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Radio-Electronics

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Electronics publishers since 1908

MAY 1981 Vol. 52 No. 5

SPECIAL FEATURES

45 **LEARNING ABOUT MICROPROCESSORS**
To learn how microprocessors work and how to program them, hands-on experience is the proven method. Single board assembly-language computers provide the means. **Jorma Hyypia**

49 **INSIDE RCA's VIDEODISC PLAYER**
Here's a look at how RCA's videodisc player works and how the signals are processed. **Chester H. Lawrence.**

BUILD THIS

53 **UNICORN-1 ROBOT—ADDING COMPUTER CONTROL**
A look at the hardware and programming requirements needed to add computer control. **Chester H. Lawrence.**

59 **LED VU METER FOR YOUR HI-FI**
Here's an all-electronic digital VU meter that you can add to your hi-fi system. **Bradley Albing**

64 **COMPUTER-TO-SELECTRIC INTERFACE**
Part 2 - An inexpensive way to use an IBM *Selectric* typewriter as a hard copy printer for your computer. **E. G. Brooner**

TECHNOLOGY

4 **LOOKING AHEAD**
Tomorrow's news today. **David Lachenbruch**

16 **SATELLITE TV NEWS**
The latest happenings in an exciting new industry. **Gary H. Arlen**

76 **HOBBY CORNER**
Negative ion generators—what they're all about. **Earl "Doc" Savage, K4SDS**

84 **NEW IDEAS**
A prize-winning application from a reader.

VIDEO

56 **HOME VIDEO UPDATE**
A look at the video innovations from Japan, most of which will be available here soon. **Leonard Feldman**

86 **SERVICE CLINIC**
If all else fails, look for a leaky transistor. **Jack Darr**

88 **SERVICE QUESTIONS**
R-E's Service Editor solves technicians' problems.

RADIO

67 **PIRATE BROADCAST STATIONS**
They're unlicensed and illegal, but they can provide an interesting alternative to the standard broadcast fare. **Robert B. Grove**

AUDIO

70 **NEW DOLBY NOISE-REDUCTION SYSTEM**
Dolby's new system provides 20dB of noise reduction. Here's how it works. **Leonard Feldman**

EQUIPMENT REPORTS

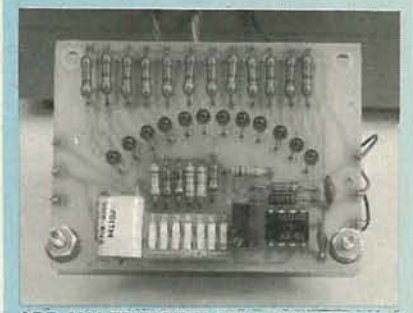
32 **Global Specialties 2001 Function Generator**
34 **Sencore Model DVM-56 Microranger DMM**
36 **Alliance Model HD-73 Antenna Rotator**
42 **Radio Shack Metal Detector**

DEPARTMENTS

14 **Advertising Sales Offices**
112 **Advertising Index**
92 **Computer Market Center**
14 **Editorial**
113 **Free Information Card**
22 **Letters**
91 **Market Center**
78 **New Products**
83 **Stereo Products**
6 **What's News**

ON THE COVER

To understand how computers and microprocessor-based equipment works, it is necessary to understand how microprocessors work and how they're programmed. This month, we evaluate several single-board computers and the supplied documentation to determine how effective each one is as a learning tool. The story starts on page 45.



ADD AN LED DIGITAL VU meter to your hi-fi system for precise recording. Construction details start on page 59.

SPEED VIEWING allows you to listen to the sound while the VCR is scanning the tape. For this and other video innovations being introduced in Japan, turn to page 56.

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looking ahead

CANON ENTERING VIDEO

This leader in 35mm still photography will field its own line of video equipment and is expected to be just one of many film-photography companies to put its name on electronic photography gear for the consumer. Canon announced it would offer a portable videocassette recorder and a color video camera on the Japanese market this June. The camera will be a compact Canon-made unit using a ⅔-inch pickup tube and 3:1 zoom lens. The VCR will be built for Canon by Funai Electric. At presstime, it wasn't known whether the Canon name would appear on such equipment in the United States. Currently another name in photography—Technicolor—has exclusive rights to the Funai-built mini-VCR (which uses a tiny cassette of quarter-inch tape) in this country.

VCR-CAMERA COMBINATIONS

Canon says its ultimate goal is a hand-held combination solid-state camera and mini-VCR, which seems to be the goal of just about every other manufacturer in the field of electronic photography. The third Japanese manufacturer to demonstrate the prototype of such a combination is Matsushita, which showed a 4.6-pound unit using a cassette about the size of a standard audio cassette, capable of two hours of recording. Matsushita's Micro Video System (MVS) is not compatible with the two previous developmental entries—Sony's Video Movie and Hitachi's Mag Camera.

In Japan, there were indications that serious talks looking toward all-in-one camera-recorder standardization were about to begin. They would include the three companies which have already demonstrated their proposed entries, along with other manufacturers interested in the field. That presumably would affect Fuji Photo Film, which says it is ready to mass-produce mini-cassettes for portable combinations. Fuji proposed a cassette similar in proportions to the audio cassette, and said it had developed two types of tape for it—metal "MV," capable of two hours' playing time, and evaporated-metal "VV," which could record and play up to four hours. Both tapes are believed to be 9-microns thick. Fuji said that although metal tape costs about three times as much as oxide tape manufactured for audio applications, the differential wouldn't be that great in video.

CHEAP VCR's

Almost simultaneously with RCA's introduction of the under-$500 videodisc player, lower-priced VCR's have started to appear in force. Sanyo continues to have the cheapest unit—a single-speed Beta which lists at $699 but often sells for $100 less. But now Panasonic, Quasar, Magnavox, and others in the VHS camp—including RCA—have introduced low-end "no-frills" recorders which are being sold at around $649 or less, although their list prices frequently are considerably higher. Sears, Ward, and J.C. Penney all have dropped catalog prices of VCR's (to $685, $790 and $688, respectively), and the same units are frequently advertised at considerably lower prices in sales catalogs and retail stores. Lower-priced VCR's probably are coming, and a stripped-down version at a suggested list of about $500 wouldn't be surprising before year's end.

VIDEODISC LINEUP

Manufacturers of 87% of the color TV sets sold in the United States are now committed to the videodisc-player market, along with a few companies not currently in the color-TV business. Companies representing 59% of the color-TV market have embraced the RCA-developed CED system, 15% the JVC-Matsushita VHD system, 13.2% the Philips-MCA LV optical system, with 12.8% uncommitted or unknown.

Here's the latest lineup of companies committed to videodisc players and the formats that they have chosen: CED—RCA, Zenith, Sears, Montgomery Ward, Sanyo, Hitachi, J.C. Penney, Sharp, Toshiba, and Radio Shack. VHD—GE, Quasar, Panasonic, JVC, and Sansui (the last is tentative and indicates it may switch to CED). LV—Magnavox, Sylvania, Philco, Gold Star, Advent, Pioneer, Fisher, and Samsung.

1,125-LINE TV

Having filed with the FCC for consideration of standards for high-definition television, CBS is exploring all proposed systems in its search for "movie-quality" TV as a new deluxe service for broadcast stations, direct satellite-transmissions and cable TV. It demonstrated a 1,125-line system developed by Japan's NHK to an SMPTE conference in San Francisco, and was planning demonstrations of other systems at presstime. The NHK system was shown using special Matsushita 32-inch picture tubes which had an 8:5 aspect ratio. The system required a 30-MHz bandwidth for a single channel. Another system, developed by CBS, uses computer techniques to conserve bandwidth.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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what's news

Negative-feedback inventor inducted into hall of Fame

In a ceremony at Arlington, VA February 18, retired Bell Labs engineer Harold S. Black was inducted into the National Inventors Hall of Fame in the U.S. Patent Office.

HAROLD S. BLACK

Though Black developed the idea of negative feedback in 1927, it did not reach consumer-audio equipment until years later. But it was used in long-distance telephone transmission as early as 1928. Seventy amplifiers using negative feedback were used for a field test of the system in 1931, in Morristown, NJ. In 1936, Philadelphia and New York were linked with a commercial long-distance system using negative-feedback amplifiers.

Besides its standard audio use, negative feedback is now applied in medical technology, computers, chemical control systems, spacecraft-guidance systems, and numerous other fields. "I have seen hundreds of thousands of uses," Black said recently.

Dr. Black holds 11 fellowships and 19 memberships in professional societies. He has received 62 U.S. patents and 271 foreign ones, and has written 42 technical papers. His awards include the John Potts Memorial Award of the Audio Engineering Society.

Radio service dealers to convene in Florida

The National Electronics Convention and Trade Show is being held in Tarpon Springs, FL (near Tampa/St. Petersburg) August third to sixth, 1981. The convention is co-sponsored by the National Electronic Service Dealers Association (NESDA), the International Society of Certified Electronics Technicians (ISCET) and the Florida Electronic Service Association (FESA).

Early registration will be profitable to the delegates. Registrations prior to April 30 will cost $90 per person, plus $80 for each additional family member. Between April 30 and June 30, the rate is $100 per person and $80 for each additional family member. After June 30, rates are $110 for one and $90 for additional family members. Persons 16 years old and under may attend the convention for $50 each.

For the registration fee the convention-goer may participate in a technical school, the "Magic of Electronics" trade show, the instructors' conference, a seminar on cable television, and golf and tennis tournaments, along with meals and cocktail parties. There will also be time for sight-seeing around the noted local attractions, such as Busch Gardens and DisneyWorld.

For those who wish to attend only the Monday and Tuesday instructors' schools, there is a special rate of $50. Fee for the management school is $20 for one, $30 for two from the same company, and $50 for each non-member.

The theme of the convention is "The Magic of Electronics." This year a seminar on cable television will also be featured.

For additional information and convention registration please write to NESDA, 2708 West Berry, Ft. Worth, Texas 76109.

Can the consumer bring back quality production in USA?

The American consumer, by exercising vigorously his right to complain about poor quality, can bring about an improvement in product quality, Dr. Norihiko Nakayama, president of Fujitsu America, told a seminar of management executives in New York recently.

"In my opinion," Dr. Nakayama declared, "Americans should refuse to settle for inferior goods." If a tool breaks, he said, take it back to the store. If the store won't give satisfaction, go to the manufacturer. And there are other avenues for protest. A groundswell of protest would cause management to take the steps necessary to heighten quality.

Those statements were made during a seminar: "Using Japanese Quality Control and Productivity Techniques in U.S. Industry," sponsored by the American Management Association and the Technology Transfer Institute.

Dr. Nakayama hinted that the Japanese consumers' attitude may be an important reason for the quality which is one of the factors in the success of Japanese imports. In his home country, customer complaints are taken seriously, he says: "To the Japanese, keeping the customer is important, and so is the company's reputation."

Radar helps steel industry

NEW IMPROVED RCA RADAR helps steel technicians control the loading of materials into blast furnaces. The newer furnaces have rotating tops that make it possible to control the distribution of the iron ore, coke, and limestone used in making steel. That new scanning radar not only measures the height of the load accurately, but also gives information on its profile, thus detecting unevenness in the loading.

Henry C. Johnson of RCA Labs is shown adjusting the new radar, which is an improvement on an older one that gave height, but not profile, information. The coiled coaxial cable above his head is a delay line designed to act as a calibration unit in improving the accuracy of the system.

Random House to distribute classroom computer items

The Radio Shack division of Tandy Corp has named Random House an authorized distributor for Radio Shack *TRS-80* computer products for classroom use. Random House is a large publisher of classroom materials for schools.

The agreement is called by Charles A Phillips of Radio Shack, ". . . an important step in Radio Shack's strategy to better address the growing market for microcomputers and instructional software in the schools."

Besides offering Radio Shack's computer products through its educational sales force, Random House is undertaking an extensive development effort to produce software for teaching and administrative applications in schools.

The Radio Shack/Random House arrangement is not exclusive, Mr. Phillips said; at least one other agreement with an educational publisher is being negotiated.

continued on page 12

Facts from Fluke on low-cost DMM's

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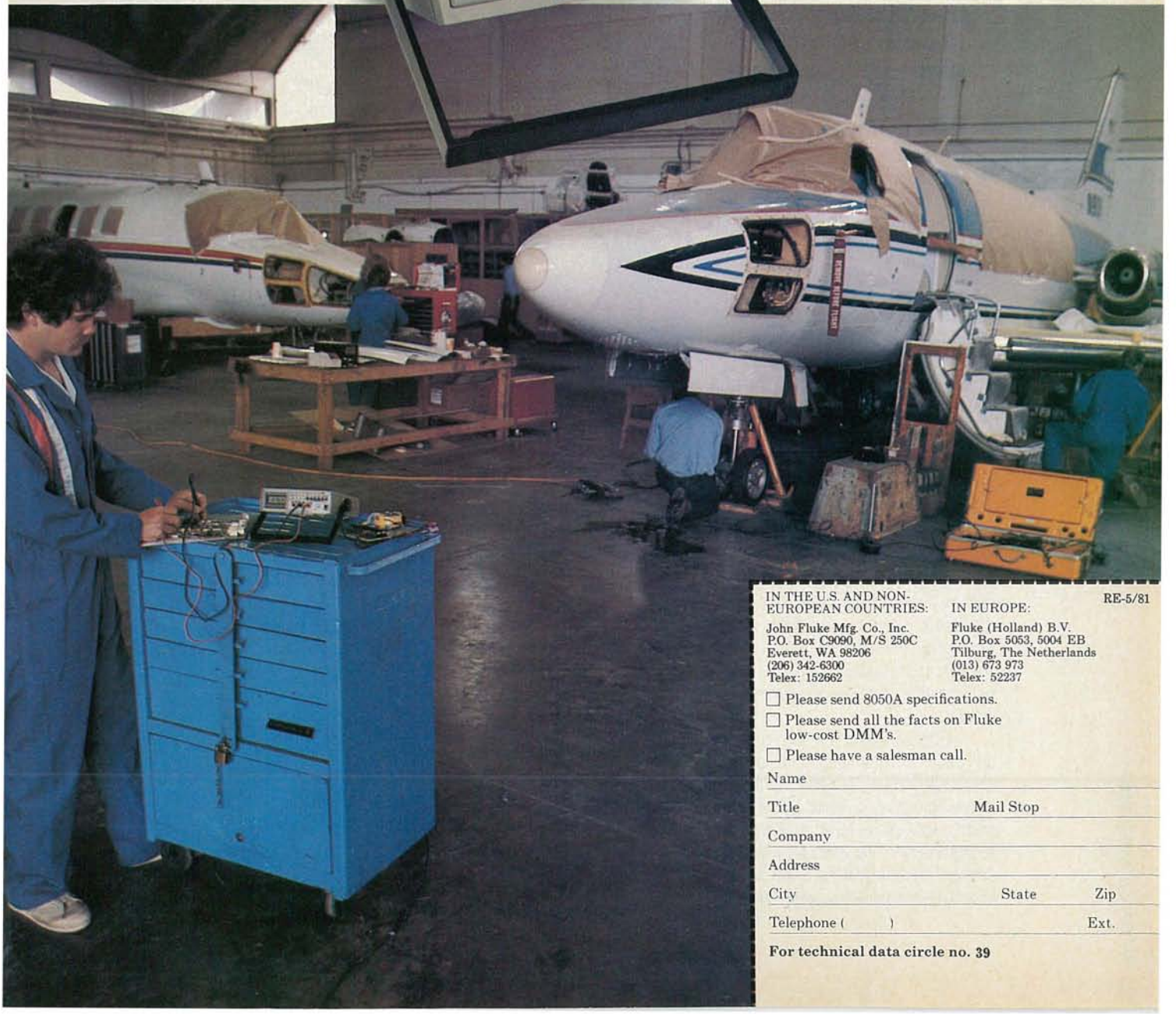

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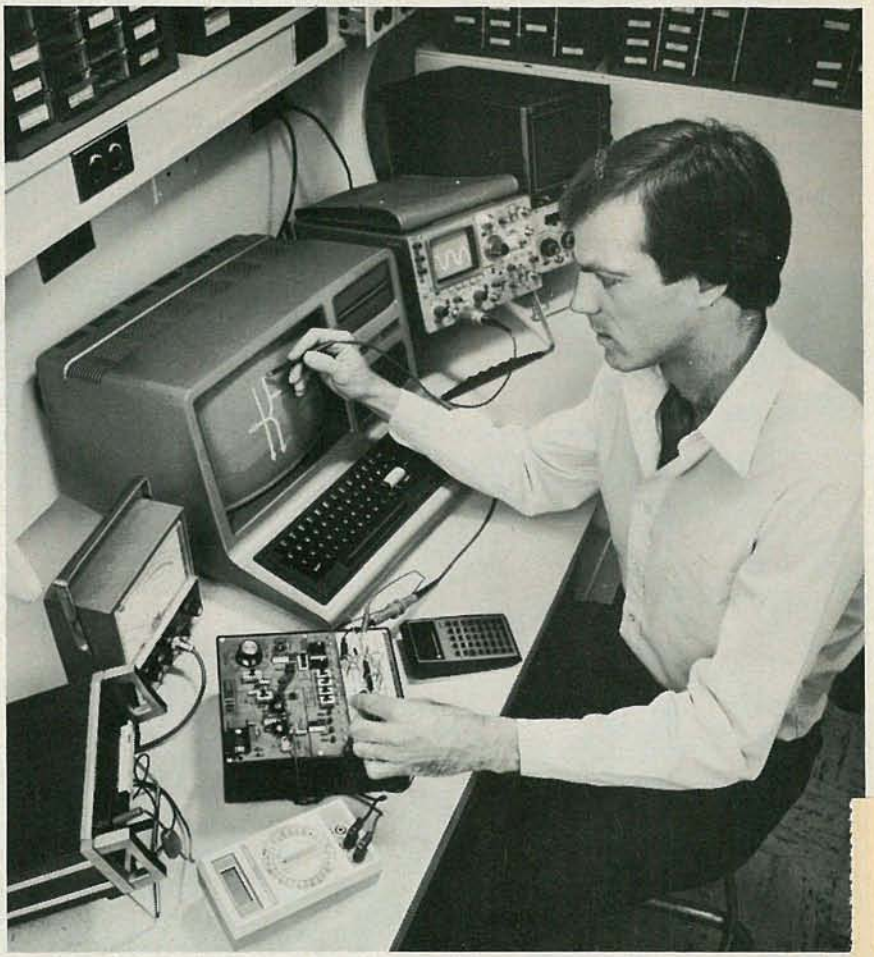

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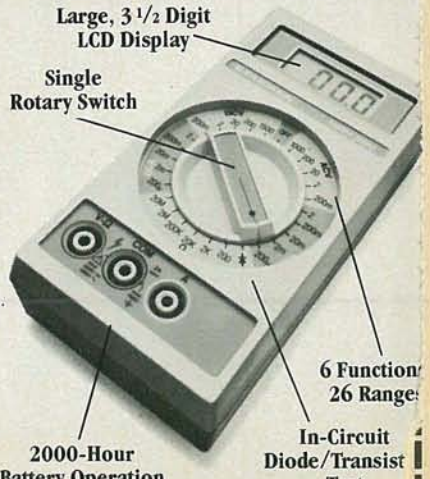

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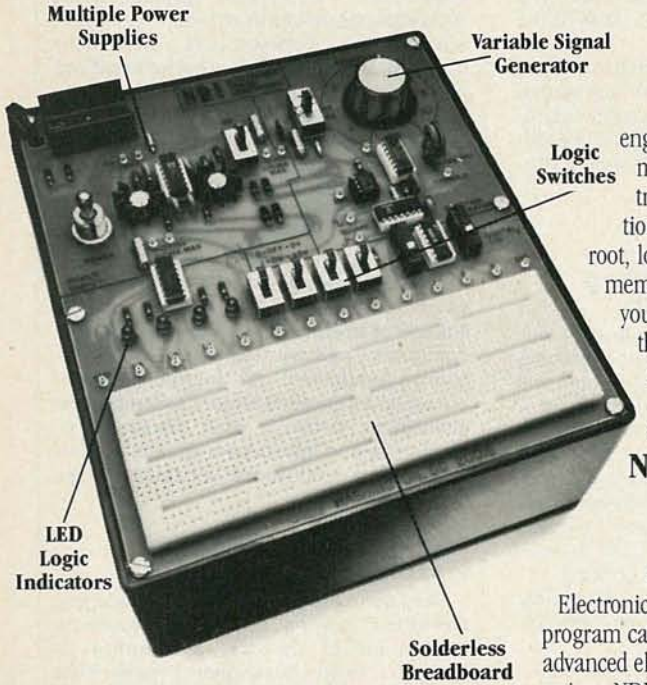

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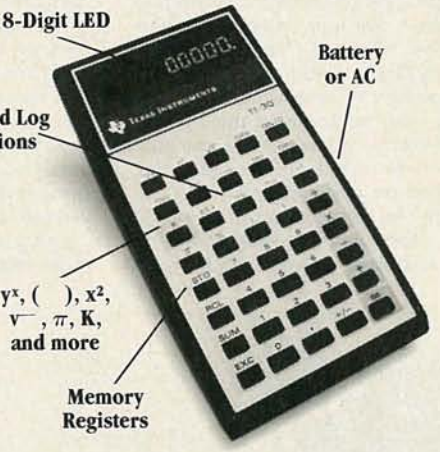

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what's news

continued from page 6

Standard & Poor's software for Radio Shack *TRS-80*

Standard & Poor's, the firm of financial experts best known as publisher of The Wall Street Journal, has prepared a complete stock analysis and portfolio-management package for microcomputer enthusiasts who are also investors.

Available for use on the Radio Shack *TRS-80* microcomputer, Standard & Poor's *STOCKPAK* provides for evaluating and managing a stock portfolio of up to 100 securities, with as many as 30 transactions on each issue. It also makes it possible to analyze 900 New York, American exchange, and over-the-counter common stocks, and generate reports to guide investment decisions.

The *STOCKPAK* system is designed for use with Radio Shack's *Model I* or *Model III TRS-80* 32K business-computer systems. It includes four program diskettes and a comprehensive user's manual.

The first program diskette is the Portfolio-Management System, which provides for the maintenance and control of a portfolio, or a simulation capability for any group of securities to be evaluated.

A second diskette contains the Screen and Select System, with which the user can apply a variety of investment criteria to the 900-stock data base, identifying securities to meet such requirements as price/earnings ratios of less than 10, selling below a given price, and more. Stocks selected and criteria statements can be stored for instant recall.

Diskette three is a Report Writer System which creates reports of stocks meeting user-selected criteria, along with additional information from the data base.

The fourth diskette is a Demo Data Base which contains the 900 common stock data base of the most widely traded stocks and includes 30 financial items on each of the companies.

The *STOCKPAK* system for the *TRS-80* is available from Radio Shack stores and other outlets for $49.95. A monthly updating of the data base is available from Standard & Poor's, if desired, at an annual subscription fee of $200.

