language; its success has made it the most popular language among non-professional programmers and computer hobbyists. It is a language intended for an amateur programmer who has a problem, wants to use a computer to solve it, wishes to prepare his own program rather than hire a programmer, and doesn't have a large budget.

A major advantage of BASIC (and APL) over other languages is its use of an interpreter rather than compiler. Programs prepared by an amateur can be inspected, modified, debugged and corrected without tedious recompilation. BASIC can accept program changes with a minimum of effort on the part of the programmer. Another advantage of BASIC is its interactivity.

BASIC is easy to learn because it has a limited vocabulary compared to FORTRAN, COBOL or other popular languages. The primary statements are arithmetic, program control and input/output. Every language consists of a set of characters; BASIC uses the 26 letters of the alphabet, all ten decimal digits (0 to 9), and fewer than two dozen additional characters (arithmetic operators, punctuation, etc.).

Here are some of the fundamental rules that were established in the original Dartmouth BASIC:

- A line can include only one statement.
- Each statement must include a line number followed by a keyword.
- Statements or instructions are performed in order of

line number.

- A BASIC program must be completed with an END statement.

A keyword indicates the type of instruction such as LET, PRINT, DATA, END, OR REM. REM (for *REMARK*) is a comment to inform or remind the user of the program content but is not acted on by the computer. LET takes the form of LET X = A + B + C where LET means the value of the expression A + B + C replaces the variable X. PRINT, appearing by itself, simply allows a line to be skipped on the printer or display device; PRINT, followed by words enclosed in quotation marks, commands the computer to display the words. For example, PRINT "THE SKY IS CLEAR" would result in THE SKY IS CLEAR being displayed or printed out. The instruction READ orders the computer to obtain data from within the program and store it in a particular memory location. The READ and DATA instructions are used together in this manner: the first variable listed in the READ statement corresponds to the first number in the DATA statement. A simple BASIC program to add 2 plus 3 will demonstrate and clarify how these statements relate:

TABLE 2

```
10 REM A SIMPLE ADDITION PROGRAM
20 READ A, B
30 LET X = A + B
40 PRINT X
50 DATA 2, 3
60 END
```

The REM comment allows us to identify the program content. The READ instruction sends the computer to the DATA storage where the first variable, A, corresponds to 2 and the second variable, B, has a value of 3. The LET statement means that the expression A + B or 2 + 3 or 5 replaces X. Then the PRINT instruction directs the value of 5 to be displayed on the output. The END statement concludes the program. For comparison purposes, the same problem listed in Table 2 is given again in binary and hexadecimal machine code for an 8080-based computer in Table 3.

There are quite a number of versions of BASIC available today with no two types exactly interchangeable. Thus a BASIC program written for an Apple computer won't necessarily work on a Radio Shack TRS-80. The programs are similar enough so that even an amateur can understand the differences; but the lack of conformity is frustrating when the program for one computer is wanted to run on another and extensive reprogramming is required. ming is required.

There are several reasons why programs written in one

TABLE 3—HEX & BINARY Representations of 8080 "addition" machine code:

Hex	Binary
AF	10101111
3E	00111110
02	00000010
06	00000110
03	00000011
80	10000000
21	00100001
88	10001000
13	00010011
77	01110111

TABLE 5—ADDITION of two numbers in FORTRAN:

```
A=2+3
WRITE 10,A
10 FORMAT (12)
END
```

BASIC will not run when transcribed into a machine that uses another BASIC. First and foremost is the fact that some BASIC's have commands that others haven't. The reason for this is often related to the amount of memory available. For example, one of the first BASIC's available for home computers was known as Tiny BASIC. In its original form, Tiny BASIC had no string capability and could not handle trigonometric functions. Some versions of it only worked with integers and no floating-point calculations were possible. These early versions generally needed only 1 or 2K of memory. But, as memory got cheaper, functions were added to these Tiny BASIC's and programs written with the updated versions were incompatible with the earlier ones.

Today, there are still more variations of BASIC. The first distinction is between integer BASIC and floating-point BASIC. Integer BASIC is generally faster, and is good for video graphics applications. A computer that offers both integer and floating-point BASIC's is the Apple II, and the incompatibility between the two languages is clearly demonstrated when one tries to run an integer BASIC program in the floating-point mode. For example, INPUT statements in floating-point are followed by a semicolon, while in integer BASIC, they are followed by a comma. Strings are handled differently, too. Integer BASIC simply has no string functions (e.g. RIGHT\$, LEFT\$, MID\$, STR\$, etc.). These functions are present in the Apple floating-point BASIC, and, are similar to those used by North Star basic.

Another thing that makes BASIC's incompatible is the way they use abbreviations. The Microsoft BASIC's use a "?" as an abbreviation for the PRINT statement. North Star BASIC uses a "!" and Radio Shack Level I BASIC uses "P." Not all versions of these languages convert the abbreviated form back to the full word when the program is listed, so that trying to transcribe a program with these abbreviations for a noncompatible machine could be quite disastrous.

If you stick to using the full word and avoid abbreviations, you'll find that there is a subset of BASIC commands that is common to almost all personal computers. Table 4 contains a list of 41 commands that are fairly universal. However, even though a command may exist in two different BASIC's, it may not do the same thing in both. An example of this is the GET command. In Applesoft BASIC this command tells the computer to wait for the user to input data from the keyboard. The computer waits for a key to be pressed and then returns the value of that key. In PET BASIC, when the GET command is encountered, the computer also looks at the keyboard for a key closure. However, if no key is pressed, it immediately returns the value 255 instead of just waiting for a key to be pressed. This means that programs must be written a little differently for each case, as illustrated below:

In Applesoft the GET statement would be used like this:

10 GET AS

To get the same action (without having the computer return the value 255) in PET BASIC you'd have to write:

```
10 GET AS:IF AS=" " THEN 10
```

This is a perfect example of how two BASIC's having the same commands can result in programs that are incompatible with each other.

TABLE 4

ABS	AND	ASC	ATN	CHR\$	COS
DATA	DEF	DIM	END	EXP	FN
FOR	FRE	GET	GOSUB	GOTO	IF
INPUT	INT	LET	LIST	LOG	NEW (or SCR)
NEXT	NOT	OR	PEEK	POKE	PRINT
READ	REM	RESTORE	RETURN	RND	SIN
STEP	TAB	TAN	THEN	TO	

Assuming that the BASIC's do have compatible commands, you're still not out of the woods. The reason is that some commands link BASIC to machine language or specific memory locations; notably PEEK and POKE. These commands are available in most BASIC's except those from Texas Instruments and Hewlett-Packard. However, because different computers have organized the use of memory differently, it is not always possible to use programs that have PEEK and POKE statements in them directly. For example, if the POKE statement is used to temporarily store a number in memory for later use on one machine we could be in serious trouble using it in another. In the Apple, memory locations around 768 are available for use by the programmer, while in the TRS-80 this area of memory is used by the operating system. So before using these commands, be sure you know a little bit about how both your computer and the one the program was written on are organized.

Finally, different computers have additional commands designed specifically for their own hardware configuration. The Apple-II for example has several commands, designed to be used in its low- and high-resolution color graphics modes, that would be meaningless on another machine.

FORTRAN

One of the earliest and still very widely used, high-level, problem-oriented languages is FORTRAN (*Formula Translation*). Developed in the mid-1950's by a group of several firms headed by Jim Backus of IBM, FORTRAN took three years of effort involving some 25,000 lines of detailed machine instructions.

FORTRAN is always compiled, never interpreted. FORTRAN compilers are available for just about any computer manufactured in the world.

As its name implies, it was intended for use on mathematical and scientific formulas. However, its applications became more diverse due to its early acceptance at colleges and universities where computers were introduced to the student body. As graduates with knowledge of computers and the FORTRAN language went into the business world, they proceeded to solve business problems with variations of FORTRAN.

In a steady, evolutionary manner, FORTRAN has been expanded into an extremely powerful language and its name has been modified to FORTRAN I, FORTRAN II, FORTRAN IV and FORTRAN 77. A high degree of standardization has taken place over the years so that a program written in FORTRAN IV will perform properly with most FORTRAN IV compilers.

FORTRAN, although geared for complex mathematical assignments, is rather straightforward in its approach. For example, to solve $X = A + B$ when $A = 3$ and $B = 5$, the instructions would read $A = 3$, $B = 5$, $C = A + B$, STOP. These source instructions would, in turn, be trans-

lated by the FORTRAN compiler into machine language to execute the step to solve the problem. An actual FORTRAN program is listed in Table 5. This program is identical to the BASIC program listed in Table 2.

A compiler to handle a FORTRAN IV language is quite extensive. Not only must it handle a considerable number of mathematical operations, but it must perform such math functions as trig, square roots, exponentials, complex numbers, and logarithms. It must also manage to cope with strings of numbers and letters and lengthy mathematical arrays.

In FORTRAN, a number can be represented as a fixed point or as a floating point. A fixed-point number must be an integer or whole number and can be positive or negative. A floating-point number is similar to scientific notation where "number" may be expressed as a number from 1 to 10 multiplied by some power of ten; 580 could be expressed as 5.8×10^2 . A floating-point number always includes a decimal point; a fixed-point number does not.

FORTRAN includes provision for two other types of numbers: constants and variables. A constant maintains the same value during the program execution while a variable can be assigned different numerical values while computations are being performed. The name assigned to a variable can include up to six characters and is selected, where possible, by the programmer for his ease in remembering its meaning. For example, SQRTF signifies square root.

The basic mathematical symbols for FORTRAN operations are:

- Addition +
- Subtraction -
- Multiplication *
- Exponential **
- Division /

For example, to indicate 2 raised to the 3rd power, we use $2^{**}3$. As with standard math notation, parenthesis are used for groupings; For example: $(2 + 3)$ raised to the 3rd power is written as: $(2 + 3)^{**}3$.

Input-output statements in FORTRAN are expressed as READ, WRITE, PRINT, PUNCH and FORMAT (this describes how the output information should be accepted). A GO TO statement informs the computer to execute an instruction or statement other than the next statement in sequence. An IF statement provides for a conditional transfer of control, or proceed to another statement if specific conditions are met. An END statement informs the compiler that the program is completed.

COBOL

COBOL (Common Business Oriented Language) was developed in 1960 by the Department of Defense together with users and manufacturers of computers. Its purpose was to handle relatively large volumes of business information for rather simple applications. The intent was to enable non-programmers such as accountants and clerical staff to express their business problems in English. For example, if a clerk wants to know the value of present stock in inventory, the COBOL statement would request "COMPUTE STOCK VALUE," leaving no doubt of the meaning to the human. A COBOL compiler in the computer would convert the statement to the necessary machine-language instructions required to initiate the actions.

The basic COBOL vocabulary consists of 250 key words; additional words can be created merely by specifying names for data and instructions.

Scientific applications generally require complex steps and considerable calculations, but have few input and output demands. Business applications, on the other hand, demand considerable input and output with relatively little computation. COBOL is designed to handle extensive filing on punched cards, tapes or magnetic disks.

Another significant difference between a scientific and business application is the repeated use of a particular program. Scientific programs may be developed for a particular problem, used for awhile and then become obsolete. A business program, on the other hand, is often repeated and used over a considerable period of time; for example, a payroll program may be used every week for years with only minor modifications for tax-rate alterations.

Since COBOL statements are expressed in a language very close to commonly-used English, its programs can be shared by many users with little chance for confusion. Every COBOL program has an Environment Division describing the computer used to compile the program and to run the program. Thus a COBOL program can be compiled on one computer and run on another completely different machine. It is also possible to interchange input and output equipment, a convenient feature since the program can be run even if the system printer becomes defective and a different model is the only available unit on hand.

COBOL's major attraction is its ability to handle large amounts of records and data, making it ideal for reporting and record manipulation. In applications where complex calculations and business decision-making is involved with such record keeping, it is not unusual to use both FORTRAN and COBOL languages, separately of course, to achieve the required results.

Since COBOL is intended for business applications, its language resembles a sequence of English words, used as variables for its mathematical applications. Thus, COBOL is concerned with rules for nouns, verbs and punctuation.

A COBOL program consists of four elements or divisions: (1) Identification, which provides a name for the source program, (2) Environmental, which identifies the computer to compile the source program and run the object program, (3) Data, which defines the files of data to be worked with or prepared by the program, and (4) Procedure, which specifies the steps the computer will execute. Precise rules dictate the reference format (spacings, margins, etc.)

COBOL's English-like sentences make it relatively simple to describe the data to be used and the operations to be performed. Of course, a clear analysis of the problem is necessary before the program can be written.

A simple COBOL program to calculate 2 multiplied by 3 might look like the program in Table 7.

TABLE 6—ADDITION of two numbers in COBOL:

```

ADD 2 TO 3 GIVING A
MOVE A TO PRINT LINE
WRITE PRINTREC
  
```

TABLE 7

```

IDENTIFICATION DIVISION.
PROGRAM-ID. SAMPLE COBOL.
AUTHOR. THOMPSON.
DATE WRITTEN. JULY 2, 1979.
REMARKS. SAMPLE PROGRAM COMPUTES
        AND PRINTS PRODUCT OF 2 AND 3.
ENVIRONMENT DIVISION.
SOURCE COMPUTER. IBM-360.
OBJECT COMPUTER. IBM-360.
DATA DIVISION.
WORKING STORAGE SECTION.
43 NUMBER ONE VALUE IS 2.
43 NUMBER TWO VALUE IS 3.
PROCEDURE DIVISION.
CALCULATION. COMPUTER TOTAL =
NUMBER ONE * NUMBER TWO.
        DISPLAY TOTAL. STOP RUN.
END PROGRAM.
  
```

Although the program appears quite detailed for the short example used, the words are simple for even a novice to figure out what the computer is being asked to do.

Pascal

Writing a large program is considerably harder than writing several smaller programs; thus, a large program requires detailed organization and systematic procedures. Structured programming is a technique used to handle such large projects as an airline reservation system or a fully automated warehouse. The objective of structured programming is to make program structure simpler using a series of simple sequences of operations; in this way errors can be precisely located and corrected before the entire lengthy program is completed.

A language geared to structured programming is Pascal, developed in Switzerland in the early 1970s. The language is simple and efficient and its compiler is not complex, making it attractive for manufacturers of mini- and micro-computers. Its creator, Professor Wirth of Zurich, gathered together useful features and instructions from existing successful languages to simplify the task of writing large, complicated programs. For example, a Pascal program is closer to plain English than BASIC.

TABLE 8—ADDITION of two numbers in Pascal

```

(* ADDITION OF TWO NUMBERS IN PASCAL *)
PROGRAM ADDITION (INPUT,OUTPUT)
VAR SUM: INTEGER;
BEGIN (* ADDITION *)
SUM := 2 + 3;
Writeln (SUM)
END. (* ADDITION *)
  
```

Pascal is rapidly becoming a popular language among manufacturers of microcomputers and thus may eventually become a more common language for smaller systems and computer hobbyists than is BASIC. For comparison the same program written in BASIC in Table 2 is shown written in Pascal in Table 8.

In summary, there are quite a number of computer languages in existence today. The question of which language is best is no different than asking a TV serviceman which of his tools is best: the VTVM, the scope, the VOM, or perhaps even his diagonal cutters? A computer language is also a tool.

For a particular business application, COBOL may be the first choice, while FORTRAN wins out for an engineering problem. With limited computer size, BASIC may turn out the only alternative for a particular problem.

Just as computer hardware manufacturers proceed at a fast clip to improve their products' performance and capabilities, so too will programmers expand their thinking to produce more efficient and creative languages. **R-E**

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The Hieronymus Machine Voice Stress
Computer, U.S. made. It can help
you tell the difference between truth
and falsehood in more ways than one.

VOCAL "TRUTH" ANALYZER

The Hieronymus Machine Voice Stress Detector

It's almost beyond belief. This tiny solid-state instrument measures 3" x 6" x 1 1/2" and fits in a pocket. Yet it contains sophisticated electronic circuitry, a microphone, and three red diodes. It analyzes the human voice for stress.

Once you learn, in about 30 minutes, how to use the Hieronymus Machine, you will be able to discover whether a person is calm or stressful — merely by monitoring his or her voice.

DEFINITELY NOT A "LIE DETECTOR"

The Hieronymus Machine is not a lie detector. Nor is it a "truth" device. Even the famed polygraph machine is not a lie detector, plain and simple. The polygraph can be used to monitor a person's pulse, respiration, blood pressure, and galvanic skin response, bodily functions affected by stress.

And in the hands of a skilled operator, the polygraph can be used to gain insights about a person's stress levels when talking about certain topics. But a very real part of the polygraph's usefulness is the "Hieronymus Effect," which we'll get to in a moment.

SPIES AND COUNTERSPIES

During wartime, counterintelligence experts wondered if science could come up with something simpler than the polygraph to help ferret out spies. Researchers became attracted to the theory that human voices emit "micro-tremors," low-frequency vibrations that are generally inaudible or masked by other voice components.

An article in **Popular Electronics** (April 1980) describes the theory in detail. But the short story is that after spending millions of dollars, researchers developed a voice stress analyzer. Now, the authors of the definitive article in **Popular Electronics** have perfected a personal voice stress analyzer, which we call the Hieronymus Machine.

WHAT IT DOES, HOW YOU USE IT

The Hieronymus Machine electronically measures changes in voice micro-tremors. The read-out is simple: one red diode indicates normal, two show moderate stress, and three reveal greater stress, ranging from mild to severe anxiety.

You, as the operator, could use the Hieronymus Machine like a thermometer, checking the "fever level" of stress. As you gain skill, your judgment will im-

prove, enabling you to pursue or avoid a line of questioning or discussion that produces stressful responses.

MANY USES AT HOME OR WORK

You can use the Hieronymus Machine at home to have fun with your family. You'll discover how it responds to different people's voices, what effect laughter and singing have on it, and even evaluate politicians' speeches over TV or radio. It works quite well on transmitted voices, as well as over the telephone or with tape recordings.

Next, try it on friends. See how well someone's favorite fish story holds up when you point out that the Hieronymus Machine doesn't believe a word of it. And watch that poker face disappear as the "stress" diode steadily insists you're not getting the whole story.

BIOFEEDBACK FOR YOU

If you're required to talk in front of groups or need to speak convincingly to one person at a time, you can use the Hieronymus Machine to monitor your voice and learn a more relaxed, self-assured, persuasive style of delivery. If you wanted to learn hypnosis, a relaxed voice would be a real asset — and the Hieronymus Machine could help you achieve it.

At work, there are numerous situations in which the Hieronymus Machine could work wonders. Here's how: Hieronymus Bosch was a 15th-century painter known for his startling originality. He was also something of a medical practitioner, and he believed that patients could be cured by passing stones over their bodies. Bosch achieved success because his patients **believed** that a cure was taking place.

Nearer our own time, a couple of science fiction writers concocted a device they named after Bosch: it produced varying sensations in the user depending on where a dial was set, from zero to 100. The amazing thing was that this machine worked on subjects even when it wasn't plugged in — a perfect Hieronymus Effect!

Now we have a true Hieronymus Machine, the Voice Stress Analyzer. It actually works, and among other things of a scientifically verifiable nature, it produces the Hieronymus Effect. In its presence, people suddenly become more forthright. In some cases, with such a machine present, employees being

CIRCLE 38 ON FREE INFORMATION CARD



asked about office theft became very cooperative in answering questions truthfully. Naturally, you'll want to use the Hieronymus Machine in plain sight and tell people what it does. This actually gets more cooperation from them.

30-DAY TRIAL, MONEY-BACK GUARANTEE

The potential uses of the Hieronymus Machine are limited only by your imagination. Try it at no risk for 30 days. We'll send you one or more with complete instructions (9v. battery not included). You'll be able to try it, experiment, even conduct your own "investigation."

Governments and police departments and huge corporations are already using large (briefcase-sized) versions of this kind of machine, and they have to pay \$3,000 or so for theirs. But you can have a personal Hieronymus Machine for only **\$119.95**. If you're not satisfied, send it back (insured) for a full refund, no questions asked. If you want two, the cost is **\$109.95** each. And if you want three or more for business use, it's only **\$99.95** each. You're also protected by a 1-year parts and labor warranty.

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The Hieronymus Machine cannot be obtained in stores or from any other source. To order, send check or money order to the address below. Or charge it on American Express, Carte Blanche, Diners Club, Master Charge or Visa. You can also call us toll free:

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OCTOBER 1980

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Synthesized Pulse Generator

This synthesized pulse generator has a range of from 1/100 Hz to 1.000 MHz. Use it for working with logic circuits—or with analog devices well into the HF range.

GARY McCLELLAN

ONE OF THE HANDIEST PIECES OF ELECTRONIC equipment you can have is a good signal generator. But one particular area that has been neglected is pulse generators for driving logic circuitry.

The Programma 1 will change that. Now you can build and test digital circuits without expensive clock circuitry, pulse generators, or other sources. The Programma 1 marries the frequency stability of a synthesizer with a logic-level output. And, when you are not using it to run your breadboard logic-circuits, you can use it as a regular signal generator.

This design has many exciting features. The output frequency is programmed via four BCD (Binary Coded Decimal) front-panel switches. There are a total of 9990 possible frequency combinations available, with each one offering crystal-controlled accuracy. Also included in the Programma 1 is a multi-stage frequency divider that extends the frequency range even farther! In fact, you can readily generate signals from 0.01 Hz to 1.0000 MHz. The accuracy of any of these frequencies is within $\pm 0.005\%$, if the generator is accurately calibrated. As far as the output voltages are concerned, you have your choice of standard TTL/CMOS output, or an adjustable 0 to 5-volt output. This is ideal for general purposes like running logic circuits, or for use as an audio signal generator. And, since its frequency range extends into the RF spectrum, the Programma 1 is also use-

ful for AM radio alignment. Still other features include drive capability for one TTL load, and an ERROR lamp that tells you that the frequency selected is correct. This lamp is helpful as a diagnostic device, should troubleshooting become necessary.

There's more

Not to be overlooked is the design of this instrument. Thanks to the latest CMOS circuitry, it uses just ten IC's. Contrast that number with the seventeen IC's that are normally required in a comparable TTL system. Besides a reduced IC count, you get CMOS advantages like low power consumption, absence of drift-causing heat, and a less noisy signal. Also, the construction has been simplified to one small, single-sided PC board, that you can easily make or buy. Not to be neglected, the other parts have been kept to a minimum by careful engineering, to make buying them easier. In fact, great care has been taken to insure that all parts for this project are readily available. You can expect to be able to assemble the Programma 1 in just a few evenings, thanks to its simplified circuitry and good parts-availability.

For the future

With "smart" test equipment on the horizon, or instruments that interface with computers, this project will become more useful. By replacing the programming switches with appropriate IC buf-

fers, the Programma 1 may be controlled by a microprocessor, automatically generating the frequencies required. This technique is being used in industry for testing, and even alignment, of finished equipment. It's a big money saver, and you'll be hearing a lot more about automatic testing. The Programma 1 has this automatic test-capability built in right now, ready for the future—some day you'll appreciate that!

Theory of operation

Figure 1 shows a block diagram of the pulse generator, so refer to it for details as you read the circuit description. Although the diagram has been stripped down to just the basics, the actual circuitry isn't much more complex. In fact, you are going to read about one of the simplest frequency synthesizers ever designed.

Why a synthesizer?

You may be wondering why a synthesizer has been used in this project, and even, for that matter, what it is. Basically, a frequency synthesizer is a circuit that takes a single frequency from a quartz crystal, and uses it to generate many others, each with the accuracy and stability of the crystal. In the Programma 1, a single color-TV crystal is used to generate 9990 different frequencies. In other words, you replace 9990 crystals with *one* single-crystal frequency synthesizer. (Now you know why they are found in CB radios, and

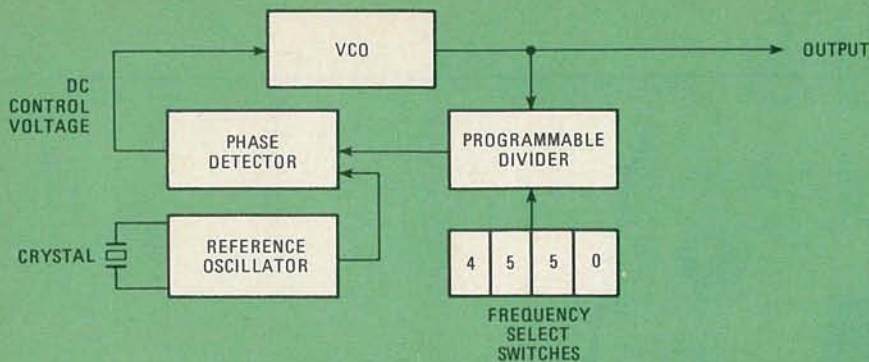


FIG. 1—BASIC FREQUENCY SYNTHESIZER, showing the four major sections. All this is accomplished by only three IC's!

other places where lots of crystals once were used.) Through frequency synthesis you gain accuracy and save money.

As you can see from Fig. 1, the synthesizer consists of four basic parts. The first is the VCO (Voltage Controlled Oscillator). It simply generates a signal whose frequency can be varied by changing a DC control voltage. In this project, the VCO frequency can be swept from 1 kHz to 1 MHz.

The next section is the *reference oscillator*. It provides a stable, fixed reference-frequency. In the Programmable 1, a single IC, combined with a 3.579545-MHz color-TV crystal, does the job. Next, a *programmable divider* takes over, dividing the VCO frequency. The exact divisor is selected by the front-panel switches. In this design, another IC performs the entire task, and can divide the VCO signal by up to 10,000.

The final section is the *phase detector*. It compares the signal from the reference oscillator with the signal from the programmable divider. In operation, the phase detector outputs a DC voltage comparable to the difference of the two signals. The greater the difference, the greater the DC output is. On the other hand, if the two input signals are the same frequency, the DC output doesn't change. Since the DC voltage drives the VCO, it can now adjust the frequency until the signals on the phase detector input are the same. The result is a VCO output-frequency equal to the product of the *divisor of the programmable divider* and the *reference oscillator* frequency. In this project, the VCO and phase detector sections are all included inside one easy-to-obtain IC. That takes care of the basics.

Refer to the schematic diagram in Fig. 2 for the circuit details. The programmable divider is IC1, whose divisor is selected by the front panel switches. It is a single LSI IC, and it costs less, works better, and is easier to use than any other divider scheme. A unique feature of this circuit is that setting the switches to 0000 results in a divisor of 10,000. That saves the cost of an extra switch. The phase detector and the VCO are in IC2. The divider input of the phase detector is pin 3, and the

reference oscillator input is pin 14. The output is pin 13. It drives resistors R19 and R20, and capacitor C6, forming a network known as a *loop filter*. Basically, this filter does nothing more than clean up the VCO control voltage. Other phase-detector circuitry includes transistor Q1, which connects a LED to the error-detecting circuitry in IC2. If something goes wrong with the circuitry, and the frequency is off, the LED will light.

The VCO portion of IC2 is simple and straightforward. The DC control voltage is applied to pin 9. Resistor R17 and capacitor C1 set the maximum operating frequency of the VCO. The squarewave output signal appears on pin 4, ready for use elsewhere. The reference oscillator circuit consists of IC3, and it contains all the devices required to excite TV crystal XTAL1 and to produce a 100-Hz reference signal. The balance of the circuitry on this board consists of five decade-dividers, IC4-IC8, that simply divide down the output signal, giving a symmetrical waveform. Since the outputs of these IC's are all at CMOS levels, with a 10-volt swing, buffer IC9 has been included to convert the voltages to TTL-compatible values.

The power requirements of this circuit are provided by IC10 and Zener diode D1. These components provide a well-regulated 10 volts for the synthesizer, and 5 volts for IC9, which is used to drive 5-volt TTL devices. Power to the PC board is supplied by a 14-volt surplus battery charger. Not much current is required (about 10 mA DC), so the entire unit can be battery-powered if desired.

Construction

Now that you know how the Programmable 1 works, let's put one together. One important reminder is in order if you are considering breadboarding the project—the output signal will be noisy unless you are careful. Like most other frequency synthesizers, this one has a high loop-sensitivity, and is susceptible to noise pickup. So if you wish to get a high-quality signal from this project, be sure to use a PC board. If desired, you

can buy one, together with assembly instructions and troubleshooting hints, from the supplier indicated in the parts list. Or you can "roll your own" using Fig. 3.

Another important reminder concerns the quality of the parts you use. It shouldn't be necessary to remind you to use top-quality components, but if the urge to use cheap substitutes is overpowering, you may wind up with problems. Generally, the quality of the output signal will suffer, and frequent servicing may be required. Play it safe, and save time and money in the long

PARTS LIST

All resistors ¼ watt, 5% unless otherwise noted.

R1-R16, R19—100,000 ohms
R17, R18—10,000 ohms
R20, R22, R23—2,200 ohms
R21—22 megohms
R24—47 ohms
R25—10,000 ohms linear taper pot (carbon) with SPST switch

Capacitors

C1—47 pF mica
C2, C8—0.1 µF disc
C3, C9—33 pF mica
C4—10 pF mica
C5—6 to 20 pF trimmer (E.F. Johnson 275-0320-005 or equivalent)
C6—4.7 µF, 16 volts, tantalum
C7, C10—10 µF, 16 volts, tantalum
C11—220 µF, 25 volts, electrolytic

Semiconductors

D1—5.1-volt, 1-watt Zener diode (1N4733 or equivalent)
D2, D3—1N4148 or 1N914
Q1—2N3906
IC1—CD4059AE CMOS divider (RCA)
IC2—CD4046 CMOS PLL (RCA)
IC3—MM5369EST CMOS oscillator (National)
IC4-IC8—MM74C90N CMOS counter (National)
IC9—CD4050 CMOS hex buffer (RCA)
IC10—MC78L05 5-volt regulator (Motorola)
LED1—.200-inch discrete LED
S1-S4—BCD thumbwheel or lever-type switches (C&K 332110000, EECO 1800 Series, or equivalent)
S5—6-position, single-pole rotary switch
S6—SPST switch (mounted on R25)
XTAL1—color-TV crystal, 3.579545 MHz, 32 pF parallel-resonant, HC-33 case
J1—jack to match connector from power source used
J2—RCA-type jack
J3—BNC connector

Miscellaneous: PC board, 14-volt DC power supply or battery eliminator, one 8-pin IC socket, five 14-pin IC sockets, two 16-pin IC sockets, one 24-pin IC socket, enclosure, knobs, solder, ribbon cable, etc.

PC boards are available. Order part SCG-1. Price, postpaid in USA, \$10.00; California residents add 6% tax. Foreign orders please add \$3.00 for shipping and handling. Order from: Technico Services, Box 20HC Orangehurst, Fullerton, CA 92633.

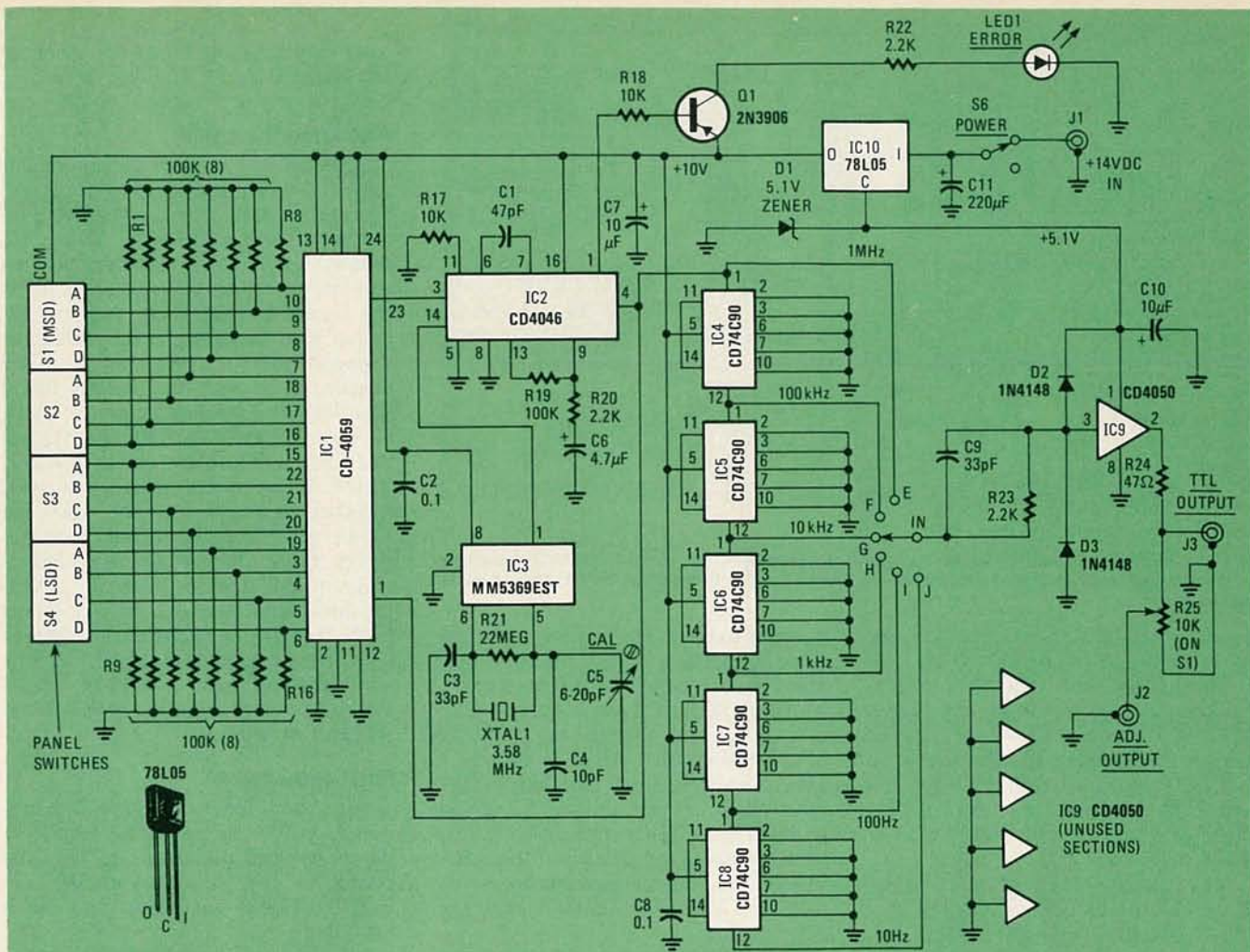
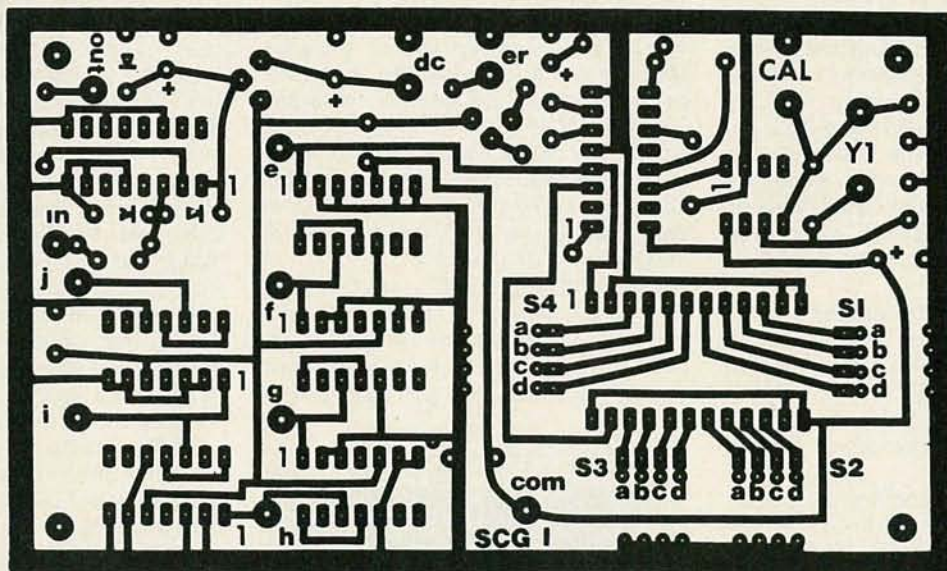


FIG. 2—PROGRAMMA 1 has a frequency range of from 0.01 Hz to 1.000 MHz. BCD panel-mount switches are used for exact selection of pulse frequency.



4-3/8 INCHES

FIG. 3—FOIL PATTERN for the Programma 1. See parts list for supplier if you prefer not to make your own PC board.

run by using top-quality parts. This is especially important with respect to the IC's and the capacitors. Although the need for quality IC's is obvious, the capacitors should be the type (e.g. mica

or tantalum) and value specified. This will insure the best possible signal stability and purity at a small additional cost.

Refer to Fig 4 as you install the parts

on the PC board. A good place to start is with the IC sockets. Begin by installing a 24-pin socket at IC1, then an 8-pin unit at IC3. Check to be sure all pins are soldered in place on the sockets—

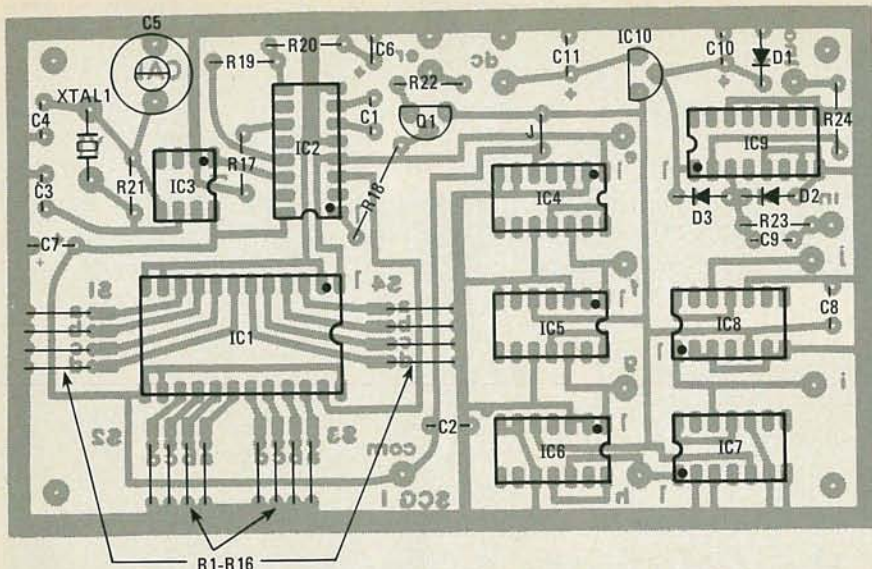


FIG. 4—OBSERVE POLARITIES shown in parts-placement diagram. Be aware that 78L05 pinouts may be shown differently from manufacturer to manufacturer. Orientation given here is correct for all versions.

especially on the 24-pin one. Continue by installing 16-pin sockets at IC2 and IC9 locations. Finish up the socket installation by adding 14-pin sockets to IC4—IC8 locations. This board has one jumper wire, which you can insert next. Locate it in Fig. 3 first (between IC4 and C11), then install it on the board. A piece of bare wire cut from a resistor will work fine.

Now you are ready for the resistors. Start with the 100K units, placing 16 of them around IC1 (R1-R16). After that, install R21, 22 megohms, next to the IC3 socket. Then mount a 10K resistor on either side of IC2. Note that, while the leads of R17 are simply bent and inserted in the board, R18's leads must be left longer (about 1/4-inch) to cover the distance between the holes. Next, install 2.2K resistors at R20 and R22, and a 100K resistor at R19. Move over to the other edge of the board and mount a 47-ohm resistor at R24. And finish up with R23, 2.2K. Be careful not to confuse the location with that for D3, just below it!

The diodes are next, and the installation will go quickly. Be careful to install them correctly, and double-check against Fig. 3 afterwards. Start with D1, a 1N4733 5.1-volt Zener diode, and then install 1N4148 diodes at D2 and D3. That's it.

The next step is to install the capacitors. You can start with C7, 10 μ F. Orient it as shown in Fig. 3. Then install a 33 pF mica capacitor at C3, and a 10 pF mica capacitor at C4. The trimmer is next, so examine C5 and note that the ground terminal is probably marked in some way. If there's no arrow or paint dot, then trace out the pin that attaches to the adjustment screw. Install it so the ground terminal faces the edge of the board. If the trimmer is reversed, the project will work, but will be tough to calibrate due to capacitance added

by your hand on the screwdriver! Continue with C6, a 4.7 μ F tantalum, and just above it install a 47 pF mica at C1. Move up the board and install a 0.1 μ F disc at C2, and another at C8, at the left. Then install a 33 pF mica at C9. Mount another 10 μ F tantalum at C10, below IC9. Finish up the capacitors with a 220 μ F electrolytic at C11. Stop for a moment, and check your capacitor installation. Correct any mistakes you may find and then continue with the construction.

By now your circuit board will be nearly complete and will look like the one in Fig. 5. There are just a few parts to go, so let's finish up the board. Mount crystal XTAL1 first, pressing the case down firmly against the board before soldering the leads. Then install IC10, a 78L05 regulator next to C11. (Note: The 78L05 pinout given by some manufacturers may differ from that shown here. To the best of our knowledge, our pinout holds true for all versions of the 78L05—Editor).

Finish up with the IC's, starting with IC1. Note that the foil side of the board and Fig. 4 indicate the orientation of each IC. Use them to guide you. After the IC's are installed, check the board

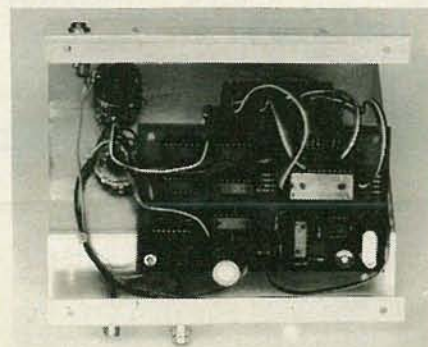


FIG. 5—FRONT-PANEL SWITCHES are connected to PC board by ribbon cable. Note power jack, J1, at back of enclosure (upper left).

over very carefully for errors. Then set the board aside for a while.

Preparing the case

Although the original version of this project was built in an old meter case, you are welcome to use any suitable enclosure. It should be metal, though, to prevent radiation of stray signals that can interfere with your tests. As far as the layout is concerned, you can exercise your judgment in the matter, or duplicate the box layout shown in the photos. Here are a few helpful tips if you decide to "roll your own." First, be sure to locate the ERROR LED and FREQUENCY switches close together. This is important because they are used together. Also, the output jacks and LEVEL pot should be located close together. In fact, they should be positioned closer to one another than they are on the prototype (see Fig. 7), since long leads degrade the shape of the signal at high frequencies. All signal-carrying leads, for that matter should be kept as short as possible. The rest of this part is straightforward.

Final assembly

After you have the enclosure prepared, you're almost done. Probably the best place to start is to wire the board to the FREQUENCY switches. Refer to Fig. 2 (schematic) and Fig. 6 for details.

Start by wiring all the common pins of the switches together with a piece of bus wire. Then attach a short piece of stranded wire to it. This is the "COM" lead to the circuit board. Next, you can wire the switches themselves, starting with S1. Note that S1 is the MSD (Most Significant Digit), and that it is the switch section on the far left of the panel as you view it from the front. Use short pieces of four-conductor ribbon cable for the connections. You can attach the ends of the switches first. In fact, it might be a good idea to solder a length of cable to each switch first, and then to the circuit board later. This is easier if you have mounted the switches in the box already.

After the wires are attached to the switches, connect the cable from S1 to the holes on the board. Note that some BCD switches are coded "1 2 4 8" and that corresponds with the "A B C D" marked on the board. In the same manner, wire the remaining switches. Switch S4 will be the section on the right when viewed from the front. Finally, connect the "COM" wire, and you are through with S1—S4.

Now for switch S5. Prepare a short length of six-conductor ribbon cable and connect one end to the fixed contacts of S5. Then attach a single piece of wire to the wiper terminal. Connect the other ends of the ribbon-cable wires

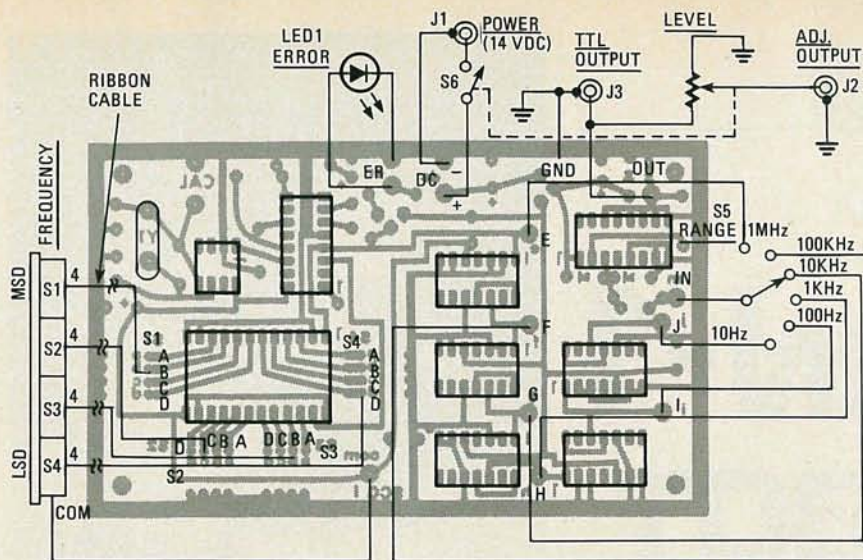


FIG. 6—CONNECTION OF OFF-THE-BOARD components. Resistor R25 is a part of the on/off switch, S6. All leads should be kept as short as possible to avoid difficulties at high frequencies.



FIG. 7—THIS LAYOUT works well, but is not ideal. Output jacks and "level" pot should be located closer to one another to keep leads short.

to the "E" through "J" outputs, and the single wire from the wiper to "IN." This wiring is shown in more detail in Fig. 6. Next, the LED may be installed. Finally, wire up pot R25, the output connectors, and the power leads. Don't forget to run a short wire from the circuit-board ground foil to the box. A good place for this is at the "minus" terminal of C11 (220 μ F). Wire up the POWER jack, J1 (on the back of the box) and you are finished.

Calibration

Although this project should work

reasonably well without any calibration, you might want to make a simple adjustment for the best frequency accuracy. To do this you'll need an accurate frequency counter and an $\times 10$ oscilloscope probe. Supply 14 volts DC to J1, then rotate the LEVEL pot to turn on the power. At this point there's no need to set any of the switches on the project. Connect the probe to the counter, and clip its ground lead to the pulse generator. Then, carefully touch the probe to pin 7 of the MM5369EST (IC3). You should get a reading of $3,579.5 \times \times$ (=variable) Hz. Adjust the trimmer so that you get exactly 3,579,545 Hz and you are all set. Disconnect the counter and you can close up the box.

Operation

Operating the Programma 1 is a snap! Simply set the frequency you want on the thumbwheel switches, and watch the ERROR LED. It will blink about four or five times, then go out. When it does, you are locked on frequency. Switch S5 selects the frequency you get out. For example, on the 1 MHz range, you'll get an output from about 900 Hz to exactly 1.000 MHz. Switch to the 100-kHz range and you'll get a tenth of that or 90 Hz to 100 kHz. The rest of the ranges work

in the same manner. If you would like an adjustable output instead of the TTL-level signal from J3, simply use J2, and adjust the LEVEL control for the voltage you want. There's nothing to using this project!

Here are a few tips to help you get the most out of your project. First, due to the design of VCO and divider circuits, switch positions from 0001 through 0009 will be inoperative. The ERROR light will come on as a reminder that these numbers are invalid. Note that the setting of 0000 is OK; in fact it will give you 1.000 MHz, but watch those other settings. As far as the output signal is concerned, it is a constant-amplitude squarewave with a 50% duty cycle. However, if you start to load it down, the amplitude will change. Also, the waveform quality will tend to deteriorate as the frequency goes up. So, for best results when you are interested in waveform quality, use a very light load, and watch out for the effects of coaxial cables at the higher frequencies. Finally, some degradation of the squarewave will be noted at the adjustable output (J1) at high frequencies. This is normal where a simple pot-attenuator is used.

Some uses for the Programma 1

There are a great many uses for this pulse generator. Although it was designed for operating digital circuits, it does well in other areas, too. Here are a few things that can be done with it: checking TTL divider circuits, decimal-counting uses (why not make a timer?), general logic-troubleshooting, and much more.

In the analog area, it can be used for amplifier squarewave-testing, electronic music (it generates a wild glide tone!), AM radio alignment, and more. How about using it as a short-wave radio marker-generator? (The harmonics go well into the HF spectrum.) Or as a programmable sinewave generator? (Active filtering can change the squarewave to a sinewave.) There are numerous uses for the Programma 1. How many can you think up? **R-E**

Television viewers want low power consumption

More than six out of ten TV viewers believed that reduced power consumption would be a "very useful feature" in a recent nation-wide survey carried out by Venture Development Corp., a Wellesley, MA, market-research firm. Prospective buyers would be willing to pay up to \$41 additional for significant energy-saving features. Runner-up, with just about 60 percent of the surveyees, is better sound quality, and TV listeners feel that better speakers would justify a \$66 increase on the price of their sets. Stereo sound, however, would be worth \$80. About 40 percent of the viewers felt that automatic tuning through the use of vertical interval

reference would be "very useful," and 25 percent opted for pushbutton channel selections. (In view of the low power consumption of modern TV sets, it might be interesting to investigate how much of the response to that question is due to consumer ignorance and the present campaigns for energy economy.)

Special features mark new video disc player

The *SelectaVision* video disc player, a product of RCA, will come with two features in its latest design that can greatly increase its usefulness to the home viewer.

Visual Search allows the viewer to scan the program at many times normal speed—either

forward or backward—while continuously displaying a picture on the TV screen. *Rapid Access* locates—at high speed—any desired segment on the disc. It uses a digital time indicator. (RCA had previously demonstrated a mechanical time indicator.)

The first VideoDisc players will be monophonic, since the users will be owners of present-day TV receivers, all of which are mono. Stereo versions will come later.

RCA expects to have the first players on the market in the first quarter of 1981. The agreements that have been reached with CBS and Zenith are expected to result in those two firms entering the video disc business with products based on the RCA capacitance system.

UNICORN-1 ROBOT



Assembling the Legs

Part 3—Every robot should have a way to get from place to place. This part of the Unicorn-One series describes the mobility base, which allows the robot to do just that.

JAMES A. GUPTON, JR.

HAVING ALREADY OUTLINED THE CONSTRUCTION of the robot's arms and hands in parts 1 and 2 of this series, we'll now discuss its *mobility base*—the powered section that allows it to move from place to place.

The mobility base houses the robot's electrical power source, its drive motors, and the heart of its wiring system.

While it may be necessary to purchase some of the components of the mobility base new, there is still a lot of money that can be saved through judicious scrounging. Remember—it doesn't really matter what you use to get something done, as long as it *does* get done and the results are what you need.

We'll present two approaches to constructing the mechanism of the mobility base. The first, which may require some cash outlay, is the one we've found to give the best results. The second, which is more economical, is a bit trickier and not quite as acceptable to the purist. Still, both work.

Figure 19 illustrates the dimensions and external appearance of Unicorn-One's mobility base. Actually, for the sake of economy, the original housing was made using a large discarded electronic chassis, as seen in Fig. 20.

One of the most stylish ways to go is to use Bud aluminum or steel panels, plates and frame sections, which can be ordered through most electronics parts distributors. The parts list shows the designations of the Bud parts required. Unfortunately, this approach, which requires only a little

cutting and drilling, can turn out to be fairly costly.

You might, therefore, want to turn to scrounging (a local sheet metal firm might have some odds and ends that could be picked up cheaply), or purchasing material that was not pre-cut. Be sure, though, that the aluminum (if that's what you're using) is *type 5005*—an indication of its strength. You must bear in mind the fact that the mobility base will be supporting at least 30 pounds of the robot's weight and that if it is too weak, the mechanical integrity of the robot will suffer.

Every part of the mobility base skin can be made from aluminum, except for the top. That should be fabricated from 0.125-inch *steel*, both to support the weight of the body and to allow the bearings upon which the body will rotate to turn freely.

The side panels can be made from .0625-inch aluminum, since they will not be responsible for bearing weight. An option is given in the parts list to use four 19 × 7-inch side panels. These are not, of course, the dimensions shown in Fig. 19, but reflect the possibility of your choosing to build a square base, and also the use of a smaller size battery. Actually, the dimensions are not critical. Just make sure that the robot's center of gravity falls within the support points (the wheels) and that there is enough room inside the mobility base for the battery, motors and terminal strip. Be sure to allow sufficient clearance for you to access the battery.

Finally, aluminum angle-bracket, available at hardware or building-supply stores, will do very nicely for the frame in place of more expensive materials.

Access to the mobility base is provided by a hinged plate at the back (Fig. 21). Lay out the interior so that the important parts can be reached through the opening this plate provides. Use the diagrams and photographs in this installment to guide your thinking. There is nothing forcing you to make a carbon copy of the original Unicorn-One. Use your imagination and ingenuity.

A 2½-inch wide curved opening will have to be cut in the top of the mobility base (refer to Fig. 19) to permit wires to be routed between the base and the body. This opening may be located at either the front or the rear of the top section. You should make sure that the wires will not jam in the slot as the body rotates—don't forget to allow slack in the wires for this purpose—and the slot should be edged with some soft material such as several layers of electrical tape, or flexible tubing which has been slit to fit over the cut metal, to prevent chafing of the wires' insulation.

Transmission and drive train

There are three main sections to the "mobility" part of the mobility base. They are the motors, the wheels, and the parts which transmit the action of the former to the latter. The wheels are easy to obtain. The two 6-inch driven wheels can come from an abandoned child's wag-

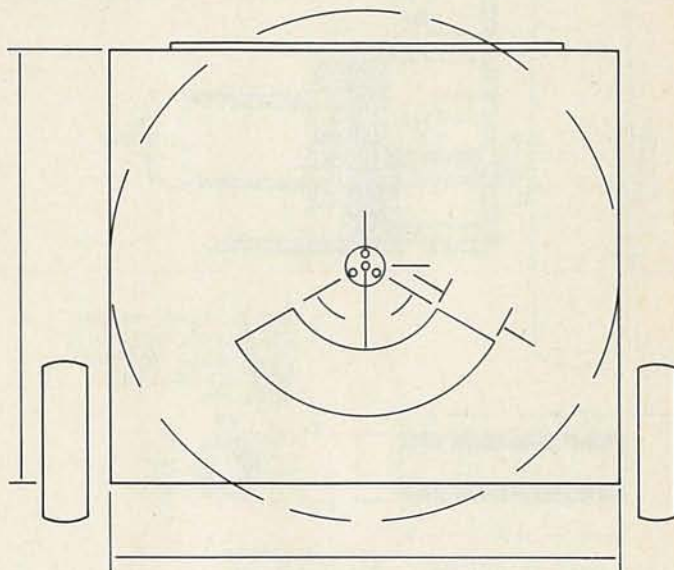
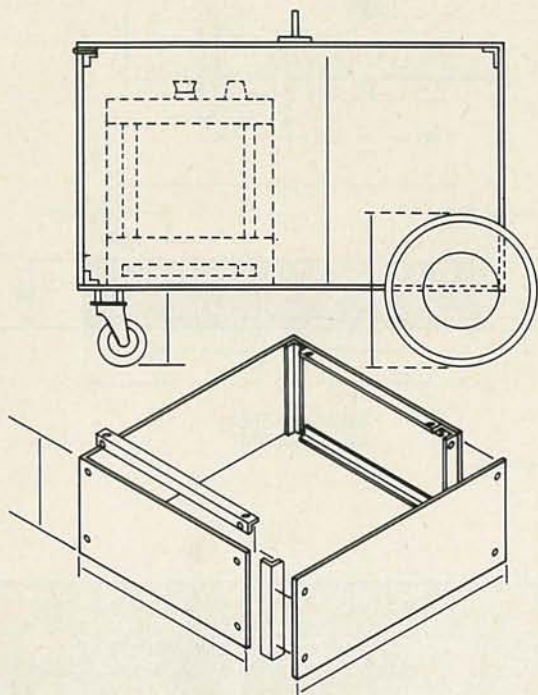


FIG. 19—MOBILITY BASE layout and dimensions. Figures here are for author's prototype—yours may differ (see text). Top plate is made of steel; rest can be aluminum.

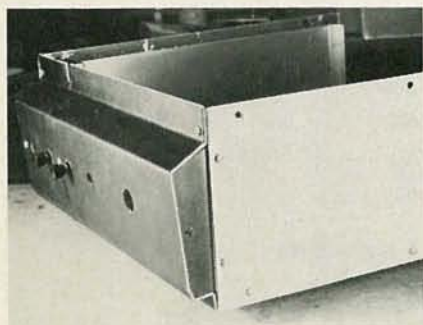


FIG. 20—EARLY VERSION of the mobility base enclosure, built from parts at hand.

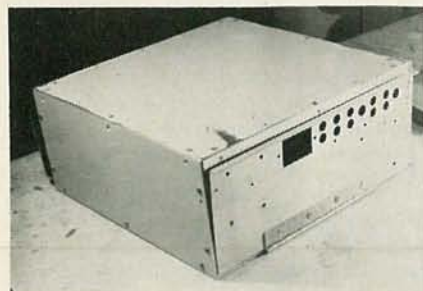


FIG. 21—HINGED BACK PANEL allows access to components mounted inside mobility base.

on or scooter, or from a lawnmower service shop, to name a few sources. The front castor wheel is probably best found in a hardware store.

The preferred motors, used in the first

approach, are gear motors which run at a speed of between 20 and 25 RPM. Sources for a 22 RPM motor are given in the parts list. If you elect to go the second route, you can use simpler, higher-speed motors. Again, refer to the parts list.

Figure 22 illustrates a section of a mobility base constructed using the 22 RPM gear motors. The motor is very easily attached to the frame of the base through the use of an aluminum angle bracket at the bottom and two 1/4-inch OD spacers at the top. Attachment is made using the existing motor mounting-holes. By using counter-sunk flat-head machine screws, the exterior of the mobility base is left free of protrusions and can be painted without further finishing.

The wheels, which usually come with 1/4-inch shafts, are coupled to the 1/4-inch motor shaft by means of a 2.5-inch long, 1/2-inch spacer, with an inside diameter of 1/4-inch, secured to both the axle and the shaft by means of set screws. Alternatively, a .374-inch OD coupler may be used and the shaft and axle secured to it with dowel pins. Refer to Fig. 23 for details.

Two motor/wheel assemblies are used, one on each side. Front support is given by a castor wheel located at the front of the assembly. Steering is accomplished by driving only one motor, using the oth-

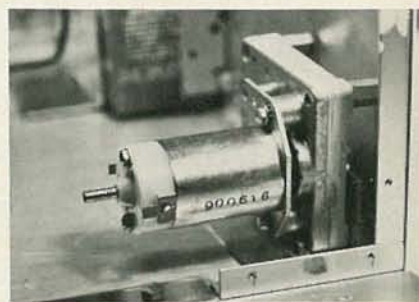


FIG. 22—ONE OF THE TWO gear motors used to drive the mobility base's wheels.

er as a pivot about which the robot turns. Or, for speed, one wheel may be run in one direction while the other is run in the other.

The alternate method for driving the mobility base, illustrated in Fig. 24, uses less expensive, but much faster-turning electric motors coupled to the wheels through a set of worm gears. This method, while less expensive in terms of materials, requires a lot of painstaking labor and probably the use of a well-equipped machine shop. It is presented here mostly as an exercise in developing alternate ways to achieve the same results.

The motor is mounted on a 1/4-inch thick aluminum plate which, in turn, is mounted on the inside of the bottom of the mobility base using four spacers. The shaft of the motor protrudes down

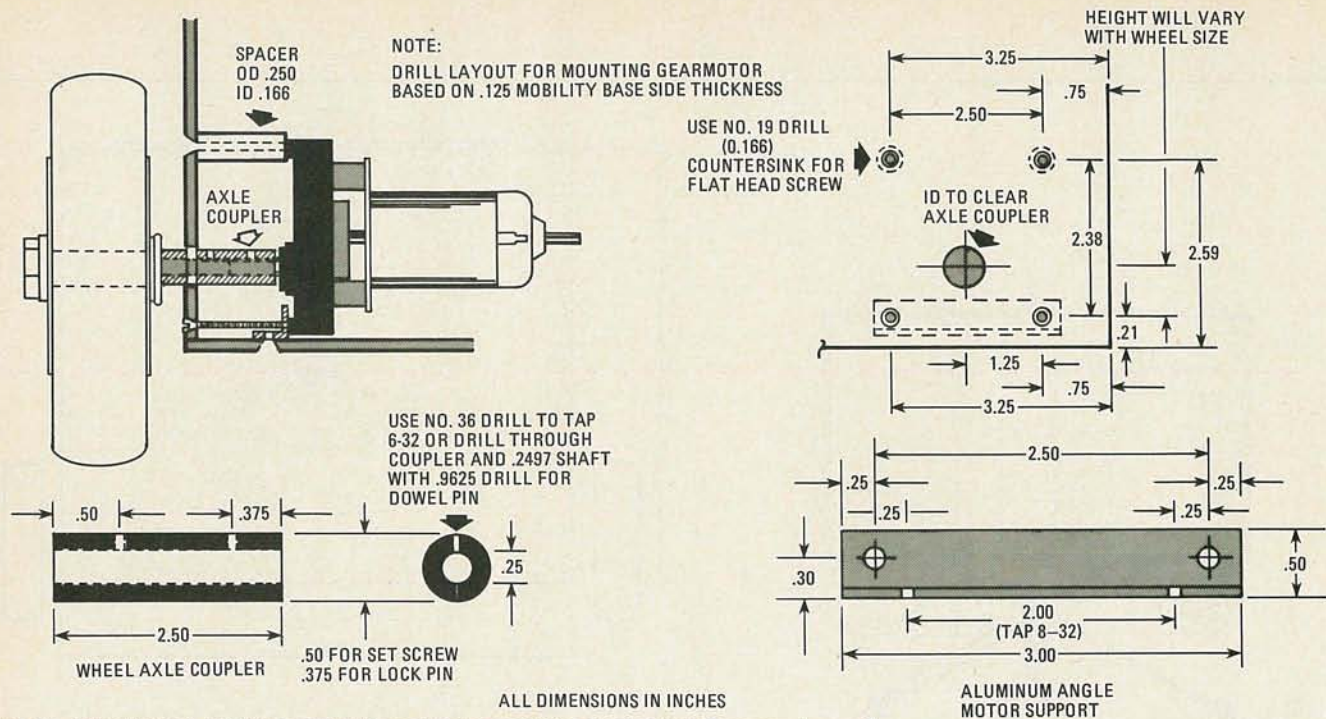


FIG. 23—MECHANICAL DETAILS of 22-RPM gear-motor mounting. Some dimensions may change if sizes of wheel or wheel-shaft you use differ from those used by author.