Computer voice processing to make big jump in '80's

Talking to your computer instead of typing instructions on a terminal, and listening to it instead of reading a printout, will become fairly common in industrial operations and financial transactions during the first half of the 1980's. During the second half, voice processing will come to the forefront in office systems and consumer products. So says an International Business Research Report, issued by Frost & Sullivan Inc. of New York City and London.

Using voice as computer input is not only more appealing because of its "naturalness," but saves time by freeing hands and eyes. At present, there are several problems: Vocabulary of most systems is limited—generally they are scheduled to respond to discrete commands, not continuous speech. The vast majority of present systems respond to only one operator, whose speech they have been trained to understand. Independent systems, which recognize the voices of different operators, are rare. (F&S believes that a sufficiently low-cost, large-vocabulary system that can accept continuous speech will be available within the next few years.)

Voice response—the other half of voice processing—is a technique that converts computer-generated digital data into human or synthetic speech, depending on whether the vocabulary has been tape-recorded or electronically synthesized. It has already been used to a limited extent, as in a Simpson-Sears experiment with linkage of telephone customer orders to a computer, military testing of voice-response equipment for instructing flight crews, and a General Motors assembly-line installation. Within a year, Texas Instruments plans to introduce a speech synthesizer with a 2,000-word vocabulary, says Frost & Sullivan.

Foundation gives $500,000 for computer education

The Foundation for Computer Education, based in Cupertino, CA, has just made its fourth set of awards, amounting to $150,000, to 26 educational systems. That brings the value of grants given to educational institutions and individuals to $500,000 since October 1979.

These grants of computer equipment are given for projects intended to improve education through the use of small, low-cost computers. The projects range from basic word-attack skills for kindergarten through third grade, to genetics and molecular biology at the university level.

Some 87 projects have been approved and have received awards of computer equipment. The 87 recipients are eligible for a grand prize—to be given to the institution or individual demonstrating the outstanding example of a program leading to improved education with small computers.

The non-profit organization was chartered as the Apple Education Foundation in 1979, and was joined since by Bell & Howell as a major supporter, and assisted by a number of computer or computer-related firms that donated equipment or services. The systems awarded include *Apple II* personal computers, Apple being still the principal sponsor of the foundation.

The systems given the educational groups range in value from something over $2,000 to about $7,000, the bulk of them between $4,000 and $6,000. **R-E**

STANDARD & POOR'S *STOCKPAK* system used with a Radio Shack *TRS-80* microcomputer.

Now, a mini-scope with the features most wanted by field engineers!

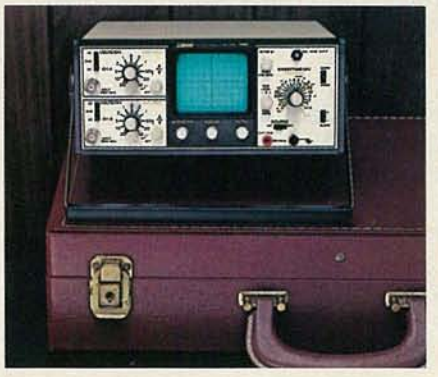
B&K-PRECISION'S new Model 1420 is a good example of what can materialize when a company listens well. This new 15MHz dual-trace mini-scope was designed by B&K-PRECISION engineers from a clean sheet of paper to respond to the special needs of field engineers . . . a *mini-scope* with *lab-scope* features.

So small in size (4.5″x8.5″x12″), the 1420 easily fits into a standard attache case with plenty of additional storage room for a DMM, tools and accessories. For use in any environment, the 1420 can be powered from an AC line, 10 to 16 VDC or an optional internal battery pack. Unlike some competitive mini-scopes, adding a battery pack will not add to the size of the slim 1420.

The rugged 1420 features dual-trace operation and an honest 15MHz response. In addition, its smooth roll-off provides useful response to 20MHz.

An efficient rectangular CRT displays waveforms with high brightness for good readability under all field service conditions.

Too many field-service mini-scopes sacrifice features and performance for compact size, handicapping the field engineer. The new generation 1420 has overcome these problems. In spite of its small size, the 1420 has eighteen sweep ranges that span from 1 μS/div. to 0.5S/div. in a 1-2-5 sequence; variable between ranges. Sweep magnification is X10, extending the maximum sweep rate to 100nS/div. For use with computer terminals or video circuits, a video sync separator is built in. For added ease of use, automatic selection of chop and alternate sweep modes is provided, as is front-panel X-Y operation.



The new 1420 mini-scope comes complete with two 10:1/probes and is available *now* from your local B&K-PRECISION distributor. Available options include carrying case and probe pouch.

To receive a free 16-page color brochure describing the 1420 and the complete B&K-PRECISION oscilloscope line, call toll-free,
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CIRCLE 46 ON FREE INFORMATION CARD

editorial

The State Of The Art Moves Ahead

The electronics industry never stands still. Not a single working day passes that engineers and scientists are not busy researching and analyzing in an attempt to advance the state of the art a notch or two. Very often, we are not aware of that massive effort until we see the results brought to the marketplace.

Two recent conferences—the International Electron Devices Meeting held in Washington, DC, and the International Solid-State Circuits Conference held in New York—provided a look at the semiconductor industries' view of where the state of the art is today and where it will be tomorrow (the next few years). Since semiconductors are often viewed as the heart of modern electronics, by watching the advances made in the semiconductor field we begin to realize the advances being made in the industry as a whole.

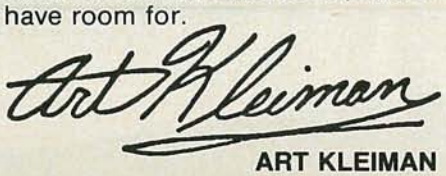
Although many topics were discussed at the conferences, one stands out as a measure of the state of the art. VLSI (*V*ery *L*arge *S*cale *I*ntegration) will be the next generation of IC's to reach us. Those IC's will pack more circuitry into less area, consume less power, and operate faster than ever before. To say the least, those IC's will be very sophisticated and extremely powerful from a designer's point of view.

To produce the new IC's, new fabrication processes are required. Called electron beam and X-ray lithography, the processes produce circuit patterns on the silicon wafers with smaller line widths. Currently, IC's are being produced with line widths of 3 micrometers. Experimental IC's are being fabricated with line widths down to 1 micrometer and industry analysts are predicting line widths down to 0.5 micrometer in the not-too-distant future.

What does that mean in terms of actual IC's? Matsushita has fabricated a 64K *static* RAM. Packed onto a 5.44 × 5.8 mm chip, this RAM contains over 402,000 components. Both Nippon Telegraph & Telephone and a joint effort by NEC and Toshiba has produced 256K-bit dynamic RAM's. The NEC/Toshiba device uses 1.5-micrometer lines while the NTT device is 20% smaller, using 1-micrometer lines.

On the microprocessor front, Intel has unveiled a three-IC set that comprises a 32-bit micromainframe (that's Intel's word). It's been dubbed a micromainframe because it has the computing power of a mainframe computer and processing power can be increased by adding CPU's without changing software. Intel has also developed a virtual memory capability that permits 1 gigabyte of address space. That's 1000 megabytes. I remember being thrilled when I finally expanded my home computer to 64K of RAM. Speed is also increasing. Zilog plans to introduce two updated versions of their 16-bit CPU, the Z8003 and Z8004, that will run at 10MHz. That would make them the fastest CPU's available.

This should give you a pretty good idea of what is happening behind the scenes and what the future may bring. If you have any comments or predictions, please send them to me and we'll publish as many of the best ones as we have room for.



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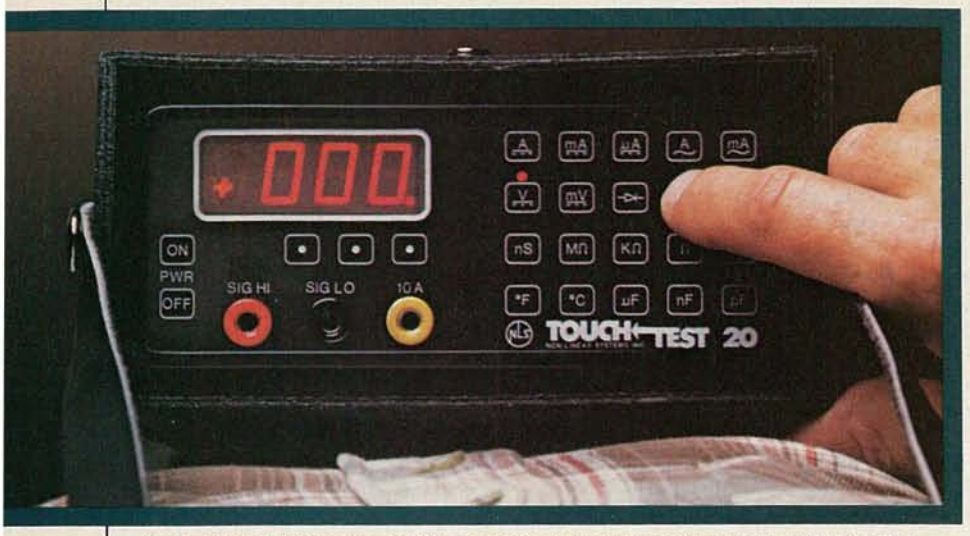
Non-Linear Systems' Touch Test 20. The 2 lb. 4 oz. test lab.



The Touch Test 20 DMM weighs only 2 lbs. 4 oz. Yet it puts twenty key test functions at your fingertips. Plus exclusive light pressure touch function selection. Shown from above on leather shoulder sling (optional).

Road test the remarkable Touch Test 20. Now, with its 20 key test functions at your fingertips, (plus the ability to measure 10 electrical parameters and 44 ranges) you can take one lab to the field instead of a cumbersome collection of individual testers.

Another bright idea. The Touch Test 20 is the only DMM with light pressure touch function selection. No more dials to fiddle with. Instead, an LED shows the function you choose. And when you switch, you get an audible bleep and a visual blip to let you know.

Operation's a snap. A light touch chooses the function. An LED shows it.

Functional. Not gimmicky. We believe that in DMM design, form should follow function. For example, it's rare that a DMM is used hand-held. Usually it's placed so the operator's hands are free to manipulate the test leads and the equipment being tested. That's why we developed the Touch Test 20—to fit where and how it would be used. The result is the most innovative portable/bench-type multimeter in the industry today.

Small wonder. The Touch Test 20 is designed specifically for mainline electronics measurement and testing. It checks AC and DC voltage, AC and DC current as well as resistance. Analyzes temperature in Celsius and Fahrenheit. Measures conductance and capacitance. It also performs diode/transistor and continuity tests. All with the accuracy that's synonymous with the name Non-Linear Systems.

Shop-proven. Field-proven. The Touch Test 20 is ideal for benchtop use. The large, 0.55-inch LED numbers make it easy to read. And its dial-free, light touch selection system prevents the unit from skittering across the tabletop. Light and versatile, it's the perfect, portable road lab, too.

The Touch Test 20 comes with test leads, temperature probe and resistor/capacitor test adapter. It features automatic polarity and overload indication plus in-circuit test capabilities. The Touch Test 20 is available in two models—rechargeable battery or line operated. All parts and labor are guaranteed for a full year. And each model is available with optional accessories like a leather carrying case with shoulder strap and belt loop, to help you get the job done.

Touch Test 20 at a glance

Measurements	
AC Voltage	10 μV to 750 VRMS, 6 ranges.
DC Voltage	10 μV to 1000 VDC, 6 ranges.
AC Current	10 μA to 10 A, 4 ranges.
DC Current	0.01 μA to 10 A, 7 ranges.
Resistance	10 milli Ω to 20 meg Ω, 7 ranges.
Temperature	−40°C to 150°C, −40°F to 302°F; 2 ranges.
Conductance	0.01 nS to 200 nS (equivalent to 5 megohms to 100,000 megohms) 2 ranges.
Capacitance	1 pF to 200μF, 6 ranges.
Tests	
Diode	Diode and transistor junctions in conducting and non-conducting directions.
Continuity	Audible signal.
Size	2.9" H x 6.4" W x 7.5" D (74 mm x 163 mm x 191 mm)
Weight	2 lb. 4 oz. (1.02 kg)
Price	$467.00 with batteries $435.00 without batteries

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CIRCLE 41 ON FREE INFORMATION CARD

satellite tv news

OTHER SATELLITES ON THE WAY

Two more satellites—carrying up to 612 new transponders—will be in orbit over the U.S. by mid-1985—and that doesn't include the proposed Comsat DBS plan. The quadrupling of satellite facilities will come as a result of the FCC's recent decision to expand its "open skies" policy. As part of the same ruling, the Commission is moving toward a "short-spacing" of birds, permitting them to fly at intervals of about 3° instead of the current 4° apart.

The new birds will be operated by GTE, Hughes Communications, Inc., and Southern Pacific Communications, each of which will launch two new satellites and build a third as a ground spare, ready for launch in case of a problem with the orbiting bird. In addition, companies already in the space game, such as AT&T, RCA Americom, and Western Union will be permitted to put more satellites in orbit.

Overall, the new satellite facilities will cost more than $2 billion. Many of the birds will be used for video service, although some of the new satellite operators are expected to concentrate on data communications, teleconferencing, and other non-video services.

The FCC hopes to come to a decision this year about spacing of satellite orbits, to avoid interference while making the most efficient use of spectrum space. The FCC is also examining related matters, such as future satellite usage of 12/20-GHz and higher bands.

NEW CABLE PROGRAMMING

The cable-TV industry continues to find itself on the receiving end of new entertainment services—many of them unveiled during the semi-annual industry conventions. At a recent industry gathering, more than half-a-dozen satellite-fed program services were announced, along with several augmentations of current program packages. Many of the new services will be on the bird shortly—with some of them, such as Showtime's expansion to a 24-hours-on-weekends service already in operation.

Culture is the main ingredient in several of the new program packages, including the previously announced CBS Cable service which is due to go on the Westar bird by June. "Alpha," a joint effort by ABC Video Enterprises and Warner Amex Satellite Entertainment, should be underway by the time you read this aboard Satcom I, using the same transponder as WASE's "Nickelodeon." Alpha will feature performing- and visual-arts programs.

Bluebird, another new program service, will offer many shows from British Broadcasting Corp. (the type now seen on public-TV channels) along with other original cultural programs. Bluebird channel is operated by an affiliate of New York's Rockefeller Center and is currently negotiating with several satellite companies for transponder space.

A number of other specialized services via satellite are also in the works. For example, an "adult" movie channel (mostly R-rated, sexploitation movies) is being offered by Satori's "Private Screenings" service from midnight to 6 a.m. aboard Westar. Bravo, another of the culture channels, will introduce an evening newscast at 8 p.m., concentrating on cultural events taking place in selected cities nationwide. Times Mirror Satellite programming will launch a home shopping service, offering catalog-type information and giving cable customers (and other satellite viewers) the opportunity to order merchandise via a special video catalog.

EUROPEAN MOVIES AND TV SHOWS

More European TV programs and movies are taking to the skies over America, thanks to two recent deals by major satellite-program delivery services. Satellite Program Network, which is establishing its second network SPN-II on Westar III Transponder 9, is turning over three hours every night to Telefrance-USA. The shows will run from 9 pm to midnight (eastern time) and include a regular cycle of shows: Sunday, family programs; Monday, French TV shows; Wednesday, "great French films;" Friday "French Life Today" and European TV specials. The other nights will offer reruns of the previous evening's shows. The Telefrance-USA package is dubbed into English and is aimed at the U.S. audience.

On Satcom I Transponder 9, USA network has begun carrying The English Channel, a series of culturally oriented programs which includes documentaries, music, drama and entertainment, much of it produced by British independent TV stations.

Meanwhile many new program suppliers are slipping programs aboard satellites, filling in the gaps between the major program services now carried aloft. For example, "Telehorse" will be beamed daily aboard Westar by Hughes TV network. The shows will be scrambled and will cover races from various Chicago-area racetracks, sent exclusively to Las Vegas betting parlors so gamblers can watch events on which they are wagering. Over on an HBO transponder on Satcom, a few moments in the morning will be turned over each month to a cable-TV industry publisher, who will present information about the business; that will be aimed primarily at cable-TV executives.

GARY H. ARLEN
CONTRIBUTING EDITOR

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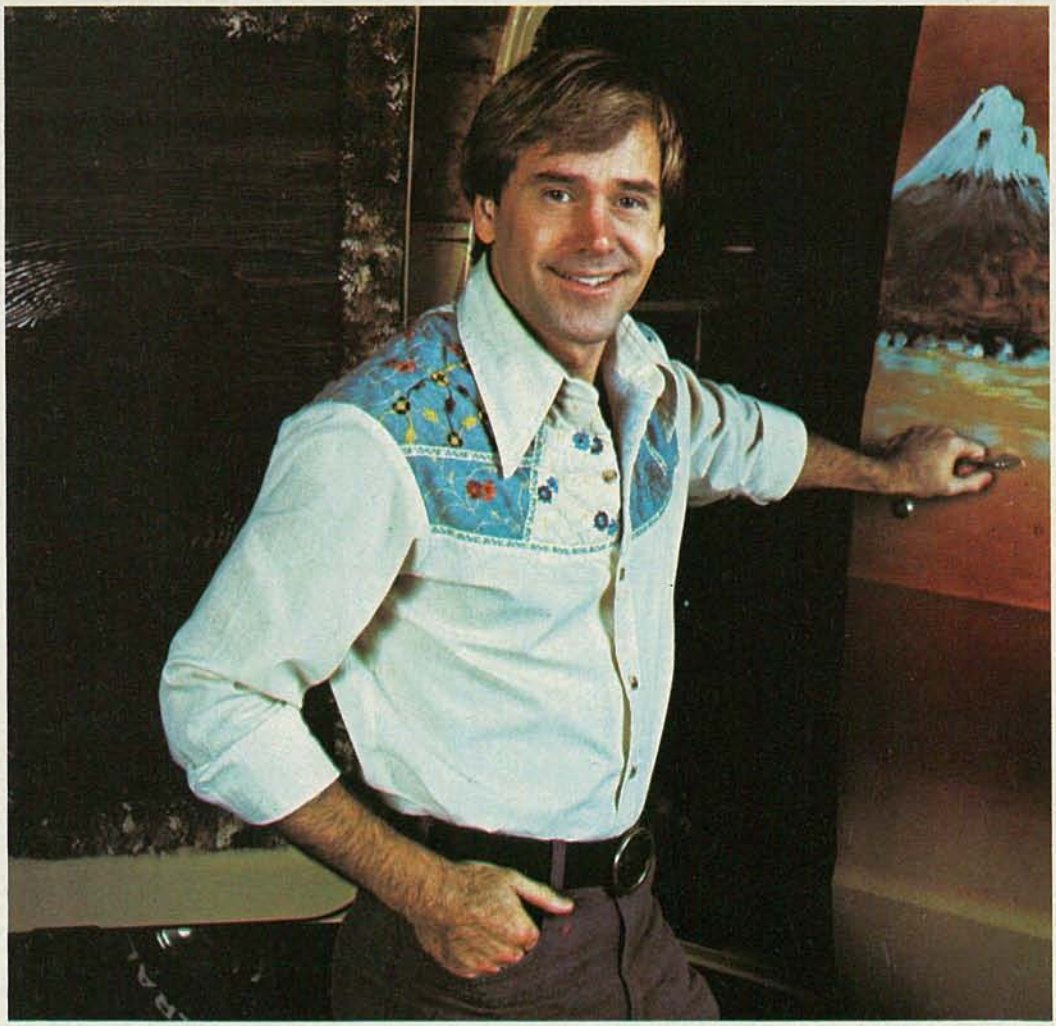
CIRCLE 14 ON FREE INFORMATION CARD

You gotta shop around.



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

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So, shop around for your training. Not for the bargain. For the best. Thorough, professional training to help give you pride and confidence.

* * *

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

Why you should shop around yourself.

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

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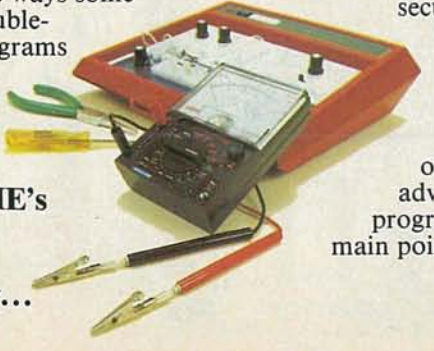
Part of what makes electronics so interesting is it's based on scientific discoveries—on ideas! So the first thing to look for is a program that starts with ideas and builds on them!

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

How practical is the training?

This is the next big important question. After all, your career will be built on what you can do—and on how well you do it.

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



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

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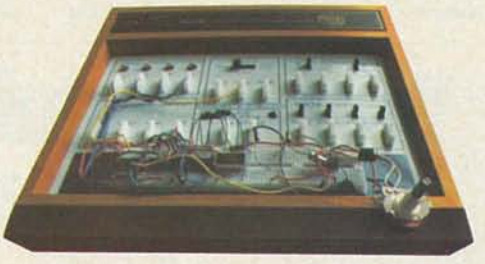

who wants to keep pace with the state of the art of electronics in the eighties. With CIE's Digital Lab, you'll be applying in dozens of fascinating ways the theory you've learned. For example, you'll compare analog and digital devices. You'll learn to make binary to decimal conversions and to work with semiconductor devices and circuits. You'll see how digital equipment is vital in today's exciting, growing fields such as security where digital theory provides the brains for space-age alarm and protective devices.

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letters

CABLE TELEVISION

Is cable television a friend or foe? With so many choices of programming—HBO, C-SPAN, BRAVO, ESPN, QUBE. etc.—it would seem imminent that a potential viewer will have a veritable video smorgasbord at his fingertips. But will he? Superficially, it would seem logical that there would be an unlimited variety of "top shelf" entertainment available, 24 hours a day.

Don't bet on it!

In the past, the three major TV networks—ABC, CBS, and NBC—were the only rivals in the vast national telecasting market. With only three suppliers of programming competing for their share of the 140,000,000 TV viewers, a substantial slice of the pie was nearly guaranteed to all. That convenient and powerful system was extremely attractive to advertisers—the only source of income in commercial TV. Coupled with the expertise of the American Research Board (ARB) and the Nielsen ratings system, demographics dictated to the advertisers exactly where their target audience was. It was scientific, lucrative, and efficient. In fact, it was a near-perfect medium in which to expose, sell, and saturate a market.

Advertising on TV is sold on a "cost per thousand" (viewers) basis. The more viewers of a program (and the commercial), the more money is charged per commercial spot run. When 140,000,000 viewers are divided by only three networks, simple arithmetic shows that a higher potential gross income can be realized than when there are 30 or more national "networks" vying for the audience.

It doesn't require a genius to extrapolate in what direction TV programming will go when the audience, and the revenues to produce network programming, is diluted to one-tenth or less of its current standing. To maintain the present quality of programming (and many think that it is already decadent), networks will be forced to increase their "cost per thousand" rates to a point where advertisers will be forced to seek alternative media to reach their targets more effectively.

Ultimately, the demise of networks and their affiliated local-TV-station outlets will become inevitable. Then we will all be forced to pay top dollars for mediocre programming on a cable system comprised of 30, 40, or 50 channels of second- and third-rate programming.