PARTS LIST

Item	Size	Quantity	Supplier's part no.	Supplier	Item	Size	Quantity	Supplier's part no.	Supplier
Sheet metal (type 5005) aluminum	.125 x 10.5 x 19 inches	2	PA-1106 (5005 alum.)	(A), (G)	Battery	or 3-amp split- phase	2	61.085	(C)
	.125 x 10.5 x 15.75 inches	2	PA-1106	(A), (G)		lead-acid, 12- volt, 12 am- pere-hours	1	local supplier	
	.125 x 19.5 x 15.75 inches	1	PS-1258 (steel)	(A), (G)		gelled-electro- lyte, for 12 volts, 12 am- pere-hours	as required	see back of Radio- Electronics	
	.125 x 19 x 15.75 inches	1	PS-1109 (alum.)	(A), (G)					
(Optional—for use with mo- tor-cycle bat- tery and 19- inch square base)	.125 x 19 x 7 inches. Note: .0625 sheets may be used for sides if de- sired.	4	PA-1104 (alum.)	(A), (G)					
Aluminum angle	.0625 x 1/2 inches	16 feet	Local hard- ware supply store						
	or .125 x .75								
	.125 x .75 in. x 3 feet	1	BI-2901-3	(A), (G)					
	.125 x .75 in. x 12 feet	1	BI-2901	(A), (G)					
Rear panel hinge	1 x 12 inches	1	Local hard- ware supply store						
Worm gear	24-pitch—1/4- inch bore, 30 teeth	2	W24b37-F30	(A), (B)					
Worm	Double pitch	2	W24s-4D	(A), (B)					
Wheel motors	22 RPM gear- motor	2	715-900153 (Brevet)	(A), (E)					

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
- (C) **Edmund Scientific Co.**
101 East Gloucester Pike
Barrington, NJ 08007
- (E) **Gledhill Electronics**
P.O. Box 1644
Marysville, CA 95901
- (G) **Bud Industries, Inc.**
Parts may be ordered through
local electronics supplier.

NOTE: Part numbers for all items with "G" shown as supplier are those used by Bud.

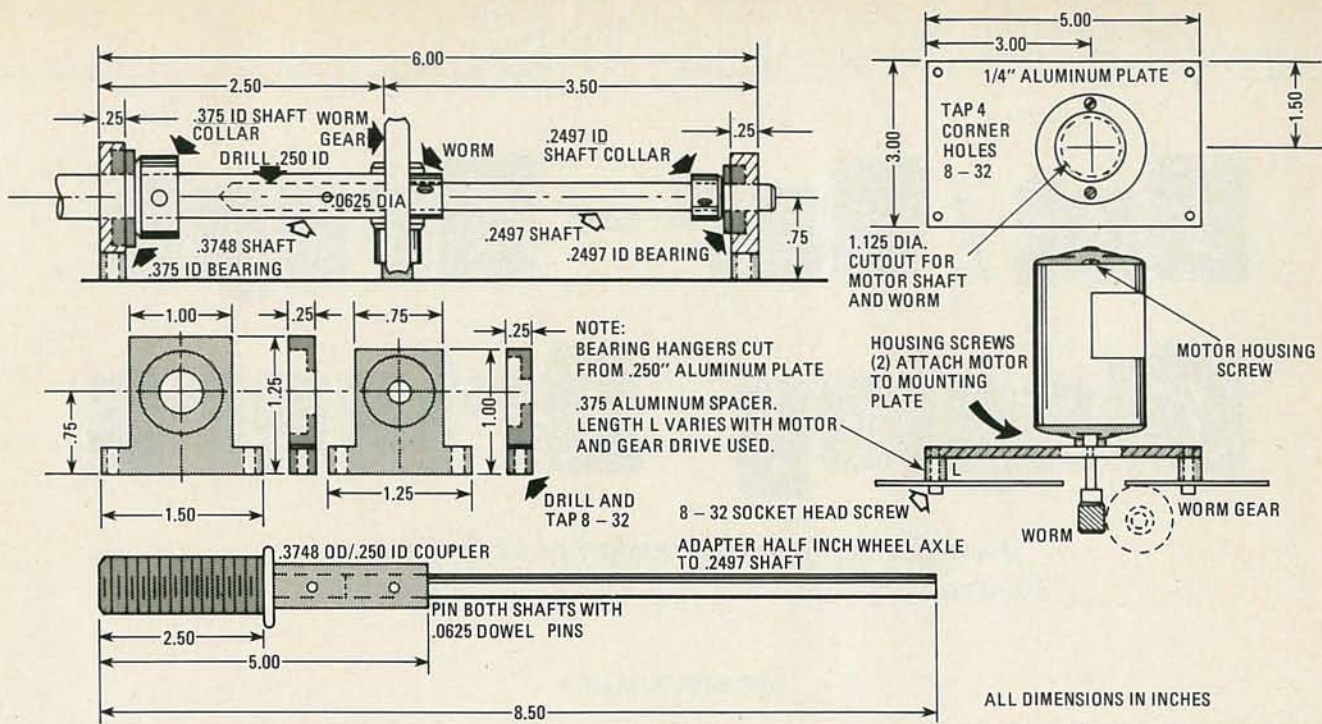


FIG. 24—MORE COMPLEX DRIVE MECHANISM is shown above. Power is transmitted to wheels through right angles, by means of worms. Gear motor drive is simpler and more reliable.

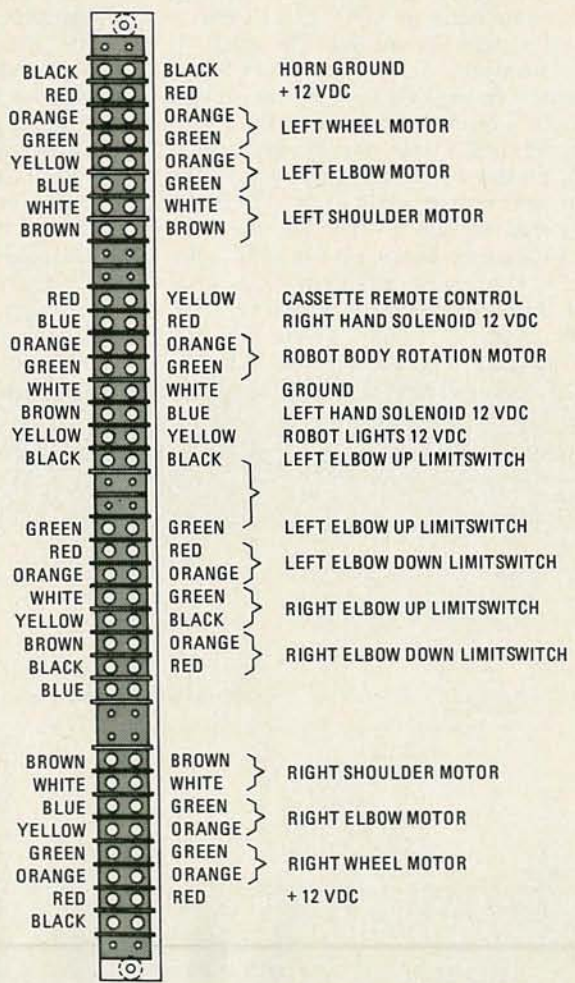


FIG. 26—THIRTY-TWO TERMINAL barrier strip (at left) for power distribution and control. Will first be connected by cable to control box and later directly to R/C receiver or computer.

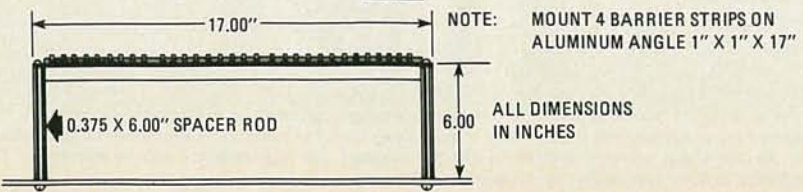
through the mounting plate and through a hole in the bottom plate of the mobility base. Attached to the end of the shaft is a double pitch worm. This worm meshes with a 24-pitch, 30-tooth, worm gear, affixed to the end of the shaft which connects to the wheel. As can be seen from the diagram, several bearings are needed for this method and the bearing hangers (the plates which hold the bearings and are attached to the frame of the body) must be very carefully machined if things are to work right. Also shown in this diagram is another coupler, used to extend the length of the wheel shaft.

While this method can be made to work, it is one place where you might want to consider splurging and buying the gear motors to use in the first method presented. The extra cost will be more than offset by the ease of construction and the final result.

Power sources

Since Unicorn-One is a mobile robot, it's intended that he carry his own power source with him. He obviously can't run on flashlight batteries—in fact he needs ten to twelve amps at 12 volts. The most economical way of obtaining this power is through the use of a conventional lead-acid battery.

A motorcycle battery, mounted as shown in Fig. 25, will do the job nicely. (Note the plate to the left of the battery, which brings its leads to the outside for recharging purposes.) A frame should be



continued on page 126

Dot / Bar - Graph Display Drivers

*New IC's simplify the design of LED displays.
They're capable of doing a lot more than that, too!*

MICHAEL X. MAIDA

THE USE OF MULTIPLE LED'S IN A BAR-graph fashion to display analog signals is becoming increasingly popular. The reasons include low cost, ruggedness, high visibility, ease of interpretation, fast response time, low voltage and current requirements, and long life. No other display technology combines all those advantages. For example, electro-mechanical meters can have better resolution, but they respond less quickly and are sensitive to shock and vibration. Liquid-crystal displays draw less power but are slow, and difficult to read in dim light. Bar graph displays based on LED's are used in stereo amplifiers for power meters, in tuners for signal-strength indicators, and in cameras for light meters. In all of those examples, the display must be interpreted quickly and easily, but high resolution is not required.

Recently, IC's have been introduced that considerably simplify the task of driving a LED array with analog signals. Examples of those include National Semiconductor's LM3914 and LM3915 LED Dot/Bar Display Drivers. Those extremely versatile devices have a reference, a voltage divider, and ten comparators all on one chip. Besides the LED's, only a few resistors and a capacitor are required to complete the display circuit. Either a bar or dot display (only one LED on at a time) is possible. The on-chip voltage reference is fully regulated, remaining constant while the power supply feeding the IC can be anywhere between 3 volts and 25 volts!

How it works

A block diagram of the LM3914 is shown in Fig. 1 where the IC is wired up as a simple 2.5 volt full-scale meter. The IC's internal reference forces the volt-

age drop across R1 to 1.25 volts, causing a current equal to $1.25V/R1$ or 1.25 mA to flow thru R1 and R2. The small 75-microampere current from pin 8 can usually be neglected so that the voltage at pin 7 is approximately $1.25V \times (1 + R2/R1)$ or 2.5 volts. The display range is set by the voltages at pins 6 and 4, the top and bottom ends of the LM3914's internal voltage divider. For the 0-to-2.5-volt meter shown, pin 6 is wired to the 2.5-volt reference while pin 4 is grounded. The reference load current (I_{REF}) in this example is equal to the 1.25 mA flowing through R1 plus the 0.25 mA

flowing through the 10K divider or 1.5 milliamperes total.

The signal to be displayed is applied to pin 5, where it is buffered by a high impedance follower and fed to the inverting inputs of the ten comparators that drive the LED's. The comparators' non-inverting inputs are connected to the taps along the voltage divider. In the LM3914, those taps are all equally spaced. Here, another comparator turns on for every 250-mV increase of the input voltage, lighting up another LED.

Current drive to each LED illuminated is set at ten times the reference-

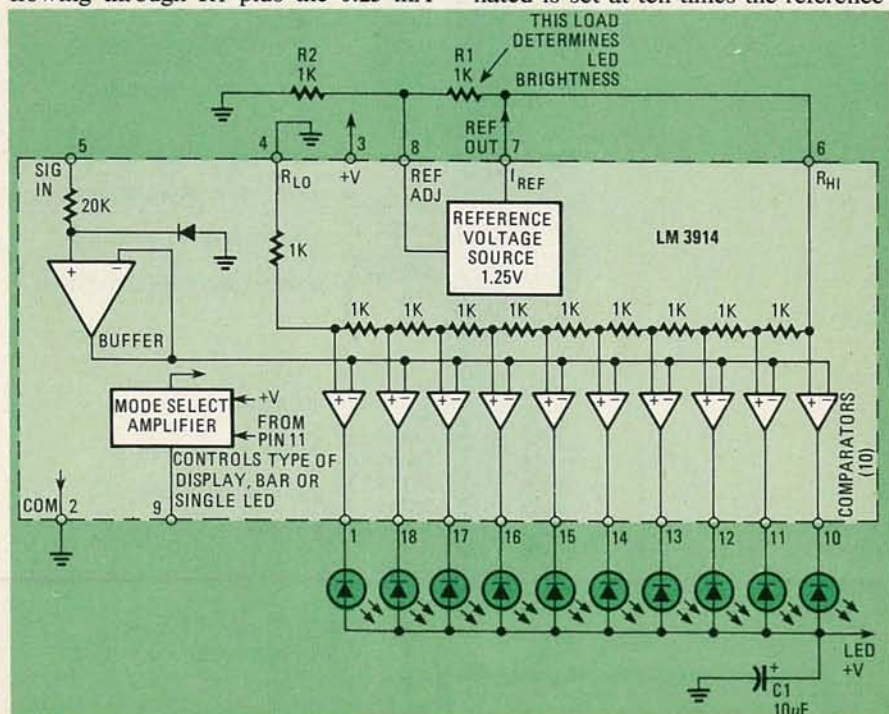


FIG. 1—THE LM3914 consists primarily of a series of comparators and a voltage-divider network. The trip point of each successive comparator is set higher than the previous comparator by the voltage divider. As the input voltage applied to pin 5 increases, the comparators trip in sequence. The comparators, in turn, illuminate their respective LED's.

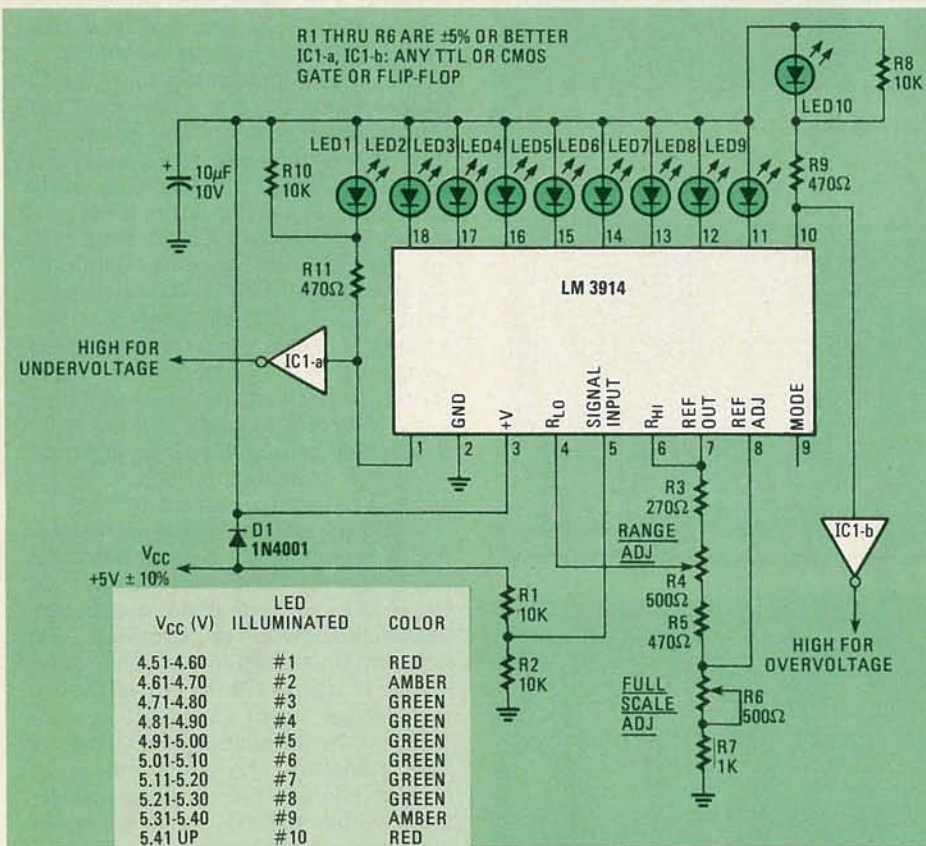
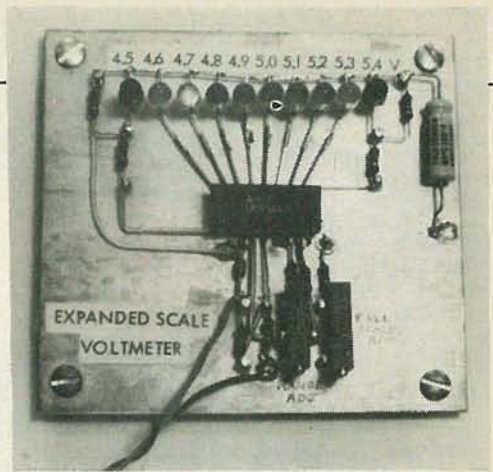


FIG. 2—EXPANDED-SCALE VOLTMETER for monitoring the output voltage of a 5-volt logic-power supply. Each LED corresponds to a predetermined voltage, as shown in the chart.

load current (I_{REF}) or 15 mA in this example. Generally, LED currents from 10 to 20 mA produce adequate brightness. A pot in series with a resistor connected from pin 7 to ground makes a simple intensity control, since it varies I_{REF} without affecting the reference voltage. Trimming the reference output voltage can be accomplished by varying R2.

For a DOT-mode display, pin 9 may be left open; for BAR-mode, pin 9 is connected to the LED supply, which

can be different from the IC's V^+ . Watch the IC's power dissipation in BAR mode, however. At 15 mA per LED, the LED supply should be no higher than 6 volts. To power the LED's from a higher-supply voltage, place a dropping resistor between the LED anodes and the supply. The LED supply should always be bypassed with a 10 μ F electrolytic capacitor to prevent oscillations. The LM3914's $+V$ supply (pin 3) must be at least 1.5 volts above the pin 7 reference output and can be as low as 3

volts when the reference is run at 1.25 volts (pin 8 grounded).

Simple voltage monitor for TTL

The LM3914's low voltage-requirements and flexibility make for some interesting applications. Figure 2 shows an expanded-scale voltage monitor for a TTL system that runs off the same single 5-volt supply it monitors! As shown in the table, each LED covers a 100-mV range from 4.5 to 5.5 volts. A simple two-step calibration is all that's required.

Here the supply voltage is attenuated by a factor of two and fed to the LM3914 signal input. Resistor R6 sets the top of the internal divider network at 2.705 volts ($5.41V/2$) and potentiometer R4 sets the bottom of the divider at 2.205 volts ($4.41V/2$). Adjust R6 until LED10 just turns on with V_{CC} set at 5.41 volts. Then adjust R4 until LED1 just turns on with V_{CC} set at 4.41 volts. There's a slight interaction so that running through that procedure a second time may improve accuracy.

TTL and CMOS-compatible under-voltage and overvoltage signals are provided, which can be used to shut down a system before damage (to either data or hardware) occurs. Optional diode D1 protects the IC in the event the 5-volt supply leads are reversed. For a simple go/no-go display, use red LED's at pins 1 and 18 for undervoltage and overvoltage and wire-OR pins 10 through 17 to the cathode of a single green LED.

Audio metering

A logarithmic scale using the decibel (dB) is a convenient and popular one for measuring audio levels. A 3-dB increase corresponds to a 41 percent voltage increase and a doubling of power. The LM3915 features a (22K ohm) logarithmic

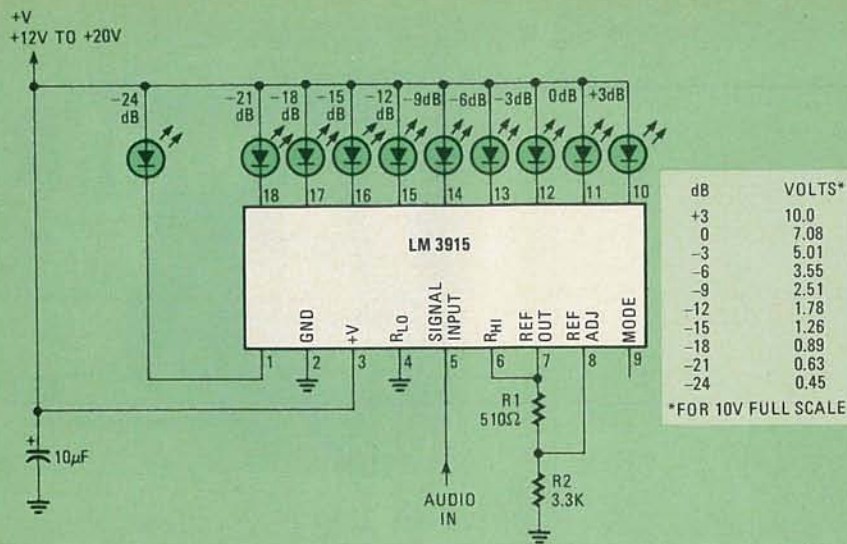


FIG. 3—AUDIO-LEVEL METER displays the instantaneous value of the audio input signal. The LM3915 provides a logarithmic response.

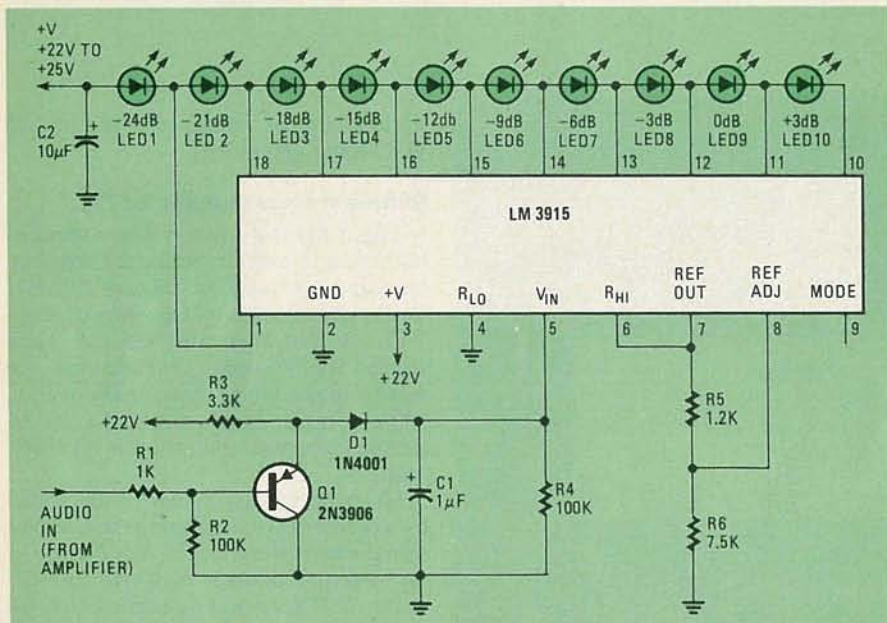


FIG. 4—PEAK-READING AUDIO-LEVEL METER is obtained by using a peak-detecting circuit on input pin 5.

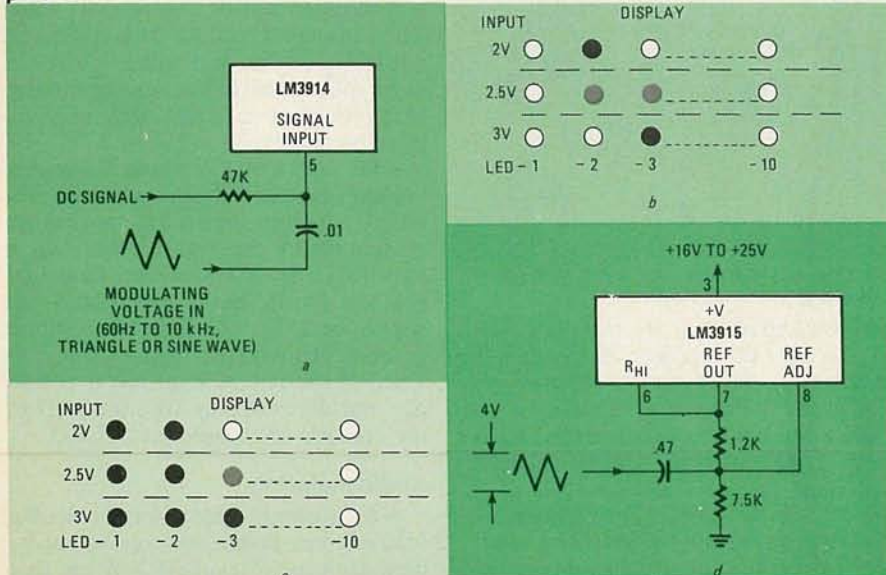
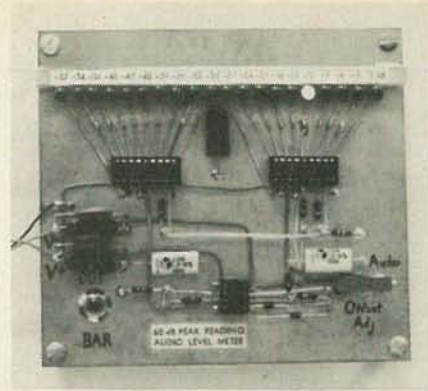


FIG. 5—INCREASED DISPLAY RESOLUTION is obtained by modulating the input signal on pin 5 with either a sine or triangular waveform as shown in a. The resulting display shown in b and c has twice the original resolution. (The display shown in b obtained in the DOT mode, while the display shown in c is obtained in the BAR GRAPH mode.) The same effect is obtained with the logarithmic LM3915 by using the configuration shown in d.



mic voltage-divider for a 3-dB-per-step display; otherwise, it's identical to the LM3914. The LM3915 is useful for displaying signals with wide dynamic range, such as RF signal strength, power level, or light intensity, in addition to audio level.

Figure 3 illustrates how simple it is to construct an audio-level indicator with the LM3915. The audio is fed straight to the IC's signal input without any rectification. Using the DOT mode, the LED illuminated represents the instantaneous value of the audio waveform. Both peak and average levels can be easily discerned. Since the dot will be constantly moving, the LED's are run at 30 mA for adequate intensity. The full-scale reading (+3 dB) is 10 volts; that is easily altered by changing R2. The LM3915's signal input can withstand signals up to ± 35 volts, which corresponds to 150 watts peak into an 8-ohm load. If there is a chance that the audio input could exceed this range, either attenuate it or include enough series resistance to limit the current to 5 mA.

If a peak-reading meter is desired, Fig. 4 shows how it's done. Since the thresholds for the first few LED's are less than 1 volt, a simple diode-capacitor peak detector won't do. The diode's 600 mV turn-on threshold would not pass low-level signals. In the circuit shown, the voltage drop across D1 is canceled out by the emitter-base voltage of PNP transistor Q1, connected as an emitter follower. These voltages usually track within 100 mV, causing a small error at low input levels.

The LED connections in Fig. 4 illustrate a tricky way to get a bar-graph display with very low current drain. With pin 9 left open, the LM3915 thinks it's in DOT mode, so only one output will be on at a time. For an input between -24 and -21 dB, the pin-1 current source turns on, lighting up LED1. When the input increases to -21 to -18 dB, the pin-18 current source turns on while pin 1 turns off. With the LED's in series, the pin-18 output current flows through LED2 and LED1, lighting them both. For every 3-dB increase in input voltage, the current shifts over to

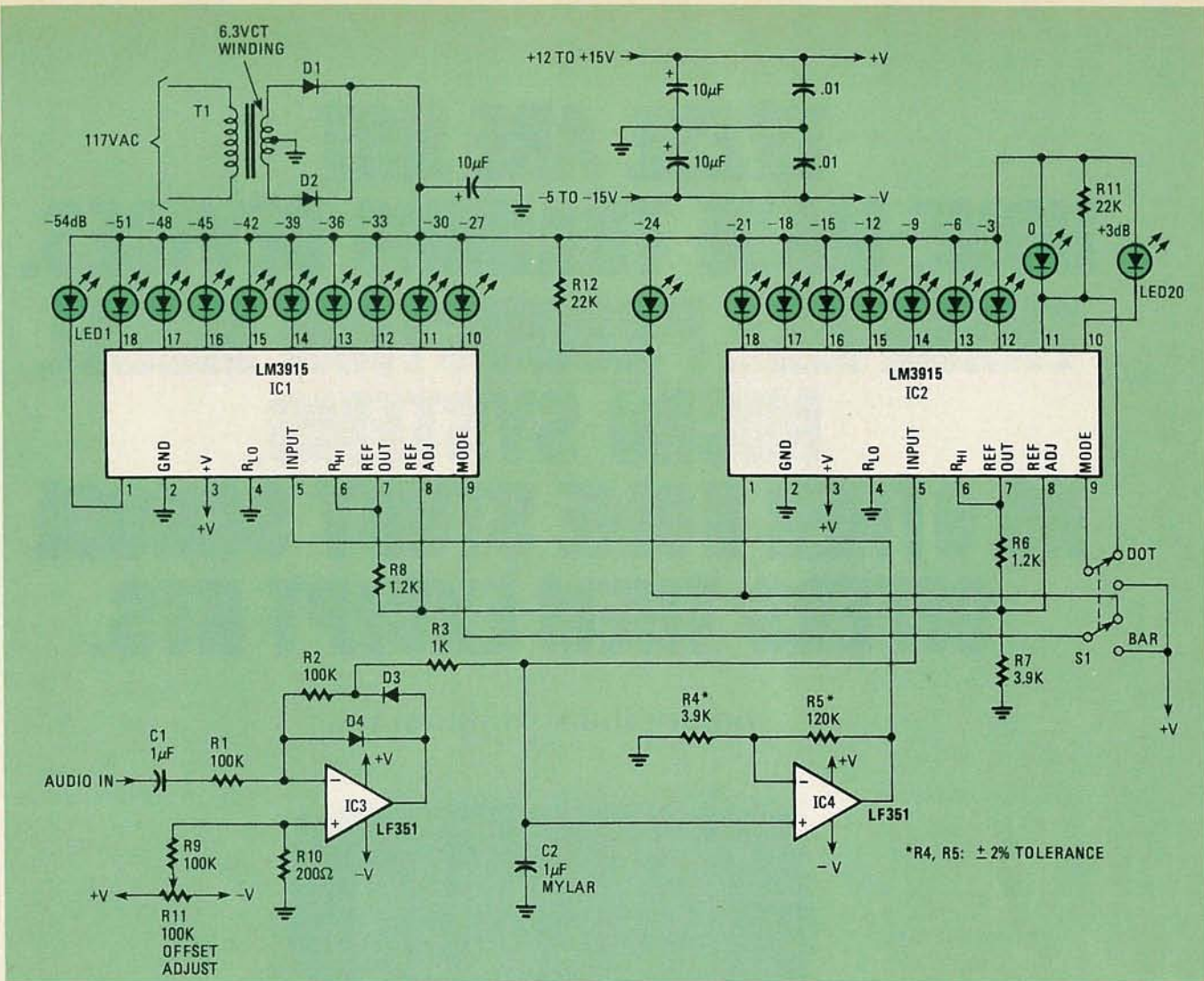


FIG. 6—TWO LM3915's can be cascaded together to obtain wide dynamic range. The circuit shown above is a peak-reading audio-level meter with a dynamic range of 60 dB.

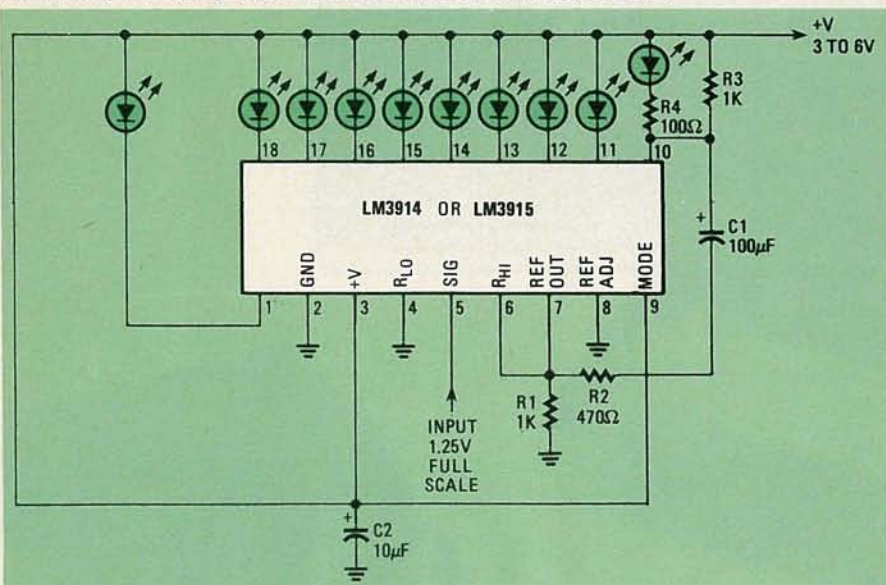


FIG. 7—OVERRANGE INDICATION with the bar-graph display is obtained with the above circuit. When the overrange condition occurs, the LED's flash.

another output pin and lights another LED. That results in a bar-graph display that draws only 20 mA while lighting ten LED's, instead of 200mA for the standard bar-graph configuration. A higher supply voltage is required, however, be-

cause all the LED forward voltages are in series. The IC still stays cool since the current drain is low. That connection may be useful when "stealing" power from pre-existing stereo equipment that cannot supply much current.

Other display ideas

For increased resolution, modulate the LM3914's input signal with an AC voltage as in Fig. 5-a. The LED's will appear to turn on gradually, producing a display that changes smoothly like a meter. For the modulating voltage, a triangle wave works best, although a sine wave (60 Hz from a transformer, for example) can be used. The peak-to-peak amplitude of the AC voltage should be equal to the voltage step between LED's. Figures 5-b and 5-c depict the resulting displays in either the bar or dot mode. To obtain the same effect using an LM3915, where the voltage step between LED's varies, one should modulate the R_{HI} voltage by 3 dB as in Figure 5-d.

Most program material has a dynamic range of over 40 dB. It's a simple matter to obtain a 60-dB display by cascading two LM3915's together, as shown in Fig. 6. A better peak-detector circuit is required because the threshold for the first LED is only 15 mV! The precision peak detector uses op-amp IC3 to overcome diode offset error. Operational amplifier IC4 is run at a gain of 30 dB or 31.6. BiFET op-amps, such as the

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OCTOBER 1980

PIONEERS OF RADIO

NIKOLA TESLA

FRED SHUNAMAN

TESLA IS BEST KNOWN (BY THOSE WHO know of him at all) as the genius who conceived, invented, designed and put into operation our alternating current electrical system, without which much of the Electrical Age would never have come into being. That invention—or series of inventions—freed the world from dependence on direct current, which limited the distance that power could be transmitted to a mile or two from the generating station.

Others know him as a dreamer who proposed such grandiose schemes as exciting the earth at its fundamental frequency and thus transmitting information—or even power—to any part of the globe, with little loss. Yet he was also the practical engineer who designed the complex Niagara Falls project, for many years the world's largest generating plant.

As for grandiose projects, his generation in 1899 of more than 12 million volts at his Colorado Springs laboratory (*Radio-Electronics*, June 1976) was unmatched for more than 70 years. Experimenting with wireless power transmission, he lighted a bank of 200 lamps (using about 10 kilowatts) 26 miles from the Colorado Springs installation. That feat has yet to be duplicated:

These fantastic accomplishments have overshadowed his very real work in the radio field. Yet he was one of the first to work with high frequencies, and many engineers know him only by that first radio-frequency transformer, the Tesla coil. That "coil" was invented in 1891. In 1893, speaking to the members of the Franklin Institute in Philadelphia, he discussed electrical resonance, among other subjects. Pointing out that if the inductive and capacitive reactance in the circuit were such as to cancel each other, resonance would be attained and current would increase without a theoretical limit. He explained that it was fortunate that pure resonance could not be produced (because of resistance in the circuit). Otherwise, he said, there would be no

telling "what dangers might not lie in wait for the innocent experimenter."

Concerning resonance, he said few words on a subject "that concerned the welfare of all. I mean," said Tesla, "the transmission of intelligible signals and perhaps even power to any distance without the use of wires. I am becoming daily more convinced of the practicability of the scheme." Admitting that most scientific men had doubts, he said "My conviction has grown so strong that I no longer look on this plan of energy or intelligence transmission as a mere theoretical possibility, but as a serious problem in electrical engineering, which must be carried out some day."

Tesla continued to work with resonance, and his patent 568,178 of September 22, 1896 shows several ways of obtaining resonance in a high-frequency circuit. In 1915 he sued Marconi for infringement of that patent, but lost the case. The court just could not understand the principles involved, and was possibly influenced by Marconi's reputation as a great man in communications. (The Marconi patent was, however, declared invalid in 1943, on the basis of prior work by Tesla and the 1896 patent, as well as later patents by John Stone Stone and Oliver Lodge.)

In 1899 Tesla staged a demonstration of radio remote control in Madison Square Garden, New York City. He maneuvered a three-foot-long model boat in a large tank, starting, stopping, reversing and steering it in response to requests from members of the audience.

The Madison Square Garden transmissions were spark. But in his studies of high frequency, Tesla pioneered two other types of transmitters that later became commercial successes in other hands. He made the first high-frequency alternators, machines like ordinary alternating current generators, but designed to produce electricity at much higher frequencies. Tesla's alternators reached 10 kilohertz. Improved by Fessenden and Alexanderson, first to 50 and later to 100

kilohertz, these alternators were made by General Electric and became the standard high-power transmitters for transatlantic and other long-distance communication, until displaced by tube transmitters.

Tesla also pioneered in the use of the electric arc as a high-frequency generator, describing one with controlled atmosphere and magnetic blowout in 1893. Re-invented by Valdemar Poulsen in 1903, and introduced into the United States by Cyril F. Elwell, it became very popular, especially for medium and low-power transmitters and ship sets. (De Forest used the Tesla arc in his phone transmitters, because he could do so without infringing on the patents that were held by Poulsen.)

In 1901 Tesla started the construction of an eight-sided wooden tower on Long Island. Surmounted by a copper-covered hemisphere 100 feet in diameter, it rose 200 feet in the air. An air of mystery surrounded the tower and its purpose, but in 1904 Tesla issued a brochure in which he described the project as a *World Wide Wireless System*, which he said would provide telegraph and telephone communication, news broadcasting, stock market quotations, aids to navigation, entertainment and music broadcasting, accurate time service, facsimile and teleprinter services—in fact the whole gamut of radio services that was to come into existence decades later.

With the withdrawal of support by Tesla's financial backer—it is said because he found that Tesla was more interested in the new project as a transmitter of wireless power than wireless communications—it became impossible to complete the work, and the tower was finally taken over by the Waldorf-Astoria in payment for a hotel bill, and torn down for scrap in 1917. This ended Tesla's radio work, and (though he continued to invent in other fields, such as steam turbines and even auto transmissions) marked the end of his career as an important scientist and engineer. He died in semi-poverty in 1943.

R-E

Hafler Model DH-200 Stereo Power Amplifier

LEN FELDMAN

CONTRIBUTING HI-FI EDITOR



1

CIRCLE 106 ON FREE INFORMATION CARD

TO THOSE OF US WHO HAVE BEEN SURVEYING the high-fidelity scene for many years, the name David Hafler should be familiar. It was Mr. Hafler who founded the well-known Dynaco firm which, for many years, offered high-quality reasonably-priced audio components in both kit and assembled form. As is true of many other American audio pioneers (such as Saul Marantz, Avery Fisher, and Sidney Harman, for example), David Hafler has long since sold his interest in his first company and has been active in the field both abroad and in this country. A couple of years ago, he founded the present David Hafler Company whose second major product is the model *DH-200* power amplifier (the first product was and is a low-cost high-performance preamp, model *DH-101*, that makes a good companion piece for the newly introduced *DH-200*).

The front panel on the *DH-200* is shown in Fig. 1 and is equipped with a lever-type power on/off switch that is adjacent to a power-indicator light. Heat-sink structures at the left and right of the unit form an attractive and practical cosmetic touch to the rugged-looking amplifier chassis. The rear panel of the amplifier, shown in Fig. 2, contains 5-way binding-post

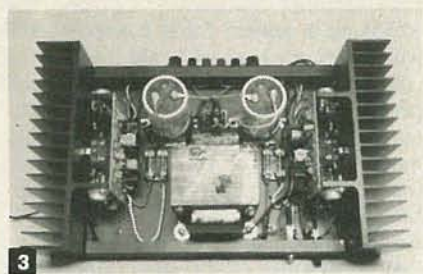


2

terminals for speaker-cable connections, phono-tip jacks for input connections and a pair of speaker fuseholders. Additional fuses are located inside the chassis in the DC power supply lines feeding each module or amplifier channel, as can be seen clearly in the internal view of Fig. 3.

If you should elect to build the *DH-200* by purchasing it in kit form, you will be surprised

to find that two completely assembled and fully tested amplifier modules comprise all of the kit's active circuitry. That leaves only a handful of parts (largely power-supply components) for the builder to complete the mechanical



3

assembly and power-supply wiring. The entire project can be completed by a reasonably experienced electronic-kit builder in one sitting. Furthermore, should service ever be needed, you can easily remove and return one of the lightweight amplifier modules without having to return the entire unit. You can even operate the remaining module monophonically while waiting for the repaired module to be returned for servicing.

The *DH-200* has a unique circuit configuration using all discrete transistors, including power MOSFET's in the output stages. Like the Hafler preamplifier that preceded it, the *DH-200* power amplifier has a completely symmetrical, mirror-image complementary push-pull circuit from input to output. For applications requiring extraordinarily high power, the *DH-200* may also be "bridged" to convert it to a 300-watt monophonic amplifier (into an 8-ohm load) with distortion specifications similar to those obtained in stereo.

Lab measurements

Table I summarizes the static measurements made on our prewired sample. The amplifier delivered more than its rated 100-watts-per-channel at all frequencies before the

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R.E.A.L. SOUND

RATES

HAFLER DH-200
POWER AMPLIFIER

EXCELLENT

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nominal 0.02% harmonic-distortion rating was reached. In fact, we were somewhat frustrated in attempting to measure all forms of distortion at the 100-watt output level. Our IM and THD test signal sources are known to contain approximately 0.002% distortion and those were the readings we obtained, indicating that the test equipment was imposing a limiting factor to our measurements. The same held true for our attempts to measure IHF IM distortion, where the dynamic range of our spectrum analyzer is limited to around 70 dB (corresponding to 0.03% distortion). Hence, we listed our measurements as "less than 0.002%" in the case of THD and SMPTE-IM and "less than 0.03%" in the case of the other two-tone IM measurements.

Note that in Table I we have measured 4-ohm performance only for a 1-kHz mid-frequency signal. That is not to imply that the amplifier is unsuitable for use with 4-ohm speaker systems. Quite the contrary; it will operate safely even at impedances below 4 ohms. The only reason we omitted any measurement reports for the frequency extremes at 20 Hz and 20 kHz is because Hafler does not supply a published distortion rating over the entire power band for 4-ohm operation. Therefore, we had no reference THD level against which it would be possible to measure output at that low impedance.

In an introductory paper concerning the design philosophy of the Hafler *DH-200*, that company introduces yet another interesting performance test described by Matti Ojala, the well known Finnish engineer who has written extensively on TIM distortion as well as a new form of distortion known as IIM (Interface Intermodulation Distortion). As explained in

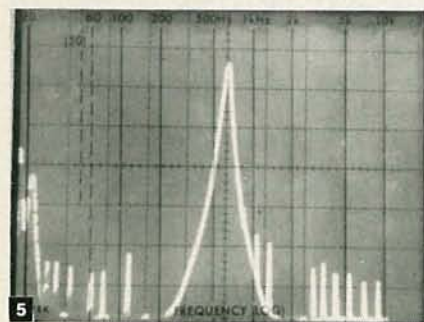
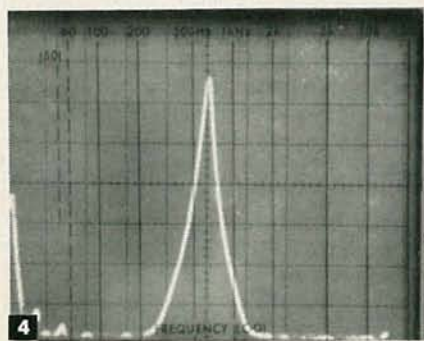
MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FTC Power Rating: Less than 0.02% total harmonic distortion at any power level up to 100 watts; continuous average power-per-channel into 8-ohms, at any frequency between 20 Hz and 20 kHz, with both channels driven. **Typical THD:** 100 watts into 8-ohms: 0.0015% at 1 kHz; 0.005% at 10 kHz; 0.009% at 20 kHz. **Frequency Response:** -3dB, 1 Hz to 100 kHz at 1 watt; ± 0.5 dB, 10 Hz to 40kHz at 100 watts. **Input Impedance:** 22,000 ohms. **Input Sensitivity:** 1.5 volts for rated output. **Damping Factor:** 150 up to 1 kHz into 8 ohms; 50 up to 10 kHz into 8 ohms. **Rise Time:** 2.5 microseconds, for a 10 kHz, 60 V P-P squarewave (10% to 90%). **Slew Rate:** 30 V/ μ sec for a 10 kHz, 60 V P-P squarewave.

that paper, the active load presented by a loudspeaker cannot be evaluated easily and is anything but a pure resistance, which most of us use on the test bench as an amplifier load. To simulate the loudspeaker as a generator, signals must be driven into the amplifier output.

While conventional theory has it that the low impedance (high damping factor) of high-fidelity amplifiers will "short out" the back electromotive-force of the loudspeaker, in actual practice the low-output impedance of an amplifier is not a physical impedance. It is the result of feedback that may vary during the signal cycle and permit some of the loudspeaker-generated signal to get into the feedback loop and mix with the source signals.

Otala proposes a method to measure what he calls Interface Intermodulation Distortion. In his test setup, the amplifier is driven with a 1-kHz signal. Simultaneously, the output of the amplifier is driven with a 60-Hz signal through an isolation resistor and a 1-kHz trap. A spectrum analyzer at the amplifier output shows both signals (60 Hz and 1 kHz) that are used for the test plus any other signals appearing at other frequencies. The latter are the intermodulation products caused by the inability of the amplifier to handle the reverse signals without distorting.



In a further effort to separate the *DH-200* from run-of-the-mill power amplifiers, we decided to try that test. The results we obtained using the *DH-200* are shown in the photo of Fig. 4. The trace shows the 60-Hz signal at the left, the 1-kHz signal near center screen, and very little else. Compare those results with those obtained using a well-known amplifier having the same power rating, driven to exactly the same composite power level (approximately half rated output in each case), as shown in Fig. 5.

Summary

Hafler maintains that the goal in the design of the *DH-200* was to reduce all known forms of distortion to their lowest possible values and to apply feedback with discretion, after first

TABLE 1
RADIO ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **David Hafler Company**

Model: **DH-200**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	114	Very good
RMS power/channel, 8-ohms, 20 Hz (watts)	108	Excellent
RMS power/channel, 8-ohms, 20 kHz (watts)	106	Excellent
RMS power/channel, 4-ohms, 1 kHz (watts)	161	Excellent
RMS power/channel, 4-ohms, 20 Hz (watts)	N/A	N/A
RMS power/channel, 4-ohms, 20 kHz (watts)	N/A	N/A
Frequency limits for rated output (Hz-kHz)	15-25	Very good
Slew rate (V/Microsecond)	35	Very good
DYNAMIC HEADROOM (dB)	1.9	N/A
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	Less than 0.002	Superb
Intermodulation distortion, rated output (%)	Less than 0.002	Superb
Harmonic distortion at 1 watt output, 1kHz (%)	Less than 0.002	Superb
Intermodulation distortion at 1 watt output (%)	Less than 0.002	Superb
CCIR IM distortion (%)	Less than 0.03	Superb
IHF IM distortion (%)	Less than 0.03	Excellent
DAMPING FACTOR AT 8 OHMS, 50 Hz	150	Excellent
INPUT MEASUREMENTS		
Frequency response, (Hz-kHz, -3dB)	1-109	Superb
IHF input sensitivity (V)	0.15	N/A
Input sensitivity for rated output (V)	1.5	N/A
IHF S/N (Re: 1W Out, "A"-weighted) (dB)	91	Excellent
S/N Re: Rated Output, "A"-weighted (dB)	111	Excellent
POWER CONSUMPTION		
Idling (watts)	118	N/A
Maximum (watts)	540	N/A

TABLE 2
RADIO-ELECTRONICS PRODUCT TEST REPORT

Retail price	\$329.95 (kit); \$429.95 (Assembled)
Price category	Low
Price/performance ratio	Superb
Styling and appearance	Very good
Sound quality	Excellent
Mechanical performance	Excellent

Comments: What can one say about an amplifier that, despite its incredibly low cost, yields levels of distortion (at all power levels within its ratings) that cannot be read on state-of-the-art test equipment such as that used in our R.E.A.L. tests? To be sure, static "bench" measurements often fail to correlate with what one hears when using an amplifier (or any other piece of audio equipment) for the reproduction of music. In the case of the Hafler *DH-200*, however, it is clear that the more subtle forms of distortion, such as TIM and IIM (Interface Intermodulation Distortion), which have only recently been identified by researchers in the field, have also been reduced to an inaudible minimum. Hafler maintains that his circuit is self-protecting and that the output stage is designed to protect against thermal runaway, without any need for signal-interrupting relays and the like. Indeed, during our bench tests, the only problem we encountered was occasional popping of speaker fuses which were accessible for replacement from outside the amplifier. It was only after we read the preliminary owner's manual that we realized that the amplifier had been shipped with 2-ampere fuses (to protect speakers with low maximum power ratings) and that we should have substituted the 5-ampere substitute fuses that are supplied with the unit. Once that was done, the amplifier became virtually indestructible.

As for sound quality, we can state that the *DH-200* offers bass reproduction as good as any we have heard from amplifiers costing hundreds of dollars more. Treble sound could also be characterized as free of any raspiness or slew-induced distortion, regardless of the transient content of the program material used for listening.

Considering its low price (especially if purchased in kit form), we know of no other amplifier that offers as much value at the present time. Hafler's first product entry, the Model *DH-101* preamplifier, has already earned itself an enviable reputation amongst knowledgeable and critical audiophiles. We suspect that the Hafler *DH-200* power amplifier will earn a similar degree of respect from this same critical fraternity. The *DH-200* deserves an R.E.A.L. overall product rating of excellent, bordering on superb.

minimizing distortion of the open-loop circuit of the amplifier. Using feedback as a refinement (not a cure-all), according to Hafler, avoided some subtle forms of distortion such as those outlined in the test of IIM and yielded audibly better sound. We couldn't agree more. Our overall product evaluation, together with our summary comments concerning the David

Hafler Company model *DH-200* will be found in Table II. That amplifier, in our opinion, is not only extremely reasonable in price (particularly in its kit version) but the sound is as good as anything we have ever heard, regardless of price. It merits a R.E.A.L. Sound Lab product rating of "excellent", bordering on "superb."

R-E

FLASHIER LED

APPLICATIONS

The flasher LED is a new component. Learn how it works and keep it among your arsenal of components for use when designing projects

CALVIN R. GRAF, W5LFM

THE FLASHER LED HAS RECENTLY BEEN INTRODUCED into the electronic parts market. It is inexpensive and offers some very interesting possibilities for circuit innovation. This article describes some applications of that simple device, which has its own built-in IC switch. With the use of a few components—a 9-volt battery, LED flasher, photocell and resistor—a series of novel circuits can be configured. They cover the areas of a continuous LED flasher for a night light, a basic flasher for TTL and CMOS circuit applications, attention-getter applications, a troubleshooting aid, and ambient light or dark detector. The Flasher LED is currently available at Radio Shack stores (part No. 276-036).

How it works

The basic LED is made to flash at a three-times-per-second (PPS) rate by a small integrated circuit that operates off a 5-volt DC power supply. The flasher LED is indeed unique when you consider that the LED is the same size as a regular LED but contains the following electrical components: the LED, the IC chip that establishes the flash rate (in effect containing an R-C time-constant circuit to switch the current to the LED), and an "effective resistor" that drops the supply voltage from 5 volts DC to a nominal 1.6 volts DC for application to the red LED. The flasher LED draws 20 mA from a 5-volt source, so for a normal red LED (which draws 20 mA) a series-dropping (current-limiting) resistor of 170 ohms would be required. So a lot is accomplished by the small IC chip that can be seen as a small black speck inside the LED epoxy case. At the present time, the flasher LED is available with a red lens only but other colors—such as green and yellow—probably will be forthcoming from LED manufacturers.

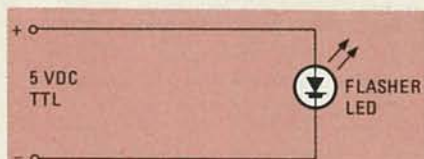


FIG. 1—LED FLASHER is powered from a 5-volt supply and flashes at a 3-PPS rate.

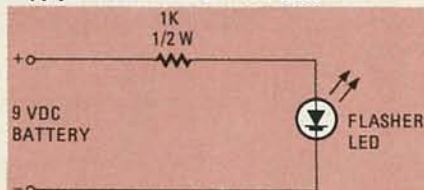


FIG. 2—POWER can be obtained from a 9-volt source if a dropping resistor is used.

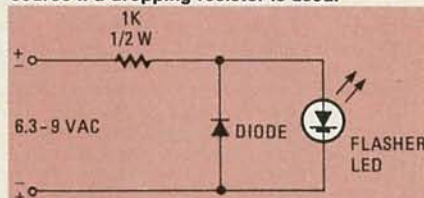


FIG. 3—AC POWER can be used if a diode and dropping resistor are included as shown.

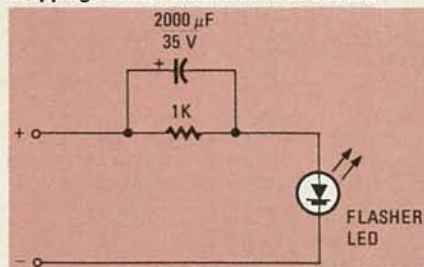


FIG. 4—FLASH RATE can be varied with an R-C circuit.

Applications

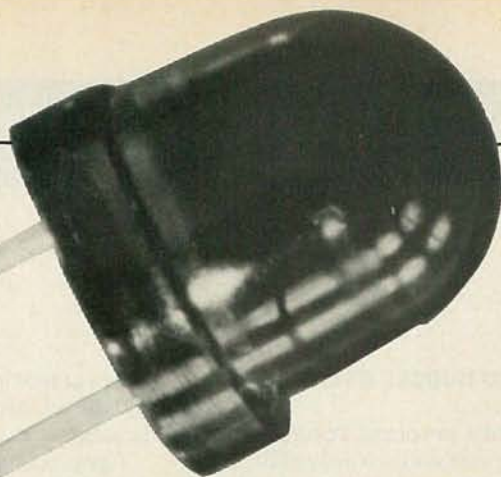
Normal flash rate. In Fig. 1 we see the basic hookup for the LED IC flasher operated off 5 volts DC. This configuration is used to drive the flasher directly off TTL and CMOS circuits and it will flash at a nominal 3 PPS. Note the electrical schematic symbol we have used for

the IC flasher LED. We have added a small rectangle to the cathode symbol of the LED to differentiate it from a regular LED. Perhaps this symbol for the flasher LED will be adapted for wider use. Figure 2 shows an arrangement for flashing the LED from a 9-volt transistor battery at a 3-PPS rate. A 9-volt battery will provide sufficient power to flash the LED for about a week, so for continuous operation you can use a 9-volt battery eliminator or charger available at radio supply houses for under \$5.00. Note that in the circuit of Fig. 2 we have added a 1000-ohm series resistor to drop the voltage across the flasher LED to a nominal 5 volts. The resistance value is not critical and the brilliance of the LED and flash rate will vary slightly with applied voltage as it is varied below 5 volts.

An alternating current (AC) power supply of a nominal 6 to 9 volts can be used to power the flasher LED by adding a diode to the circuit to protect the LED/IC chip during negative voltage swings of the AC voltage. This circuit arrangement is shown in Fig. 3. The 6.3- to 9-volt AC power supply can be obtained by using a 115-volt to 6.3 volt filament transformer or an AC pocket calculator charger which usually has a nominal 8-volts AC output.

Fast flash rate. We can increase the flash rate by adding a large capacitor across the series-dropping resistor as shown in Fig. 4. The flash rate is increased to a nominal 10 PPS by the R-C circuit introduced in series with the IC chip. The capacitor can be any value from 500 to 3000 μF at a nominal 10- to 35-volts DC working voltage. Experiment with the value of R and C until you reach the flash rate you want.

If the flash rate is increased to slightly above 10-to-12 PPS, the LED will appear to be on continuously as the eye cannot perceive faster flash rates. To observe the



LED flashing (if your circuit leads are long enough), wave the LED back and forth slowly and you'll observe it to make an on-off streak as it moves.

Ambient light detector: When we put a photocell in series with the flasher LED as shown in Fig. 5, it will flash only in the presence of light. Photocells available from any radio-supply house have a nominal resistance of 1-to-10 megohms in darkness and their resistance drops rapidly to a nominal 100-to-1000 ohms in bright light. In darkness, the circuit will draw virtually no standby power as the total resistance in the circuit is over 1 megohm. Considering the IC chip as a short at this time, the circuit will draw only 9 microamperes from the battery, virtually its shelf life. You can use this circuit to tell you when it gets dark outside (if you are in a windowless room) or if you *really* want to see if the refrigerator light goes out when the door is closed! For light levels in between light and dark, where the applied voltage to the IC chip will vary from 0-to-5 volts, we will find the flasher LED doing some strange things such as flashing faster, slower, staying on or off, and varying its brilliance.

When we place the photocell across the flasher LED as shown in Fig. 6, we now find that the LED will not flash in bright

light (the low resistance of the photocell shorts out the IC chip) but when the photocell is in darkness, the LED will flash. In darkness the photocell resistance rises to about 10 megohms and this appears as an open circuit to the IC chip, 5 volts appears across the chip and the LED begins to flash. That circuit will draw power from the battery in the standby (light-present) condition and nominal power when flashing, so you might want to use a 9-volt battery eliminator for long-time operation. This circuit is handy for a flashing night-light in use in hallways and

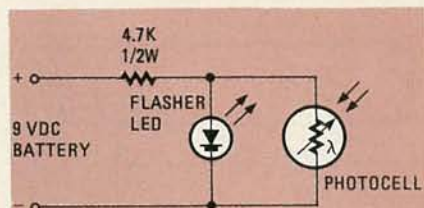


FIG. 6—PARALLEL PHOTOCELL permits LED to flash only in dark ambient light conditions.

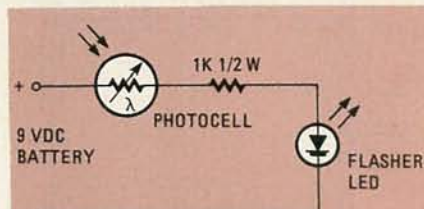


FIG. 5—SERIES PHOTOCELL permits LED to flash only in bright ambient light conditions.

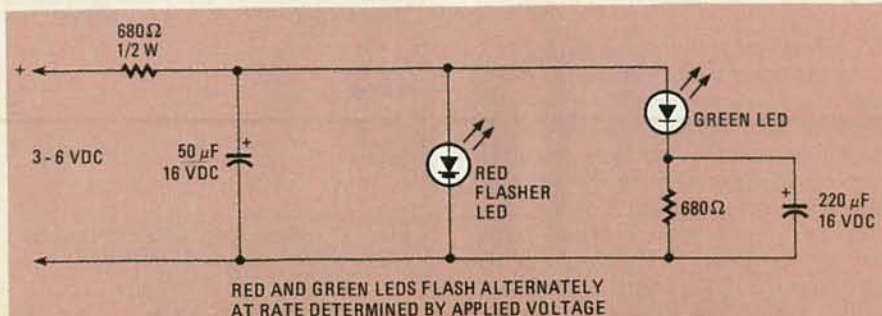


FIG. 7—RED AND GREEN LED's flash alternately at a rate determined by the applied voltage.

other locations or areas where you might need to know that a certain light is still on and operational.

Alternate flashing red and green LED's: The flasher LED can be used in a circuit arrangement as shown in Fig. 7 to alternately flash a second LED. The two LED's can be spaced several inches or feet apart to attract your eye back and forth to each LED as it flashes. Alternately flashing red and green LED's are particularly interesting as they are eye-catching and can serve as baby sitters, novelties, or attention-getters. The circuit of Fig. 7 will operate from a nominal 3-to-6 volts DC, the flash rate increasing as the voltage is decreased. At 6-volts DC, such as you get from a Type-F lantern battery available at hardware stores, the flash rate is the nominal 3 PPS. If the circuit voltage is increased past 6 volts, up to 7 or 8 volts, the LED's will stop flashing and remain on continuously. That condition should be avoided for use over long periods of time as it might damage the IC chip in the flasher LED.

As the voltage is reduced to about 3 volts, the flash rate increases to about 10 PPS and the LED's are not as bright as at 6 volts. The LED's will flash faster and faster as the voltage is reduced below 3 volts until they appear to be on continuously, though they are dim at this time.

As you experiment and work with the flasher LED, you will find it a very interesting electronic component. You may observe that its flash-rate changes, depending on the amount of ambient light striking the IC chip inside its epoxy case. Depending on the manufacturer of the LED, the flash rate will be a nominal 3 PPS in bright bench light or sunlight. But as you darken the room, the flash-rate will decrease slightly, depending on the circuit you are using at the time. Do your own experimenting with this unique device until the manufacturers correct for some of its interesting characteristics! They might add a Zener voltage-regulator to keep the flash-rate constant with applied voltage and then hide the IC chip in a lightproof case—and that would take away all the fun!