Our only hope may be that, after a few years of "all-pay TV" someone will come up with the idea of supplying first-rate entertainment free to anyone who can receive a TV signal via wireless techniques, and which will be sponsored by advertisers in exchange for commercial announcements within the programs that they sponsor. *Eureka!* We will have re-invented commercial TV! But will it be too late?

MYLES H. MARKS,
Technical Director WIIC-TV (NBC Affiliate)

Mr. Richard Johnson's comments in the letters department of your February 1981 issue stir me. Perhaps Mr. Johnson is so involved in his work that he can only see the trees and cannot concern himself with the forest. Not being familiar with El Cajon-San Diego TV services, I can't comment on them, but I *can* comment on the cable TV in Reno. If Teleprompter TV is a "mom & pop" operation, it certainly has expanded.

As I understand it, from the San Francisco Bay area to Iowa it is one system.

But perhaps Mr. Johnson means that the systems in El Cajon, CA, Wellington, NV, and Hawthorne, NV, are "mom and pops" and number three systems, while Teleprompter is only one system.

The January 1981 issue of Saturday Review has another comment: "Can PBS Survive Cable?", by Peter Caranicas. That is a very interesting article. But perhaps again CBS cable is a "mom and pop" operation. Sure.

It is my present personal opinion that Mr. Johnson is so anxious to get the cable-industry view across to the public that he doesn't pay any attention to the facts.

As a viewer of several years, and an electronics hobbyist of some more years, the future is of great concern to me. We have viewed the great variety of TV around the large population centers. And, as at present, we have also been in other locations where only one channel was available. In Reno, three stations broadcast the three networks only, and cable opens up the programming with three more channels—two independent, and PBS. I believe that is a necessary service.

However, what with the increasing costs, I am uncertain about how long it will last. When we first subscribed, the price was under $5.00 a month; now it is $7.50, with indications that the company wants more. Fortunately, competition is on the scene, and the price increase has not yet happened—and, strangely, the reception has improved tremendously.

With our economic system the way it is, perhaps enough viewers will not be able to afford the increasing costs of cable TV, and thus broadcasting will continue.

J.T. KING
Reno, NV

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We have upgraded the Bally Arcade from what many publications think of as a toy to a very serious small microcomputer.

THE CURSOR GROUP.
Fred Cornett, President

MODULATION

In the "Letters," department (January 1981), Mr. Davis states: "White is 12.5% carrier level, not zero modulation, which is the blanking level. Maximum modulation (87.5%) occurs at white, not sync, which is +40%."

Much of that statement is incorrect. That is not unusual in articles I have read about TV modulation down through the years. So let's try to set the matter to rest.

In this particular case, I believe we have an IEEE graticule that's causing the confusion. That scale is very useful around a TV studio, and other spots, for measuring levels; and, of course, for transmitter-modulation measurements, if used properly.

When modulating a TV transmitter, it sees only the overall signal, which means the whole composite signal (sync plus video). We cannot speak of +40% sync or minus that. The blanking level is not zero modulation; it is simple zero on the IEEE scale (no relation). Tip of sync is 100% modulation, as Jack Darr stated. Sync is transmitted at 25% and is not 40%. The scale reads 40 *units*—not 40%.

The total units on the scale for transmitter measurements must be 160 units—two divisions above 100 units, which appear on the scale. Zero carrier should be set at that point. Zero carrier is displayed, on the scope, by chopping the signal after it is detected from the transmitter, either by a mercury relay or electronic means.

That signal is generally not available to the studio engineer, so he never sees it. That probably causes much of the confusion. If we set the carrier at two divisions above 100, we wind up with a total of 160 divisions; thus, if sync is set at 40 divisions, we end up with 25% sync (measured from zero carrier to tip of sync), which is correct. 100% modulation of *video* is never reached. It is set by FCC rules. A 12.5% protection area is provided, for two reasons. Firstly, to avoid white-picture saturation, due to characteristic curve distortion; second, to eliminate over-modulation (carrier chatter), which would cause problems with intercarrier receivers.

A word about power output may be useful. We must consider video as a subtractive process. As we fill in the white-picture area, our power output decreases. TV and AM transmitters act quite differently. In AM, an average signal does not change the power input (DC input). The output power *does* change, due to the modulation in *added* fashion. But in a TV transmitter, the power output changes in a drastic fashion. The difference here is that the DC input power changes in TV and consequently the output power changes, too. The TV transmitter power is at a maximum *only* with an all-black picture (with sync-only modulated). As we apply video, the power decreases in accordance with the white content of the picture. At all-white picture, the power is minimum. In a typical 50 kW transmitter, the plate current can change from 6 amps to 11 amps using 6800 volts. Quite a power change, eh? Those figures might make a ham operator drool.

C. M. ROGERS.
Valley Center, KS

THE HP-85

With reference to Mr. Gilder's report on the HP-85 in your December 1980 issue: There are a couple of minor errors. Firstly, the beeper can be programmed for both duration and pitch. The standard pack of programs, supplied with each machine, includes a rendition of the *William Tell Overture* using the beeper.

Second, if a binary routine, included with a tape from the user's library, or available in the printer/plotter ROM, is used, the entire graphics image can be stored as a single string. The graphics screen can thus be used for storage, adding 6K to the available memory.

BOB STAINER
Cape St. James., B.C. Canada

KEEPING AIRWAVES PUBLIC

I was interested in your editorial (December 1980) on keeping the airwaves public; but the fact is, as you know very well, the airwaves haven't all been free to the public for at least the last 50 years. I cite as an example the scrambled telephone messages which have been transmitted on our shortwave bands as far back as the mid '30's. Those messages were—and as far as

continued on page 26

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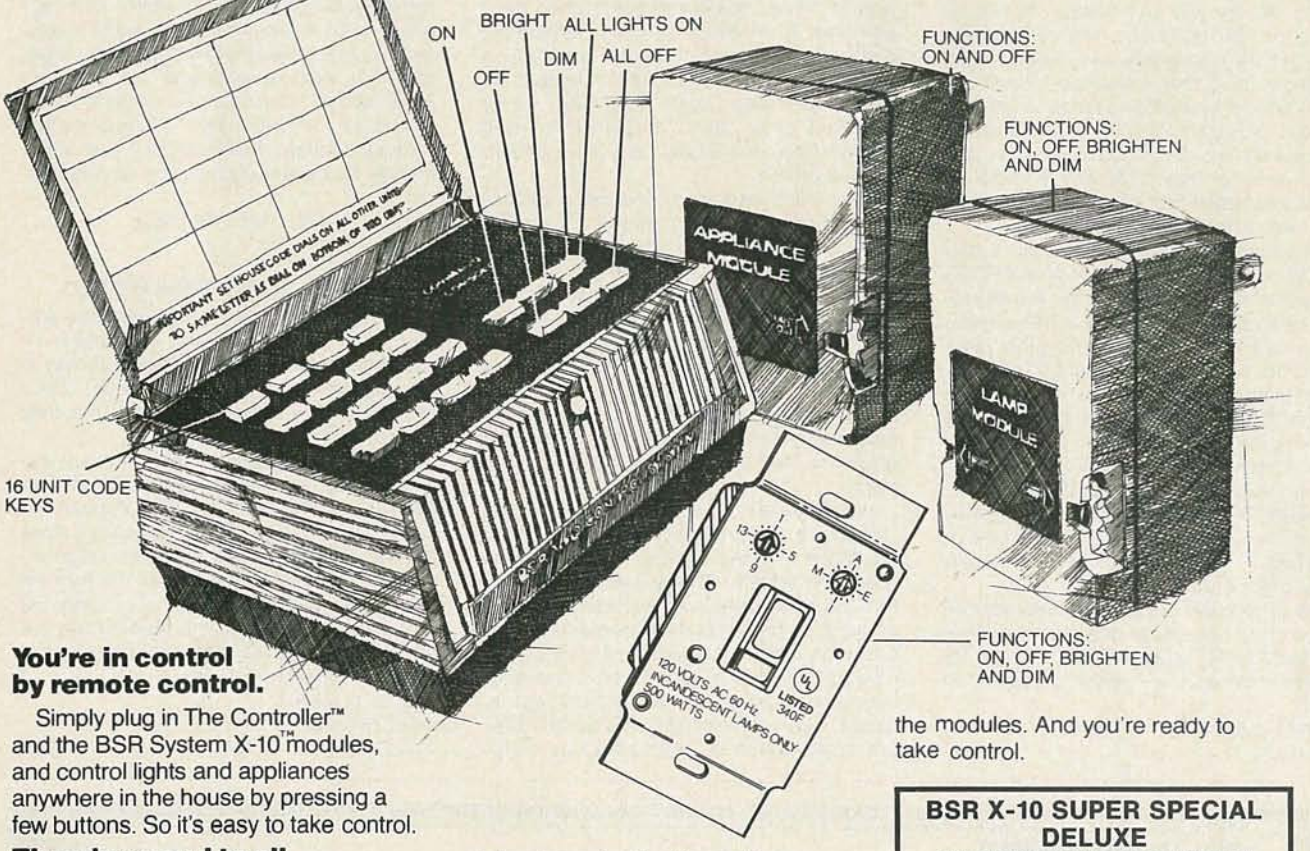

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I know still are—scrambled for the sake of privacy, but are nonetheless transmitted on our public airwaves.

That, to my way of thinking, is just as wrong as the thing you are complaining about. I have always felt that it wasn't right. Messages broadcast over our "free" airwaves should be available for all to listen to without special "secret" deciphering equipment. Yet, for some reason, I have never seen or heard of any complaints about scrambled broadcasts over the public air waves in any radio magazine.

But something that is of much more concern to me than that is some of the FCC's proposals of butchering up the AM broadcast band even worse than it has already been messed up—like narrowing the bandwidths to 9 kHz and eliminating the so-called clear-channel stations. After all, the original idea was that frequencies between 550 kHz and 1700 kHz were for long-distance communication. Local broadcasting can as well be done at much higher frequencies. But that is not what is being done and as a result the AM band has become so cluttered up with stations that it is only good for local coverage.

That is certainly not in the public interest. On the other hand, I, for one, do not believe that the 70-UHF channels will be used for TV entertainment in years to come—if ever.

JOHN R. SIMPSON
Tampa, FL

EINSTEIN NOT CONTRADICTED

In the January 1981 issue, under "Letters," Mr. Anthony Hans Klotz of Babylon, N.Y., claims that certain rules postulated by Einstein were "never real originally." I'm afraid that he is overlooking a key word in the consequences of the postulates: *"observed."* The behavior of light (which must be used to make length measurements) causes an *observed* length contraction which is quite real. One might claim that the length contraction in an "absolute" sense does not occur. Such a claim is in itself "unreal" because it could never be verified experimentally.

Mr. Klotz's supposed "charged capacitor contradiction" arises because he applies special relativity considerations to the observed dimensions of the moving charged capacitor but totally ignores the special relativity considerations which must be applied to the electromagnetic fields of the capacitor. (The special theory applies to electromagnetic radiation of *any* frequency, while light is simply electromagnetic radiation within a very narrow band of frequencies that can be perceived by the eye.)

Unfortunately, the editor repeats the ubiquitous misconception that the mass of an object moving at the speed of light would be infinite. The accepted reality is that the *mass does not vary with the speed at all*; it is the *observed momentum* that becomes infinite at the speed of light. No reputable physicist today would consider the mass of an object to increase with its speed. As an authoritative reference, I offer the book, *Classical Mechanics*, by Goldstein (published by Addison-Wesley); see the last paragraph of Chapter 6, section 4, entitled "The force and energy equations in relativistic mechanics."

To the best of my knowledge, there exists no experimental evidence to date that contradicts Einstein's special theory of relativity. Unfortunately, however, there appears to be a proliferation of authors possessing inadequate knowledge of the subject, but who nevertheless are quick to write about "Einsteinian impossibilities," "exposés on unreality," "contradiction through thought experiments," and other equally ridiculous discussions on the subject.

MARTY NAGEL, M.S. (Physics)
Chagrin Falls, OH

SUGGESTIONS REQUESTED

During the past year, I have read the articles you ran on building a satellite-TV reception system. I would be interested in hearing from any readers who constructed systems from your articles, telling how they turned out.

It would be especially nice if someone living in the San Diego area could get into contact with me. An investment of $1000.00 needs to be investigated before my construction begins. While the electronics end of it doesn't seem bad, I'm worried about the construction of the spherical antenna required, and the amount of time and effort that must be spent to assure the spherical surface.

JOE ST. LUCAS,
8685 Ferndale,
San Diego, CA, 92126 **R-E**

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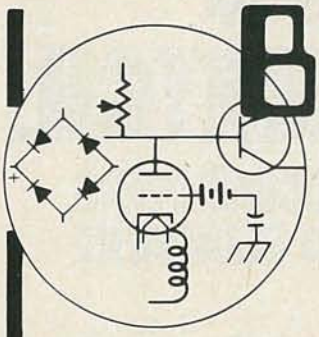

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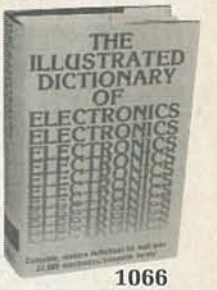

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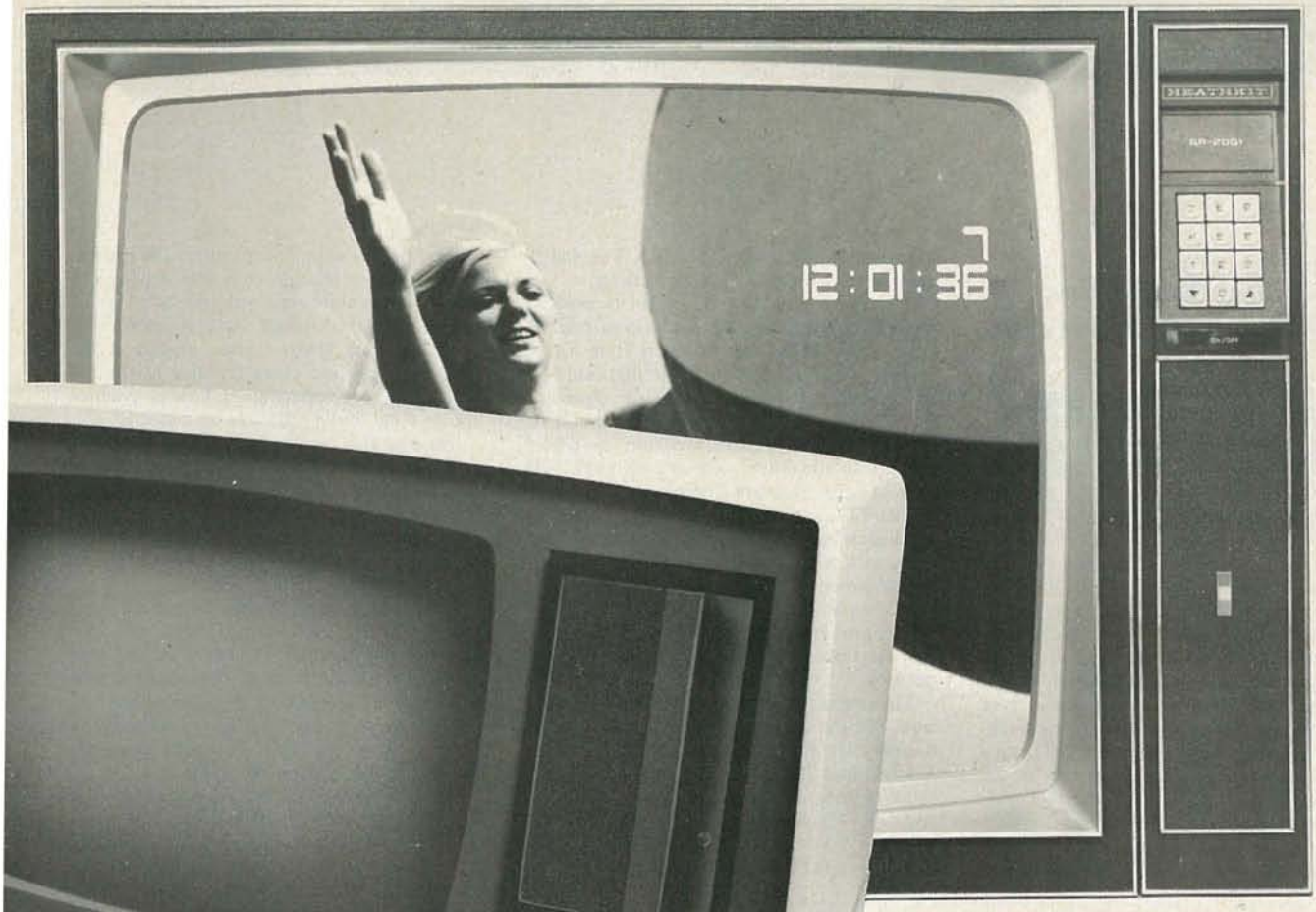

Simulated TV Reception

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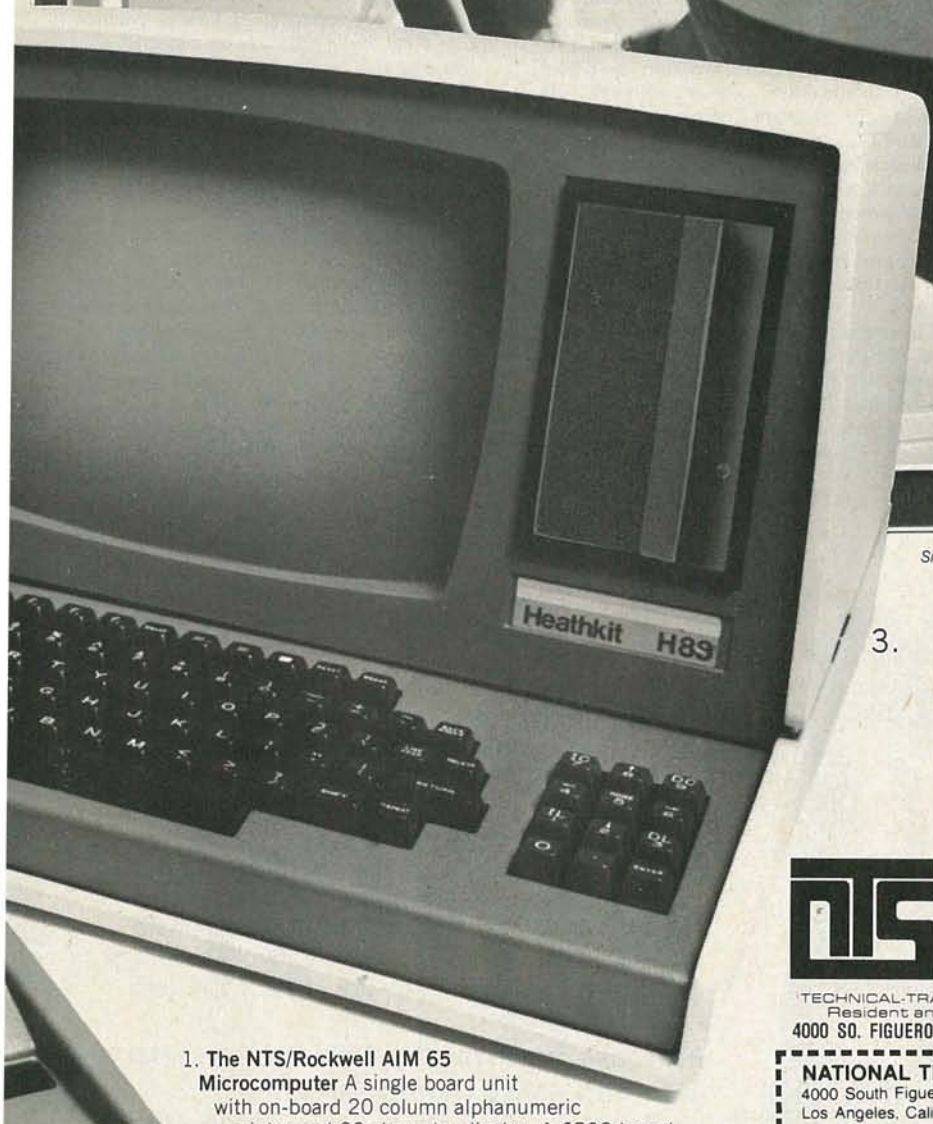

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equipment reports

Global Specialties 2001 Function Generator

CIRCLE 101 ON FREE INFORMATION CARD

GLOBAL SPECIALTIES CORPORATION (70 FULton Terrace, New Haven, CT 06509) has introduced the *model 2001* function generator. This versatile instrument produces four different output waveforms: a sinewave, a squarewave, a triangle wave and a TTL-level squarewave. The *model 2001* covers frequencies from 1.0 Hz to 100 kHz in five overlapping pushbutton-selectable ranges. A vernier dial is calibrated from 0.1 to 1.0. The frequency of the output waveform is the dial measurement multiplied by whatever range pushbutton is selected (10 Hz, 100 Hz, 1 kHz, 10 kHz, or 100 kHz). For example, dial 0.5 and push the 1-kHz button and you get 500 Hz. The dial is accurate to within ±5% of the setting.

A variable output-level control is used to control the level at two output jacks marked HI and LO. The high output delivers from 0.1 to 10.0 volts P-P (or more than 40 dB) into 600 ohms. The low output is −40 dB down, or from 1–100 millivolts into an open circuit or 0.5 to 50 millivolts into 600 ohms. The *model 2001* holds the output constant within 0.5 dB over its entire frequency range.

The TTL squarewave output is at the dial frequency and capable of driving up to 10 TTL loads with risetimes and falltimes of less than 25 nanoseconds. The amplitude is 0 or 5 volts, and is not adjustable by the level control. The TTL signal is always in phase with the other outputs (other outputs can be used simultaneously).

The sinewave output has less than 2% distortion. The triangle waveform is within a ±1% linearity error; the squarewave has risetimes and falltimes of less than 100 nanoseconds. All those outputs can be swept over any desired frequency band. An AC voltage of up to ±10 volts can be fed into the SWEEP IN jacks. That can be used to check the frequency response of a filter, for example. The manufacturer recommends using a triangle wave and driving the scope's horizontal sweep with the same type of wave. Since the triangle wave is linear with time, the scope shows a linear display of the frequency-response characteristics of the filter. Any peaks, regeneration, lack of symmetry, or other faults will show up instantly.

The operator's manual contains full instructions for this. To show the response of a 5-kHz bandpass filter for example, set the frequency dial at 0.55 and press the 10-kHz range pushbutton. Setting the sweep voltage at 9.7 volts (P-P) will cause the *model 2001* to sweep from 1 kHz to 10 kHz.

If an offset signal-voltage is needed (one that is not symmetrical about zero), press the DC OFFSET pushbutton. The LEVEL control now becomes an offset control. For instance, you can create a squarewave that goes from 0 volt to +5 volts, or from 0 volt to −5 volts. If the scope is set to DC input, that also varies the position of the trace on the screen.