R-E

new ideas

PC-BOARD BUBBLE ETCHER

MY NEW IDEA INVOLVES CONSTRUCTION plans for an inexpensive (under \$10) bubble etcher that reduces the time to etch printed circuit boards considerably. The materials required for the etcher consist of a phenolic instrument case, $\frac{3}{16}$ -inch OD rigid PVC tubing, instant-setting

pieces of tubing, use a No. 76 drill to drill a .020-inch-diameter hole at each marked location.

Upon completion of the drilling, remove all loose fragments from inside the tubing, arrange the pieces into a $6\frac{1}{4}$ -inch \times 4-inch rectangle and cement the tubing ends together, being careful not to get cement inside the tubing. Let the cement

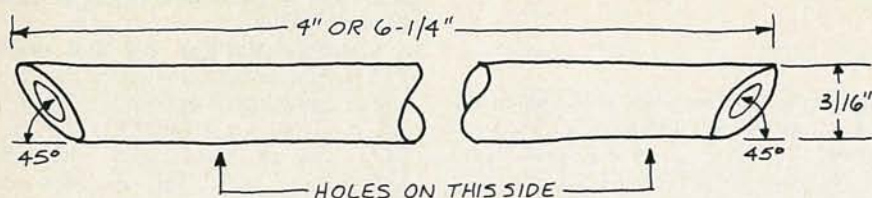


FIG. 1

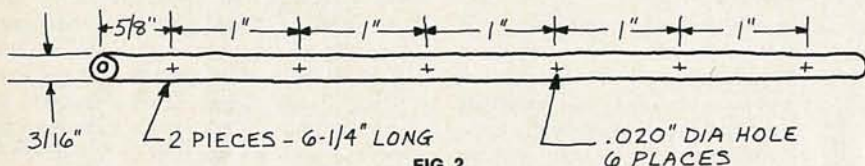


FIG. 2

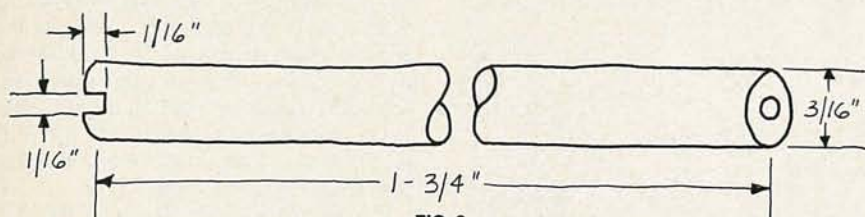
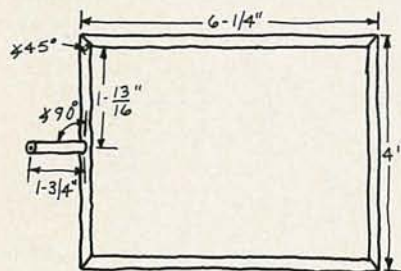


FIG. 3

PVC cement, an aquarium air pump, a piece of $\frac{1}{8}$ -inch ID flexible plastic tubing, and a piece of plastic canvas of the type used for needlepoint. (The "canvas" has an open grid containing $\frac{3}{32}$ -in. square holes.) Any size etcher may be constructed simply by cutting the length of PVC tubing to fit the case size. The etcher described below uses a standard-size instrument case having inside dimensions of $6\frac{1}{2} \times 4\frac{31}{32} \times 2\frac{5}{32}$ inches. The PVC tubing, cement, flexible tubing, and plastic needlepoint canvas were purchased at a hobby and crafts store, the aquarium air pump at a pet store, and the case at an electronics parts supply house.

The heart of the etcher is a rectangular air tube constructed from two $6\frac{1}{4}$ -inch and two 4-inch lengths of the rigid PVC tubing (these dimensions fit the case I used). The ends of each piece of tubing are cut at a 45° angle as illustrated in Fig. 1. Refer to Figs. 1 and 2 and mark the locations of the air holes in the $6\frac{1}{4}$ -inch



dry before going to the next step.

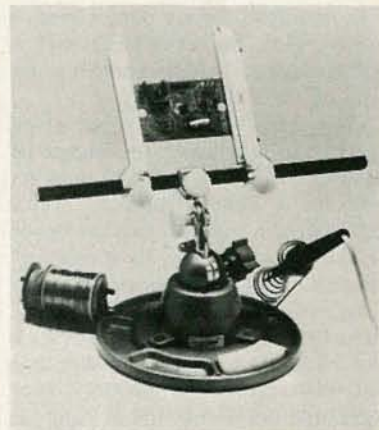
At the top center of one of the 4-inch legs of the rectangle, drill a $\frac{3}{16}$ -inch-diameter hole through one wall of the tubing and remove any loose fragments from inside. Next cut a $1\frac{3}{4}$ -inch length of tubing and cut a notch in it about $\frac{1}{16}$ -in. wide by $\frac{1}{16}$ -inch deep, centered across one end as shown in Fig. 3. Align the notch parallel to the length of the drilled 4-inch tubing and cement the notched

continued on page 122

NEW IDEAS

This column is devoted to new ideas, circuits, device applications, construction techniques, helpful hints, etc.

All published entries, upon publication, will earn \$25. In addition, Panavise will donate their model 324 Electronic Work Center, having a value of \$49.95. It combines their circuit-board holder, tray base mount, and solder station (see photo below). Selections will be made at the sole discretion of the editorial staff of **Radio-Electronics**.



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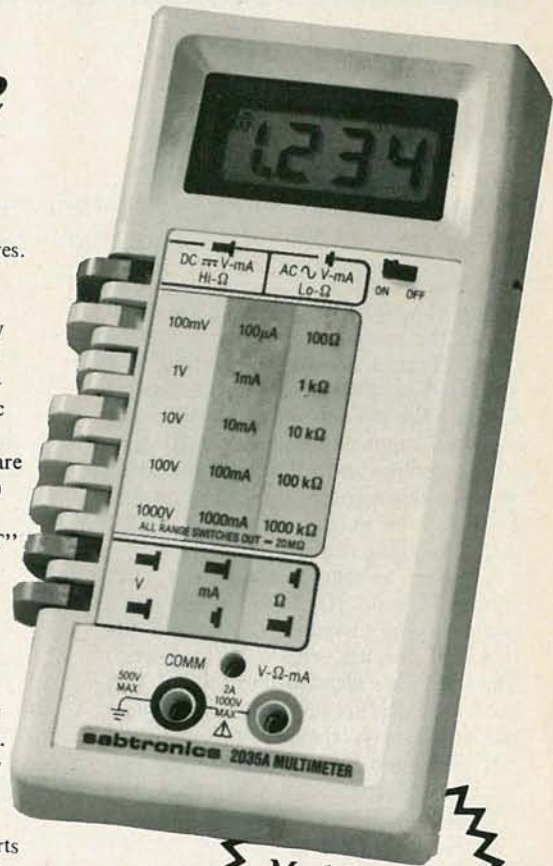
The Hi-and-Low power ohms capability allows you to make in-circuit resistance measurements and to check semiconductor PN junctions. In addition automatic polarity, automatic zero, automatic decimal point and overload protection are standard features. And you get up to 200 hours operation from a single 9V transistor battery. The automatic "LO BAT" indicator warns you of the last 20% of battery life. The large, crisp LCD readouts allow easy viewing indoors or outdoors in bright sunlight.

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OCTOBER 1980

hobby corner

A one-chip (almost) digital panel meter in half an hour.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

THERE IS A DIGITAL PANEL METER (DPM) IC on the market from Intersil (10710 North Tantau Avenue, Cupertino, CA 95014). The 40-pin CMOS IC contains not only the 3½-digit A/D converter but also the 7-segment decoders, display drivers, a reference and a clock. All you add is power, a few resistors and capacitors and a display to make a complete digital meter. Nothing could be simpler!

The fact is that there are two such Intersil IC's: the ICL7106 for use with a liquid crystal display (LCD) and the ICL7107 for use with a LED display. These IC's are identical in function, but, because of drive requirements for the two types of displays, they use different power (9 volts and 5 volts, respectively) and there are other internal differences. The 7106 and 7107 are *not* interchangeable.

Perhaps of greater interest are the available "evaluation kits," including all parts for a complete digital meter except power supplies. For example, the 7106 kit contains the IC, a 3½-digit LCD, a PC board, 5 capacitors, 4 resistors, a pot and hardware (battery holder and connector, Molex socket pins and test lead jacks). About 30 to 40 minutes with your soldering iron and you have a working 0-200 millivoltmeter.

[The 7106 kit sells for \$29.95 and the 7107 kit sells for \$24.95. Order these directly from your nearest Intersil distributor. You can obtain a distributor listing by writing to Intersil at the address already given.—Editor]

Recently, I assembled a 7106 kit. The instructions are quite clear, assembly is simple and the meter worked beautifully right from the beginning. The only ticklish part of construction is getting the IC and LCD into the Molex pin socket.

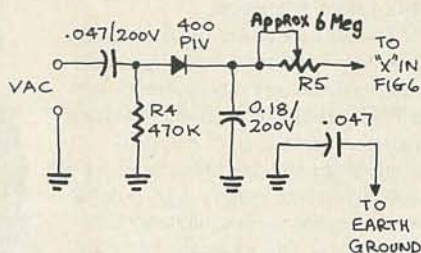


FIG. 2

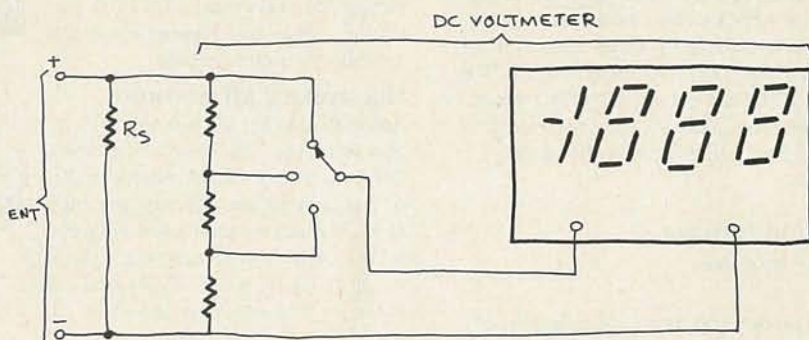


FIG. 3

Patience and perseverance are the keys here.

The ease of measurement and reading is as great as you would expect from a digital meter. First, the input resistance is very high so that delicate transistor circuits are not upset when the test leads are introduced. Second, when did you last see an analog meter that measured to *tenths of a millivolt*? The 7106 kit, by the way, is well powered by a standard 9-volt battery. Total current for the IC and the LCD is only about 1 mA, so battery life will be long. Of course, the 7107 kit requires considerably more current because of the LED display.

By changing the values of two resistors

minus and gives you the reading (actually, no sign means a plus). You needn't worry, either, about overvoltage. If it is greater than 1.999 volts or less than -1.999 volts, the last three digits simply turn off to tell you of the overrange condition with no harm done.

You can add a little voltage divider circuit like the one in Fig. 1 if you want to be able to measure larger voltages. Note that the resistor values are approximations. They should be adjusted to provide readings on the 20-volt and 200-volt scales (the 2-volt scale is already calibrated).

You can use a standard 10% resistor for R1. If pots are used for R2 and R3 (about 1.5 megohms and 150K), they can be adjusted easily. Again, the values can be measured and fixed resistors substituted.

The circuit of Fig. 1 makes no provision for shifting the decimal point in the display. This can be accomplished by adding another section to the switch and wiring it to the DP terminals on the circuit board. You may also wish to add another switch to serve as an on-off switch for the DPM.

To measure AC voltages, add the cir-
continued on page 114

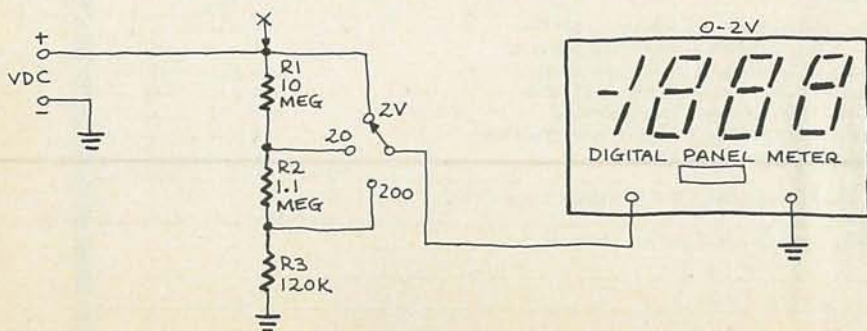
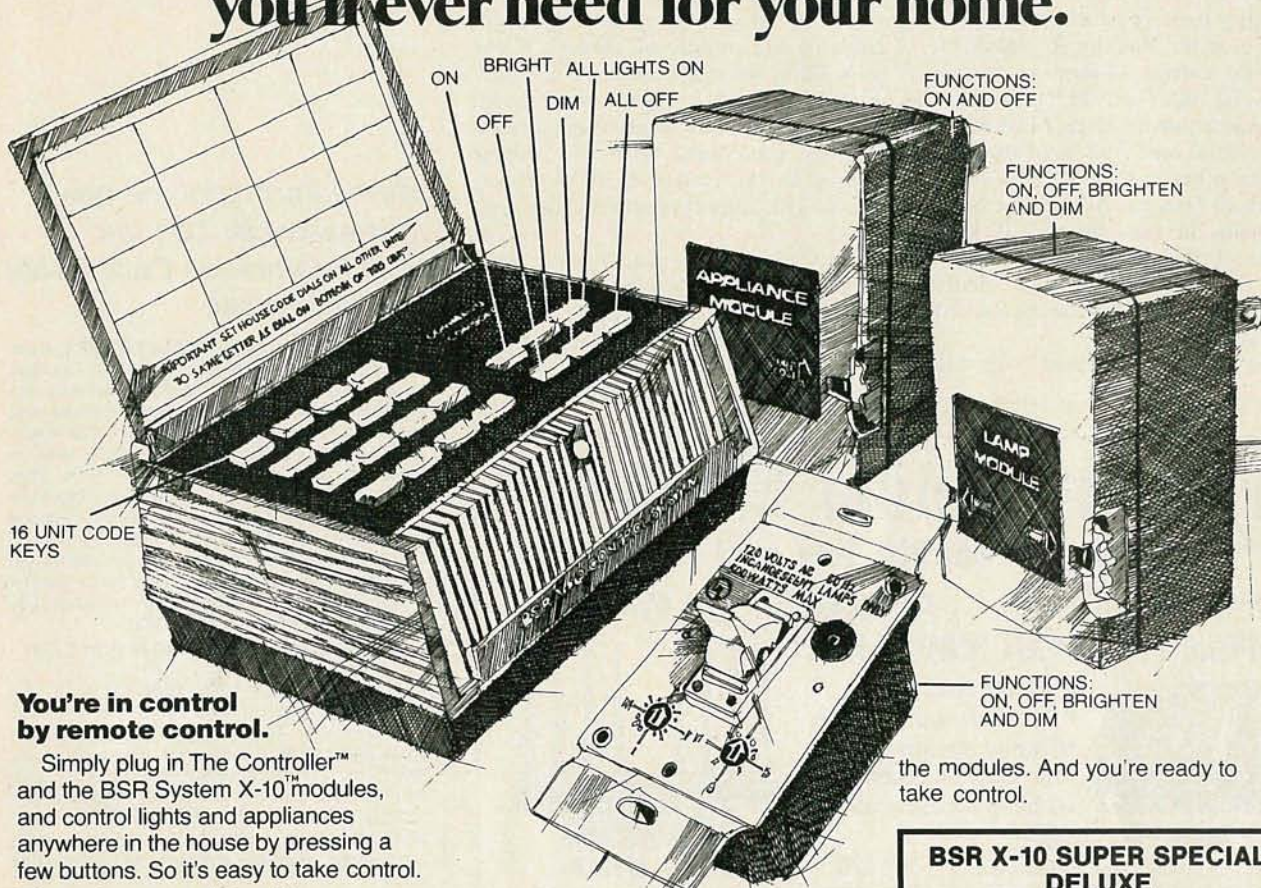


FIG. 1

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And when it's time to turn in, just push a button and turn everything off. And sleep soundly. But, if you hear a strange noise in the middle of the night, you can press a button to turn on all the lights and scare the daylight out of an intruder.

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NEW



OCTOBER 1980

113

ADVANCE ELECTRONICS

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HOBBY CORNER

continued from page 112

cuit in Fig. 2. Although R4 is not critical, R5 is. You can make up a variable resistor by using fixed resistors and a high-value pot in series. Resistor R5 should be adjusted for correct calibration on one scale, say 20 volts, and the other scales will read approximate values. (This is one of the problems with this oversimplified circuit; the other is that the *hundredth* digit tends to jitter on AC but the earth ground helps in this regard.) If your major use of the AC meter will be to measure the line voltage, you should adjust R5 for greatest accuracy on the 200-volt scale.

Current may be measured with the

Intersil DPM just as with analog meters. (See "Hobby Corner," May 1980 issue.) The shunt resistor (R_s) is connected as shown in Fig. 3. Its value is found just as for the analog shunt.

Greater sensitivity and less circuit effect would result, of course, if the basic DPM were left wired for 200 mV instead of 2-volts. Again, you should select a shunt value to make the current readings correspond with the voltage reading on the meter—there is no way you can put a new face on a dial that isn't there!

Despite all they have to offer, these Intersil kits are quite reasonably priced. The ICL7107 LED kit is about \$25 and the ICL7106EV, for LCD's, about \$30.

R-E

new lit

More information on new lit is available. Use the Free Information Card inside the back cover

SGL WABER MULTIPLE OUTLET STRIPS, *Catalog 102*, contains 24 illustrated pages. The new, completely-revised catalog gives detailed descriptions and specifications for 119 outlet-strip models, 65 of them UL-Listed and 28 CSA-Certified. Multiple outlet strips are widely used in industrial, commercial, and military fields. They offer a quick, safe, and easy way to multiply, relocate, and switch-control outlets in an electrical branch circuit without changing the wiring.

The catalog also includes typical application areas, examples of custom design, and general ordering information.—SGL Waber Electric, 300 Harvard Ave., Westville, NJ 08093.

CIRCLE 141 ON FREE INFORMATION CARD

ELECTRONIC TEST ACCESSORIES, 1980, is a 100-page catalog with over 500 photos and over 100 drawings. The products include banana plugs, jacks, and patch cords; phone-tip jacks, plugs, and connecting cords; test clips, probes, and holders; binding posts, black boxes, and sockets; molded patch cords, cable assemblies, and test socket adaptors; 3/4" space molded accessories, molded test leads, and connecting leads.

The catalog also includes new products, conversion tables of temperatures, a metric conversion chart, BNC and triaxial cable procedures, and a cross-index of connector MIL numbers.—ITT Pomona Electronics, 1500 East Ninth Street, Pomona CA 91766.

CIRCLE 142 ON FREE INFORMATION CARD

MINIMICROMART CATALOG, for winter is a letter-size, illustrated booklet listing microcomputers, small computer systems, printers, kits, disk drives, terminals, floppy disk systems, memory boards, and other accessories for the hobbyist. Features and some specifications described. They also have a limited inventory of the now-discontinued Cromemco kits.—MiniMicroMart, Inc., 1618 James Street, Syracuse, NY 13203.

CIRCLE 143 ON FREE INFORMATION CARD

INSTRUMENTS FOR TESTING AND DESIGN, is Global Specialties Corporation's new 36-page catalog. You will find here the company's well-known line of solderless breadboards, instrument cases, logic probes, frequency counters, and other test and measuring instruments.

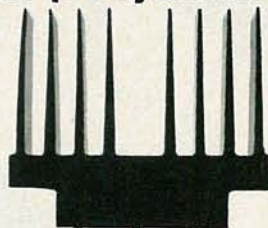
Among the new products listed are the Universal Counter-Timer (*model 500 T*), suggested price \$360; a benchtop 650 MHz Frequency Counter with a 0.1% crystal oven oscillator (*model 600 T*), suggested price \$385; and a triggerable 40-channel multiple-threshold logic state indicator (*model LM-3 Logic Monitor*), suggested price \$585. Other newcomers to the catalog are a breadboard wire jumper kit, including prepared color-coded wires in 14 lengths designed for use with the company's solderless breadboards in place of user-prepared hookup wires (\$10), and a binding post assortment which includes five red and five black binding posts, 20 insulating shoulder washers and 20 mounting nuts. These binding posts accept banana plugs, alligator clips, bare wire, tip

continued on page 127

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new products

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OSCILLOSCOPE, model LBO-515B, an upgraded version of the LBO-515, has been increased in bandwidth to 30 MHz and a 10-turn calibrated delay-time function control has been added. It features a 5 mV sensitivity in both sweep and X-Y display modes and dual-channel



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displays which can be either chopped or alternated and the sum or difference of the channels indicated. The trigger controls include selection of CH-1 and CH-2, AC- or DC-coupling, video frame or line sync filters and + or - slope selection, and includes a trigger HOLD-OFF control. The 4-inch CRT features an internal 8 x 10 graticule which is calibrated for measurement of risetime. The LBO-515B measures 11 3/4" x 5 1/4" x 14 1/4". Accessories include a probe pouch and special-purpose probes. Price is \$1,530.—**Leader Instruments Corp.**, 380 Oser Ave., Hauppauge, NY 11787.

VOLTAGE CONTROLS, models L-221, L-501 and L-1010, use a portable variable AC-control system operating from a 120-volt AC line. The system enables the user to select and adjust AC voltage at any level from 0 to 140 volts to provide power for applications up to 10 amperes continuous duty or to 100 amperes surge. Housed in an aluminum enclosure, the units feature fused



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three-wire grounded circuitry for user safety, an on-off switch, a pilot lamp, and front-panel controls. Model L-221 is rated 1.75 amps, L-501 is rated 4.5 amps and L-1010 is rated 10 amps. Applications include portable use, lab and bench applications, or incorporation into machines and equipment. Model L-221 is \$58.00, Model L-501 is \$74.00 and L-1010 is \$88.00.—**Staco Energy Products Co.**, 301 Gaddis Blvd., Dayton, OH 45403.

KEYBOARDS, designated *Fastype*, are a line of alphanumeric keyboards featuring a patented membrane-switch technology that provides a life rating of 50 million operations per key, and a con-

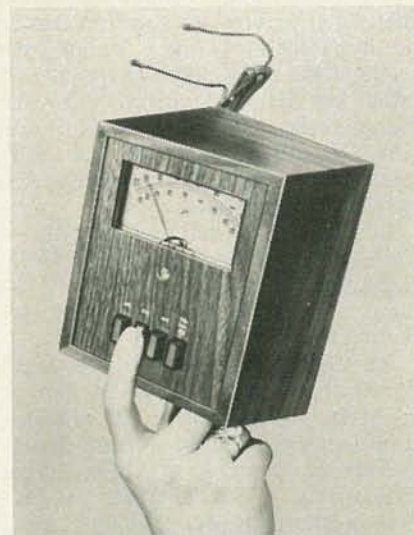


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tact bounce less than 2 ms. Characterized by low EMI emissions, the units run silently with a force of 3 to 5 ounces per key and 5 to 7 ounces per space bar over a 0.150" travel.

The keyboards come in a variety of models with various key-cap styles and widths, special colors and legends. Backer boards come in either phenolic, metal or PCB. Flextail terminations are standard; other terminations can also be provided. Price is typically \$30.00 each in OEM quantities.—**Chomerics, Inc.**, 77 Dragon Ct., Woburn, MA 01888.

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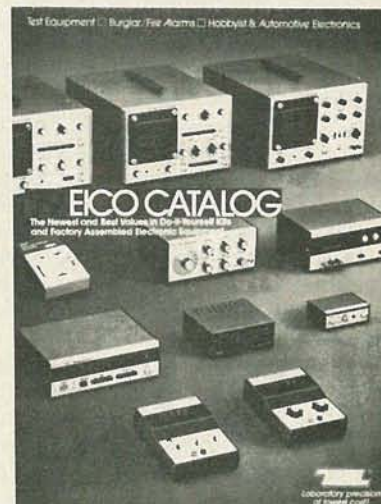
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communications corner

How two or more radios can share the same antenna in simple peace and harmony.

HERB FRIEDMAN, COMMUNICATIONS EDITOR

EVERYONE KNOWS SOME PERSON WHO IS always working for a "good cause." If it's not raising money for starving children on the other end of the earth, it's getting a sponsor for a Little League team, or blood donors for a hemophiliac.

The problem is that these people are really sincere, and it's almost impossible to refuse them when they appear at the door. Our neighborhood "do gooder" recently showed up with a stack of VHF receivers he had collected so that guests in the local Retirement Home could listen in to police, fire, emergency calls and the radio-telephone service. Naturally, I couldn't refuse his request to "get them working," though even Heaven couldn't get some of them to stop drifting long enough to receive a complete thought.

One of the interesting aspects of that motley assortment of VHF/UHF receivers was that almost all of them used separate antenna inputs for VHF and UHF, and some even had separate VHF-low and VHF-high antenna connections. Perhaps that was excusable back in the good old days—whatever they may be—but after the introduction of the CB/BC (citizens band and broadcast band) antenna-splitter in the early 1960's, there was never a valid reason for separate antennas and multiple antenna inputs on consumer equipment. Today, of course, VHF/UHF gear uses but one antenna input for two, and sometimes three, individual front ends without interaction—that is, without one front end shorting the signal meant for another front end.

To understand how one antenna input is used for two or more front ends, we need only look at a CB/BC antenna splitter, for it is the least complex in terms of design, and also the most easily understood.

Figure 1 shows two versions of the same CB/BC splitter. Figure 1-a shows the original low-loss design, while Fig. 1-b shows the final commercial version using a low-cost resistor in place of the relatively expensive radio-frequency choke, RFC1. Except in rare instances, the additional loss created by the resistor went unnoticed, hence, Fig. 1-b became the standard commercial version.

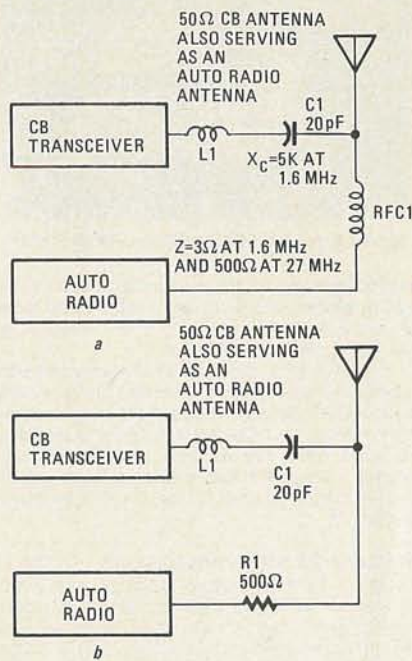


FIG. 1

The splitter operates on the principle that when two resistors or impedances are in parallel, and one is 10 times the value of the other, there is virtually no effect on the working circuit by the higher resistor. The inverse is true in series circuits. (I am certain that many readers can document numerous exceptions to that rule.)

In Figure 1-a, L1 and C1 form a series-resonant circuit tuned to 27 MHz. Capacitor C1 has a reactance of 5000 ohms at 1.6 MHz, a frequency representing the top of the broadcast band.

RF Choke RFC1 has an impedance of 500 ohms at 27 MHz, and 3 ohms at 1.6 MHz. The antenna system is a dual-band automotive radio antenna. It acts as a standard antenna at AM broadcast frequencies (0.550-1.6 MHz) and provides a 50-ohm load at 27 MHz.

When the CB transmitter is keyed, the RF output "sees" a low-impedance path through the series-resonant L1-C1 network to the 50-ohm antenna load. In parallel with the 50-ohm antenna load, the CB transmitter sees the 500-ohm impedance of RFC1, so virtually all the RF flows to the antenna. A received 27-MHz signal sees the low-

impedance path through L1-C1 to the CB, with a parallel load of RFC1, so almost all the received signal goes to the CB.

When a broadcast-band signal is received, the signal from the antenna sees a 3-ohm path through RFC1 to the broadcast radio, and a series path to the CB of at least 5000 ohms through the impedance of L1 and C1; hence, essentially all of the received AM broadcast signal goes to the broadcast band radio.

In actual practice, L1-C1 is tuneable, and is user-adjusted for minimum SWR at the CB transmitter output.

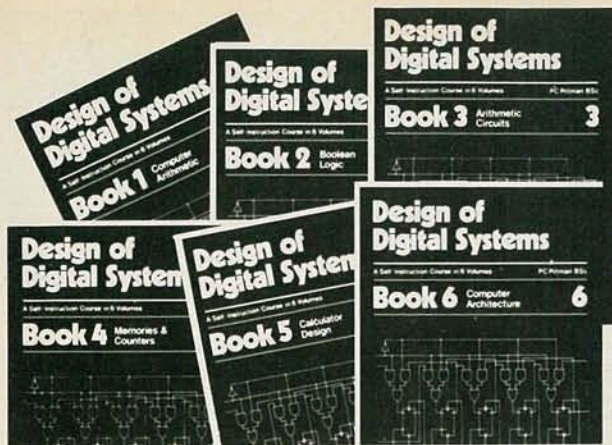
Everyone always likes to come out with a less expensive model than his competitor; there's little that can be eliminated from the circuit other than substituting a resistor for RFC1, and that's just what was done in many CB splitters. Figure 1-b shows the "budget" model. The theory remains the same except we now have a fixed impedance for RFC1. Now the broadcast signal from the antenna must flow through 500 ohms to the receiver, rather than 3 ohms maximum. Is there a loss? You betcha. But the radio's AGC can often compensate for the loss. Only extremely weak signals—usually too weak to activate the AGC—will be lost because of R1.

Another reason for the switch from an inductor to a resistor for RFC1 was the sudden popularity of AM/FM automotive radios. If RFC1 could block a CB signal at 27 MHz, it sure as heck could block an 88-108 MHz FM signal. Resistor R1, on the other hand, will pass the FM frequencies, though there will be a loss of some 21 dB, not an insignificant value when it comes to FM. A moderate signal can simply disappear into the noise level or the signal might be reduced below the receiver's stereo threshold.

That type of splitting, whereby one antenna is used for two or more inputs, outputs, front ends, or what have you, at the same time, is called *multiplexing*. Now let's look at how one antenna is multiplexed in a modern VHF-UHF scanner.