An instrument like this one can be very helpful in all kinds of audio testing. The triangle waveform, for example, is ideal for locating

continued on page 34

Yesterday you could admire all-band digital tuning in a short wave receiver.* Today you can afford it.

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*Short wave reception will vary with antenna, weather conditions, operator's geographic location and other factors. An outside antenna may be required for maximum short wave reception.

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CIRCLE 36 ON FREE INFORMATION CARD

continued from page 32

clipping in any stage from input to output. You can detect the slightest clipping tendency by noting the flattening of the triangle wave's sharp peaks. Nonlinearity shows up instantly as a curvature of the rising and falling ramps. Faults such as those show up very easily with these tests.

The instruction manual details all modes of operation and shows control settings, waveforms, and a handy chart showing the scope patterns produced by many typical defects. Full calibration data is in the back of the book, if needed. The *model 2001* is a handy instrument with many possible uses. It sells for $186.00. **R-E**

Sencore Model DVM56 Microranger DMM

CIRCLE 102 ON FREE INFORMATION CARD

WITH THE AVAILABILITY OF LOW-COST MICROprocessor IC's it was just a matter of time before they would be used in electronic test equipment. One of the most recent additions to the field is the *model DVM56* Microranger from Sencore (3200 Sencore Dr., Sioux Falls, SD 57107). According to the company's service manual the *model DVM56* was designed to free the technician or engineer from the need to switch ranges manually, interpolate readings, or have to figure out where the decimal point should be, making servicing faster. The *model DVM56* does all of those things automatically.

Physically, the *model DVM56* is somewhat large as compared to more conventional DMM's. The unit measures 4 × 8 × 11½ inches. The front panel measures approximately 4 × 8 inches. The unit is solidly built and its large size gives you an idea of the amount of circuitry packed inside the cabinet.

The *model DVM56* measures AC and DC current up to two amperes. Resistance measurements from 0.01 ohm to 99.99 megohms can be made in either the high- or low-power mode. The low-power mode is used for in-circuit testing of solid-state devices as there is insufficient voltage to forward-bias a junction. AC voltage is measured in three modes over three ranges: peak-to-peak (two kilovolts maximum), average RMS, and true RMS (.0001 mV to 999.9 volts for both RMS modes). DC-voltage measurements up to 10 kilovolts are possible with the *model TP222* 10-kilovolt probe (included). Without the probe, DC voltages from 0.1 mV to 1.999 kilovolts can be measured.

There are two decibel ranges. The dBm range uses the standard reference of 1 milliwatt into 600 ohms (0.7746 volts RMS). If any other reference is desired, the dBP range is used. To "program" a reference into the *model DVM56*, simply press the OHMS & dBP ZERO button while measuring the reference. All further dB readings will be referenced to the programmed reading.

Another feature is the ability to select the resolution for a particular application. By pressing one of the three pushbuttons on the front panel, the user can select 3-digit, 4-digit, or 4½-digit resolution. As the instruction booklet points out, the 4½-digit readout will most likely be most important when using the *DVM56* in calibrating procedures. For most applications, 3 digits will suffice. Certainly, 4 digits exceed the capabilities of most DMM's.

There is also a RANGE HOLD button. Since the *model DVM56* will actually switch through as many as three basic ranges of voltages, it will be useful to be able to perform multiple measurements using the same range. For instance, if you are servicing a piece of electronic equipment where all the voltages will be in the kilovolt range, there seems to be little reason to allow the *model DVM56* to start off in the MILLIVOLT range, autorange to the VOLT range, and finally up to the KILOVOLT range. When you want to use one range, a press of the RANGE HOLD button while a reading is displayed, will keep the meter in that range until you want to use the autoranging feature again. That feature works the same way for all functions (voltage, resistance & current).

Another unusual feature is PEAK & NULL. As most technicians and engineers are already aware, DMM's are unable to take the place of analog meters when it comes to adjusting traps or tuned circuits where an exact minimum or maximum reading is needed. This feature will do a fantastic job of such peaking or nulling. Two small LED indicators (labeled with + and − signs and direction indicators) on the front panel are used to indicate a peak or null.

continued on page 36

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CIRCLE 31 ON FREE INFORMATION CARD

continued from page 34

In use, the operator selects the desired function, depresses the PEAK & NULL button, connects the test leads to the circuit to be adjusted, and watches the two red lamps on the panel. When both lamps glow (and one or the other of them goes out when you adjust the coil or other device) the circuit is in perfect adjustment. The markings indicate which way you must adjust to obtain a peak or null.

Large (0.5-inch) LED's are used in the display and are easy to read at a distance. A bail-type handle also serves as a handy tilt stand for bench use, and the construction of the cabinet is rugged enough to withstand hard useage.

Front-panel banana jacks let you use any test leads you may already own. Three high-quality leads are supplied. Two of the leads (black and red) have alligator-clip terminations, while the third (red) has a probe.

As already mentioned, the unit comes with a 10-kilovolt transient-protector probe (*model TP222*). The probe allows the *model DVM56* to make DC-voltage measurements up to 10 kilovolts. Sencore recommends that the probe be used whenever DC voltage measurements are made, as it increases the meter's input impedence, resulting in less circuit loading. That means, of course, a more accurate reading. The isolation resistor in the probe also tends to decouple the leads from the circuit, and that results in less capacitive loading.

Although readings obtained using the probe were good, there were some drawbacks. In use, the probe, which is five inches long, is slipped onto the end of the standard probe, which is also five inches long. That results in a rather clumsy, 10-inch-long test probe. Additionally, the probe must be removed for all ranges other than DC VOLTS.

The *model DVM56*'s case has feet for stability when used on a flat surface. Other case features include a provision for cord storage, a clip for the 10-kilovolt probe, and a spare-fuse compartment. There is also a 15-volt accessory jack for use with the optional *LA220* AC amplifier. A slide-out chart at the bottom edge of the case (just under the front panel) has complete instructions for using the unit.

One of the few problems noted in use is the delay in obtaining readings once the test probes have been attached to the circuit. The instructions list the "thinking time" for the microprocessor as two seconds, maximum. However, you will have to get used to that delay first, as most good technicians place a probe on a connection and look at the meter with the expectation of seeing a reading immediately. The two seconds may seem like an eternity to a fast technician. The delay is shortened when using the RANGE HOLD function, as the unit will not have to cycle through the ranges. However, it seems as though the time is lengthened when using the *TP222* probe. When you consider that you would have to reach up and change the ranges of a normal meter, perhaps the wait is justified. To be sure, you can get used to it.

The *model DVM56* sells for $795. **R-E**

ALLIANCE, MANUFACTURER OF THE FAMOUS *Tenna-Rotor* TV antenna rotators since the early 1950's, has released a heavy-duty antenna rotator designed for amateur and CB use. The *model HD-73* comes well packaged with a control unit, a rotator motor, accessory hardware, and a manual. The six-conductor cable required for installation is not included.

Before purchasing any rotator, you should determine whether it will be adequate for your antenna. Wind loading and vertical-weight bearing are probably the two most important considerations. Because the rotator is affixed to the uppermost part of the antenna mast or tower, an additional vertical support is required to attach the antenna to the rotator. The longer that vertical support is, the greater the stress on the rotator because of leverage from

continued on page 38

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wind loading. When vertically polarized beam antennas are used, that problem is aggravated. No metal vertical part of the antenna support should be closer than one-quarter wavelength to the lowest tips of the antenna elements. Assuming that a two-meter beam is used, a nonmetallic support between the antenna boom and rotator should be about three feet long.

In CB installations the nonmetallic support above the rotator theoretically should be at least 18 feet long! Obviously, that length is rarely (if ever) met in the field, but it could be a consideration for those operators who want the best radiation pattern possible from a vertically polarized antenna. Horizontally polarized antennas present no such problem, and can be mounted as close to the rotator as is practical.

The *model HD-73* rotator weighs approximately 10 lbs. when mounted, and is housed in heavy-duty aluminum. It is designed for wind loading in excess of 100 miles-per-hour (10.7 square-feet-per-wind-load area) and is water resistant. The rotor provides 400 inch/pounds of starting torque, and 1800 inch/pounds of brake torque to resist windmilling.

The motor is designed to operate from only 20 VAC (provided by the control unit) in order to comply with safety limits mandated by Underwriters' Laboratories, Inc.

An improved braking action reduces torque stresses on the antenna system. There is very little play noticeable in the bearings. Those bearings fill two complete raceways to help equalize the weight load on the rotator. The system can accommodate up to 1000 lbs. of balanced vertical load.

The support bracket is designed for in-tower centering without having to use shims. Four bolts are provided for mounting the unit without spacers; in addition, a drilling template is supplied.

Alternatively, the rotator can be mast-mounted. No-slip support brackets are supplied that have a good "bite," and can accommodate a mast pipe of 1⅜-2½ inches O.D.

The control unit is powered from 120 VAC at 0.8 amps. It is housed in a plastic cabinet and features a large, brightly illuminated azimuth-indicating meter that is lighted by a replaceable bayonet-base panel bulb.

Calibration is shown in 10-degree increments, as well as in compass points. In our tests, resolution of the indicator was very good—within a few degrees. A front-panel calibration control definitely helps to trim up the accuracy.

The motor is activated by pressing a bar on the control unit, either to the left or the right to correspond with the desired beam rotation. Dual speeds are featured: FAST (approximately 1 rpm) and SLOW (approximately ⅔ rpm).

Overload protection is provided by both a fuse and a thermal switch. Overheating is a problem, and it is recommended that the *model HD-73* not be used for extended periods of rotation. The transformer is small and becomes quite warm with only moderate use. The control unit is switched off when not in use.

Contact sparking of the controlling wafer switch was visible and audible during some rotator activation. Subsequent inspection revealed that the open contacts are large enough

continued on page 42

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CIRCLE 15 ON FREE INFORMATION CARD

continued from page 38

to accommodate the current. The sparks may be disconcerting but do not appear to pose any hazard.

Cable installation is simple. A chart directs the user as to which type of cable to order for the length of control line needed. Screw-type terminal blocks are included on both the control unit and rotator housing to accommodate the six-conductor cable.

The manual is one of the best we've seen. It is fully illustrated, and includes theory, instructions, a troubleshooting guide, a schematic diagram, an exploded diagram of the rotator, and a complete parts list.

We judge the Alliance *model HD-73* heavy-duty antenna rotator to be a reliable system for most nondemanding amateur and CB installations. It sells for $154.95. From the Alliance Manufacturing Co., 22790 Lake Park Blvd., Alliance, OH 44601. **R-E**

Radio Shack Model 63-3001 Metal Detector

CIRCLE 104 ON FREE INFORMATION CARD

THE MAJORITY OF METAL LOCATORS CAN BE divided into three basic types: BFO, induction balance, and transmitter-receiver. The new Radio Shack (1400 One Tandy Center, Ft. Worth, TX 76102) *model 63-3001* metal locator is the latter type.

The unit is equipped with a telescoping aluminum shaft that may be adjusted in length to suit the user. The extendable shaft is long enough for average-height users. A tall adult might have to stoop over slightly to get the search head close enough to the ground for sensitive searching.

The locator requires 6 "AA" cells (not supplied). The battery compartment is easily accessible through a sliding cover. No assembly is required and the unit is ready to go as soon as it is unboxed.

The search head is made of plastic and it is water resistant. But it is not immersion-proof, so don't plan on using the unit to probe for objects below the water line. The tilt of the search head is adjustable to suit the user.

Two coils located in the search head are used to locate buried or hidden objects. The coils are arranged so that the signal from the transmitting (search) coil cannot be detected by the receiving coil. When the search head passes over an object, an electromagnetic field between the coils changes shape, and the receiving coil can then detect the signal from the transmitting coil.

Some materials (non-ferrous) cause the field to diverge (spread out), while ferrous (iron) substances cause the field to converge (squeeze together). Those dissimilar fields are used to analyze a target, or to discriminate against trash in the ground. The search coil is Faraday-shielded to minimize capacitive effects.

Two controls are used to adjust the detector for best sensitivity. One of those controls selects between ferrous and non-ferrous materials; the other is used for peaking. Indication is provided both by a visual panel meter and a speaker. A third control sets the speaker volume. The meter is tilted for a comfortable viewing angle. For noisy environments, or where quiet operation is preferred, an earphone (included) can be used. Using the earphone turns off the speaker.

A shielded four-conductor retractable mike cable connects the search head and the control compartment. It is mounted internally through the center of the heavy-gauge, seamless aluminum-tubing shaft. The shaft itself is securely attached to the control compartment.

A phenolic printed-circuit board contains five transistors and two diodes. It is etched well and neatly laid out. The board is very roomy and is easy to service should service ever be required. Unfortunately, no circuit diagram is provided.

In order to extend battery life, we followed the manual's instructions and bought Radio Shack's alkaline batteries. The detector wouldn't work at all. A close inspection revealed the cause. The center-post terminals of the Radio Shack alkaline batteries are too short to touch the contacts in the battery compartment. Use standard "AA" cells, or make sure that the batteries you buy have center posts long enough to make contact with the battery holder.

Once the unit was operating, we proceeded to adjust it as recommended in the manual. The manual provides a number of valuable tips. Read it, then read it again! Metal locators are tricky to use; practice is necessary!

There was some capacitance effect; non-

continued on page 89

Video Review® knows a bright idea when it sees one.

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"We thought the Magnavox picture quality and resolution were superb."

"Ever since *Video Review* began testing products," says the magazine, "we've been looking for a top quality, 19-inch TV set that might serve as a standard of reference for all of the other products we test...video cameras, video cassette recorders, video cassettes.

"We thought the Magnavox picture quality and resolution were superb, and that off-the-air sensitivity was also extremely good.

"Major VHF channels were received with uniformly accurate color fidelity. This receiver produced superior color pictures even when using its own indoor VHF and UHF antennas."

"The special tuning features and remote control capabilities of the Magnavox receiver are awesome."

"The tuning system is purely electronic and totally digital," they continue. "There is a fine tune switch and a memory lock button. If any channel is received mistuned, the user simply fine tunes up or down in frequency by holding the button, and when perfect tuning has been achieved, the button is released and the memory lock button is depressed once.

"Nearby is Magnavox's Videomatic feature. Depressing this button activates the electronic eye for automatic brightness adjustment, color adjustment circuits and automatic fine tune."

"...unusually good for any receiver."

Overall, *Video Review* rated the Magnavox 9.5 or better (out of a possible 10.0) on Video Quality, Reception Sensitivity, Color Fidelity, and Video Resolution and Fidelity. As they put it, "...unusually good for any receiver."

We can only add that once you see a Magnavox color TV at your Magnavox dealer, we think you'll agree.

For Magnavox color TV specifications, write Magnavox Consumer Electronics Company, Dept. 700, P.O. Box 6950, Knoxville, Tennessee 37914.

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COMPUTERS

LEARNING ABOUT MICROPROCESSORS

How do microprocessors do what they do? Use an assembly language computer to find out.

JORMA HYYPIA

THE MOST ENJOYABLE WAY TO LEARN THE ESSENTIALS of computer programming is to play with a hobby-type computer that permits communicating with the machine in "plain English" by means of a typewriter-style keyboard. However, that way you learn little or nothing about the way computer magic is actually created by the complex patterns of electrical signals whizzing around through those mysterious "black-centipede" integrated circuits that cling to the PC boards inside every computer. To truly understand the more esoteric, fascinating *fundamentals* of microcomputer operation, you need to work with a training-type computer or with a hobby computer that uses assembly-language programming.

Comparing hobby computers that use the BASIC programming language with assembly-language training-computers is a little like trying to equate competitive Frisbee throwing with chess mastery. It can't be done because each requires the development of uniquely different special skills. So before plunking down several hundred dollars for a bona-fide trainer, know what it can and can't do. For

example, you should understand that it is *not* suitable for game playing and other conventional entertainment applications, or for balancing checking accounts. It is for serious study, either in an academic environment, or at home. through some sort of self-education program.

The five computers discussed in this article are reliable, thoroughly user-tested machines. They are anything but carbon copies of each other, since each offers unique options you should consider carefully before making a purchase. The E&L *MMD-1* computer is an outstanding example of a basic teaching and control computer. The *SYM-1* has found widespread use in computer-control applications. The *ELF II*, available in kit form, is the least expensive way for a soldering-iron hacker to get into assembly-language computing while still having the option of expanding the system by adding an ASCII-keyboard.

Computer knowledgeable readers may be puzzled by the inclusion of the *COSMAC VIP*, which is marketed as a home-entertainment computer. Its inclusion in this article is justified because it provides a comfortable middle ground for those who might be fearful of an all-out intellectual plunge into computer fundamentals. The *VIP* can be used to explore some of the more esoteric aspects of computer operation and programming; but it can also be used for highly entertaining game-playing when there is need of a temporary respite from study.

Finally, for those who want an easy-to-understand but thorough, course in computer fundamentals, there's the Heathkit *ET-3400* and its associated learning program.

Any one of those computers is ideal for an electronics hobbyist who invents computerizable gadgets, because it can be used as a control device as well as a learning aid.

All other factors being equal, you may wish to choose a training computer that uses the same microprocessor used in the high-level language computer you already own or plan to buy. That way your training will relate more directly with your other computer activities. For example, the *SYM-1* uses the 6502 microprocessor developed by MOS Technology that is also found in such popular computers as *Apple II, Challenger 1P, Superboard II*, and *PET*. The popular 8080A microprocessor, originally from Intel, used in the *MMD-1* is also found in *Compucolor II* and in the Heathkit *H8* computer. The *VIP* uses RCA's own 1802 microprocessor, which is also in *ELF II*. Heathkit's *ET-3400* features a 6800 microprocessor designed by Motorola. The Z-80 microprocessor developed by Zilog, used in the Exidy *Sorcerer* and Radio Shack's *TRS-80*, is, unfortunately, available only on fairly high-priced single-board computers.

Some general information

All of the computers discussed here are programmed in what's known as *machine language*. While programs written in machine language may take a bit more effort on the part of the programmer, they are worth it: They run more quickly and occupy less memory than programs written in BASIC—which you may already be familiar with from using hobby-type computers.

Machine language uses numbers, rather than words, to generate the binary code—ones and zeroes—that is used by the microprocessor as instructions and data.

Machine *code* (instructions in machine language) is generally expressed using one of two counting systems—*octal* or *hexadecimal*.

In our normal, non-programming, lives we use a counting system based on the number ten (0, 1, 2, 3, 4, 5, 6, 7, 8, 9). After "9," we move over one position and start again (10, 11, 12 ... etc.). The octal system uses the base eight. In octal, you count "0, 1, 2, 3, 4, 5, 6, 7, 10, 11, 12 ... etc." The number eight is represented by "10", nine by "11," and so on.

The hexadecimal system uses the base 16. In it, you count "1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, 10, 11 ... etc." The first six letters of the alphabet are used to represent single-digit numbers above nine—in hexadecimal, that is. Confusing as that may seem, it soon becomes second nature.

Hexadecimal (or *hex*, for short) is particularly convenient for working with eight-bit microprocessors because with just two digits you can express any value that requires eight bits or fewer.

In practice, you'll probably write your programs in *assembly language*. Assembly language uses abbreviations, called *mnemonics*, to give the programmer a kind of shorthand with which to work. Each mnemonic represents a computer instruction and has a corresponding *op code*—a hex or octal number that can be fed into the computer through a simple keypad.

After hand-assembling your programs using mnemonics, you'll translate the mnemonics to op-codes in hex or octal, and enter them into the computer.

Before you purchase your training-type computer, watch the prices carefully if you want to obtain full value for your dollars. In general, a training computer should cost substantially less than a good high-level language computer of comparable quality. However, you can pay a great deal more for the trainer of your choice than for one of the least expensive hobby jobs. It is impractical to specify prices in this article because market conditions could make them change by the time you read it. But, more important, what you pay depends on the extras you want, or *need*, to buy to make the computer of your choice fully operable.

Four of the five computers described here use simple LED readouts, but the *VIP* requires the purchase of an RF modulator so you can use a regular TV set as your display device. Although the *ELF II* has an LED readout, it too can be used with a TV set and RF modulator.

It is very important that you consider carefully the completeness and intelligibility of the instructional literature that comes with any computer. If it is inadequate, or simply hard to understand, you'll find yourself spending more money on books. And right there you have one of the most persuasive arguments for taking a good look at E&L's *MMD-1* if you want the best in self-education opportunities. The *Bugbook* literature that comes with it is without peer, especially because the text is intimately related to the *MMD-1* itself.

Mini-Micro Designer (MMD-1)

This trainer, which is widely used a an educational aid in computer schools here and abroad, and also as a control computer for industrial operations, makes use of an 8080 A microprocessor and octal notation. For any serious student/hobbyist, that computer stands out as the Rolls-Royce for both self-education and control applications. It comes complete with a power supply, for instant plug-in operation, and commands a premium price.

The basic unit comes with an octal keyboard, 24 discrete LED's that serve as readouts to tell you what is going on inside the computer, and a handy solderless breadboard on which to plug in simple electronic components for experimentation. Since those components are not soldered, you can disassemble an experiment quickly to clear the board for the next. If you intend to do a great deal of experimentation, the use of a second, outboard, solderless breadboard is strongly recommended since replacement of the built-in breadboard is difficult if it should be damaged.

You get 256 bytes—8-bit words—of RAM (*R*andom *A*ccess *M*emory) for programming, plus another 256 bytes of ROM (*R*ead *O*nly *M*emory) that control computer operations. The odds are that you will soon want to expand that basic setup by adding a memory interface upper-deck (see Fig. 1) that provides up to 2048 additional bytes of RAM plus the circuitry needed to interface the computer with a cassette tape-recorder and/or Teletype equipment. Beyond that, you can expand the memory all the way to 64K (65,536 bytes) if you have the need and can afford the cost.

To derive the greatest learning benefits

from the *MMD-1* and *Bugbooks*, plan to invest in at least some of the many outboard units that can be purchased factory-assembled or at lower cost, in kit form. But perhaps the best choice is a "student station" that incorporates many of the outboards into a single peripheral unit, and comes with an extra solderless-breadboard plus more than a score of extra IC's and other components for use in experiments.

The *MMD-1* comes with a keyboard executive (KEX) PROM (*P*rogrammable *R*ead *O*nly *M*emory) to handle the assembly-language instructions. You should start with that IC, plus an associated load/dump (L/D) IC because they relate best to the *Bugbook* text. Later you may wish to trade those PROM's for replacements, a combined KEX/L/D and a Monitor PROM, so that you can single-step through any program in *running* sequence, not merely through consecutive memory locations.

After completing the self-training course in microcomputer use, you can continue to use the *MMD-1* as an experimental tool and/or control device. For example, it could be used to operate a model railroad system automatically.

SYM-1

The *SYM-1*, shown in Fig. 2, is an extremely versatile machine constructed on a single 8 × 11-inch printed circuit board. It uses the 6502 microprocessor and is programmed in hex. The board includes a 28-key control pad for data entry, a six-digit 7-segment LED readout display, 4K bytes of ROM that contain the operating system and 1K of static RAM.

The board also contains five programmable interval timers, four relay drivers/input buffers, 15 bi-directional TTL-level lines, and 51 I/O lines (expandable to 71). Interfaces include a dual-baud-rate cassette recorder interface with remote control and RS-232 (serial) and TTY (parallel current-loop) interfaces.

On-board memory is expandable to 4K bytes (and even more, off-board) and there is provision for up to 28K bytes of user-programmable ROM.

Software options include an 8K Microsoft BASIC and a resident assembler/editor/loader, both in ROM. There is also a Keyboard Terminal Module that, together with an inexpensive RF adaptor and your TV set, gives you a complete computer system with keyboard entry and video display.

The *SYM-1* requires only a five-volt power supply. You can either provide your own or buy one specifically designed for the *SYM*.

One feature of the *SYM-1* that should not be ignored is that fact that is closely related to the recently discontinued *KIM-1*, a single-board computer that enjoyed great popularity among hobbyists and for which an enormous amount of software has been written. The *SYM-1* is *KIM-1*-compatible: Not only does it use the same microprocessor as the *KIM*, but one of the two cassette formats it uses for program storage is the same as the *KIM*'s *and* it uses the same hardware interface busses as the *KIM*. What this boils down to is that any software written and/or recorded for the *KIM* will also run on the *SYM-1*!

In addition to the *SYM-1*'s copious documentation (two thick manuals—*Reference* and *Programming*) the *SYM-1* user has at his disposal sources of information such as *The First Book of KIM* by Butterfield, Ockers and Rehnke (Hayden Book Company).

The *SYM-1* is not the least complex computer described here, but it is worthy of consideration by anyone who has committed himself to learning how microcomputers work and to making the most of the capabilities of his machine.

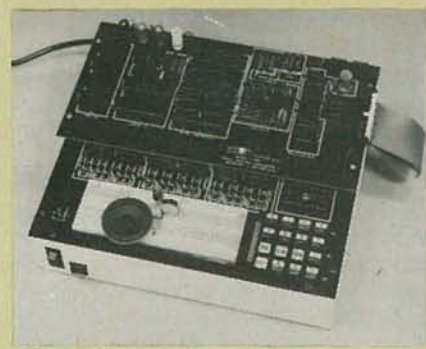


FIG. 1—MINI-MICRO DESIGNER, the MMD-1, from E&L Instruments, is shown with its memory expansion board.

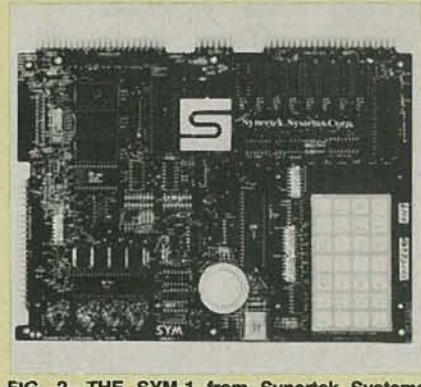


FIG. 2—THE SYM-1 from Synertek Systems Corporation is compatible with the KIM-1. It uses a 6502 microprocessor.

ELF II

This computer, which makes use of RCA's 1802 microprocessor, comes factory-assembled or as an easy-to-build kit that can be put together in one evening. Quality components are used throughout. The PC board, for example, is of highest grade, double-sided with plated-through holes. Sockets are provided for three of the 17 integrated circuits, and I picked up additional sockets for the other IC's for less than five dollars. I think that the slight extra expenditure for sockets is a good investment since they totally eliminate the chance of damaging IC's with soldering-iron heat, and because troubleshooting by component-substitution becomes a cinch. The kit-assembly instructions are very clear.

The kit costs under $100, and you can buy a power supply for about five dollars extra. Another five spent on Tom Pittman's *Short Course on Microprocessor & Computer Programming* would be no waste. You can also buy the *ELF II* fully assembled and tested, complete with power supply, RCA 1802 User's Manual, and the *Short Course*.

The *ELF II* features a full hex keypad, two-digit hex output display, stable crystal-clock for timing purposes, and 256 bytes of RAM that is expandable to 64K. Included in the kit is an RCA 1861 video-IC that permits display of your programs on any video monitor, or on a regular TV set by use of an inexpensive RF-modulator.

Most of the left-half of the PC board (see Fig. 3) is unused, but is ready for the addition of all kinds of add-on's as your needs and desires grow along with your increasing familiarity with the *ELF II*. Its 5-slot, plug-in, expansion bus permits you to add such features as: *Giant Board* kit with cassette I/O, a *Kluge* (prototyping) *Board* that accepts up to 36 IC's, 4K RAM boards, an ASCII keyboard, a light pen, a color graphics & music system and a video-display board.

Software available includes: Tiny BASIC, an assembler, a disassembler, the Elf-Bug monitor, and a text editor. There is also a recently introduced full BASIC that requires 8K of RAM plus ASCII and video-display boards.

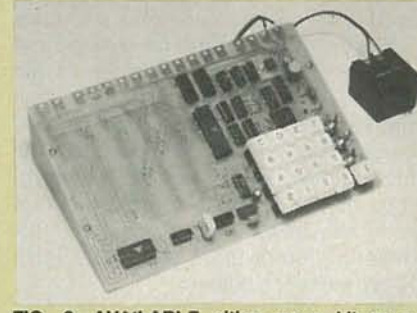


FIG. 3—AVAILABLE either as a kit or assembled, the ELF II from Netronics has 256 bytes of RAM (expandable to 64K).

All that can come later. If you are a novice, and are interested in gaining some insights into assembly-language programming, begin with the kit, which permits basic experimentation with such fascinating things as a counter, alarm system, lock, controller, thermostat, timer, and telephone dialer, to mention a few possibilities. The assembly manual includes a sample program that displays a picture of a space-

ship on your TV screen, and suggestions about where to obtain additional literature.

COSMAC VIP

That computer, shown in Fig. 4, uses RCA's own 1802 microprocessor and must be connected to a computer video monitor or to a conventional TV set by means of an RF-modulator. The modulator can be used with the add-on color board and a color TV if you want full-color pictures.

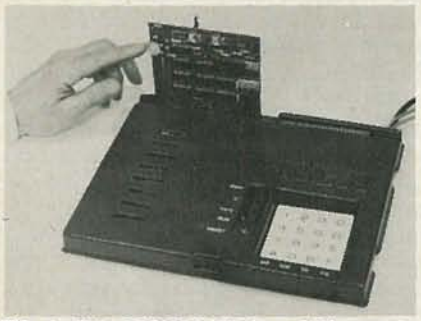


FIG. 4—THE COSMAC VIP from RCA must be connected to a video monitor or, using an RF modulator, a conventional TV.

The *VIP* comes with 20 interesting game programs that you can key into the computer with the hex keyboard, and then store on cassette tape for more convenient future use. Since the computer is not intended as a trainer, RCA provides no self-instruction material other than the programming manual. However, you can learn much about assembly-language programs just by studying the game programs in the manual in context with mnemonic code and other technical data also provided.

Several add-on modules are available. For example, a color board (*VP590*) greatly enhances games by displaying them in full color on your TV set. You can develop your own color programs with full control of both foreground and background colors. Conversion of the basic *VIP* board to color is easy. Just remove three IC's from the main PC board and transplant one of them to the plug-in color board. You must also reprogram the CHIP-8 control program used with black-and-white image programming into a more powerful CHIP-8X program for color.

For the ultimate in game-playing fun, also install a plug-in Simple Sound Board (*VP595*). If you have an early *VIP* model you may have to add several IC's and resistors to make the sound board operative. If your sound board puts out only a continuous tone that can't be shut off except with the main power switch, look for the missing components.

For more serious electronic music-making, try the Super Sound Board (*VP550*) that features *two* independent sound-generating systems so that you can obtain stereo music on your hi-fi audio equipment. There's independent control of note frequency, duration, and amplitude for each channel, and you can program both melody line and harmony. It's even possible to add an optional drum synthesizer.

The instruction manual provides a short course in music writing, and shows how to convert any sheet music into computer language so that the music can be played through a home hi-fi system. You need know nothing about writing or reading music, and you don't even have to know how to play a kazoo to make electronic music, or to create all sorts of weird sounds, including "outer space" type music.

My only problem with the Super Sound Board came with writing the required PIN-8 machine-language program that drives the system. More than 3,500 digits on a reference sheet must be keyed into the computer memory correctly or the program "bombs out" and you have to start all over again. For that reason, be sure to make a copy of your freshly keyed-in program on cassette tape *before* you attempt to run it! That way, if it bombs, you can quickly put the defective program back into memory for debugging. It's a lot less painful than starting all over again from the beginning. If you still have trouble, try to borrow a demonstration tape from your *VIP* dealer, or make a copy in his store. But that's the easy way out.

Heath ET-3400

For those interested in working with the 6800 microprocessor, Heathkit's *ET-3400* (Fig. 5), available either in kit form or assembled, fills the bill.

It has its own power supply and comes with 256 bytes of RAM (expandable to 512 bytes) and a 1K monitor program in ROM. Programming is done in hex using a built-in keypad and data is displayed by six 7-segment LED's.

One nice feature of that computer trainer is a built-in solderless breadboard for prototyping and interfacing, and for memory circuits that can be connected to the microprocessor. Associated with the breadboarding section is an 8-position DIP switch for inputting binary data to circuits built on it, and eight discrete LED's to indicate logic states within those circuits.

Heath also has an accessory, the *ETA-3400,* that connects to the trainer by means of a 40-wire ribbon cable. The unit comes with 1K of RAM and can be expanded to 4K. It has an RS-232 serial interface for connection to a teletype or video terminal, and an audio cassette interface that permits programs to be stored.

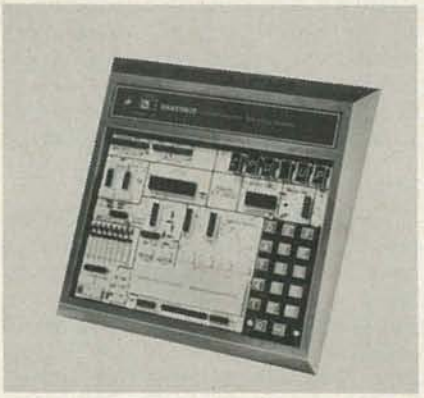


FIG. 5—A BUILT-IN solderless breadboard is among the features of the ET-3400 computer trainer from Heath.

Also included with the *ETA-3400* is a Tiny BASIC interpreter in ROM. Working from a terminal, you can program in BASIC and, from within a BASIC program, call machine-language routines that were written using the trainer.

To round things out, Heath offers a Microprocessor Self-Instruction Program (course) that uses the *ET-3400* as a teaching tool.

As was stated at the beginning, working with a training-computer or other assembly-language machine is very different from keyboard/video chatting with a high-level language computer that tells you when you've made a mistake, and that may even suggest where to look for the trouble. Not so with training computers. So you'll have to apply yourself a lot harder, but that's the way you'll learn about microprocessors. Learning the inner secrets may not be as tough as learning chess, but it will be no Frisbee-fling either. Still interested? Then it's your move! **RE**

MANUFACTURERS

Write to the following manufacturers if you are unable to find detailed information about any of these microcomputers through local retail computer stores:

MMD-1: E&L Instruments, Inc. 61 First Street, Derby, CT 06418
CIRCLE 95 ON FREE INFORMATION CARD

SYM-1: Synertek Systems Corporation, P.O. Box 552, Santa Clara, CA 95052
CIRCLE 96 ON FREE INFORMATION CARD

COSMAC VIP: RCA Cosmac VIP Marketing, New Holland Pike, Lancaster, PA 17604
CIRCLE 97 ON FREE INFORMATION CARD

ELF II: Netronics R&D Ltd., 333 Litchfield Road, New Milford, CT 06776
CIRCLE 98 ON FREE INFORMATION CARD

ET-3400: Heath Company, Benton Harbor, MI 49022
CIRCLE 99 ON FREE INFORMATION CARD

RCA VIDEODISC CIRCUITRY

It sure doesn't work like a VCR. Look what happens between picking the signal off the disc and converting it into something that will produce a picture on your TV

CHESTER H. LAWRENCE

IN THE OVERVIEW OF THE RCA VIDEODISC system presented last month, we pointed out that the output signal from the pickup arm was composed of several separate signals. This month we will follow the video and see how it is processed by the videodisc player circuitry.

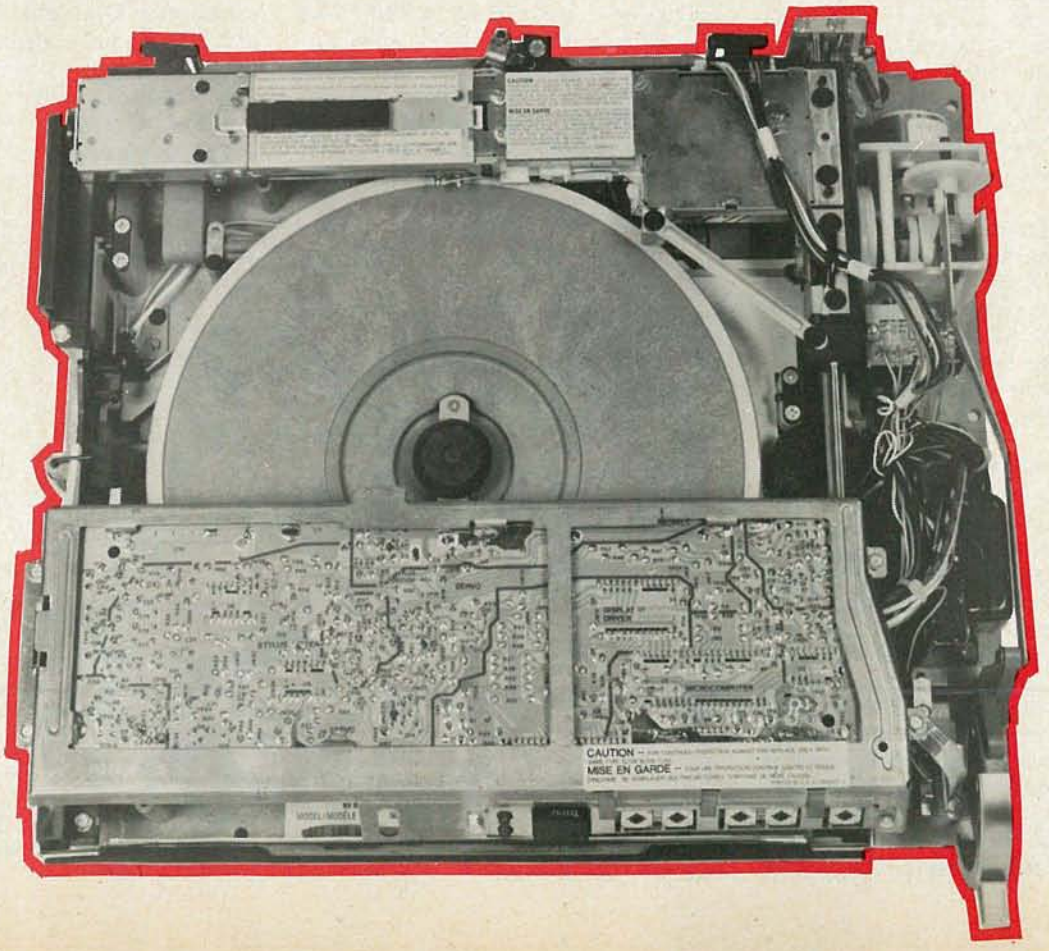
Figure 1 is a block diagram of the video-processing circuitry. Since the signal from the pickup arm includes a 260-kHz servo signal that could interfere with the demodulation of the video carrier, the composite signal from the pickup arm is first fed through a 260-kHz trap that removes the servo signal, thus eliminating this source of possible interference.

Another potential source of trouble is the relatively low-frequency 716-kHz sound carrier. It can cause modulation of the spacing between the stylus and signal on the disc. The phase modulation of the video carrier that results can result in an undesirable 716-kHz visual beat (sound beat) in the video picture on the TV screen.

To keep this from happening, the NLAC (*N*on-*L*inear *A*perature *C*orrection circuit) shown in Fig. 1 separates the sound-beat information, phase inverts it and adds it to the original signal. In effect, this cancels the sound-beat signal before it can appear in the video FM signal.

After passing through the NLAC, the video carrier is fed through a 2- to 9-MHz bandpass filter network and then on to the video demodulator. In the video demodulator, the video carrier is demodulated to develop the composite video signal that is fed to the comb filter.

The defect detector is also a part of the video demodulator. It is activated whenever a defect in the video carrier is spotted. When the defect detector is activated its output is applied to the comb filter. It causes the comb filter to automatically insert the corresponding portion of the previous horizontal line of information into the output signal whenever a defect is spotted. In this way, momentary defects in the video



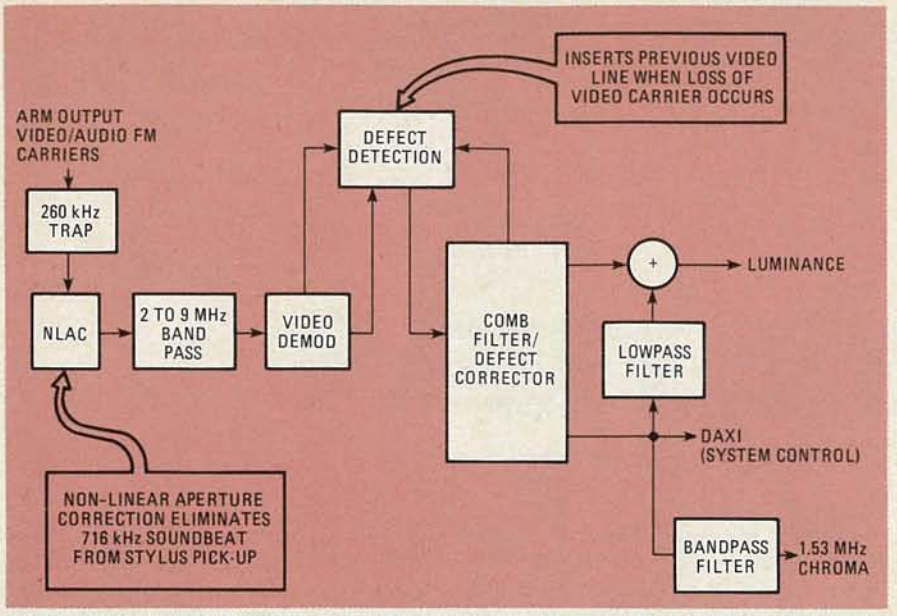


FIG. 1—BLOCK DIAGRAM OF THE VIDEO PROCESSING circuitry. The NLAC and DEFEAT DETECTION blocks represent circuits you probably haven't even seen before.

carrier do not appear as visible noise impulses on the picture displayed on the TV screen. Instead the previous horizontal line fills the gap. The fault circuit can fill up to three horizontal lines with color information before any visible degradation in the signal performance becomes noticeable to the viewer.

The comb filter is primarily used to separate the chrominance and luminance signals. Efficient chrominance/luminance separation is rather important, because the RCA videodisc system uses a "buried" subcarrier system that places the chrominance information at a subcarrier frequency of 1.53-MHz. This frequency is approximately at the midpoint of the luminance bandpass.

The chrominance information, however, is frequency interleaved with the luminance. As a result, the energy content of the chrominance signal is spaced at 1/2 the horizontal-rate difference from the luminance signals. This is why the comb filter can effectively separate these signals.

Non-linear aperature correction

The signal from the pickup arm is a composite of several signals. These include the 5-MHz video FM carrier, a 716-kHz audio FM carrier, a 260-kHz servo-sensor signal and a 5-MHz ±716-kHz beat signal. The servo-sensor signal is eliminated by a trap in the bandpass filter that passes frequencies between 0.5 and 9 MHz. But this filter and trap cannot eliminate the 5-MHZ ±716-kHz beat signal. If this signal is not eliminated undesirable sound beats appear on the screen of the TV being used to watch the videodisc picture.

Figure 2 shows the circuitry that corrects for the 716-MHz soundbeat signal. The video FM carrier is applied to the base of Q101, the NLAC buffer, after passing trhough the bandpass filter. The buffered signal from Q101's emitter is then fed through RC network C106, R108, and C104 to the base of Q103, the NLAC amplifier. This signal contains the audio carrier and the video carrier plus an in-phase soundbeat.

At the same time the signals from Q101's emitter are also fed through capacitor C105, diode CR102 and capacitor C108 to Q102's collector. Diode CR102 mixes the video and audio carrier signals and generates a 5-Mhz ±716-KHz soundbeat signal that is 180° out of phase with the beat signal amplified by Q101. The in-phase audio and video carriers are also there after mixing.

Since the signal from Q101's emitter is also coupled to the base of Q102; diode CR101, which is connected from Q102's emitter to ground through C107, conducts out of phase with diode CR102. This produces a soundbeat signal that 180° out of phase with the soundbeat signal from diode CR102. This signal is inverted by Q102 and along with the signal from CR102 appears at Q102's collector.

In Q103's base circuit, the 180° phase-shifted 716-kHz soundbeat is added to the in-phase 716-kHz soundbeat from Q101's emitter. This cancels the soundbeat information in the video carrier signal, which is then amplified by NLAC amplifier Q103 and NLAC driver Q104. The output signal is coupled from the emitter of Q104 and supplied to the video demodulator circuit.

Video FM demodulator

The video FM carrier output from the NLAC circuit, after having been corrected for sound-beat information, is supplied through a 2- to 9-MHz bandpass filter to pin 3 of video demodulator IC U201 (see Fig. 3). The incoming FM video carrier is first amplitude limited by a limiter stage and then coupled to one input of a phase-lock-loop detector. The other detector input is a 5.3-MHz VCO signal. Its center frequency is set by C215. This capacitor is connected between pins 5 and 6 of the integrated circuit. A filter network is coupled to pins 5 and 6 of the integrated circuit to filter the PLL (*P*hase *L*ock *L*oop) feedback signal.