Figure 2 is a simplified diagram of the antenna/front end of Radio Shack's latest programmable scanner, the PRO-2008. It has separate front ends for VHF-low (30-50 MHz), VHF-high (144-174 MHz), and UHF (410-512 MHz).

continued on page 122



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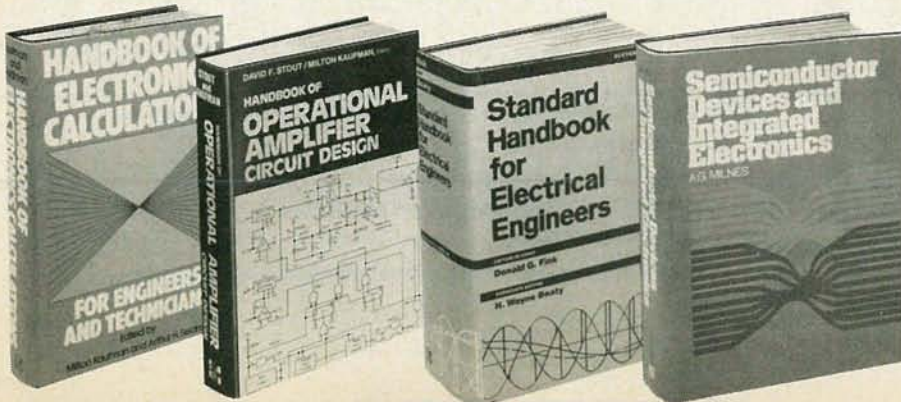
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NEW IDEAS
continued from page 110

end of the tube into the hole, again being careful not to get cement inside the tubing. Allow sufficient time for the cement to dry before handling the air pipe further. The completed air pipe should look like the one illustrated in Fig. 4. Finally, cut a piece of plastic canvas to fit on top of the air-pipe assembly and cement it in place. The canvas provides a level resting surface for all PC-board sizes, and its open grid allows the air bubbles to flow easily to the surface.

To use the etcher, place the air pipe and board to be etched in the case, connect the air pump and air pipe with a piece of the 1/8-in. ID flexible tubing, and fill the case with enough etchant solution to cover the top of the board. Then, plug in the air pump and watch the resulting action.—David L. Holmes

COMMUNICATIONS CORNER
continued from page 116

Inductor L1's reactance, while low enough to pass 30–50-MHz signals, is sufficiently high to block VHF-high and UHF signals from being shorted to ground by T1's primary (antenna) winding. Only VHF-low signals enter T1, where they are passed into the VHF-low tuner.

VHF-high signals enter their tuner through L2 and C21. Inductor L2's reactance is high enough to block UHF signals from T4. Capacitor C21's reactance is high enough to block VHF-low signals.

UHF signals are passed through C32 to the "top" of L3. Capacitor C32's reactance is sufficiently high to block both VHF-high and VHF-low without seriously affecting UHF reception.

On paper, that can look complex at first glance, but as you can see it's not much different from the basic CB splitter shown in Fig. 1-a.

Now think. If it's really that easy, was there any valid reason why some late-model solid-state "scanners" required more than one antenna input? (Again, I expect a stack of letters on why multiple antennas are better.)

By the way, if you have any old scanners lying about, or know where there are some, they are certain to be appreciated at your local Retirement Home, VA hospital, or Children's Shelter. For that matter, any working "entertainment" electronic equipment is sure to be welcome. **R-E**

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Excessive brightness and the circuit faults that can cause it.

JACK DARR, SERVICE EDITOR

IN THE DECEMBER 1979 COLUMN WE DISCUSSED raster-cutoff problems and their causes. Now we take up the equal but opposite reaction, where the screen flares up and the brightness control won't turn it down. In mild cases, the raster will be too bright, the colors pale, and vertical retrace lines may show up. (It's a good idea to check the setting and range of the AGC control before anything else; that can cause it, too.) In the worst cases, the raster will be far too bright, colors will bloom and there will be a loss of focus.

The basic cause will be the same as before. Something is upsetting the bias on the picture tube so that it is conducting far too heavily. It cannot be cut off with the controls. Let's look at some real cases.

One common cause is setting the SCREEN controls too high. Since that controls the *cutoff point* of the pix tube, the controls must be set correctly. My pet method is recommended by several set makers. Set the SERVICE switch to the SERVICE position and then turn all screen controls all the way down. Bring one SCREEN control up until a line is barely visible, then turn it back until the line just disappears. Do that with the other two

SCREEN controls and they'll be very close to the correct setting.

You can get boobytrapped on this! I once was. Got the set from another shop. The complaint was "Raster but no video." Right. Checked for video signal and found it on the grid of the video output tube; none at all on the plate. There was no plate voltage on the tube, either.

Normally, that should have put the raster out due to raising the cathode voltage. Yet, I could see a raster! Frankly, I forgot one thing and spent a bit too much time before it hit me. The last guy who worked on it hadn't found the missing plate voltage but he had cranked all three screen controls wide open! That raised the cutoff point of the tube to the point where even the high cathode voltages couldn't bias it off. Replacing the open resistor and resetting the screen controls fixed it up.

In the older sets, the cathodes of the three color-amplifier tubes were all tied together and fed by the black-and-white video signal. The three control grids were each fed by one of the color signals. Those came from the three color-difference amplifiers. The red and blue signals are amplified here and the green signal is developed by matrixing (mixing) the red

and blue signals in a common cathode resistor. Figure 1 shows that circuit as found in many sets. Older sets used a twin triode and one triode section of another tube. Later sets used a special triple-triode, but the circuits were identical.

The plate voltages of those tubes controlled the DC voltages and signals on their respective color grids in the picture tube. So, what happens if you see a one-color problem? Too much red or not enough red, etc.? You have a fault in the stage that amplifies that color only. What happens if you have a fault in something that affects all three at once? You have an upset of all three grid voltages on the picture tube, and in most cases, the grid voltages go too far positive and the raster flares and gets far too bright!

In one case, an RCA CTC-25, the raster flared. With the SERVICE switch in the SERVICE position, the setup lines were at least an inch wide and so bright we didn't dare leave the set on for more than a few seconds for fear of burning the screen! We hunted around and finally solved the problem. We happened to look at the *top* of the chassis. *Both* of the diffamp tubes (6GU7) were dead! Checking the picture-tube grid voltages we found the full +350-volt DC potential from the supply on each one. Without a heater in the tubes, they drew no plate current at all.

The cause of that was a bad solder joint in a wire jumper on the PC board, in the 6GU7's heater circuit. In another RCA chassis with similar symptoms, the difference-amplifier tubes were good. The bad solder joint this time was at one end of the common cathode resistor. This time, we used the method I've been recommending and found the cause far faster than we had in the first case. I have said—and I say again—*always* check the DC voltages on the picture tube!

Since the bias voltage on a picture tube is always the difference between the cathode and grid voltages anything that happens to either one can change it. Grids can go positive or the cathode can go too far negative. I remember one set with a flaring raster and blooming. A check showed the cathode voltages to be almost zero. Since grids were still at +200 volts, that left them with a high positive bias. That was due to an open video peaking coil between the video output tube plate and the picture tube cathodes. The high B+ voltage to the cathodes was fed through this coil.

Some of the early sets use a sort of

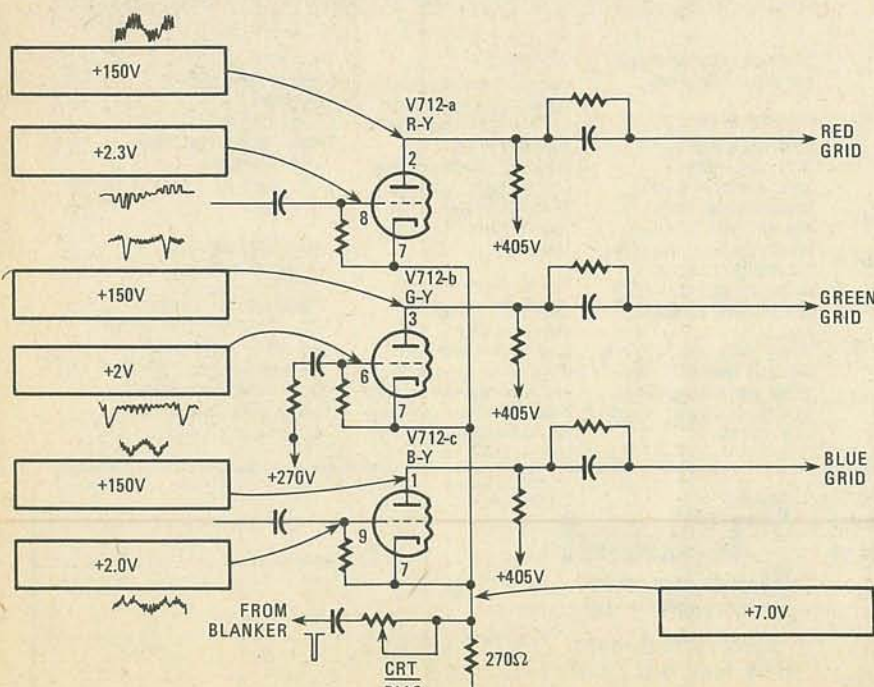


FIG. 1

elementary brightness-limiter circuit. That is usually called a BRIGHTNESS RANGE control, and is simply a pot in series with the main brightness control. To set this up correctly, the main brightness control is turned all the way up and the BRIGHTNESS RANGE control set so that the picture is just below the point of blooming. Some recommend setting for a specified DC voltage developed across a test-point resistor. If the range control isn't set correctly, it can be possible to turn the main brightness control to the point where the raster will flare or be far too bright. Normal symptom of this is when the brightness control will not turn the raster off.

To repeat something mentioned recently: in the later RGB sets with common grids, the DC bias-voltage is set by a resistance divider. If the ground leg of the divider opens, the grids go too far positive and the raster is too bright.

No matter how new or old a TV set is, you'll find the same basic relationship between the grid, cathode, and screen voltages of the picture tube. And the same results, if any of the bias levels go off value. So, as I keep saying, develop a habit of checking those voltages whenever you run into any kind of brightness problem. That can save you one heck of a lot of time!

R-E

service questions

SUB FOR 60060 TRANSISTOR

I've got a WT-509A RCA cathode ray tube tester. Wrote to VIZ for an up-to-date setup booklet. With it, they sent an addendum to the manual, suggesting replacing the 39278 transistor with a 60060. Now, I can't find this transistor anywhere, and no listing of it! Do you know of a sub?—R.F., Chicago, IL.

RCA lists a 60060 (industrial number) in their SPG-202X Guide. They say that an SK-3054 will replace it. This is a TO-5 cased, high voltage type, "with flange".

AGC BUCKING RESISTOR

There's an AGC problem in this Westinghouse model CP19A770. I can't get the right voltages. There is a keying pulse on the AGC tube, and a small change on the plate with or without a signal. The picture is too dark, and I can't adjust it.—F.N., PEAUKEE, WN.

Your AGC voltages and reactions seem to be OK. Suggestion: There's a 15-megohm resistor in a line from the AGC test point over to the B+ 255-volt line. Lift one end of this resistor and check it. If it is open or has gone way up in value, there won't be enough "bucking voltage" to keep the AGC from driving itself too far negative. This cuts the IF gain, which results in a dark picture. This used to be

quite a common problem some time ago; the case you describe is the first I've seen for quite a while.

VOLTAGE-REGULATOR PROBLEMS

Here's a dandy one in a Panasonic CT-914 (ETA-12) chassis. If you get one with a vertical flutter in the picture, don't concentrate on the vertical circuits! It could be caused by the DC power supply!

Capacitor C808, 1.0 μ F, 160 volts, may be open. That is in the line from the bridge-rectifier output to the Trigger-Pulse SCR, TR802. Evidently a pulse-shaper in an R-C network with R804, (56K) to the gate of TR802.

If the sets shuts down instantly when you put the new capacitor in, yank it out and check for leakage! Even a new one can be bad. Symptoms of that flutter: +110-volt DC supply will be low, about +107 volts or so, and it will fluctuate.

Thanks a lot to Douglas P. Hoff of Vacaville, CA for that helpful hint.

TWO PROBLEMS—ONE SET

I've got a sticky problem in this Zenith 16Z8C50. The high voltage is up to 31 kV, and the high-voltage adjust pot won't change it. The brightness control does vary brightness and the high voltage. I've checked several things in this circuit. No luck. I have another odd one. My voltmeter probe slipped while checking the damper plate, and hit the cathode. There was a loud 'pop', and now I read +500 volts instead of +390, +310 volts instead of +250, and I get +1036 volts on the 880V boost. Can you tell me what to check from here on?—D.P., Berwyn, IL.

Yes, First, check your voltmeter and make sure it's OK! That may explain the extra 60 volts. (Ask me how I know? I did the same thing some years ago in same place with same results! Sixty bucks for new parts for my meter made me much more careful.)

As for the high-voltage problem, you mentioned that the voltage on the 6HV5 regulator-tube grid is off. That is apt to be the cause of your high-voltage problem. Check it while turning the high-voltage adjust control; see if it varies as it should. If not, check all resistors and capacitors in the grid circuit. Those have been known to break down under load causing the symptoms you mentioned.

NO REGULATION ON PICTURE TUBE

When I wrote you originally, you told me to check the DC voltages on the picture tube. (RCA CTC-72 chassis, no voltage regulation on picture tube, high-voltage way up. I did; the DC voltage on the common grids read normal, but there was an open connection between the picture-tube socket and the pin to the grids! Bit of prying fixed this and everything works.

Thanks to R. Jimenez of NJ for the feedback.

R-E

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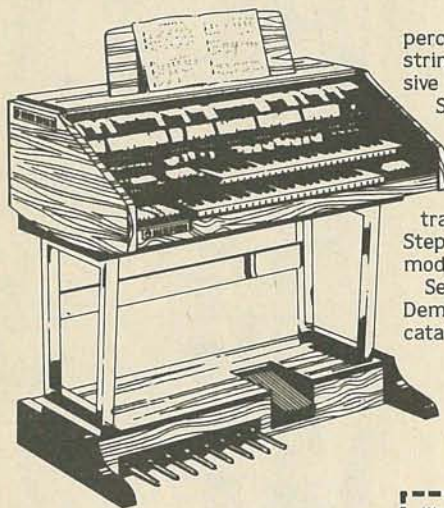
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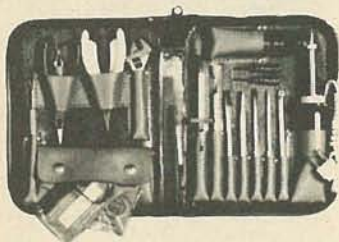
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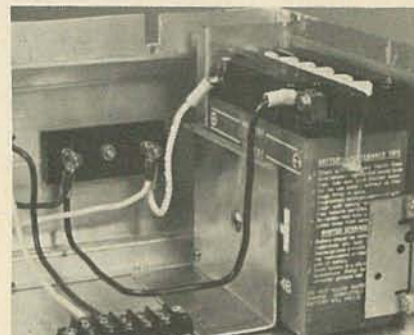


FIG. 25—MOTORCYCLE BATTERY used to power robot. See text for important mounting precautions.

used to hold the battery in place and to support its weight, since the plates that cover the mobility base are probably not strong enough to do this by themselves.

Certain precautions *must* be observed when using this type of battery! As shown in the photograph, the battery is unenclosed, which means that there exists the possibility of sulphuric acid, the battery's electrolyte, spilling on the aluminum or steel of the mobility base. You do not want this to happen! The battery should be (and is, in later versions of the robot) enclosed in an acid-proof plastic container to contain any possible leaks or drips. This container should also have a small vent, or vents, at the top to permit the hydrogen gas which is generated when the battery is charging, to escape. These vents should be led to the outside of the mobility base, to allow the gas to escape directly to the air.

There is another type of battery which might be considered for powering the robot. That uses a gelled-electrolyte and is, in theory, less hazardous. New batteries of this type are more expensive than lead-acid batteries, but several advertisers at the back of **Radio-Electronics** have surplus gelled-electrolyte available, and they may suit your purpose.

Whatever power source you use, take precautions so that it cannot harm, directly or indirectly, the innards of the robot.

Leads are run from the battery to a 32-position barrier strip (see Fig. 26) which is also mounted inside the mobility base. Power for the robot's various motors and control circuitry is obtained by running jumpers from the +12 VDC and ground terminals to those connected to the points to be powered. Note the use of color-coding in order to make circuit tracing easier.

Several terminals have been allocated for functions that have not yet been discussed. Don't worry—we'll get to them.

In the next installment of this series, plans for the robot's body will be given, along with an option or two previously hinted at.

R-E

NEW LIT

continued from page 114

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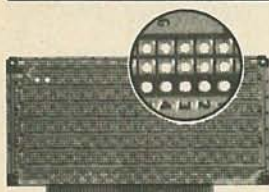
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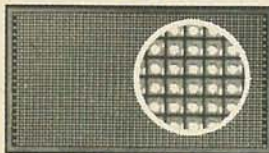
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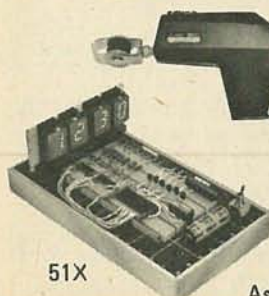


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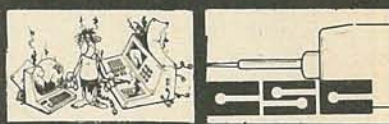
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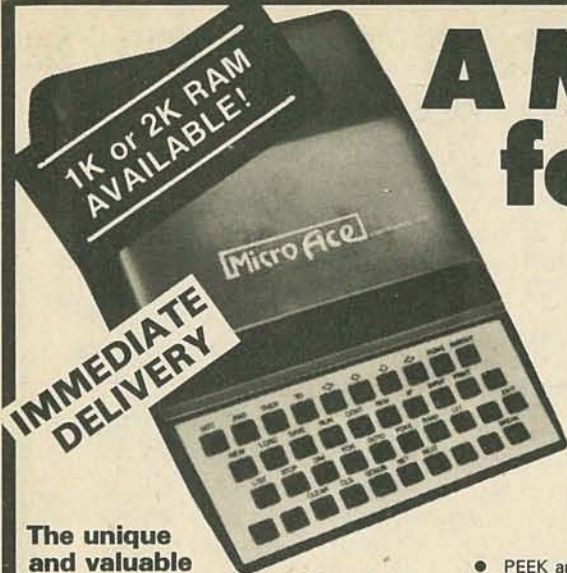
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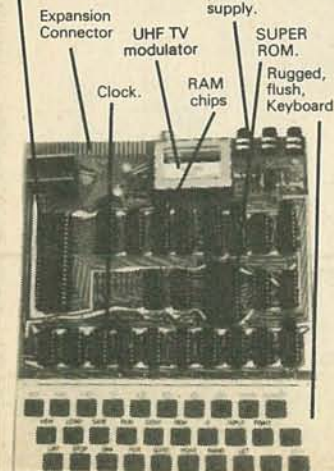
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74LS08	276-1908	.79
74LS32	276-1915	.89
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74LS90	276-1923	1.19
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74LS157	276-1930	1.19
74LS161	276-1931	1.59
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74LS175	276-1934	1.39
74LS193	276-1936	1.69
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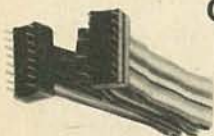
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All 100% Prime from Major Manufacturers. Specs and Pin Out Diagram Included with Each Device.

16-Pin DIP Jumper Cable



3⁹⁹

Two 16-pin DIP plugs connected by an 18" color-indexed ribbon cable. Simplifies linking up digital circuits. 276-1976 3.99

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Rugged thermoplastic. Prevent shorts. Ideal for audio equipment, power supplies. Terminals extend 3/16".

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4⁴⁹

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SN76477. Music, explosions, phasers, gunshots and more — almost any sound imaginable! Line-level output. 6-15VDC. With data. 276-1765 4.49

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9⁹⁹

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6⁹⁵

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16,384 x 1 bits in a 16-pin DIP. Access time: 250 nanoseconds. Refresh: 1 millisecond. Requires +5, +12, and -5VDC. TTL compatible. 276-2505 13.95

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Only **99¢** Pkg. of 6

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Speaker Terminals

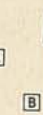
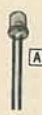
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1⁹⁹



Just right for hi-fi, instrument or PA speakers. Push-terminals accept up to 16-ga. wire. Also has 2-conductor 1/4" phone jack with sealing plug. 274-624 1.99

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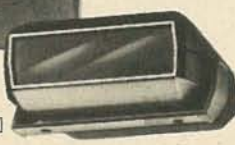
New! **1⁹⁹**

Pkg. of 2

Right hand decimal, 3.0V/segment @ 20 mA. Common cathode. 276-067 Pair/1.99

Cases and Cabinet

Save up to **33%**



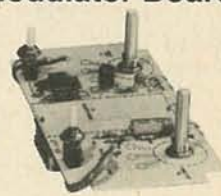
A Deluxe "Wood Look" Cabinet. Metal, slide-off cover, rubber feet. 2 3/4 x 4 1/4 x 5 1/8". 270-262 (Reg. 5.95) Sale 3.95
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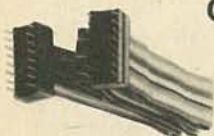
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11⁹⁵



Etched, drilled & labeled PC board with pre-wired RF module and back-of-set ant. switch. Ch. 3 or 4 out. Produces color or b/w video, 30-15,000 Hz hi-fi sound. With instructions. Parts extra. 277-122 Sale 11.95

16-Pin DIP Jumper Cable



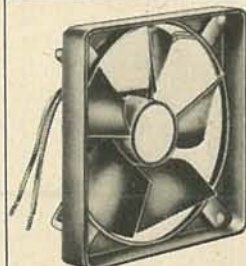
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Two 16-pin DIP plugs connected by an 18" color-indexed ribbon cable. Simplifies linking up digital circuits. 276-1976 3.99

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14⁹⁵



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29⁹⁵

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OCTOBER 1980

135

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74C74 .39	74C227 .169

74LS00 TTL

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74LS97 .35	74LS236 .106
74LS98 .35	74LS237 .106
74LS99 .35	74LS238 .106
74LS00 .35	74LS239 .106

J608 PROGRAMMER

2704/2708 EPROM PROGRAMMER



• 3-segment Display Register & LED (for Hex Key entries, 18 LED's (12" x 2") for Address Register & LED's for Data Memory Register, The Data Memory Register displays the content of the RAM from the EPROM Chip.
• Development of microprogram systems by means of a ribbon cable from the programmer panel to the EPROM socket on the microprogrammer board.
• Rapid checking verification of programmed data changes.
• User may move data from a master to RAM or write into RAM with Hexadecimal keys.
• Allows manual changing/inserting logic and down at any address location.
• Stand alone EPROM programmer consisting of:
• A 15 Key Hexadecimal Keypad assembly, Programmer Board assembly with a power supply and a LED/7 Segment Panel Board assembly, The Test Socket board from the programmer panel, Power requirements: 115VAC, 60Hz, 500mA.
• Compact desk top enclosure. Color coordinated equipment. 100% light test parts and tested unit passes in moisture tests. Size: 2 1/2" x 11 1/2" x 8 1/2" Height: 8 1/2".

The J608 EPROM Programmer is a completely self contained unit which is independent of computer control and requires no additional systems for its operation. The EPROM can be programmed from the Hexadecimal Keypad or keyboard directly into the memory circuits with the J608 Programmer can emulate a programmed EPROM by the use of its internal RAM circuit. This will allow the user to test 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 Keypad so that rewriting the entire program will not be necessary. The J608 Programmer contains a Programmer/Board with 25 IC's and including power supplies of -5V, -15V, +12V and +20V. The Hexadecimal Keypad and LED/7 Segment Panel Board are separate assemblies within the system.

J608 KIT \$399.95
J608A Assembled and tested \$499.95

DISCRETE LEDS

XC56R .200" red 5/51	MV50 .005" red 6/51	XC11R .190" red 5/51
XC56G .200" green 4/51	XC20R .125" red 5/51	XC11G .190" green 4/51
XC56Y .200" yellow 4/51	XC20Y .125" yellow 4/51	XC11Y .190" yellow 4/51
XC56C .200" clear 4/51	XC20C .125" clear 4/51	XC11C .190" clear 4/51
XC22R .300" red 4/51	XC52G .185" green 4/51	
XC22Y .300" yellow 4/51	XC52Y .185" yellow 4/51	
MV10B .170" red 4/51	XC52C .185" clear 4/51	

INFRARED LED
IRL - 5/51

DISPLAY LEDS

C.A. - Common Anode C.C. - Common Cathode

Type	Polarity	Ht.	Price	Type	Polarity	Ht.	Price
MAN 1							

BLAK-RAY Ultraviolet Intensity Meter



TWO MODELS:
LONG WAVE
AND
SHORT WAVE

Meter consists of a sensor cell attached to a compact (3" x 3 1/2" x 3") metering unit. Can be hand-held or placed directly on surface for measuring. Can be used remotely, while connected to a meter housing by a 4-foot extension cord. Two models available — one for long wave and one for short wave ultraviolet. Readings are in microwatts per square centimeter. Weight: 1 lb.

Completely assembled (includes sensor cell, reduction screen, extension cord, contrast filter and certification report.)

J-221 LONG WAVE
(300nm-400nm) \$242.00

J-225 SHORT WAVE
(200nm-280nm) \$260.00

EPROM Erasing Lamp



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

UVS-11E \$79.50

Jumbo 6-Digit Clock Kit

- Four .630" ht. and two .300" ht. common anode displays
- Uses MMS34 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6 1/4 x 3 1/8 x 1 1/4

JE747 \$29.95

- Bright .300 ht. comm. cathode display
- Uses MMS34 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 1/4" x 3-1/8" x 1 1/4"

JE701

6-Digit Clock Kit \$19.95

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

JE200 \$14.95

- **ADAPTER BOARD** — Adapts to JE200 — +5V, +9V and +12V

DC/DC converter with +5V input. Toroidal hi-speed switching XFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3 1/2" x 2" x 9/16" H

JE205 \$12.95

MICROPROCESSOR COMPONENTS

8080/8088 SUPPORT DEVICES		MICROPROCESSOR MANUALS	
8080A CPU	\$ 7.95	M-280 User Manual	\$7.50
8212 8-Bit Input/Output	3.25	M-COP1802 User Manual	7.50
8214 Priority Interrupt Control	5.95	M-2850 User Manual	5.00
8216 Bi-Directional Bus Driver	3.49		
8224 Clock Generator/Driver	3.49		
8226 Bus Driver	3.49		
8228 System Controller/Bus Driver	4.95		
8238 System Controller	5.95		
8251 Prog. Comm. 1/0 (USART)	7.95		
8253 Prog. Interval Timer	14.95		
8255 Prog. Periph. 1/0 (PPI)	8.95		
8257 Prog. DMA Control	19.95		
8259 Prog. Interrupt Control	14.95		
8080/8088 SUPPORT DEVICES		ROM'S	
MC6800 MPU	\$14.95	1101 256X1 Static	\$1.49
MC6802CP MPU with Clock and Ram	19.95	1103 1024X1 Dynamic	.99
MC6810API 128X8 Static Ram	4.95	2101(8101) 256X4 Static	3.95
MC6821 Periph. Adapt. (MC6820)	7.49	2102 1024X1 Static	1.75
MC6828 Priority Interrupt Controller	10.95	21102 1024X1 Static	1.95
MC6830L8 1024X8 Bit ROM (MC68A30-8)	14.95	2111(8111) 256X4 Static	3.95
MC6850 Asynchronous Comm. Adapter	6.95	2112 256X4 Static MOS	4.95
MC6852 Synchronous Serial Data Adapt.	6.95	2114 1024X4 Static 450ns	5.95
MC6850 0-600 bps Digital MODEM	10.95	2114-3 1024X4 Static 300ns	7.49
MC6862 2400 bps Modem	12.95	2114-3 1024X4 Static 300ns low power	7.95
MC6880A Quad 3-State Bus Trans. (MC8726)	2.25	5101 256X4 Static	7.95
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Z80(780C) CPU	\$13.95	7489 16X4 Static	1.75
Z80A(780-1) CPU	15.95	UPD114 4K Dynamic 18 pin	4.95
CDP1802 CPU	19.95		
2650 MPU	16.95		
6502 CPU	11.95		
8035N46 8-Bit MPU w/clock, RAM, 1/0 lines	19.95		
P8085 CPU	19.95		
TMS9900L 16-Bit MPU	49.95		
SHIFT REGISTERS		PROM'S	
MM500H Dual 25 Bit Dynamic	\$ 50	1702A 2048 FAMOS	\$5.95
MM503H Dual 50 Bit Dynamic	50	2716 16K* EPROM (Intel)	29.95
MM506H Dual 100 Bit Static	50	2716 16K* EPROM (2716)	19.95
MM510H Dual 64 Bit Accumulator	50		
MM515H 500-512 Bit Dynamic	89		
2504(1404A) 1024 Dynamic	3.95		
2518 Hex 32 Bit Static	4.95		
2522 Dual 132 Bit Static	2.95		
2524 1024 Dynamic	.99		
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2529 Dual 240 Bit Static	4.00		
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3341 File	6.95		
74LS870 4X4 Register File (TriState)	2.49		
UART'S		DIGITAL THERMOMETER KIT	
A-Y-5-1013 30K BAUD	5.95	74528 1024 Static	4.95

Function Generator Kit



Provides 3 basic waveforms: sine, triangle and square wave. Freq. range from 1 Hz to 100K Hz. Output amplitude from 0 volts to over 6 volts (peak to peak). Uses a 12V supply or a ±6V split supply. Includes chip, P.C. Board, components & instructions.

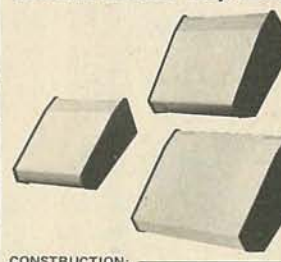
JE2206B ... \$19.95

DIGITAL THERMOMETER KIT

- Dual sensors—control switch for indoor/outdoor or dual monitoring—extension up to 500 feet
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- Accuracy: ±1° nominal
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- Sim. walnut case—AC wall adapter incl.
- Size: 3 1/4" H x 6-5/8" W x 1-3/8" D

JE300 \$39.95

DESIGNERS' 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 .680 thk alum. Anodized type 1200 finish (gold tint color) for best paint adhesion after modification.
- Vented top and bottom panels for cooling efficiency.
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MM2114-3 \$5.95 each
4K STATIC RAM (300NS)
(8 EACH \$43.95) (100 EACH \$450.00/lot)

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TRS-16K \$49.95

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 @ 10mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two user-define 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.