The modulation on the video FM carrier causes the frequency of the

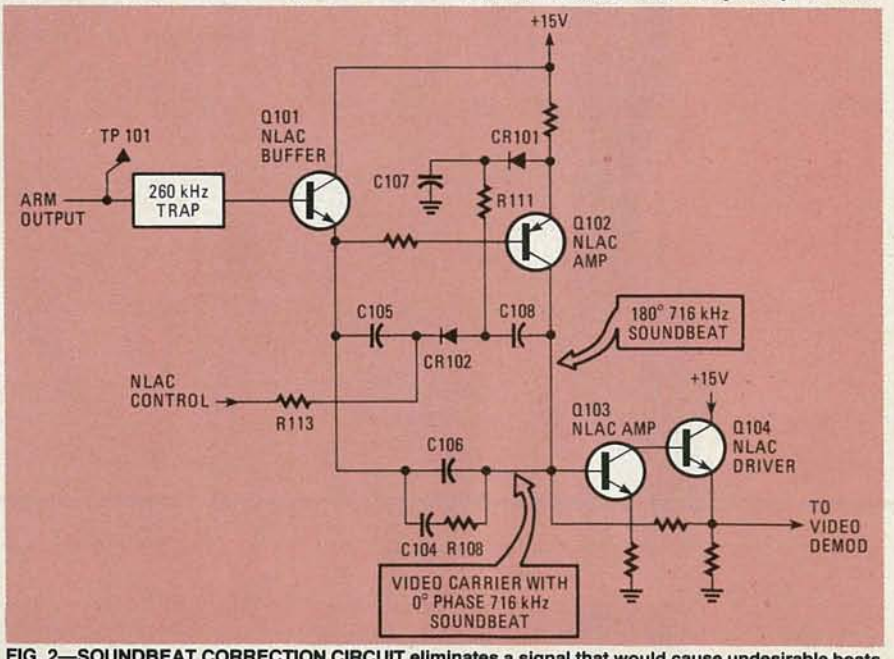


FIG. 2—SOUNDBEAT CORRECTION CIRCUIT eliminates a signal that would cause undesirable beats to appear in the picture on the TV screen when the videodisc is played.

carrier to vary. The PLL detector generates a difference signal that is proportional to the instantaneous phase difference between the carrier and VCO reference. This difference signal (or error signal) controls the frequency of the 5.3-MHz VCO to maintain phase lock between the carrier and the VCO. Since the VCO frequency is forced to track the carrier, the error signal, that controls the VCO, is the original video information.

Demodulated video output exits the integrated circuit at pin 7. Here it is filtered and then coupled to the base of phase equalizer transistor Q201 through VIDEO LEVEL ADJUST control R202. After being phase equalized by Q201, the signal is reinstated into the integrated circuit at pin 9 where it passes through a gated inverting amplifier and leaves the IC at pin 11.

Before demodulation, the amplitude-limited video carrier signal is applied to a defect-detection circuit in U201. It compares the incoming video FM carrier with the VCO. The defect-detector circuit generates a logic HI whenever video-carrier loss is detected. The logic HI defect-detector input is fed through an inverting amplifier to produce a logic LO output during a defect. The logic LO defect-detector output pulse at pin 13 is coupled to the comb-filter circuit to gate ON the defect-correction circuitry.

During LOAD/UNLOAD, RAPID ACCESS FORWARD and REVERSE, and PAUSE, the output of the video FM demodulator is "squelched" to prevent noise from appearing on the TV receiver screen. This is done by applying a NOT SQUELCH signal ($\overline{SQ}$) to pin 8 of the integrated circuit. Internally, the squelch circuitry controls both the inverting amplifier that provides the composite video-output signal to the comb filter, and the defect pulse-inverter circuit. The squelch action on the defect-inverter circuit prevents the defect gate output from going to a logic LO when the carrier disappears because the stylus has been lifted off the disc. If the defect-detection output were not disabled, the comb-filter circuit would continue to recycle the previous horizontal line of information.

When the NOT SQUELCH line returns to logic HI, the video demodulator is allowed to operate. However, noise generated by lack of video carrier does not appear in the demodulator output signal at pin 11. Internal positive-going defect-detector pulses, generated when the PLL detector is unlocked hold a charge of about 2 volts on C221 connected to pin 10.

As the stylus begins picking up good signals and the demodulator PLL locks, the defect pulses cease, allowing the voltage on C221 to discharge to 1 volt through the time constant of C221 and R212. At this point, the internal squelch circuitry is deactivated allowing the video-demodulator output amplifier to resume normal operation.

The time constant of C221 and R212 allows enough time for adequate video carrier to be recovered. This provides nondistorted video information to the display when returning to the PLAY mode. Once the squelch system unsquelches, the squelch circuit no longer responds to defect pulses. Therefore, the system can only be squelched by pulling pin 8 LO via the NOT SQUELCH line.

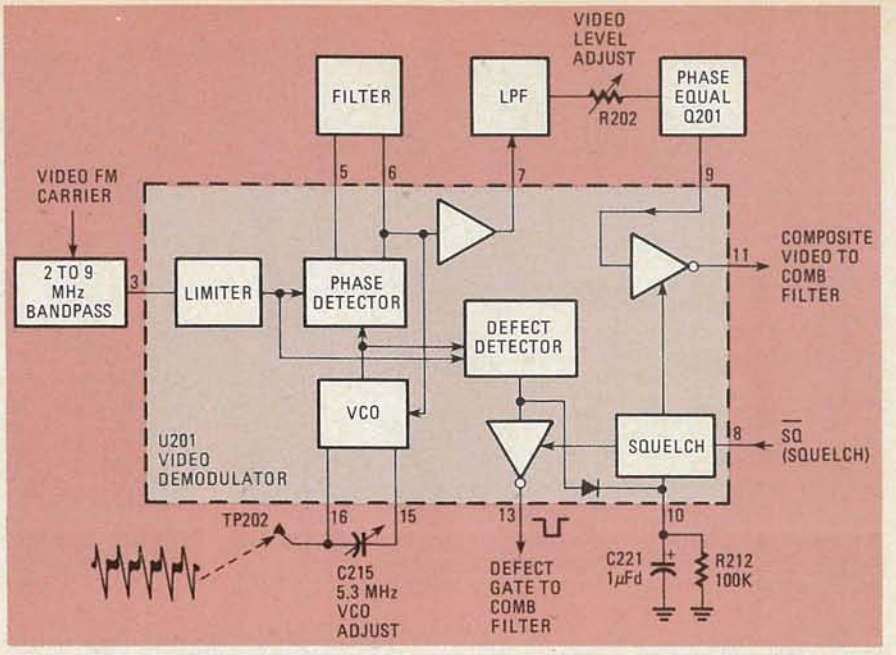


FIG. 3—VIDEO FM DEMODULATION CIRCUIT is effectively contained in a single IC. Note that the defect detector is also built into this rather special-purpose device.

Comb filter/defect corrector

Figure 4 is a simplified diagram of the video-processing operation. You'll note that the composite video from the video demodulator is fed to one input of an electronic DEFECT SWITCH. This is built into the comb-filter IC. At the same time, delayed video is fed to the other input of the DEFECT SWITCH.

The defect gate pulse from the video demodulator automatically switches the input to the comb filter from the composite video output from the video demodulator to the delayed video input from the comb filter delay line, whenever the defect pulse appears.

When the video carrier is recovered, the defect gate pulse goes HI, switching the comb-filter input back to the normal composite video output from the video demodulator.

In addition to supplying the delayed

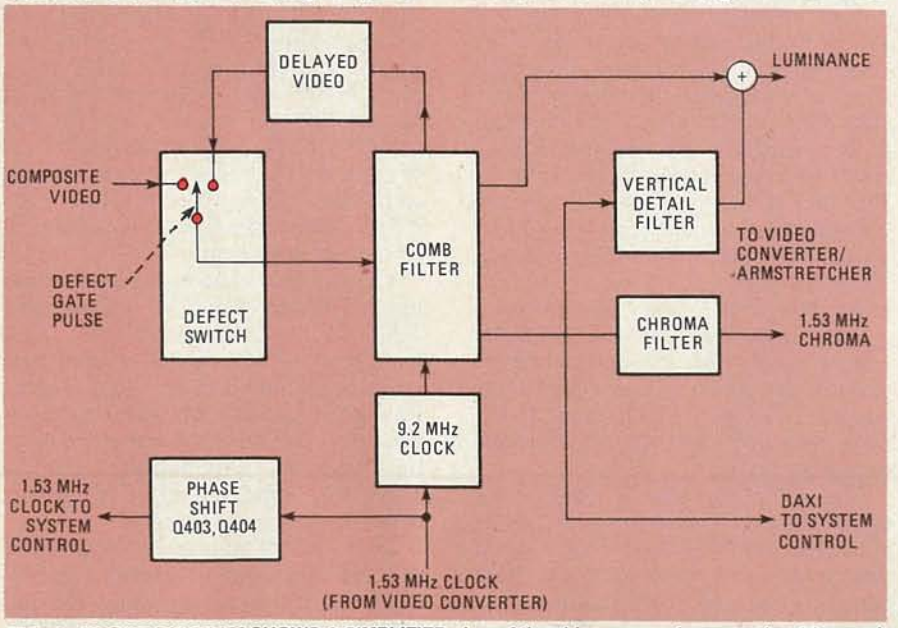


FIG. 4—BLOCK DIAGRAM SHOWS A SIMPLIFIED view of the video processing operation. The comb filter is fed the composite video signal circuit or a delayed composite video signal. The decision is made by the defect switch.

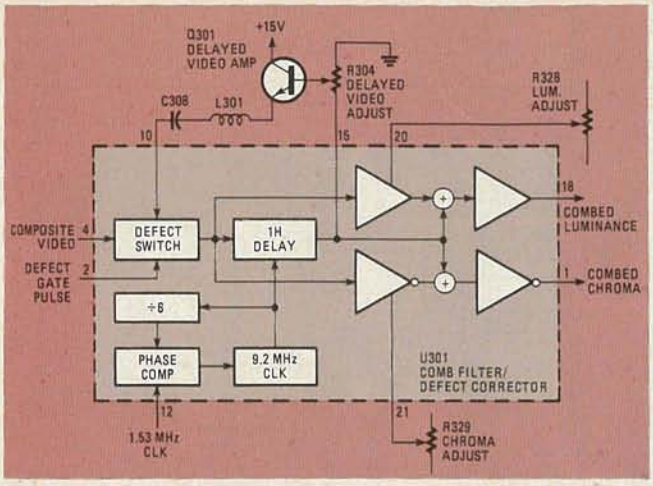


FIG. 5—COMB FILER/DEFECT CORRECTOR operation is detailed in this block diagram. It's important that you understand how it works.

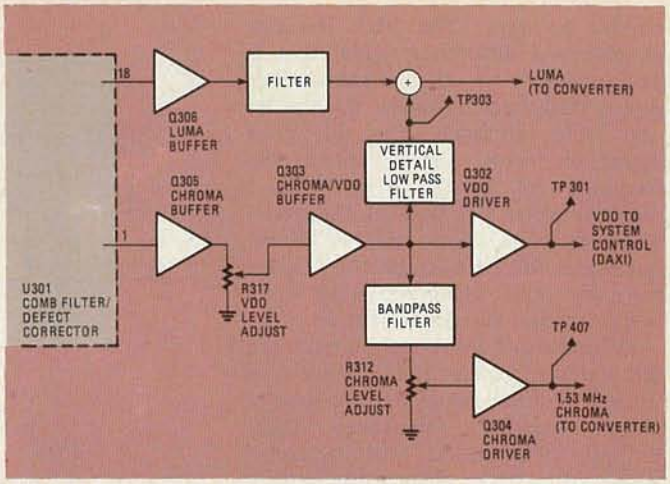


FIG. 6—FOLLOWING THE COMB FILTER some additional signal processing is required. Details are shown here.

video signal, the comb filter also separates the luminance and the buried subcarrier chrominance information. The combined chrominance is then bandpass filtered to separate the vertical detail and DAXI (*D*igital *A*u*X*iliary *I*nformation code used to develop the time indication) from the combed chrominance signal.

The comb filter uses a 9.2-MHz clock that is developed from the 1.53-MHz clock signal generated by the video converter. This 1.53-MHz signal is also fed through two phase-shifting transistors to provide the clock signal needed by the system control circuits.

As shown in greater detail in Fig. 5, composite video from the video demodulator is applied to pin 4 of U301, the comb-filter defect corrector. The defect gate pulse from the demodulator is applied to pin 2. Delayed video information from the comb filter's output appears at pin 15 and is applied through R304 the DELAYED VIDEO ADJUST control to the base of Q301 the video amplifier. The signal is amplified by Q301 and returned to the defect switch through pin 10.

During normal operation the input to the delay line consists of the composite video output from the video demodulator. Whenever the video-carrier signal is lost, the defect gate pulse on pin 2 of U301 goes to Logic LO. This switches the defect switch so it now supplies the delayed video signal.

If the video carrier is lost for an extended period, the horizontal line of information that occurred before the video-carrier loss is recirculated through the delay line and back to the defect switch several times.

At the same time the composite video is fed to the delay line, it is also coupled to two separate amplifier channels. One of these is the luminance pass channel. This signal is amplified and its gain controlled by R328 the LUMINANCE ADJUST control.

The amplified signal is then fed to one input of an internal adder circuit. The other input to this adder circuit is fed from the output of the delay line. Since adjacent lines of luminance information contain essentially the same information, the adder's output will be the sum of the luminance signals. However, since the chrominance signals have a 180° phase shift from one line to the next, these signals will cancel, removing chrominance information from the adder's output. As a result, the signal at pin 18 contains only combed luminance information. All of the chrominance signal has now been eliminated.

The incoming composite video from the defect switch also passes through the chrominance pass channel. The chrominance pass-channel amplifier is an inverting amplifier whose gain is controlled by R329, the CHROMINANCE ADJUST control.

The inverted signal from this amplifier is then fed to one input of another internal adder circuit. The other input of this adder is the delayed composite video. Because of the inversion in the amplifier, the chrominance information that appears at the inputs to the adder are now in phase and a combed chrominance output appears at pin 1 that is twice the value of the incoming chrominance.

At the same time the inversion results in the luminance signal being out of phase with the delayed signal and the luminance signals cancel in the adder. Therefore, the luminance has been removed from the chrominance output at pin 1.

The delay line that is used in the comb filter is driven by a 9.2-MHz clock. Its output is divided by six and then applied to a phase comparator that compares the phase of the divide-by-six clock signal with the 1.53-MHz clock signal from the video converter. The phase comparator output is then applied to the 9.2-MHz clock voltage-controlled oscillator to insure that the clock signal is exactly six times the 1.53-MHz clock rate.

After being processed by the comb filter, the combed chrominance information from pin 1 of U301 is passed through Q305, the CHROMA BUFFER as shown in Fig. 6. The chroma signal is then fed through R317, the VDO LEVEL ADJUST (*V*ertical *D*etail *O*utput) control to Q303 the VDO BUFFER transistor. Q303's output is then split into three. One path is through a filter network that passes only vertical-detail output signals. These signals are coupled to an adder, where they are combined with the combed luminance.

Another output from Q303 is applied through VDO driver Q302 and contains the DAXI code that is coupled to the system control circuit.

The third combed chrominance signal from Q303 is applied to a bandpass filter that passes only frequencies between 1 and 2 MHz. This signal contains the chrominance information (1.53 MHz ±500 kHz). The output of this bandpass filter is fed to R312, the CHROMA LEVEL ADJUST control. Its arm is connected to the CHROMA DRIVER transistor, Q304. The resulting 1.53-MHz chroma subcarrier is then coupled to the video converter IC.

The combined luminance information taken from pin 18 of U301 is coupled to Q306 the LUMINANCE BUFFER. And from there it goes through a filter network to one input of an adder circuit. The other input to this adder contains the signal that has been separated from the combed chrominance output. These two signals are added to develop complete combed luminance.

Now that we've taken a trip through the video-processing circuitry of the RCA videodisc player there are important circuits still to be described. We will examine more of them next month. **R-E**

JAMES A. GUPTON JR.

Computer Control for the UNICORN-1 ROBOT

Part 10—If your robot is going to use computer control, here are some thoughts on the subject that will help you in setting up your system.

WITH THE UNICORN-1 ROBOT OPERATING under radio control, what now? Why, *computer* control, of course! This part will deal with that subject, although, because of its complexity, only in general terms.

For those of you already involved with computers—micro or otherwise—much of what will be discussed here may seem elementary. For those who have not yet been exposed to that fascinating area of electronics we will try to keep things as simple as possible.

What will be covered here will be the *concepts* involved in having the actions of a robot determined by an electronic device rather than by a human operator. That's where much of the challenge of computer control comes in.

A human can exercise his judgment—without necessarily having to think about it—and change the robot's actions to meet the circumstances. The computer also has to exercise judgment, but before it can do that it must be taught—or programmed—*how* to make judgments; that involves a great deal of highly detailed programming.

For those of you who are unfamiliar with computers, it is not enough just to connect a computer to the robot and say, "Go ahead . . . do your stuff." Every action must be pre-planned, and, more important, every consequence of every action must be considered and the appropriate reaction prepared.

That is one reason why we will not present specific programs for robot control but will, instead, talk about the way those programs will have to function.

Methods of computer-control

To put it broadly, there are three ways that a computer can be used to control the robot's actions.

The first, and simplest, would substitute a computer, *located outside the robot*, for the command consoles described earlier in this series. That computer would be linked to the robot either by cable or by radio.

The program for that system would be fairly simple and would allow the operator to type in a command, to which the robot would respond. For example, entering "GO" or "G" would cause the robot to move forward; "TURN LEFT" or "L" would cause it to turn to the left, and so on.

That elementary program could be modified to operate with a speech-recognition device—several of which are available for a couple of hundred dollars—to allow the robot to respond to the spoken

word. The vocabulary would be limited (but adequate) but the commands would have to be given to the external computer, not to the robot directly.

The second system would be a program, or series of programs, that would command the robot to perform a predefined sequence of actions.

For example, the robot might be instructed to move forward for ten seconds, stop, raise its right arm in a salute, beep its horn, and then turn around and return to its starting position.

Such programs could become very elaborate, but have a major drawback. Unless the robot is equipped to respond to its environment (and, so far, it isn't) any unknown factor that enters the picture could have serious consequences.

Using the program above as an example, suppose that, unknown to you, the robot is facing a brick wall, five feet in front of it. Shortly after the robot begins to carry out the instructions given to it by the computer, it will run smack into that wall! Not only will that interfere with the rest of the program, but it can also cause damage to the robot and, possibly, the wall. Or maybe, instead of a brick wall, there's a person or a piece of furniture in the way. The overall damage—and its consequences—could be considerably more serious.

In any case where the robot is operating without human intervention, provision must be made for the program to be overridden!

Any program of that nature must contain some means for the human supervisor to stop or alter the robot's actions at any time. That is one reason that the "drop-dead" circuit was included on the latch board (Part 9)—one command would activate that circuit and cause the robot to stop in its tracks, should any unforseen circumstance arise.

The third method of computer control, and the most fascinating, involves the robot having its own, on-board, computer. The precautions given for the second method also hold here. We'll talk about that method in more detail shortly.

Interfacing

Whichever method is chosen, the robot must be equipped to respond to (and, perhaps, "talk back" to) the computer. Fortunately, the circuits already being used by the robot are designed with that in mind.

There are two formats that computers can use to output data or to receive it: *parallel* and *serial*. The parallel format is always used by the computer internally.

The unit of information that the computer uses for communication is called a *byte*. A byte is made up of eight bits (*bi*nary dig*its*)—each one either at a logic-"high" or logic-"low" state—and the computer operates on all eight bits at once. Frequently, when a computer is used to operate a printer, the parallel format is used and eight lines are used to connect to the printer—one for each bit of the byte.

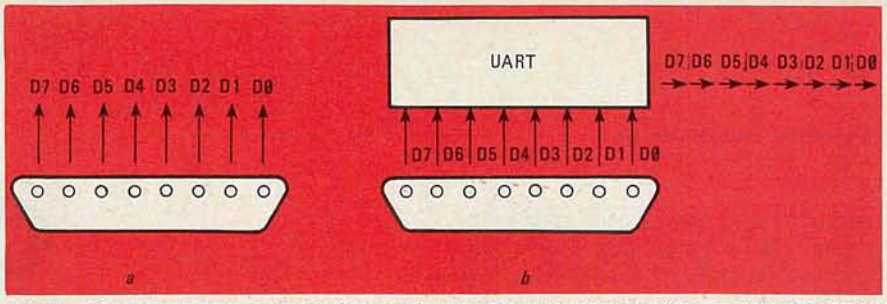


FIG. 83—ALL THE BITS of a byte are sent simultaneously in parallel communications (*a*). A UART (*b*) converts parallel data into serial data for transmission over a single line.

On the other hand, sometimes it is convenient—or even necessary—to transmit computer data using only a single line (by telephone, for example). In that case, the serial format is used. The computer takes each byte and sends it out bit-by-bit, one after the other, indicating the beginning and end of each byte. At the other end, the eight bits are received in the order in which they were sent; when they have all arrived, they are used in parallel. Both of those systems are illustrated in Fig. 83. The device that performs the parallel-to-serial and the serial-to-parallel conversions is known as a UART (*U*niversal *A*synchronous *R*eceiver/*T*ransmitter). UART's would be used if commands were transmitted to the robot by radio.

If you connect your computer to the robot by means of a cable from the computer's parallel port, it would be a good idea to use twice as many lines as necessary (16) and ground every other one. That will help keep electrical noise from getting mixed in with the data.

(For more information on how computers operate see "Your Own Computer" in the October 1980 issue of **Radio-Electronics** and the article on assembly language computers on page 45 of this issue.)

The decoder-, latch-, and relay-driver-boards in the Unicorn-1 use parallel data. Using the same technique as used with the 7402 IC's on the decoder board, any two bits of an eight-bit word (byte) can be NOR'd or NAND'ed to produce a single control bit for the relay-driver board. If you're knowledgeable, more complex and versatile encoding/decoding schemes can be used.

Which computer?

There are two classes of computers that must be considered: those for external use and those that can be mounted on-board the robot.

Almost any computer that has at least one parallel port can be used for the first purpose and it is not our intention to single out one manufacturer's over the other. If you are contemplating buying a computer, refer to the articles mentioned above.

The important thing is that the computer be equipped with a parallel port and that it be flexible enough to meet your needs—present and anticipated. For example, if you are considering using voice control, make certain that there is a speech-recognition board available for your computer.

It should be noted that some computers—such as the Radio Shack *TRS-80* and the Commodore *PET*—do not have parallel ports as such, but that their expansion connectors—frequently used to connect to printers—are actually just that. The thing to look for is eight *data lines*, usually designated "DØ" through "D7." If you have those, you have your parallel port.

You will also want a cassette and/or disk interface to allow you to save programs that you have written for the robot.

One thing you should avoid are inexpensive computers that are actually glorified video games. They generally will not have the facilities you need and it will prove difficult (or impossible) to add them.

The other possibility is a single-board computer that can be mounted in the robot. In addition to a parallel port and cassette interface, that computer must also have a hexadecimal ("hex") keypad for programming, and some kind of LED display, if it is not going to be used together with an external computer. An example of how such a computer would be interfaced to the robot is shown in Fig. 84.

A good computer for the purpose is the *KIM-1*. Unfortunately, that computer was recently discontinued; but you may still be able to find one here and there. Other possibilities include the *SYM-1* (a sort of super *KIM*), the *ELF-II* or the *Explorer/85* (keypad version). Again, refer to the article on page 45. Both the ELF-*II* and the Explorer/85 are manufactured by Netronics, 333 Litchfield Road, New Milford, CT 06776. The SYM-1 is produced by Synertek Systems Corporation, P.O. Box 552, Santa Clara, CA 95052.

Bear in mind that some of those computers may require a power supply other than 5- or 12-volts DC. In that case a power inverter (see Fig. 85) can be used to turn the robot's 12-volt supply into 117 VAC, which the *computer's* power sup-

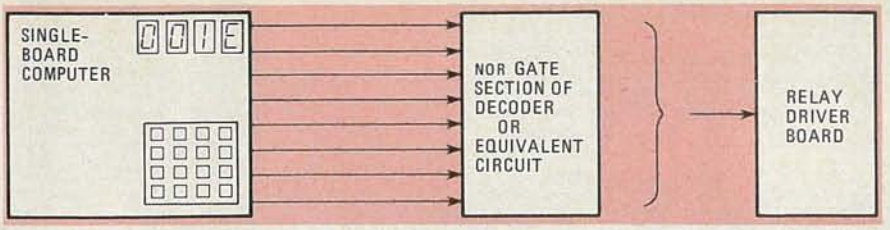


FIG. 84—SINGLE-BOARD COMPUTER can be connected to NOR gate section of latch board or to an equivalent circuit designed to give a single output from a two-bit input. That is only one of many possible schemes.

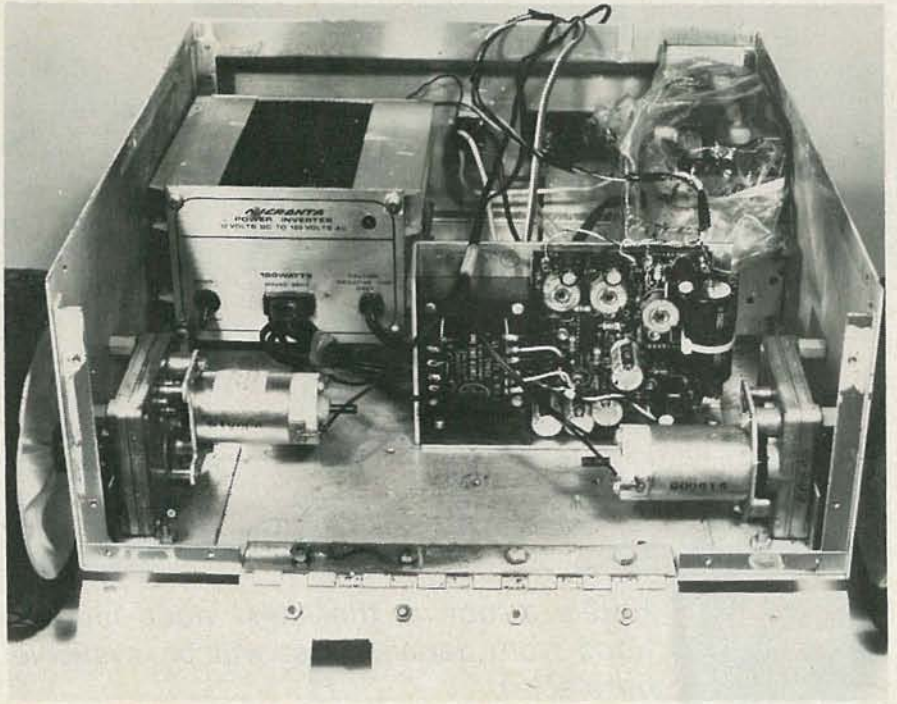


FIG. 85—AN INVERTER (left rear) may be needed if the on-board computer has power requirements other than +5 or +12 volts DC.

ply can then convert readily to its own requirements.

Finally, if you already own a computer but intend to install another in the robot, it would be a good idea to make sure that both computers use the same-type, or compatible, microprocessors. The *KIM-1* and *SYM-1* use the 6502, which is also found in the *Apple II,* OSI *Challenger(s)* and the *PET*, and the Z-80 in the *TRS-80* is compatible with the *Explorer/85's* 8085.

The 1802, used in the *ELF II* and in RCA's *VIP*, is not normally found in larger computers, but that does not mean that an 1802-based single-board computer should not be used in the robot.

The fact that both of your computers use the same microprocessor means that both of them speak the same language, at the microporcessor level. That, in turn, means that you can use your larger computer to develop and debug (troubleshoot) programs to run on the robot's computer and to *download* (transfer from the larger to the smaller computer) those programs, either directly or, if the cassette interfaces are of the same type, from tape.

The programming itself will also be easier, since—assuming that your programs are in machine language and not in BASIC—you will be able to use an assembler, making your work go more quickly and also making it easier to follow the flow of the program.

Programming

As you may have gathered by now, it would be impossible to present computer programs for robot-control, there being so many variables involved.

If you are working with an external computer, you will probably want to work in BASIC or another high-level language, using the OUT command, or its equivalent, to transfer data to the robot.

As mentioned above, the on-board computer will almost certainly have to be programmed in machine language. It's more difficult to work with than BASIC, but it *does* have advantages. Programs take up much less memory space, and also run more efficiently. You may even want to write your "big-computer" programs entirely in machine language through the use of an assembler.

This section has of necessity, been sketchy: after all, even books on the subject have not been able to cover the matter completely.

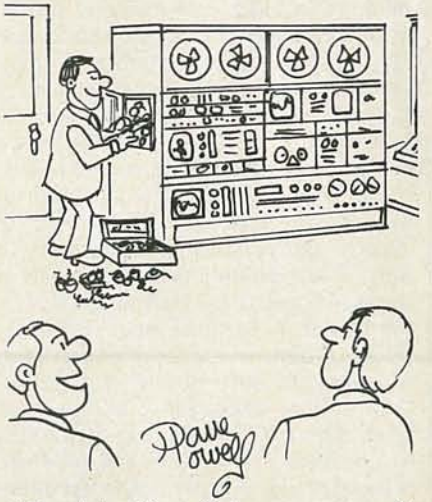
If you are going to use a computer with your robot, we recommend that you do as much supplementary reading as you can. Personal-computer magazines such as Byte magazine and Interface Age have had special issues dealing with robots, and the subject comes up frequently there and in other computer publications. Another good source of information that is often overlooked is your local library.

Todd Loofbourrow's book, *How to Build a Computer-Controlled Robot* (Hayden Publishing Company) contains a number of robot-control programs written for the *KIM-1* (or *SYM-1*) as well as a number of more generalized flowcharts. Much of the information presented there may be adaptable to your robot.

A very good—although rather technical—article on "An Interactive Programming Language for Control of Robots" by Li Chen Wang appeared in the September 1977 issue of Dr. Dobb's Journal of Computer Calisthenics & Orthodontia. It involves a robotic simulation on a computer's video display and its principles could be adapted to control a "flesh-and-blood" robot. (That issue, #18, Volume II, No. 8, is available in limited quantities from: Dr. Dobb's Journal, 1263 El Camino Real, Box E, Menlo Park, CA 94025 for $2.50, postpaid, second class.) It's worth looking into for readers already familiar with computer programming.

In the next part of the Unicorn-1 series we will take a look at sensors. We will discuss sensors in general, and show you some specific examples that can allow your robot—and the computer that controls it—to respond to the world around it.

We would like to hear about how you're doing with your version of Unicorn-1. Write (and send photographs) to: ROBOT UPDATE, **Radio-Electronics,** 200 Park Avenue South, New York, NY 10003. **R-E**



"Charlie's OK at fixing computers. He seldom does any damage that an electronic technician can't repair."

HOME VIDEO UPDATE

LEONARD FELDMAN
CONTRIBUTING EDITOR

Here's a look at the latest video innovations from Japan. Most will be available here soon.

THE EMPHASIS IN HOME-ENTERTAINMENT products seems to be shifting, at least for the moment, from high-fidelity components to video and its many related products. Both in the United States and in Japan, new video products and advances in video technology abound. In this article, I will present a few of the newsworthy developments that have come to my attention in recent weeks.

Having just returned from a visit to the Japan Electronics Show held in Tokyo, and personal visits to many of Sony Corporation's factories, much of the news presented here originated in the Orient. It has been my experience, though, that even if the products seen in Japan are not yet sold in the U.S., with a few exceptions they will all be sold here within the next six months to one year. New ideas and products originated by Japanese manufacturers are most often test-marketed in their own domestic market and then exported to the rest of the world.

Jitterless VCR still-pictures

Many VCR's, both VHS and Beta format, have, for some time, featured a "freeze-frame" mode that stops playback of a video tape so the helical-scan head drum repeats a single picture over and over again, presenting what appears to be a still picture on the face of the associated TV screen. Unfortunately, most of these "still frame" systems present a picture that, at its best, is somewhat blurred and at its worst is marred by wide bands of noise streaking across the picture horizontally or diagonally.

To understand why this happens, it is necessary to review the way video signals are recorded on video cassette recorders (VCR's). The system used is called an azimuth recording system. In the NTSC system of television transmission, the TV picture consists of two fields for each frame. There are 60 fields per second or 30 complete frames per second. A VCR uses multiple heads to record the video signal. In the Betamax system, for example, the two video heads are located 180° apart, around the perimeter of the fast-spinning head-drum. One head, tilted at one angle, is designated as a "plus" azimuth head, while the other head is set at different, opposite, angle and is designated as a "minus" azimuth. One head normally records one field and the other head records the signal of the adjacent field which, together with the first recording, equals one complete frame. This system, one of *Betamax's* distinguishing characteristics, prevents the video signal of one track from interfering with that of the adjacent track.

With this type of arrangement, when the VCR is put in the "still-frame" mode (the horizontal motion of the tape is stopped and only the head drum revolves), the video head straddles two tracks at once, as shown in Fig. 1. That is, the head scans part of the A-1 field's

picture as well as B-1 field's picture. The "still" picture produced is actually a combination of two fields, or one complete frame. As can be seen in Fig. 2, when there is a fast moving object in the scene being reproduced, such as the rapidly moving end of the golf club in the diagram of Fig. 2, the resulting picture becomes quite blurred. It can no longer be regarded as a true "still" picture.

Sony Corporation, at the Electronics Show in Japan, introduced a new model *Betamax* VCR, the *SL-J9*. They claim it is the first home video recorder that can produce still-frame pictures that are as good as those used in broadcast equipment. The new capability is the result of what Sony calls their Double-Azimuth Head.

The diagram at the left, in Fig. 3, shows the ordinary head/drum arrangement, in which the "A" side has a "plus" azimuth head while the "B" side of the drum incorporates a "minus" azimuth head. In the diagram at the right, however, one of the video heads (the one that would normally be designated as having the "minus" azimuth) also has a "plus" azimuth (hence the name Double-Azimuth Head).

When the VCR is placed in the "still frame" mode, the signal is read or scanned by the normal "plus" azimuth head as well as by the "plus" azimuth section of the double azimuth head. During this mode of operation, the "minus" azimuth portion of the head is inactive. As shown in Fig. 4, when the tape is stopped, only the signal that was recorded on the "plus" azimuth track is scanned. This means that the B1 field (in Fig. 1) is not traced at all. In playback, the A1 field is played back twice during the still mode of operation. All this results in a completely motionless picture. To get slow-motion that is equally noise and jitter free, Sony has combined this new still-frame approach with normal playback. Thus, in the slow-motion mode, still frame is followed by normal playback, which, in turn is followed by another still picture, etc.

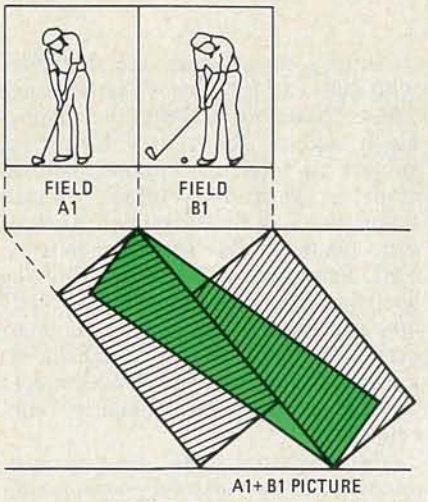


FIG. 1—DUAL HEADS IN TODAYS VCR's often result in blurred pictures because the two fields that make up a single picture can be different.

FIG. 2—THIS BLURRED PICTURE was caused when the two fields shown in Fig. 1 were combined to form this stop-frame picture.

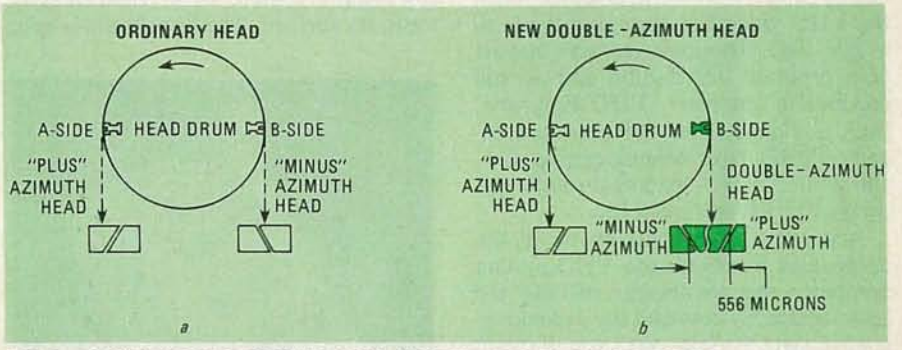


FIG. 3—COMPARISON OF CONVENTIONAL HEAD WITH DOUBLE-AZIMUTH HEAD can be seen in this side-by-side comparison—only the azimuth of the second head has been changed in the double-azimuth head.

Other video innovations

The Tokyo Electronics Show also saw the introduction of new VCR's and receivers that can handle any of the world's major broadcast video systems, new lightweight video cameras, and what may well become the central component in the home entertainment system of the future, a TV monitor color screen called *Profeel*, also introduced by Sony Corporation.

Profeel, as presently offered to the Japanese domestic consumer, consists of three different sized high-quality color monitor components ranging from a giant 27-inch screen (measured diagonally) down to a 16-inch version. Since the monitors contain only the electronics needed to produce the high-quality color picture and its associated audio tracks (there is no TV-RF/IF section), the tuner section of a VCR is used with the *Profeel* monitors. Optionally, the viewer can buy a separate *Profeel* component tuner at a cost (in Japan) of approximately $300.00. In Japan many of the broadcast programs already transmit stereo audio along with the TV picture. The stereo audio signals coming from the VCR or the component tuner can be fed directly to a component high-fidelity system or the matching *Profeel* speaker systems available as part of the program. The whole idea suggests that someday in the future, video will become component-oriented in much the same way that audio equipment did in the 1960's and 1970's. When you think about that, it makes a lot of sense, since we are seeing more and more video-related items that need to be interfaced with a television monitor but do not require the RF and IF circuitry contained in a full TV receiver.

Panasonic (National, in Japan), Sharp, and Sony all offered three-system videocassette decks. The three systems referred to have nothing to do with the VCR format, but rather relate to the three systems of standards used in TV broadcasting around the world. Thus, Sony's version of this new VCR, the *SL-T7*, can record and play back in the PAL and SECAM modes used in Europe and elsewhere, and can play back (without being able to record) prerecorded video cassettes using the American and Japanese NTSC system. To deliver that

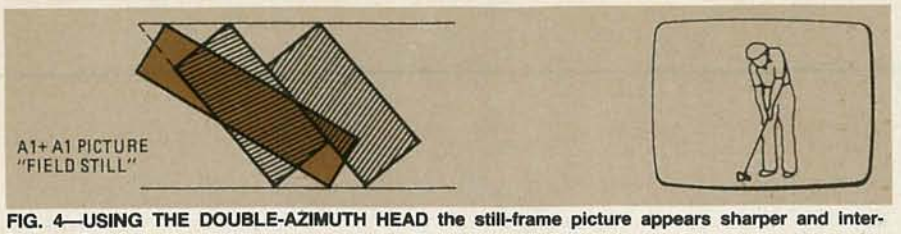


FIG. 4—USING THE DOUBLE-AZIMUTH HEAD the still-frame picture appears sharper and interference-free.

added versatility, the machine requires about 50% more parts than a conventional VCR and, at Japanese prices, will cost about $200.00 more than similar-featured one-system machines. Sharp's *model VC-6500E,* a VHS-format unit, is similarly priced and also handles all three video formats. There were universal TV receivers in a variety of screen sizes and prices that are also switchable and can handle all three of the world's major TV standards, as well as a variety of different electric line voltages and frequencies.

Status of videodiscs

Some manufacturer-exhibitors at the Tokyo Electronics show exhibited more than one type of videodisc—presumably to illustrate their technical and manufacturing capabilities. Toshiba, in fact, showed not only the optical Philips/Magnavox/Pioneer type of player and a JVC/Panasonic/GE VHD capacitance type, but even had on hand a player that could handle the U.S.-originated RCA *SelectaVision* (CED) discs.

A few weeks after the Tokyo Electronics Show closed in Japan, there was important news about the looming videodisc battle right here in the United States. Late in October, 1980 General Electric Company, Matsushita Electric Company of Japan, (MEI), Victor Company of Japan (JVC) and Thorn EMI of Great Britain announced formation of three jointly-owned companies to launch the VHD videodisc system in the U.S. in late 1981. The joint ventures consist of a program distribution and artistic production company, VHD Programs, Inc., a videodisc manufacturing company, VHD Disc Manufacturing Co., and a disc player manufacturing company, VHD Electronics Inc.

According to executives of all the companies involved, the VHD system combines the advantages of both the laser-optical system and the capacitive-groove type systems with which it will compete. Its 10.2-inch diameter disc, developed by JVC, features fast and slow motion, fast foward and reverse, still-frame mode, and random access, with one hour's playing time on each side. Since the big question about VHD's ability to compete with other systems had been the question of available programming or software, the entry of Thorn EMI into the group is a significant development.

Already negotiations are underway with 20th Century-Fox, Warner Home Video, Columbia, MGM/CBS and other major studios. The initial VHD library, subject to final negotiations, will include at least 160 current, all-time favorites, and future motion pictures from major studios and independents. VHD Programs, Inc. is also negotiating licensing agreements to distribute VHD disc programs to the home video market with Walt Disney Productions, Filmways and a number of independent production companies, including Time-Life films.

The projected VHD player reproduces full-color video programs in two-channel stereo sound. The user will also be able to select a videodisc with a different language on each of the two sound tracks. The VHD player rotates the disc at 900 revolutions per minute (as compared with 1800 rpm for the laser-optical disc and 450 rpm for the RCA *SelectaVision* discs). An optional random access feature will permit viewers to program more than 10 separate segments for playback in a preselected order and speed selected for each segment. By adding an optional digital audio processor to the basic player, digital audio sound for high fidelity enthusiasts becomes available.

In the mastering process of the VHD system, information is recorded onto a photo-sensitized glass master disc by focusing a minute laser beam directly onto its surface. The laser beam is split in two, with one part used to record program information while the other is used to record a special tracking signal. A metallic disc produced from the glass disc is used for the remainder of the manufacturing process, similar to the procedure that is used in audio-record stamping.

SPECIAL SPEED-VIEWING CIRCUITRY permits viewer to listen to sound while he scans the tape. The circuitry is in the VCR.

The VHD diamond capacitance-playback stylus used in playing these discs has an electrode that detects the capacitance variations between the disc and the stylus. The stylus is able to detect both the main signal and the tracking signal simultaneously and is therefore able to track effectively even though there are no grooves in the VHD disc itself.

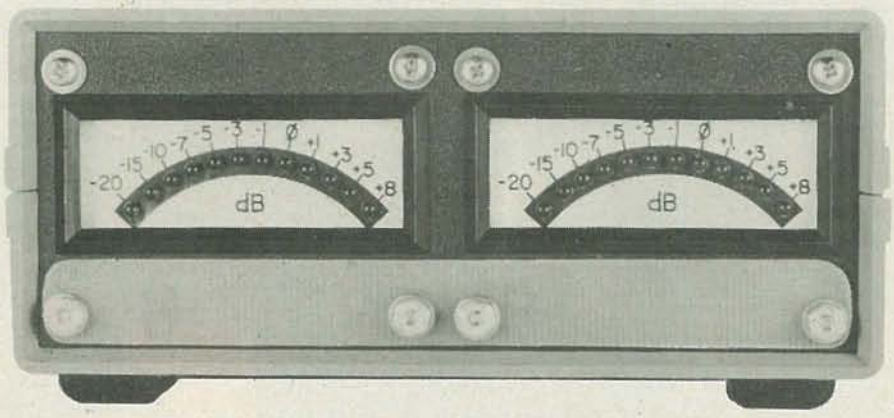
Listen fast—or slow

The hand-held remote control unit shown in Fig. 5 should be familiar to most readers who have seen or own one of the new VCR's equipped with the special-effects features shown on the face of the controller. What may not be so familiar is the VSC logo that has been affixed to the top of the unit. It stands for Variable Speech Control Company, a small San Francisco-based outfit that has come up with audio circuitry that meets the new requirements of the VCR's. Now, thanks to the development of a new custom IC, it becomes cost-effective for manufacturers to include what VSC calls their "speed listening feature." While viewers are now able to double the viewing speed (or, in some cases, increase it even more) on a home VCR, they have had to content themselves with either turning off the audio tracks or listening to unintelligible "Donald Duck"-like speech that normally occurs at increased speeds. As explained by Mr. Marvin Flaks, president of VSC Corporation, the human brain can easily process verbal information at speeds of 250 to 300 words per minute, or about twice the average speaking rate. At this speed, comprehension may actually increase, as concentration intensifies. The VSC feature simply allows you to listen to the increased audio rate by restoring the *pitch* or frequency range of the audio tracks to their normal range.

Among the companies that have already licensed VSC technology are Sony, Panasonic, JVC, General Electric and Aiwa. The feature also lends itself to use in hand-held audio-cassette decks, car tape decks, telephone-answering machines, and, possibly, videodisc players that also feature fast-play modes.

That's a quick look at what's new and what's coming soon in home video. One thing you can be sure of is that there will be many more innovations as manufacturers try to keep up with each other, and with the public's demand for more sophisticated equipment. **R-E**

LED VU Meter



for your Hi-Fi

Here's a high-precision, all-electronic VU meter for home recording. An LED display replaces the conventional meter movement.

BRADLEY ALBING

ANYONE FAMILIAR WITH RECORDING, BE it the home recordist or the pro, recognizes the need for an accurate VU meter to facilitate setting audio levels. An accurate VU meter allows us to maximize the S/N ratio while minimizing the distortion caused by clipping in amplifier stages or saturation of the tape.

In the past, the analog, or mechanical, VU meter was used. Those meters were (and are) available with varying degrees of accuracy for varying amounts of money. As with most other things, higher accuracy means higher cost. The VU meter responds, more or less, to the average level of the audio; although it can respond fairly quickly, it is not a peak-reading or responding meter.

In an attempt to overcome some of the shortcomings of the analog VU meters, an all-electronic VU meter has been designed around the Exar XR-2276 IC. This bar-graph generator IC is one of a series of recent developments by IC manufacturers intended for the market previously dominated by mechanical meters.

Up until about two years ago, anyone wishing to construct a "moving LED" or "bar-graph" display had to assemble a series of comparators and resistive voltage dividers to monitor the analog input and light a series of LED's. With the introduction by Texas Instruments, National Semiconductor, and Exar Integrated Systems of a series of IC's, the task has been greatly simplified.