JE610 (Case not included) \$79.95

Desk-Top Enclosure for JE610 ASCII Encoded Keyboard Kit

Compact desk-top enclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3 1/2" H x 14 1/2" W x 8 3/4" D.
DTE-AK \$49.95
SPECIAL: JE610/DTE-AK PURCHASED TOGETHER
(Value \$129.90) \$124.95

JE600 Hexadecimal Encoder Kit



The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation.
JE600 (Case not included) \$59.95

Desk-Top Enclosure for JE600 Hexadecimal Keyboard Kit

Compact desk-top enclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3 1/2" H x 8 3/4" W x 8 3/4" D.
DTE-HK \$44.95
SPECIAL: JE600/DTE-HK PURCHASED TOGETHER
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103A	0.80	175	1.30	263	1.60
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107	0.60	179	5.00	267	1.00
108	0.75	180	4.00	268	1.20
109	0.30	181	2.90	269	1.30
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111	1.20	183	3.00	271	4.50
112	0.80	184	1.00	272	0.80
113A	0.80	185	1.20	273	1.20
114	0.80	186	0.90	274	2.60
115	0.80	186A	1.20	275	3.00
116	0.30	187	1.10	276	7.75
117	0.30	187A	1.30	277	9.80
118	1.30	188	1.50	278	2.50
119	1.00	189	1.40	279	5.00
120	0.90	190	1.80	280	3.40
121	2.70	191	2.00	281	4.60
122	4.00	192	0.45	282	3.10
123	0.60	193	0.45	283	6.00
123A	0.55	194	0.45	284	4.20
123AP	0.70	195A	1.90	285	5.70
124	1.60	196	1.20	286	5.70
125	0.30	197	1.30	287	0.60
126	1.20	198	1.40	288	0.70
127	4.00	199	0.40	289	0.60
128	0.85	209	0.30	290	0.60
129	1.00	210	0.85	291	1.30
130	1.30	211	1.00	292	1.50
131	1.00	213	10.00	293	0.80
132	0.60	218	2.70	294	1.00
133	0.55	219	3.50	295	0.60
134A	0.50	220	1.60	297	0.90
135A	0.50	221	1.50	298	1.00
136A	0.50	222	1.80	299	0.75
137A	0.50	223	3.00	300	0.70
138A	0.50	224	3.00	302	1.30
139A	0.50	225	4.50	306	1.30
140A	0.50	226	1.80	307	0.60
141A	0.50	226MP	4.90	308	6.80
142A	0.50	228A	1.00	309K	3.20
143A	0.50	229	0.60	310	6.50
144A	0.50	230	4.20	311	2.00
145A	0.50	231	3.80	312	0.60
146A	0.50	232	0.60	313	1.90
147A	0.50	233	0.50	314	7.50
148A	0.50	234	0.45	315	0.90
149A	0.50	235	1.50	316	2.50
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151A	0.50	237	2.40	318	20.00
152	0.90	238	3.30	319	1.10
153	1.00	239	2.70	321	3.60
154	1.40	241	2.00	322	1.90
155	2.20	242	2.00	323	2.20
156	0.45	243	2.10	324	2.50
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160	1.80	247	4.00	328	9.00
161	0.90	248	4.00	329	3.70
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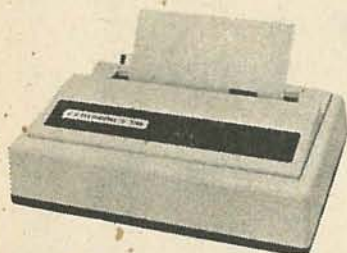


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26-1181 VOXBOX	145.00
26-1104 Factory Upper/Lower	
Case Modification Installed	70.00
26-1506 Scripsit - Tape	60.00
26-1563 Scripsit - Disk	85.00

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26-1054
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Fast 100 CPS Centronics
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Text Quality Centronics
737 Printer - \$850.00

MICROSOFT

Model I Basic Compiler.....\$180.00
Model II Basic Compiler.....360.00

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System.....72.00
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10-8" Diskettes.....47.00

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\$360.00
Cobol Run Time Package
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OCTOBER 1980

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the first name in Counters!



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 150 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 3½ digit, ½ 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:	0.1uA 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

\$34.95 Kit \$44.95 Wired

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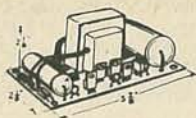
TERMS

Satisfaction guaranteed, examine for 10 days, if not pleased, return in original form for refund. Add 5% for shipping - insurance to a maximum of \$10. Overseas add 15%. COD add \$2. Orders under \$10, add \$1.50. NY residents add 7% tax.

INTERNATIONAL ELECTRONICS UNLIMITED

POWER SUPPLY KIT

+5V, +12V, +15V
A regulated power supply using a 115V/29V CT transformer, 3-LM340T and 3-LM320T regulators to supply the above voltages. Heat sink provided for +5V.



PARTS INCLUDED
Transformer
6 regulators
PC board
4 diodes
Capacitor 1000 uf
Capacitor 500 f
3 Capacitors 10 uf

10-24 \$14.95ea
25- 13.50ea
12-50ea

LED DISPLAYS

.4" ORANGE LED DISPLAY \$1.19ea
7 segment RHD 10/\$7.95
MAN4610 - common anode 25/\$17.50
MAN4640 - common cathode 100/\$65.00



.4" ORANGE overflow ±1 \$.89ea
MAN4630 - common anode 10/\$5.95

.3" RED LED DISPLAY \$.99ea
7 segment RHD 10/\$7.95
XAN72 (MAN72 equiv) 25/\$17.50
common anode 100/\$65.00

.3" RED LED DISPLAY \$.79ea
7 segment RHD 10/\$6.95
NSN74R common cathode 25/\$16.25
100/\$59.00

.6" RED LED DISPLAY \$1.25ea
7 segment LHD 10/\$11.50
XAN6940 - common cathode 25/\$26.50
100/\$98.00

CERAMIC CAPACITORS

1pf	22pf	56pf	120pf	270pf	.0047uf	.030uf
5pf	27pf	68pf	150pf	390pf	.001uf	.050uf
7pf	33pf	82pf	180pf	470pf	.0015uf	.015uf
10pf	47pf	100pf	220pf	600pf	.003uf	.022uf
1pf - .050uf					.1uf	
Total	EA.	PK-10	PK-100	EA.	PK-10	PK-100
1-1000	\$.20	1.00	6.50	.25	1.25	9.00
1000-	.20	.85	6.00	.25	1.10	8.00

CERAMIC CAPACITOR KIT
CK-c2 5ea. of the above values \$11.50
CK-c3 10ea. of the above values 20.50

POLYESTER FILM CAPACITORS - 100V ± 10%

	EA.	PK-10	PK-100	EA.	PK-10	PK-100
.001uf	\$.15	.95	6.50	.033uf	\$.20	1.00 10.00
.0015uf	.15	.95	7.50	.047uf	.20	1.15 10.50
.0022uf	.15	.95	7.50	.068uf	.25	1.30 12.00
.0033uf	.15	.95	7.50	.1uf	.30	1.75 13.50
.0047uf	.15	.95	7.50	.15uf	.35	2.25 14.00
.0068uf	.15	.95	7.50	.22uf	.40	2.55 20.00
.01uf	.15	.95	7.50	.33uf	.45	2.75 25.00
.015uf	.15	.95	7.50	.47uf	.50	3.50 30.00
.022uf	.15	.95	7.50			

TOTAL QTY. 1000 pcs. -10%, 5000 pcs. -15%

POLYESTER CAPACITOR KIT
5 ea of the above values \$14.95

TANTALUM CAPACITORS

solid dipped ± 20%

.1uf/85V	.30	.25	4.7uf/16V	.38	.30	22uf/16V	.50	.40
.22uf/35V	.30	.25	4.7uf/25V	.45	.35	22uf/35V	.60	.55
.33uf/35V	.30	.25	6.8uf/6V	.35	.28	33uf/6V	.55	.45
1uf/20V	.30	.25	6.8uf/18V	.45	.39	33uf/10V	.60	.50
1.5uf/20V	.30	.25	10uf/20V	.42	.35	47uf/6V	.60	.50
2.2uf/20V	.35	.25	15uf/6V	.42	.35	47uf/15V	.65	.55
2.2uf/35V	.38	.28	15uf/20V	.50	.40	56uf/6V	.85	.75
3.3uf/35V	.40	.30						

CAPACITOR KIT ck-t2 tantalum

solid dipped ±20%

.22uf/35V	2.2uf/25V	6.8uf/16V	22uf/16V
.33uf/35V	3.3uf/35V	10uf/20V	33uf/10V
1uf/20V	4.7uf/16V	15uf/20V	47uf/20V

Sea of above values.....\$17.75
Supplied in clear styrene utility box.....\$21.95



ELECTRONIC BUZZER
5V or 12V \$1.25ea
10-24 1.00ea
25- .90ea

DISCRETE LED'S



JUMBO LED
.20" dia, diffused
Red, Clear or White 10/\$1.00 25/\$2.00 100/\$7.50
Green or Yellow 7/\$1.00 25/\$2.85 100/\$9.75

SUBMINIATURE LED
.125" dia, diffused
Red or Clear 10/\$1.00 25/\$2.00 100/\$7.50
Green or Yellow 7/\$1.00 25/\$2.85 100/\$9.75

DIODES

1N4148 (1N914) 400mw 15/\$1.00 100/\$5.00 1000/\$40.00
1N4001 50PIV 12/\$1.00 100/\$7.00 1000/\$60.00
1N4007 1000PIV 10/\$1.25 100/\$11.00 1000/\$10.00

TRANSISTORS

2N3904 NPN TO-92 \$.25ea 10/\$1.65 25/\$3.25 100/\$12.00
2N3906 PNP TO-92 \$.25ea 10/\$1.65 25/\$3.25 100/\$12.00
2N2222A NPN TO-18 \$.45ea 10/\$3.50 25/\$8.00 100/\$29.50

DIPSWITCH - 4 sw
8 pin DIP SPST
1-9 \$1.65ea
10-24 1.55ea
25- 1.49ea



DIPSWITCH - 8 sw
16 pin DIP SPST
1-9 \$2.10ea
10-24 1.95ea
25- 1.85ea

DIPSWITCH - 10 SW
20 pin DIP SPST
1-9 \$2.20ea
10-25 2.05ea
25- 1.95ea

LINEAR CIRCUITS

1/2 PRICE SALE

LM300H	REG.	SALE
LM300H	\$.59	\$.30
LM301CN	.32	.16
LM302H	.59	.30
LM307CN	.32	.16
LM308H	.79	.40
LM308CN	.79	.40
LM310CN	1.05	.53
LM310H	1.07	.54
LM311H	.89	.45
LM311CN	.89	.45
LM311H	.89	.45
LM322N	.89	.45
LM340T-6V		
(7806)	1.19	.60
LM376CN	.50	.25
LM380-8	.89	.45
LM565N	1.15	.58
LM709H	.39	.20
LM733H	.89	.45
LM739N	.89	.45
LM748CN	.35	.18
LM1414N	1.25	.63
LM1800N	2.40	1.20
75453CN		
(351CN)	.18	
75491N	.38	
75492N	.45	

TTL

7400	\$.18	7464	.30	74155	.50
7401	.18	7465	.30	74156	.64
7402	.18	7470	.49	74157	.60
7403	.18	7472	.32	74158	.75
7404	.20	7474	.18	74160	.70
7405	.25	7475	.49	74161	.79
7406	.20	7576	.49	74162	.85
7407	.20	7480	.35	74163	.85
7408	.27	7482	.25	74164	.85
7409	.27	7483	.58	74166	.85
7410	.18	7485	.50	74170	1.50
7415	.29	7486	.42	74173	1.25
7416	.20	7489	1.75	74174	1.05
7417	.20	7490	.59	74175	.85
7420	.20	7491	.64	74176	.70
7425	.39	7492	.59	74177	.70
7426	.35	7493	.35	74180	.35
7427	.25	7494	.59	74181	1.85
7430	.25	7495	.35	74182	.35
7432	.20	7496	.35	74189	.50
7437	.20	74105	.48	74190	1.15
7438	.18	74107	.35	74191	1.15
7440	.18	74121	.35	74192	.50
7441	.59	74122	.39	74193	.79
7442	.35	74123	.39	74194	.85
7443	.55	74125	.50	74195	.69
7444	.60	74126	.50	74196	.80
7445	.50	74132	.75	74197	.75
7446	.59	74141	.35	74198	1.40
7448	.59	74145	.50	74199	1.25
7450	.18	74148	1.25	745200	3.75
7451	.22	74150	1.35	74279	.65
7453	.18	74151	.50		
7454	.18	74153	.35		
7460	.18	74154	1.45		

8000 (Signetics) 8263 2.95 8267 1.75 8281 .85

CMOS

4000 Series CMOS

4000	\$.25	4020	1.14	4050	.45
4001	.39	4021	.95	4051	1.15
4002	.25	4022	.95	4066	.79
4006	.95	4023	.30	4069	.39
4007	.39	4024	.75	4071	.29
4008	.95	4025	.22	4072	.39
4009	.46	4027	.59	4073	.39
4010	.45	4028	.85	4078	.39
4011	.45	4030	.49	4081	.39
4012	.25	4035	.95	4082	.30
4013	.59	4040	1.15	4518	1.25
4014	.95	4041	1.20	4528	1.50
4015	.95	4042	.95	4585	1.50
4016	.64	4043	.85	4901	.59
4017	1.08	4046	1.69		
4018	.95	4049	.45		

IMMEDIATE DELIVERY OF QUALITY RESISTORS

CARBON FILM RESISTORS

PRICING 1/4 & 1/2 watt

CARBON FILM 25%	total quantity ea	pk-10	pk-100	pk-1000
1/4watt (R.0hm R25)	1-999	\$.10	.45	2.00
.095" dia X .250" long (body)	1000-	.10	.40	1.80 15.00
1/2watt (R.0hm R50)	5000-	.10	.30	1.70 14.50
.146" dia X .354" long (body)	10000-	.10	.25	1.55 13.00

VALUES STOCKED (ohms)

.5	3.9	16	68	300	1.2K	5.1K	22K	91K	390K	1.6M	*6.2M
1.0	4.3	18	75	330	1.3K	5.6K	24K	100K	430K	1.8M	*6.8M
1.1	4.7	20	82	360	1.5K	6.2K	27K	110K	470K	2.0M	*7.5M
1.2	5.1	22	91	390	1.6K	6.8K	30K	120K	510K	2.2M	*8.2M
1.3	5.6	24	100	430	1.8K	7.5K	33K	130K	560K	2.4M	*9.1M
1.5	6.2	27	110	470	2.0K	8.2K	36K	150K	620K	2.7M	*10M
1.6	6.8	30	120	510	2.2K	9.1K	39K	160K	680K	3.0M	*11M
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
2.2	9.1	39	160	680	3.0K	12K	51K	220K	910K	3.9M	*15M
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	
3.3	13	56	240	1.0K	4.3K	18K	75K	330K	1.3M	5.6M	
3.6	15	62	270	1.1K	4.7K	20K	82K	360K	1.5M		

METAL FILM RESISTORS

METAL FILM 1%
RN60 (R.0hm CRB60F) 1/4watt
Low temp coef - 50ppm/°C
.138" dia X .355" long (body)
color banded

total quantity ea	pk-10	pk-25	pk-100	pk-250
1-999	\$.25	1.00	2.00	7.50 17.50
1000-	.20	.90	1.80	7.00 16.25
5000-	.20	.85	1.70	6.50 15.00
10000-	.20	.80	1.55	6.00 13.75

10 or more resistors - not individually packaged - mixed - specify any assortment of values \$.15ea

VALUES STOCKED (ohms)

Standard 1% metal film values from 10 ohm to 475K ohm

10.0	12.1	14.7	17.8	22.6	27.4	33.2	40.2	48.7	59.0	71.5	88.7
10.2	12.4	15.0	18.2	23.2	28.0	34.0	41.2	49.9	60.4	73.2	90.9
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	

7400

SN7400N	19	SN74123N	59
SN7401N	22	SN74125N	39
SN7402N	22	SN74126N	44
SN7403N	22	SN74128N	59
SN7404N	22	SN74132N	69
SN7405N	23	SN74139N	95
SN7406N	23	SN74139N	95
SN7407N	23	SN74141N	69
SN7408N	26	SN74142N	295
SN7409N	23	SN74150N	29
SN7410N	22	SN74144N	295
SN7411N	29	SN74145N	62
SN7412N	29	SN74147N	195
SN7413N	39	SN74148N	120
SN7414N	29	SN74155N	67
SN7416N	29	SN74151N	67
SN7417N	29	SN74152N	67
SN7420N	22	SN74153N	67
SN7421N	35	SN74154N	119
SN7422N	29	SN74155N	67
SN7423N	29	SN74156N	89
SN7425N	29	SN74157N	69
SN7426N	29	SN74158N	165
SN7427N	29	SN74160N	99
SN7428N	45	SN74161N	99
SN7430N	23	SN74162N	99
SN7432N	29	SN74163N	87
SN7437N	29	SN74164N	99
SN7438N	29	SN74165N	99
SN7439N	29	SN74166N	120
SN7440N	24	SN74167N	195
SN7441N	79	SN74170N	199
SN7442N	57	SN74172N	595
SN7443N	79	SN74173N	79
SN7444N	79	SN74174N	89
SN7445N	79	SN74175N	89
SN7446N	79	SN74176N	85
SN7447N	59	SN74177N	85
SN7448N	79	SN74179N	180
SN7450N	23	SN74180N	75
SN7451N	23	SN74181N	175
SN7453N	23	SN74182N	75
SN7454N	23	SN74184N	195
SN7459N	29	SN74185N	180
SN7460N	23	SN74186N	995
SN7470N	39	SN74188N	390
SN7472N	34	SN74190N	115
SN7473N	36	SN74191N	115
SN7474N	36	SN74192N	85
SN7475N	38	SN74193N	85
SN7476N	36	SN74194N	85
SN7479N	460	SN74195N	85
SN7480N	110	SN74197N	85
SN7482N	110	SN74198N	139
SN7483N	55	SN74199N	139
SN7485N	65	SN74201N	139
SN7486N	39	SN74202N	139
SN7487N	175	SN74203N	109
SN7490N	39	SN74209N	89
SN7491N	65	SN74283N	215
SN7492N	52	SN74284N	390
SN7493N	49	SN74285N	390
SN7494N	72	SN74290N	129
SN7495N	65	SN74299N	95
SN7496N	72	SN74305N	68
SN7497N	310	SN74306N	68
SN74100N	99	SN74307N	79
SN74107N	32	SN74308N	79
SN74109N	53	SN74309N	190
SN74116N	195	SN74303N	190
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74LS00

74LS00N	35	74LS164N	110
74LS01N	28	74LS165N	89
74LS02N	28	74LS166N	248
74LS03N	28	74LS168N	189
74LS04N	39	74LS169N	189
74LS05N	39	74LS170N	199
74LS06N	39	74LS173N	89
74LS09N	39	74LS174N	99
74LS10N	28	74LS175N	99
74LS11N	39	74LS181N	220
74LS12N	39	74LS180N	119
74LS13N	47	74LS191N	115
74LS14N	125	74LS192N	98
74LS15N	39	74LS193N	98
74LS16N	39	74LS194N	119
74LS21N	38	74LS195N	95
74LS22N	38	74LS196N	89
74LS26N	39	74LS197N	89
74LS27N	39	74LS221N	149
74LS28N	39	74LS240N	229
74LS30N	29	74LS241N	249
74LS32N	39	74LS242N	229
74LS37N	79	74LS243N	229
74LS38N	39	74LS244N	295
74LS40N	26	74LS245N	395
74LS42N	79	74LS247N	110
74LS47N	79	74LS248N	110
74LS48N	79	74LS249N	169
74LS51N	26	74LS251N	179
74LS52N	26	74LS252N	179
74LS55N	35	74LS257N	98
74LS73N	45	74LS258N	98
74LS74N	59	74LS259N	295
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74LS83AN	99	74LS273N	175
74LS86N	119	74LS275N	440
74LS88N	45	74LS279N	59
74LS90N	75	74LS283N	110
74LS92N	79	74LS290N	129
74LS93N	75	74LS293N	195
74LS96N	88	74LS295N	110
74LS98N	98	74LS298N	129
74LS107N	45	74LS324N	175
74LS109N	45	74LS347N	195
74LS112N	49	74LS348N	195
74LS113N	49	74LS352N	185
74LS115N	45	74LS353N	185
74LS122N	55	74LS363N	149
74LS123N	119	74LS365N	99
74LS124N	135	74LS366N	99
74LS125N	89	74LS367N	99
74LS126N	99	74LS368N	99
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74LS136N	59	74LS374N	275
74LS138N	89	74LS375N	69
74LS139N	89	74LS377N	195
74LS140N	119	74LS383N	195
74LS148N	149	74LS386N	195
74LS151N	79	74LS390N	195
74LS153N	79	74LS393N	195
74LS154N	249	74LS395N	170
74LS156N	119	74LS399N	170
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74LS158N	75	74LS567N	229
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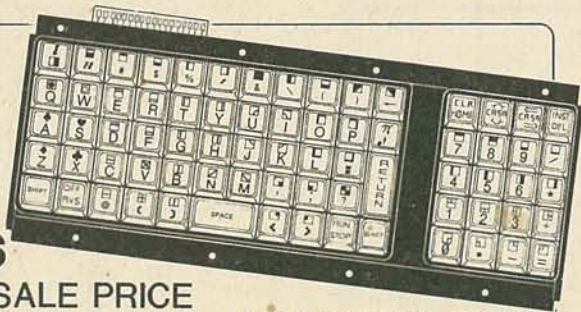
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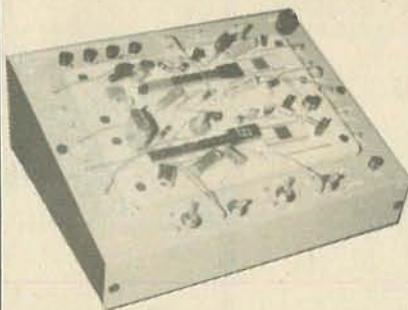
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PNP sim 2N2906 100/\$8.95
4N28-S opto-isol. 5/\$2
SN76477-S sound IC 1/\$2.50
MA1003-S 12V DC clock module 14.95

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BULLET ELECTRONICS

PO Box 401244R
Garland TX 75040

NPN HIGH VOLTAGE 1.59



HOUSE #

VCEO = 450 VDC IC = 3A (5A Peak)
FOR TV HORIZONTAL SECTIONS; HIGH VOLTAGE REGULATORS
REPLACES: 2N5076, 2N5077, 2N5838, 2N5665, BDY94, BU126, 2SC2121, 2N5840, 2SC1046, 2N5466, TIP566 AND MANY OTHERS.

LM3046	(CA3046) Transistor Array	.75
RCA 40430	400V 6A TRIAC TO-66	.75
CA3086	RCA Transistor Array	.80
LM567	Tone Decoder	.99
CD4046	PLL CMOS	.99
LM3302	Quad Comparator	.89
2SC1849	High Freq NPN TO-92	6/1.00
MPS A20	NPN GEN PUR	8/1.00

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 1/2" 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 CHIP IS INCLUDED. EXTRA CHIPS \$3.15 EACH

AY3-8910 PROGRAMMABLE SOUND GENERATOR

The AY3-8910 is a 40 pin LSI chip with three oscillators, three amplitude controls, programmable noise generator, three mixers, an envelope generator, and three D/A converters that are controlled by 8 BIT WORDS. No external pots or caps required. This chip hooked to an 8 bit microprocessor chip or Buss (8080, Z80, 6800 etc.) can be software controlled to produce almost any sound. It will play three note chords, make bangs, whistles, sirens, gunshots, explosions, bleats, whines, or grunts. In addition, it has provisions to control its own memory chips with two IO ports. The chip requires +5V @ 75ma and a standard TTL clock oscillator. A truly incredible circuit.

\$14.95 W/Basic Spec Sheet (4 pages)

60 page manual with S-100 interface instructions and several programming examples, \$3.00 extra.

1/2W RESISTOR ASSORTMENT

A good mix of 5% and 10% values in both full lead and PC lead devices. All new, first quality.

(Asst.) 200 pieces/2.00

7 WATT AUDIO AMP KIT

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. \$5.95

ULTRASONIC RELAY KIT

INVISIBLE BEAM WORKS LIKE A PHOTO ELECTRIC EYE. USE UP TO 25 FT. APART. COMPLETE KIT. ALL PARTS & PC BOARDS. \$21.50

THE PERFECT TRANSFORMER

117VAC primary, 12VAC secondary @ 200ma Great for all you CMOS, or low power TTL projects. PC board mount. 99¢ ea. 3/\$2.50
Size: 1.5" W x 1.25" D x 1.25" H

XAN SUPER DIGITS

.6" JUMBO LED RED
6920 COMMON CATHODE
6640 COMMON ANODE
99¢ 7 SEGMENT

NOW A SUPER READOUT AT A SUPER BUY! These are factory fresh prime LED readouts, not seconds or rejects as sold by others. Compare our price and send for yours today, but hurry, the supply is limited! SPECIFY: COMMON ANODE OR COMMON CATHODE

NEW! MUSIC FOR YOUR EARS

Bullet's Electronic Music Maker™ Kit has a single 28 Pin Microprocessor Chip with ROM that has been programmed to play the first 6 to 10 notes of the 25 popular tunes listed below. Each tune can easily be addressed individually or played sequentially at the push of a button. The 3 chime sequences are activated at any time by separate switch closures so when used as a doorbell, one door can play songs while two others will play different chimes. The unit has a 5 watt audio Amp and will run on either 12VAC or 12VDC. Optional 117VAC transformer is available. Construction is very simple, works with any 8 or 16 ohm speaker, or horn speaker. (Not Included.) Tunes can be remotely programmed using a single rotary switch, (not included), if desired.

Complete Kit \$16.95 Transformer \$1.35
(For operation on 117VAC)

Tunes: Toreador * William Tell * Hallelujah Chorus * Star Spangled Banner * Yankee Doodle * America, America * Deutschland Leid * Wedding March * Beethoven's 5th and 9th * Hell's Bells * La Vie En Rose * Star Wars Theme * Clementine * Augustine * Jingle Bells * God Save The Queen * Colonel Bogey * Marseillaise * O Sole Mio * Santa Lucia * The End * Blue Danube * Brahms Lullaby * Westminster Chime * Simple Chime * Descending Octave Chime.

PARTS

TL490	Bar/Graph Driver	2.50
7805	5V 1A Regulator	.99
78M05	1/2 A TO-5 Reg. 5V (Hse. #)	.60
LM3911	Temp. Transducer	1.10
555	Timer IC	.49
723	Voltage Reg. 14 Pin Dip	.50
7812	1A 12V Reg	.99
2N6028	P.U.T. W/Specs	.50
IL-1	Opto Isolator W/Specs	.60

- * NO C.O.D.'s
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TEST EQUIPMENT, TOOLS, TELEPHONE DEVICES, AUTO STEREO PRODUCTS

FREE 8 pc. Tool Set (value \$14.95) with \$200.00 purchase of merchandise from this ad

Logic Probe

- Compact circuit powered
- Detects pulses as short as 50 μ sec
- DTL/TTL/HTL/CMOS compatibility

\$44.95



Model LP-1

100 MHz 8-Digit Counter

- 20 Hz to 100 MHz range
- LED display
- Fully automatic

Model MAX100 Reg. \$150.00 **\$127.50**



Function Generator

- Model 2001
- Reg. \$185.95
- Sine, square, triangle, and separate TTL square wave output

\$157.95



Preassembled Proto Boards

- Model PB-104
- Fully assembled breadboard contains four QT-59S sockets, seven QT-59B bus strips and four 5-way binding posts

\$49.95

Proto Board with Built-in Power Supplies

- Regulated
- Short-proof

Reg. \$154.95 **\$129.95**



Model PB-203A

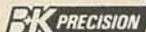
3 1/2-Digit 0.1% Digital Capacitance Meter

- 9 ranges from 1999 pF to 199.9 μ F
- 0.1% of reading accuracy
- Auto over and under range indication

Model 3001 Reg. \$190.00 **\$170**

Portable Digital Capacitance Meter

- Measures capacitance from 0.1pF to 1 Farad
- Resolves to 0.1pF
- 10 ranges for accuracy and resolution
- 4 digit easy-to-read LED display
- 0.5% accuracy



Model 820



Model 2815

3 1/2-Digit DMM with LCD Readout

- 0.1% DC accuracy
- 0.5% LCD display for high readability
- 100 μ A current range
- 100 μ V, 100nA, 0.01 Ω resolution
- Battery life of over 100 hours
- Shielded to stay accurate in RF fields
- Low battery warning



Model 1479P

Dual Trace 5" 30 MHz Triggered Scope

- Rise time 11.7 nS or less
- Built-in signal delay line
- Flat response with smooth rolloff past 30 MHz
- 5mV/cm vertical sensitivity
- Probes included

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Sinclair PDM 35
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Hickok LX 303
\$69.50



Beckman TECH 310
22 M Ω input resistance
10 Amp AC DC
1500V Overload
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2 year battery life
\$140.



Simpson 461
Complete with nickel-cadmium batteries, AC charger adapter, test leads
\$149.95

LEADER



RF Wide Band Signal Generator Model LSG-16
Solid state FET oscillator circuitry
100 KHz to 100 MHz freq. range
300 MHz on harmonics

Transistorized LCR Bridge

Model LCR-740
Highly accurate 3 digit readout
Operates on one 9V battery or with AC adapter
Measures inductance, capacitance, resistance and loss factor

25 MHz Dual Trace Time Base



with Calibrated Variable Delay

Model LBO-515A with probes
1 μ sec to 5 sec built-in delay



20 MHz Dual Trace Oscilloscope Model LBO-508A with probes
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Finds faulty components quickly and easily
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- Spring balanced arms
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- Colors: Red, Yellow, Blue, Black, Oyster White
- UL for 60W

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Precision ground and polished magnification lens
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8-Track Tape Player with AM/FM/MPX Radio
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Model CAS-999 **\$79.95**



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Stereo Power Booster

Model POW-40
40W stereo
20W per channel
Bass boost
Model POW-40 **\$24.95**

6" x 9" 3-Way Speaker

Model BP2000-69TR
20 oz. ceramic magnet
\$14.95 ea.

Miniature High Fidelity 3-Way Stereo Speakers

MINI speakers
MAXI sound
Model HF-9
\$69.50 pr. Reg. \$149.95

- Die Cast Aluminum
- Long Throw Woofer
- Soft Dome Tweeter
- Extended Midrange Speaker
- 80-20,000 Hz
- 50W, 8 ohms

BK PRECISION

30 MHz Portable Frequency Counter

Reg. \$130.00 **\$65**

HICKOK Digital CB In-Line Tester

- Measures all 4 transmitter output characteristics
- Frequency
- Power
- SWR
- Modulation %

Model 388 **\$169.95**

Portable VOM Multitester

20 K Ω VDC
10 K Ω VAC
Model VM520 **\$19.95**

SPECIALS

RCA-VIZ Super Chro-Bar

Model WR-538A
Reg. \$129.95 **\$89.95**

RC Circuit Board

36 resistors (15 Ω to 10 M Ω)
18 capacitors (100 pF to 0.22 μ F)
Reg. \$49.95 **\$42.**
includes test leads



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7 levels of play
Model BBC
Reg. \$110.00 **\$79.95**



CANON Calculator Portable Printer with Adding Machine Tape

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GTE Flip-Phone[™]
\$37.95

BSR X-10 Remote Control for Lights & Appliances



4 Pc Standard Starter Kit • One (1) Standard Command Console Reg. \$87.95
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FORDHAM

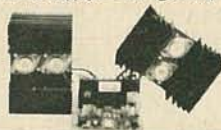
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100W CLASS A POWER AMP KIT

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: $\pm 40V @ 5amp$



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 $\pm 12dB$ 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 \$117.00 ea

SUB MINI SIZE FET CONDENSER MICROPHONE



Specification:

Sensitivity: $-65dB \pm 3dB$
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 $+5dB$. The Mark III indicator is applicable to 1 watt - 200 watts amplifier operating voltage is 3V - 9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

IN KIT FORM \$18.50

SOUND ACTIVATED DISCO LIGHT KIT

Latest design electronic color light organ, with both sound and line input, the three color lights (not included) will change colors with the rhythm of the music; controlled by 3 ranges, low, middle and high. Ideal for party, bar, or home entertainment. Max. controlled output 1000 watts per color (3 colors). Kit includes aluminum cabinet, all electronic parts, P.C. board and transformer.



(Color Organ)
\$45.50 per kit

TY-23

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 $-36dB$ to $+3dB$. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6V to 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

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 100Mz and 10KHz.



\$32.50 PER 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 lumination of the lantern.

\$10.50 EA

STEREO AMPLIFIER



60 W
+
60 W

COMPLETED UNIT - NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8 Ω . Power supply is 24 - 36V AC or DC. Complete unit. Assembled \$49.50 ea. Power transformer \$ 8.50 ea.

5W AUDIO AMP KIT



2 LM 380 with Volume Control
Power Suply 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 (FREE)

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!

A NEW LED ARRAY AND DRIVER FOR LEVEL METERS

This series covers a wide range of level indication uses, output and input voltage, time related change, temperature, light measurement and sound level. The problem of uneven brilliance often encountered with LED arrangements as well as design problems caused by using several units of varying size are substantially reduced. 12 LEDs in one bar:

LED ARRAY	
GL-112R3 Red, Red, Red	\$5.50
GL-112N3 Green, Yellow, Red	\$6.50
GL-112M2 Green, Green, Red	\$6.50
GL-112G3 Green, Green, Green	\$6.50

0.27"

2.28"

LED DRIVERS

1R 2406G is an I.C. specially designed to drive 12 LED. The number of LED is lineally illuminated according to the control voltage input terminal 21. Operating voltage is 9 12V D.C. \$5.35 EACH

DUEL CHANNEL VU METER

P.C. BOARD AVAILABLE AT \$4.50 EA.

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.



WANT TO BUILD YOUR OWN BLACK MAGIC BOX ON TOP OF THE TV FOR FIRST RUN MOVIES?

We have all the parts including hard to find UHF variator tuners and P.C. board. Call us for more information.

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

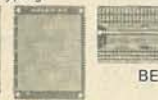
MAIN AMP (15W x 2)
Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply ± 16V DC (not included). Power band with (KF 1% ± 3dB). Voltage gain 33dB. 20Hz - 20KHz.

UNIVERSAL PROJECT BOARD

All P.C. boards are made from high quality phenolic, predrilled in different patterns for different purpose. All boards 1/16" single sided copper. Hole spacing is standard 0.1". Fits all kinds of I.C. transistors, capacitors and resistors. Ideal for school projects, engineering designs and prototyping.



SB072



BEL-008



M-34



BEL101



BEL202

BEL101	3 1/2" x 6"	\$1.75 EA.
SB072	3 1/2" x 6"	\$1.75 EA.
M-34	3" x 5"	\$1.75 EA.
CIRCUIT FIT	3" x 3 1/2"	\$1.25 EA.
BEL202	3" x 4"	\$1.25 EA.
BEL-008	2 1/4" x 5 1/2"	\$1.25 EA.

PUSH-BUTTON SWITCH



N/Open Contact
Color: Red, White, Blue, Green, Black
3/\$1.00
N/Close also Available
50¢ each
LARGE QTY. AVAILABLE

HEAVY DUTY CLIP LEADS



10 pairs — 5 colors Alligator clips on a 22" long lead. Ideal for any testing.
\$2.20/pack

BATTERIES

PK/\$10.00
2 PK/\$19.00



NICKEL CADMIUM
BATTERY
PACK
'D' SIZE

ILLUSTRATED
LESS COVER

Output: 3.6 Volts @ 3.0 Amp/Hour. Consists of three each, 1.2 Volt 'D' size Nickel Cadmium Cells stacked and plastic film encapsulated. Tabs are provided at each end for electrical connections. The individual cells can be cut apart if desired. Rated recharge rate is 30 mA, 14-18 hours. Size: 1 1/4" dia. x 7" long. New. Shpg. Wt. each pack, 1 lb.

"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

ELECTRONIC ALARM SIREN COMPLETE UNIT



AU-999 \$7.50

Ideal for use as an Alarm Unit or hookup to your car back-up to make a reverse indicator. Light Output up to 130dB. Voltage supply 6 12V

SUB MINIATURE TOGGLE SWITCH



SPST 2 FOR 2.80 SPDT 2 FOR 3.20
6 AMP 125V AC CONTACT

TRANSFORMERS ALL 117 VOLT INPUT

30V	4 AMP	\$8.50 EA.
36V CT	3 AMP	\$10.50 EA.
48V CT	3 AMP	\$10.50 EA.
24V CT	0.5 AMP	\$3.00 EA.
18V CT	0.5 AMP	\$3.00 EA.
12V CT	0.5 AMP	\$2.50 EA.
6.3V	0.5 AMP	\$2.00 EA.

AC POWER SUPPLY

Wall Type Transformer		
12V AC	Output 200 MA	\$2.75 EA.
16V CT AC	Output 100 MA	\$2.10 EA.
6V DC	Output 120 MA	\$1.90 EA.
12V DC	Output 100 MA	\$1.90 EA.

ULTRASONIC SWITCH KIT



Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver. All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operates by 9-12 DC. \$15.50

COMPLETE TIME MODULE

0.3" digits LCD Clock Module with month and date, hour, minute and seconds. As well as stop watch function! Battery and back up light is with the module. Size of the module is 1" dia. Ideal for use in auto panel, computer, instrument and many others! \$8.95 EACH

SOUND ACTIVATED SWITCH



\$1.75 ea.

All parts completed on a PC Board SCR will turn on relay, buzzer or trigger other circuit for 2 - 10 sec. (adjustable). Ideal for use as door alarm, sound controlled toys and many other projects. Supply voltage 4.5V 9V D.C. 2 for \$3.00

FM WIRELESS MIC KIT



It is not a pack of cigarettes. It is a new FM wireless mic kit! New design PC board fits into a plastic cigarette box (case included). Uses a condenser microphone to allow you to have a better response in sound pick-up. Transmits up to 350 ft! With an LED indicator to signal the unit is on #FMM2. KIT FORM \$7.95

REGULATED DUAL VOLTAGE SUPPLY KIT

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

\$12.50 PER KIT

AA SIZE NI-CD SPECIAL SALE 4 FOR \$6.00

RECHARGEABLE BATTERIES LIMITED QUANTITY AVAILABLE

POCKET SIZE AM-FM RADIO TR-945 with LED TUNING EYE



TR-945

New design body with see thru speaker grill.
SPECIAL PRICE \$16.50 EACH

POWER SUPPLY KIT

0-30V D.C. REGULATED
Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts. Transformer for Power Supply, 2 AMP 24V x 2 \$8.50



0-30 Power Supply \$10.50 each

I.C. TEST CLIPS

Same as the E-Z clips With 20" Long Leads In Black and Red Colors per pair \$2.75



SOUND GENERATOR I.C.

Creates almost any type of sound — gun shot, explosion, train, car crash, star war, birds, organ ext. A built-in audio amplifier provides high level output. Operates from one 9V battery, 28 pin dip; we supply the datas. \$2.90 EACH



ELECTRONIC SWITCH KIT

CONDENSER TYPE
Touch On Touch Off
uses 7473 I.C. and 12V relay
\$5.50 each



1 WATT AUDIO AMP

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



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

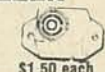
Incorporates brand-new D.C. design that gives a frequency response from 0Hz — 100KHz ± 0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuation! Specifications: • T.H.D. less than .005% • T.I.M. less than .005% • Frequency response: DC to 100KHz ± 0.5dB • RIAA deviation: ± 0.2dB - S/N ratio: better than 70dB • Sensitivity: Phono 2MV 47K/Aux. 100MV 100K • Output level: 1.3V • Max. output: 15V • Tone control: bass ± 10dB @ 50Hz/treble ± 10dB @ 15Hz • Power supply: ± 24 D.C. @ 0.5A
Kit comes with regulated power supply, all you need is a 48V C.T. transformer @ 0.5A

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X'former \$4.50 ea.



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Mini size 1" x 3/4" x 3/4"
Supply voltage 1.5V - 12V
Ideal for Alarm or Tone Indicator \$1.50 each



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Contacts: solid silver S.P.D.T.
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cylindrical body 1/4" high



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Flat Lever Bat 1922
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3 inch long 2 1/4 inch slide knobs for slide pots 20e each

50K SLIDE POT

Knobs for Slide Pots 20e each

audio taper

• 3-1/2 inch long • 2-3/4 inch slide

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14 pin style
3 amp contacts
24 V.D.C. or 120 V.A.C. coil

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4006	1.10	4029	85	4083	99	74C83	130
4007	27	4030	90	4084	96	74C85	130
4009	45	4034	2.25	4010	90	74C83	130
4015	45	4035	87	4011	96	74C85	140
4011	35	4040	1.00	4014	1.96	74C86	50
4013	35	4042	89	4015	1.96	74C83	130
4014	40	4043	1.00	4016	1.00	74C101	75
4016	1.20	4044	90	4018	1.20	74C135	175
4018	1.00	4046	1.86	4020	1.00	74C189	130
4019	45	4048	75	74C00	27	74C181	175
4021	1.06	4050	87	74C05	37	74C181	175
4028	90	4061	1.10	74C06	40	74C181	175
4031	45	4062	1.10	74C08	30	74C171	130
4030	1.10	4063	1.10	74C10	27	74C181	175
4031	1.10	4066	1.10	74C12	130	74C171	130
4032	1.00	4068	70	74C20	27	74C181	175
4033	35	4071	70	74C22	46	74C201	130
4034	75	4072	30	74C23	46	74C201	130
4038	35	4078	1.00	74C73	75	74C226	6.96

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4" x 6" DOUBLE SIDED EPOXY BOARD 1/16" thick
\$6.00 ea. 5/82.60

EPOXY glass vector board
1/16" thick with 1/10" spacing 4 1/2" x 6 1/2" \$1.95

74S00	30	74S20	40	74S153	1.10
74S02	30	74S30	40	74S151	1.25
74S05	45	74S32	40	74S157	1.25
74S08	40	74S89	1.90	74S158	1.25
74S11	35	74S112	85	74S174	1.40
74S15	40	74S140	1.00	74S257	1.50

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25 watt Infra Red Pulse (SG 2006 equiv.)
Laser Diode (Spec sheet included) \$24.95

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100, 5K, 10K, 20K, 250K, 1 Meg, .75 each... 3/2.00

2N3820 P FET	45
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2N2646 UJT	45
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2N 6028 PROG. UJT	6.86

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IL-5 OPTO ISOLATOR	80
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PRV	1A	3A	12A	50A	125A	240A
100	.06	.14	.35	.90	3.70	5.00
200	.07	.20	.40	1.30	4.25	6.00
400	.09	.25	.65	1.60	6.50	9.60
600	.11	.30	.80	2.50	8.50	12.50
800	.15	.35	1.00	2.50	10.50	16.50
1000	.20	.45	1.25	3.00	12.50	20.00

IN 4148 (IN914) \$1.00
1 or 1 of 25V ceramic disc. caps. 16/81.00, 100/850.00

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323K 5V 3A	45.75	340T-5, 6, 8, 12, 15	
79HGK 5V at 5A	46.95	18 or 24 V	11.10
723	5.50	320M5	6.75
320T-5, 12, or 15V			
LM305H	.75		

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2N1303 PNP GE TO-5	3/81.00
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7400	17	7448	75	74157	65
74101	17	7450	17	74162	80
7402	17	7472	17	74168	1.20
7403	17	7473	35	74169	85
7404	24	7474	42	74165	85
7405	24	7475	43	74166	1.05
7406	33	7476	45	74167	1.25
7407	35	7480	45	74170	1.00
7408	27	7483	60	74173	1.30
7409	24	7485	75	74174	85
7410	17	7486	42	74175	75
7411	22	7489	160	74176	75
7412	22	7490	50	74177	75
7413	42	7491	55	74180	75
7414	90	7492	50	74181	1.50
7415	33	7493	50	74190	1.20
7417	37	7494	60	74191	1.20
7420	17	7495	80	74192	79
7425	35	7496	60	74193	79
7426	35	7497	60	74194	85
7427	35	74121	39	74195	65
7428	17	74122	39	74196	65
7430	27	74123	42	74197	87
7431	27	74124	45	74279	26
7432	27	74125	45	74285	2.25
7433	27	74126	45	74355	80
7440	17	74145	75	74362	80
7441	85	74150	110	74368	65
7442	50	74151	85	74369	65
7443	50	74153	85	74371	1.05
7444	75	74154	110	74382	65
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14 pin headers

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PRV	2A	6A	25A
100	1.40	1.40	1.40
200	.80	1.20	2.20
400	1.00	1.65	3.30
600	1.30	1.90	4.40

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8 PIN	.17	22 PIN	.30
14 PIN	.20	24 PIN	.35
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18 PIN	.25	40 PIN	.60

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SI 1020 G 20 WATTS \$13.75
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74LS02	28	74LS155	1.19
74LS03	28	74LS156	1.19
74LS04	28	74LS157	1.19
74LS05	28	74LS158	1.19
74LS06	28	74LS159	1.19
74LS07	28	74LS160	1.19
74LS08	28	74LS161	1.19
74LS09	28	74LS162	1.19
74LS10	28	74LS163	1.19
74LS11	28	74LS164	1.19
74LS12	28	74LS165	1.19
74LS13	28	74LS166	1.19
74LS14	28	74LS167	1.19
74LS15	28	74LS168	1.19
74LS16	28	74LS169	1.19
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7402N	7402N	7402N	7402N
7403N	7403N	7403N	7403N
7404N	7404N	7404N	7404N
7405N	7405N	7405N	7405N
7406N	7406N	7406N	7406N
7407N	7407N	7407N	7407N
7408N	7408N	7408N	7408N
7409N	7409N	7409N	7409N
7410N	7410N	7410N	7410N
7411N	7411N	7411N	7411N
7412N	7412N	7412N	7412N
7413N	7413N	7413N	7413N
7414N	7414N	7414N	7414N
7415N	7415N	7415N	7415N
7416N	7416N	7416N	7416N
7417N	7417N	7417N	7417N
7418N	7418N	7418N	7418N
7419N	7419N	7419N	7419N
7420N	7420N	7420N	7420N
7421N	7421N	7421N	7421N
7422N	7422N	7422N	7422N
7423N	7423N	7423N	7423N
7424N	7424N	7424N	7424N
7425N	7425N	7425N	7425N
7426N	7426N	7426N	7426N
7427N	7427N	7427N	7427N
7428N	7428N	7428N	7428N
7429N	7429N	7429N	7429N
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7438N	7438N	7438N	7438N
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7460N	7460N	7460N	7460N
7461N	7461N	7461N	7461N
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7467N	7467N	7467N	7467N
7468N	7468N	7468N	7468N
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7472N	7472N	7472N	7472N
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7475N	7475N	7475N	7475N
7476N	7476N	7476N	7476N
7477N	7477N	7477N	7477N
7478N	7478N	7478N	7478N
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7480N	7480N	7480N	7480N
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7482N	7482N	7482N	7482N
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7494N	7494N	7494N	7494N
7495N	7495N	7495N	7495N
7496N	7496N	7496N	7496N
7497N	7497N	7497N	7497N
7498N	7498N	7498N	7498N
7499N	7499N	7499N	7499N
7500N	7500N	7500N	7500N

TEXAS INSTRUMENTS GOLD EDGEBOARD CONNECTORS

RELIABLE, COST-EFFICIENT CONTACT DESIGN
 • 50 (Wire Wrap) to 500 (Tail) metal inches gold alloy over a nickel diffusion barrier.
 • Copper-nickel to CA 725 alloy.
 • Rugged contact points.
 • Preflashed, cantilever spring design.
 • Contacts are user removable.
 • Wire - Dimensions below are for center to center measurement unless noted.
 • Wire - Dimensions below are for center to center measurement unless noted.

H4 SERIES 100 x .200" EDGEBOARD CONNECTORS

Part No.	Description	Min. 100 Microinch Tin	Min. 100 Microinch Tin
MA1000	100 pin, 100 x .200" edgeboard connector	100	100
MA1001	100 pin, 100 x .200" edgeboard connector	100	100
MA1002	100 pin, 100 x .200" edgeboard connector	100	100
MA1003	100 pin, 100 x .200" edgeboard connector	100	100
MA1004	100 pin, 100 x .200" edgeboard connector	100	100
MA1005	100 pin, 100 x .200" edgeboard connector	100	100
MA1006	100 pin, 100 x .200" edgeboard connector	100	100
MA1007	100 pin, 100 x .200" edgeboard connector	100	100
MA1008	100 pin, 100 x .200" edgeboard connector	100	100
MA1009	100 pin, 100 x .200" edgeboard connector	100	100
MA1010	100 pin, 100 x .200" edgeboard connector	100	100
MA1011	100 pin, 100 x .200" edgeboard connector	100	100
MA1012	100 pin, 100 x .200" edgeboard connector	100	100
MA1013	100 pin, 100 x .200" edgeboard connector	100	100
MA1014	100 pin, 100 x .200" edgeboard connector	100	100
MA1015	100 pin, 100 x .200" edgeboard connector	100	100
MA1016	100 pin, 100 x .200" edgeboard connector	100	100
MA1017	100 pin, 100 x .200" edgeboard connector	100	100
MA1018	100 pin, 100 x .200" edgeboard connector	100	100
MA1019	100 pin, 100 x .200" edgeboard connector	100	100
MA1020	100 pin, 100 x .200" edgeboard connector	100	100

H4 SERIES 125 x .250" EDGEBOARD CONNECTORS

Part No.	Description	Min. 125 Microinch Tin	Min. 125 Microinch Tin
MA1200	125 pin, 125 x .250" edgeboard connector	125	125
MA1201	125 pin, 125 x .250" edgeboard connector	125	125
MA1202	125 pin, 125 x .250" edgeboard connector	125	125
MA1203	125 pin, 125 x .250" edgeboard connector	125	125
MA1204	125 pin, 125 x .250" edgeboard connector	125	125
MA1205	125 pin, 125 x .250" edgeboard connector	125	125
MA1206	125 pin, 125 x .250" edgeboard connector	125	125
MA1207	125 pin, 125 x .250" edgeboard connector	125	125
MA1208	125 pin, 125 x .250" edgeboard connector	125	125
MA1209	125 pin, 125 x .250" edgeboard connector	125	125
MA1210	125 pin, 125 x .250" edgeboard connector	125	125
MA1211	125 pin, 125 x .250" edgeboard connector	125	125
MA1212	125 pin, 125 x .250" edgeboard connector	125	125
MA1213	125 pin, 125 x .250" edgeboard connector	125	125
MA1214	125 pin, 125 x .250" edgeboard connector	125	125
MA1215	125 pin, 125 x .250" edgeboard connector	125	125
MA1216	125 pin, 125 x .250" edgeboard connector	125	125
MA1217	125 pin, 125 x .250" edgeboard connector	125	125
MA1218	125 pin, 125 x .250" edgeboard connector	125	125
MA1219	125 pin, 125 x .250" edgeboard connector	125	125
MA1220	125 pin, 125 x .250" edgeboard connector	125	125

H4 SERIES 150 x .200" EDGEBOARD CONNECTORS

Part No.	Description	Min. 150 Microinch Tin	Min. 150 Microinch Tin
MA1500	150 pin, 150 x .200" edgeboard connector	150	150
MA1501	150 pin, 150 x .200" edgeboard connector	150	150
MA1502	150 pin, 150 x .200" edgeboard connector	150	150
MA1503	150 pin, 150 x .200" edgeboard connector	150	150
MA1504	150 pin, 150 x .200" edgeboard connector	150	150
MA1505	150 pin, 150 x .200" edgeboard connector	150	150
MA1506	150 pin, 150 x .200" edgeboard connector	150	150
MA1507	150 pin, 150 x .200" edgeboard connector	150	150
MA1508	150 pin, 150 x .200" edgeboard connector	150	150
MA1509	150 pin, 150 x .200" edgeboard connector	150	150
MA1510	150 pin, 150 x .200" edgeboard connector	150	150
MA1511	150 pin, 150 x .200" edgeboard connector	150	150
MA1512	150 pin, 150 x .200" edgeboard connector	150	150
MA1513	150 pin, 150 x .200" edgeboard connector	150	150
MA1514	150 pin, 150 x .200" edgeboard connector	150	150
MA1515	150 pin, 150 x .200" edgeboard connector	150	150
MA1516	150 pin, 150 x .200" edgeboard connector	150	150
MA1517	150 pin, 150 x .200" edgeboard connector	150	150
MA1518	150 pin, 150 x .200" edgeboard connector	150	150
MA1519	150 pin, 150 x .200" edgeboard connector	150	150
MA1520	150 pin, 150 x .200" edgeboard connector	150	150

TEXAS INSTRUMENTS I.C. SOCKETS

Part No.	Description	Min. 100 Microinch Tin	Min. 100 Microinch Tin
MA1000	100 pin, 100 x .200" edgeboard connector	100	100
MA1001	100 pin, 100 x .200" edgeboard connector	100	100
MA1002	100 pin, 100 x .200" edgeboard connector	100	100
MA1003	100 pin, 100 x .200" edgeboard connector	100	100
MA1004	100 pin, 100 x .200" edgeboard connector	100	100
MA1005	100 pin, 100 x .200" edgeboard connector	100	100
MA1006	100 pin, 100 x .200" edgeboard connector	100	100
MA1007	100 pin, 100 x .200" edgeboard connector	100	100
MA1008	100 pin, 100 x .200" edgeboard connector	100	100
MA1009	100 pin, 100 x .200" edgeboard connector	100	100
MA1010	100 pin, 100 x .200" edgeboard connector	100	100
MA1011	100 pin, 100 x .200" edgeboard connector	100	100
MA1012	100 pin, 100 x .200" edgeboard connector	100	100
MA1013	100 pin, 100 x .200" edgeboard connector	100	100
MA1014	100 pin, 100 x .200" edgeboard connector	100	100
MA1015	100 pin, 100 x .200" edgeboard connector	100	100
MA1016	100 pin, 100 x .200" edgeboard connector	100	100
MA1017	100 pin, 100 x .200" edgeboard connector	100	100
MA1018	100 pin, 100 x .200" edgeboard connector	100	100
MA1019	100 pin, 100 x .200" edgeboard connector	100	100
MA1020	100 pin, 100 x .200" edgeboard connector	100	100

K-Series

NEW! K-Series
 New Panasonic K series are miniature, low cost aluminum electrolytic capacitors. Their size and performance characteristics make them viable alternatives to tantalums in many applications.
 CAPACITANCE TOLERANCE: ±20%
 D.C. LEAKAGE CURRENT, MAX. I = 0.01 C V OR 3A
 ALL K-SERIES CAPACITORS WE CARRY ARE RADIAL

Part No.	Capacitance (pF)	Voltage (V)	Temp. (°C)	Price (100)
MA1000	100	10	100	1.00
MA1001	100	10	100	1.00
MA1002	100	10	100	1.00
MA1003	100	10	100	1.00
MA1004	100	10	100	1.00
MA1005	100	10	100	1.00
MA1006	100	10	100	1.00
MA1007	100	10	100	1.00
MA1008	100	10	100	1.00
MA1009	100	10	100	1.00
MA1010	100	10	100	1.00
MA1011	100	10	100	1.00
MA1012	100	10	100	1.00
MA1013	100	10	100	1.00
MA1014	100	10	100	1.00
MA1015	100	10	100	1.00
MA1016	100	10	100	1.00
MA1017	100	10	100	1.00
MA1018	100	10	100	1.00
MA1019	100	10	100	1.00
MA1020	100	10	100	1.00

PANASONIC METALLIZED POLYESTER CAPACITORS

NEW! KIT
 170 Metallized poly-ester capacitors. Includes convenient plastic box with space for easy storage and use.
 CAPACITANCE TOLERANCE: ±20%
 D.C. LEAKAGE CURRENT, MAX. I = 0.01 C V OR 3A
 ALL K-SERIES CAPACITORS WE CARRY ARE RADIAL

Part No.	Capacitance (pF)	Voltage (V)	Temp. (°C)	Price (100)
MA1000	100	10	100	1.00
MA1001	100	10	100	1.00
MA1002	100	10	100	1.00
MA1003	100	10	100	1.00
MA1004	100	10	100	1.00
MA1005	100	10	100	1.00
MA1006	100	10	100	1.00
MA1007	100	10	100	1.00
MA1008	100	10	100	1.00
MA1009	100	10	100	1.

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A LIFETIME GUARANTEE AND 11 OTHER REASONS TO BUY AN "OPTOELECTRONICS" FREQUENCY COUNTER

1. SENSITIVITY: Superb amplifier circuitry with performance that can't be matched at twice the price. Average sensitivity of better than 15 mV from 10 Hz to 500 MHz on every model and better than 30 mV from 500 MHz to 1.1 GHz on the Series 8010A and 8013.

2. RESOLUTION: 0.1 Hz to 12 MHz, 1 Hz to 50 MHz, 10 Hz over 50 MHz.

3. ALL METAL CASES: Not only are the heavy gauge aluminum cases rugged and attractive, they provide the RF shielding and minimize RFI so necessary in many user environments.

4. EXTERNAL CLOCK INPUT/OUTPUT: Standard on the 8010/8013 series and optional on the 7010 series is a buffered 10 MHz clock time base input/output port on the rear panel. Numerous uses include phase comparison of counter time base with WWVB (U.S. National Bureau of Standards). Standardize calibration of all counters at a facility with a common 10 MHz external clock signal, calibrate scopes and other test equipment with the output from precision time base in counter, etc., etc.

5. ACCURACY: A choice of precision to ultra precision time base oscillators. Our ± 1 PPM TCXO (temperature compensated xtal oscillator) and ± 0.1 PPM TCXO are sealed units tested over 20-40°C. They contain voltage regulation circuitry for immunity to power variations in main instrument power supply, a 10 turn (50 PPM) calibration adjustment for easy, accurate setability and a heavily buffered output prevents circuit loads from affecting oscillator. Available in the 8010 and 8013 series is our new ultra precision micro power proportional oven oscillator. With $\pm .05$ PPM typical stability over 10-45°C, this new time base incorporates all of the advantages of our TCXO's and virtually none of the disadvantages of the traditional ovenized oscillator: Requires less than 4 minutes warm-up time, small physical size and has a peak current drain of less than 100 ma.

6. RAPID DISPLAY UPDATE: Internal housekeeping functions require only .2 seconds between any gate or sample time

period. At a 1 second gate time the counter will display a new count every 1.2 seconds, on a 10 second gate time a new count is displayed every 10.2 seconds. (10.2 seconds is the maximum time required between display updates for any resolution on any model listed).

7. PORTABILITY: All models are delivered with a 115 VAC adapter, a 12 VDC cord with plug and may be equipped with an optional ni-cad rechargeable battery pack installed within its case. The optional Ni-Cad pack may be recharged with 12 VDC or the AC adapter provided.

8. COMPACT SIZES: State-of-the-Art circuitry and external AC adapters allowed design of compact easy to use and transport instruments.

Series 8010/8013: 3" H x 7-1/2" W x 6-1/2" D

Series 7010: 1-3/4" H x 4-1/4" W x 5-1/4" D

9. MADE IN U.S.A.: All models are designed and manufactured at our modern 13,000 square foot facility at Ft. Lauderdale, Florida.

10. CERTIFIED CALIBRATION: All models meet FCC specs for frequency measurement and provided with each model is a certificate of NBS traceable calibration.

11. LIFE TIME GUARANTEE: Using the latest State-of-the-Art LSI circuitry, parts count is kept to a minimum and internal case temperature is only a few degrees above ambient resulting in long component life and reliable operation. (No custom IC's are used.) To demonstrate our confidence in these designs, all parts (excluding batteries) and service labor are 100% guaranteed for life to the original purchaser. (Transportation expense not covered).

12. PRICE: Whether you choose a series 7010 600 MHz counter or a series 8013 1.3 GHz instrument it will compete at twice its price for comparable quality and performance.

MODEL 8010A/8013 1.1 GHz/1.3 GHz

MODEL 7010A 600 MHz



MODEL	RANGE (From 10 Hz)	10 MHz TIME BASE			AVG. SENSITIVITY		GATE TIMES	RESOLUTION			EXT. CLOCK INPUT/OUTPUT	SENSITIVITY CONTROL	NI-CAD BATTERY PACK
		STABILITY	AGING	DESIGN	10 Hz to 500 MHz	500 MHz to 1.1 GHz		12 MHz	60 MHz	Max. Freq.			
7010A	600 MHz	± 1 PPM	<1 PPM/YR	TCXO*	15 mV	N/A	(3) .1, 1, 10 sec.	1 Hz	1 Hz	10 Hz (600 MHz)	YES OPTIONAL	NO	YES OPTIONAL
7010.1A		± 0.1 PPM											
8010A	1.1 GHz	± 1 PPM	<1 PPM/YR	TCXO*	15 mV	30 mV	(4) 01, 1, 1, 10 sec.	.1 Hz	1 Hz	10 Hz (1.1 GHz)	YES STANDARD	YES	YES OPTIONAL
8010.1A		± 0.1 PPM											
8010.05A		$\pm .05$ PPM											
8013.1	1.3 GHz	± 0.1 PPM	<1 PPM/YR	TCXO*	15 mV	30 mV	(4) 01, 1, 1, 10 sec.	.1 Hz	1 Hz	10 Hz (1.3 GHz)	YES STANDARD	YES	YES OPTIONAL
8013.05		$\pm .05$ PPM											

TCXO = Temperature Compensated Xtal Oscillator

**OCXO = Proportional Oven Controlled Xtal Oscillator

SERIES 7010A

7010A	600 MHz Counter - 1 PPM TCXO	\$199.95
7010.1A	600 MHz Counter - 0.1 PPM TCXO	\$249.95

OPTIONS:

70-H	Handle/Tilt Bail (not shown)	\$2.95
Ni-Cad-701	Ni-Cad Battery Pack & Charging Circuitry Installed Inside Unit	\$19.95
EC-70	External Clock Input/Output	\$35.00
CC-70	Carry Case - Padded Black Vinyl	\$9.95

SERIES 8010A/8013

#8010A	1.1 GHz Counter - 1 PPM TCXO	\$399.00
#8010.1A	1.1 GHz Counter - 0.1 PPM TCXO	\$450.00
#8010.05A	1.3 GHz Counter - .05 PPM Oven	\$499.00
#8013.1	1.3 GHz Counter - 0.1 PPM TCXO	\$550.00
#8013.05	1.3 GHz Counter - .05 PPM Oven	\$599.00

OPTIONS

#Ni-Cad-801	Ni-Cad Battery Pack & Charging Circuitry Installed Inside Unit	\$49.95
#CC-80	Carry Case - Padded Black Vinyl	\$ 9.95

ACCESSORIES

#TA-100	Telescope antenna with right angle BNC	\$ 9.95
#P-100	Probe, 50 Ohm, 1X	\$13.95
#P-101	Probe, Lo-Pass Audio Usage	\$16.95
#P-102	Probe, Hi-Z General Purpose	\$16.95
#LFM-1110	Low Frequency Multiplier X 10, X 100, X 1000 For High Resolution of Audio Freq.	\$119.95

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2. It's made better...

3. It's proven best!

...Here's what the leading CB publications said.

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MORE FLEXIBILITY:

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.



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, Zellenolpe, 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."

—Jerome R. Brown, 7800 S. Linder, Burbank, IL



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GUARANTEE I: The K-40 will transmit farther and receive more clearly than the antenna it replaces or the customer will receive a prompt and full refund from the Registered K-40 Dealer who installed and tuned it.

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