All of those IC's are generally the same; they use a voltage-divider network with ten or twelve voltage taps, ten or twelve comparators, a stable internal reference voltage, and an analog input signal buffer. Each voltage tap is applied to one input of each comparator, while the other inputs are tied together and fed from the output of the analog signal buffer. As the input signal increases, succeeding stages of comparators trip, supplying drive current to their corresponding LED. If the LED's are arranged in line, we have a bar-graph display; or, in the variation used with the VU meter, we may imitate a conventional meter dial.

The resistors in the voltage divider may be selected to produce a linear response (e.g., 1 volt between any trip point and the previous or next trip point), a logarithmic response (e.g., 3 dB between any trip point and the previous or next trip point), or a specialized logarithmic scale such as the VU meter with its inherent expanded scale around the 0 VU point. At the present time, only Exar is manufacturing an IC suitable for use in a VU meter.

The XR-2276 has all the circuitry necessary to determine the level of the incoming signal and display it instantaneously. This peak-reading ability helps prevent pre-amp or tape overload from rapid, short-duration peaks in the program material to which a normal VU meter won't respond. Instead of using the conventional moving needle, the XR-2276 drives a series of LED's arranged in a manner similar to the VU meter scale with which most people are familiar.

Circuit description

Referring to Fig. 1, the input signal is applied to resistive divider R1 through R8; the appropriate tap is selected with DIP switch S1 through S7. The signal is then amplified by IC1; R11 is a vernier gain adjustment to supplement S1 through S7. IC2 functions as a full-wave precision rectifier.

The signal is next applied to IC3 which may be configured for different response characteristics: 1) A low-pass filter which gives the meter an averaging response; 2) peak-and-hold response which will show short-duration peaks and hold them long enough to be seen; or 3) fast or peak-responding without "hold." The last variation includes a jumper that allows the user to determine quantitatively the amplitude and duration of audio peaks by the brightness of the LED's while the first two variations conform more to standard response times for VU and

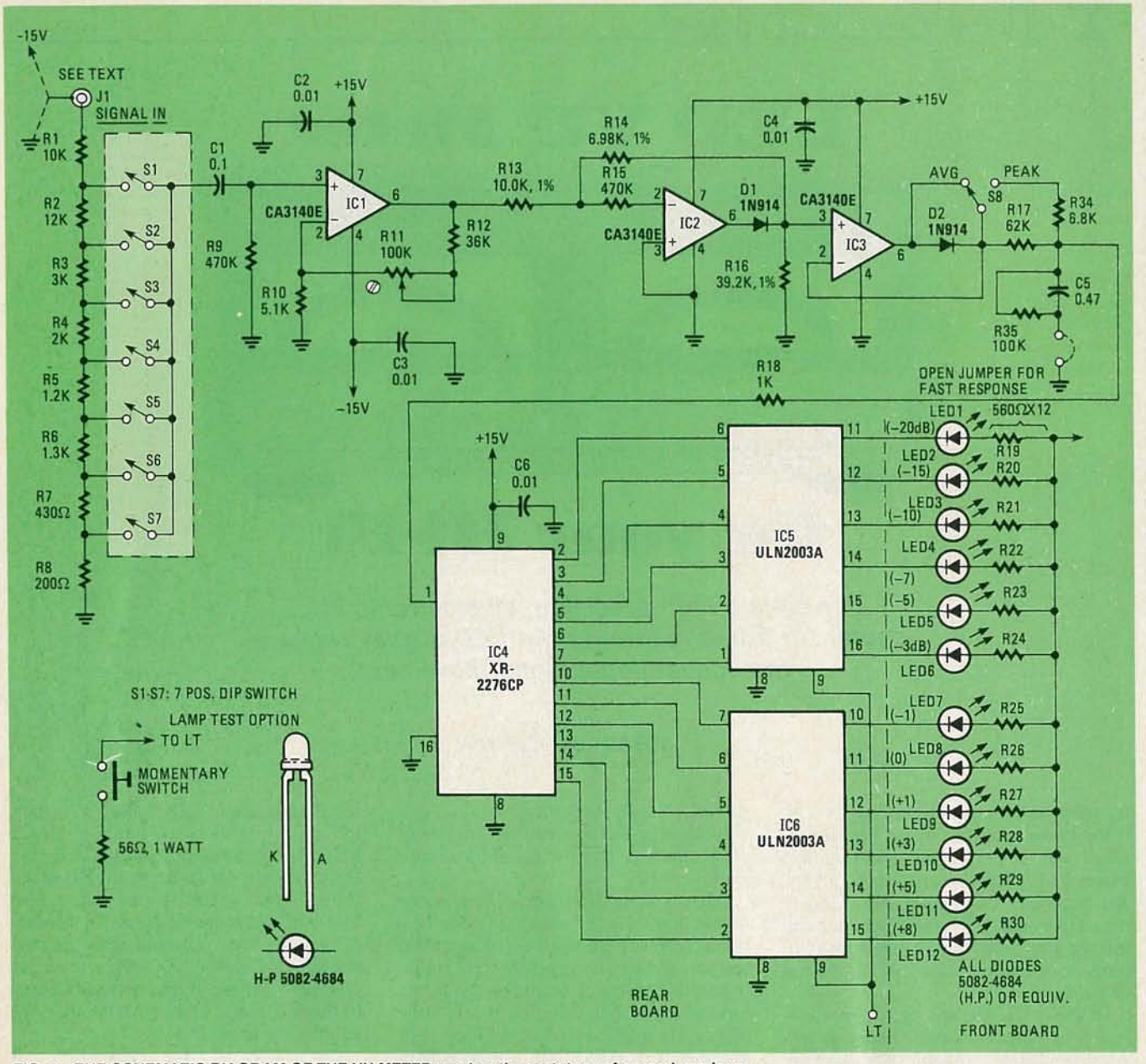


FIG. 1—THE SCHEMATIC DIAGRAM OF THE VU METER used as the prototype of several versions. Interior and exterior views are shown in the photographs.

peak-reading audio-level meters. (You can wire a SPST switch in place of the jumper to allow switch-selectable response.)

The audio signal finally arrives at IC4, the XR-2276, where it is converted into one-(or more)-of-twelve digital output signals. The output of that device goes to the driver-transistor arrays (IC5 and IC6) and then to the LED's.

The power supply is an unregulated split supply delivering approximately + and − 15 volts.

There are several variations and options available to the constructor. Those options concern the input attenuator, the LED drive circuitry, and the power supply. See Figs. 2 and 3 for details.

Construction

Nearly all components are mounted on PC boards. The display and associated circuits for each VU meter are mounted on two boards—the foil patterns are in Figs. 4 and 5. The pattern for the power-supply board is in Fig. 6. The components used, and the wiring of the boards, will be determined by the options and variations that you select. The two boards used for the circuitry and display panel are mounted with their foil sides facing each other and interconnected with short sections of No. 20 or 22 solid wire. You can use pieces clipped off resistor leads for this purpose. There are twelve jumpers across the top of the boards and others on each side. Figure 7 is an interior view of a stereo VU meter with the Option-E (120-volt AC) power supply. That combination is Version 2. See parts list.

The appropriate components are mounted on the power-supply board which should then be connected to two signal processing and display boards.

The LED's protrude through the meter dial which can be fabricated by gluing a facsimile of Fig. 8 to stiff cardboard and punching ⅛-inch holes at the crosshairs. Alternately, you can order a ready-made meter dial. (See parts list.) Next, the bezel is mounted in the enclosure's front panel. The easiest way to hold it in place is to run a hot soldering iron tip along the adjoining surfaces of the bezel and front panel to weld the two pieces together. Be careful—don't use too much heat.

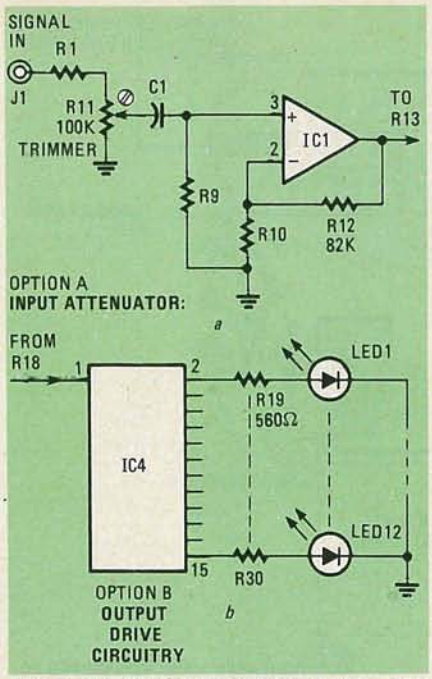


FIG. 2—OPTIONS FOR HOME recording use. In circuit at a, the stepped attenuator and switch have been replaced by a multi-turn trimmer resistor originally used in controlling the gain of IC1. Use the modified LED drive circuitry at *b* if you can get along with lower brightness from the indicators.

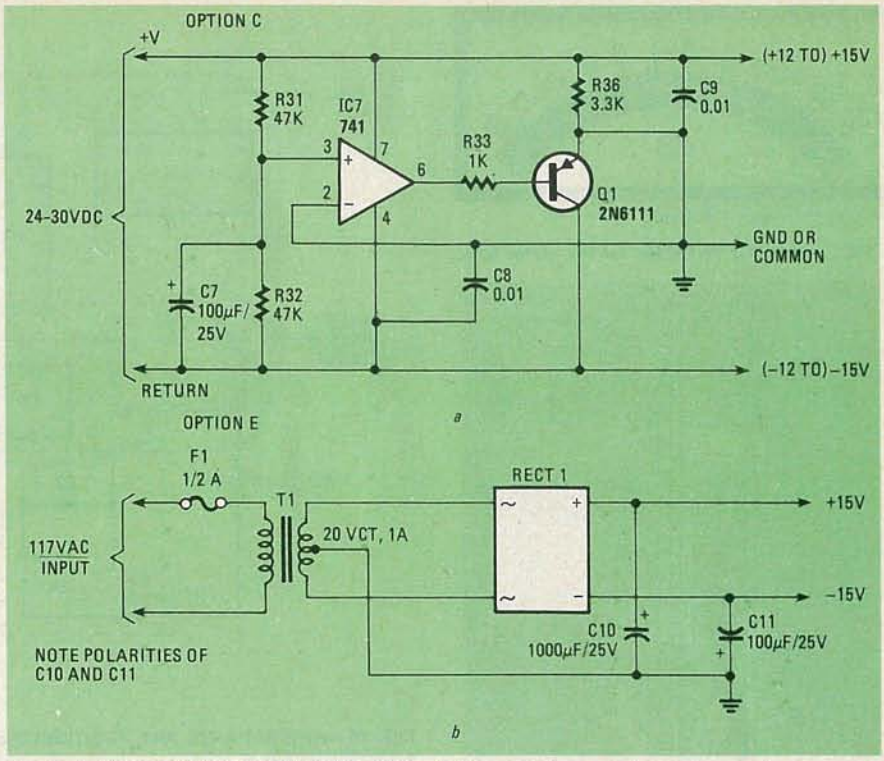


FIG. 3—POWER SUPPLY VARIATIONS. Option C is used when you have a convenient external source of 24-to-30 volts DC. IC7 and Q1 provide the dual-polarity output voltages. Use the arrangement at *b* (Option E) when you want to power the instrument from 117-volt AC lines.

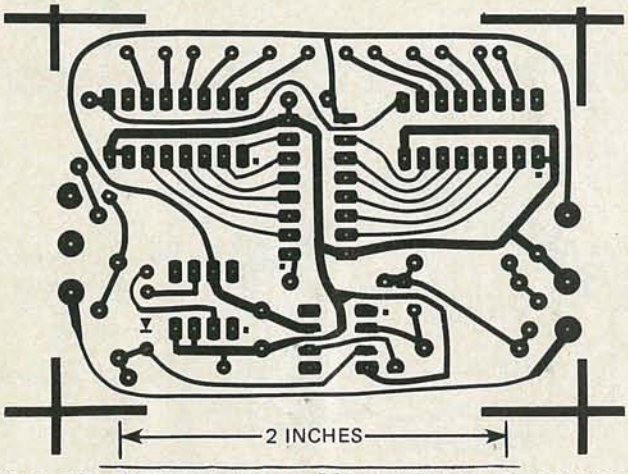


FIG. 4—FOIL PATTERN for the rear PC board. This board is 2.7 inches wide and 2 inches high.

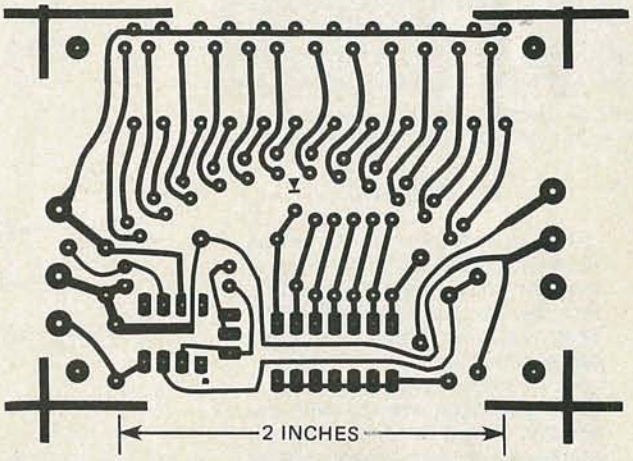


FIG. 5—PC PATTERN for the front board. The LED indicators are arranged so they protrude through holes in an arc in the meter dial.

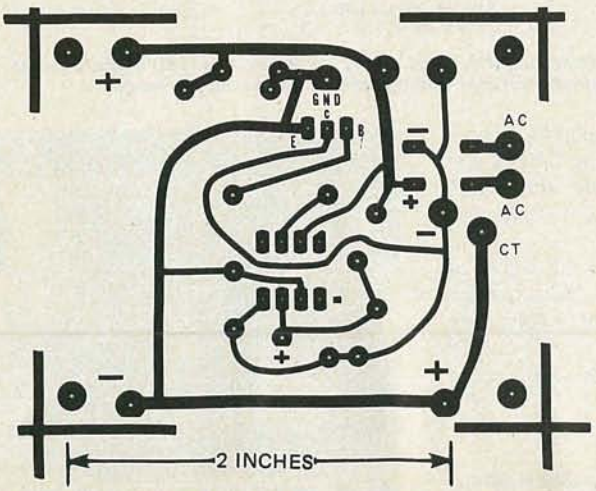


FIG. 6—FOIL PATTERN for the power-supply PC board. It is used for both versions of the supply circuit.

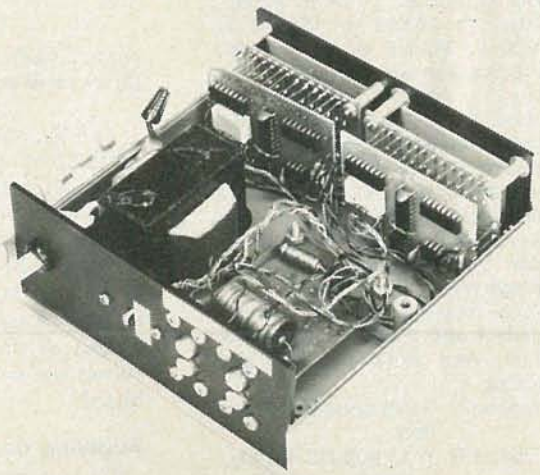


FIG. 7—INTERIOR VIEW of the prototype stereo VU meter. Note how the two circuit boards, meter face, and front panel go together.

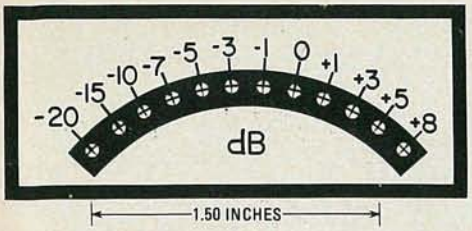


FIG. 8—PHOTO PATTERN for the meter face.

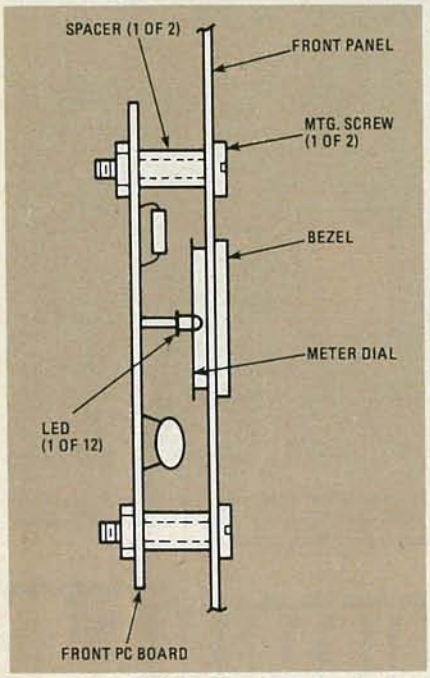


FIG. 9—CROSS-SECTIONAL DRAWING shows how parts are fastened to the front panel.

KIT OF PARTS

A complete kit of parts for the different version of the VU meter is available from: BFA Electronics, P.O. Box 212, Northfield, OH 44067. Ohio residents please add applicable sales tax.

VU-1: Includes Boards 1 and 2 (front and back boards) and, optionally, Board 3, depending on power source; also 1 bezel, 1 meter dial and all parts needed for PC boards, case not included. Request either Option C, D, or E.* Order: VU-1-C @ $27.00 *or* VU-1-D @ $24.00 *or* VU-1-E @ $31.00. Add $2.00 postage and handling.

VU-2: Includes 2 pieces each of Boards 1 and 2 and 1 Board 3, 2 bezels, 2 meter dials, all appropriate parts for all P.C. Boards (parts for Board 3 will be for Option E) and a plastic case. (Case has no holes—user must machine it as required). Order: VU-2 @ $74.95. Add $2.50 postage and handling.

VU-3: Includes 2 pieces each of Boards 1 and 2 and 1 of Board 3. $10.00. Add $1.00 postage and handling.

***Option C: 24-30 volts DC operation**
Option D: ± 15 volt DC supply already available
Option E: 120 volts AC operation

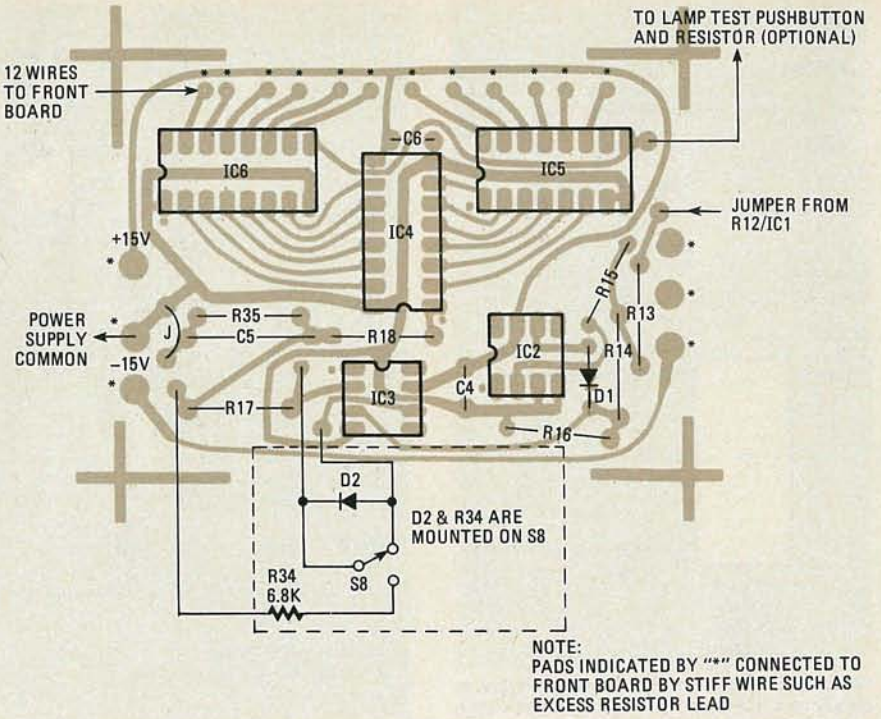


FIG. 10—WHERE PARTS ARE POSITIONED on the rear PC board when using the circuit in the schematic in Fig. 1.

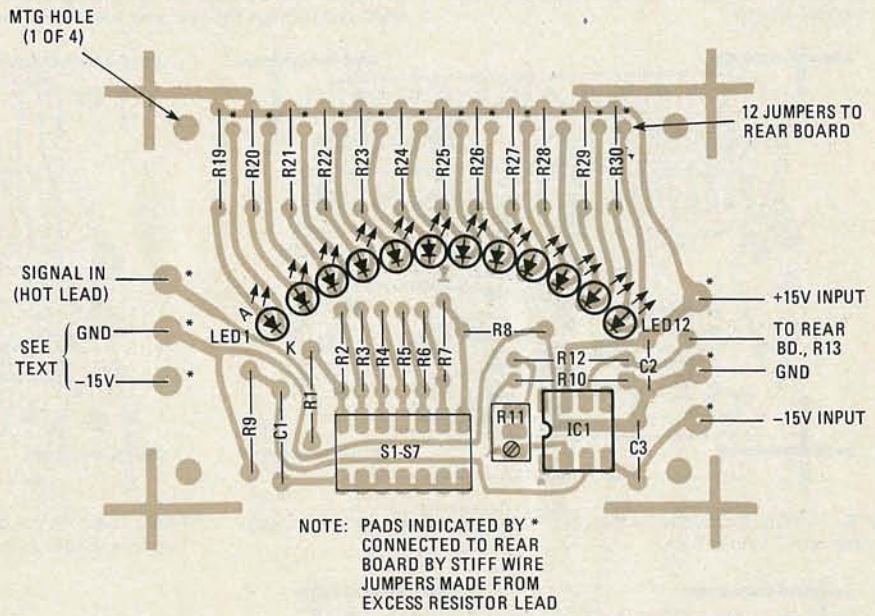


FIG. 11—PARTS LAYOUT for the front circuit board. Check the polarity of all LED's before installing. On the types specified, the cathode terminal lead is shorter than that for the anode.

Finally, mount the coupled PC boards on the front panel with the LED's and meter dial extending into the bezel. Use spacers and No. 4-40 nuts and bolts as shown in Fig. 9.

Figures 10 and 11 show the layout of parts on the rear and front circuit boards, respectively, when using the circuit as shown in Fig. 1. Figure 12 shows the component side of the front board.

Applying the options

If you eliminate the switchable attenuator and substitute an adjustable trimmer resistor as in Fig. 2-a, refer to the

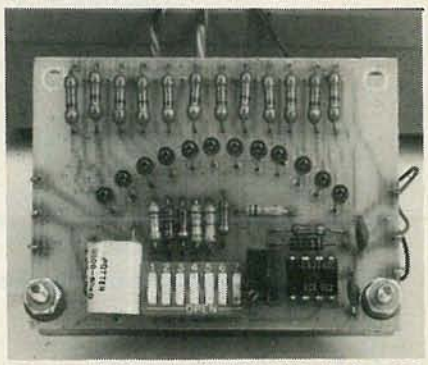


FIG. 12—FRONT-VIEW PHOTO of the front PC board. The switch must be set for the desired calibration before the cabinet is buttoned up.

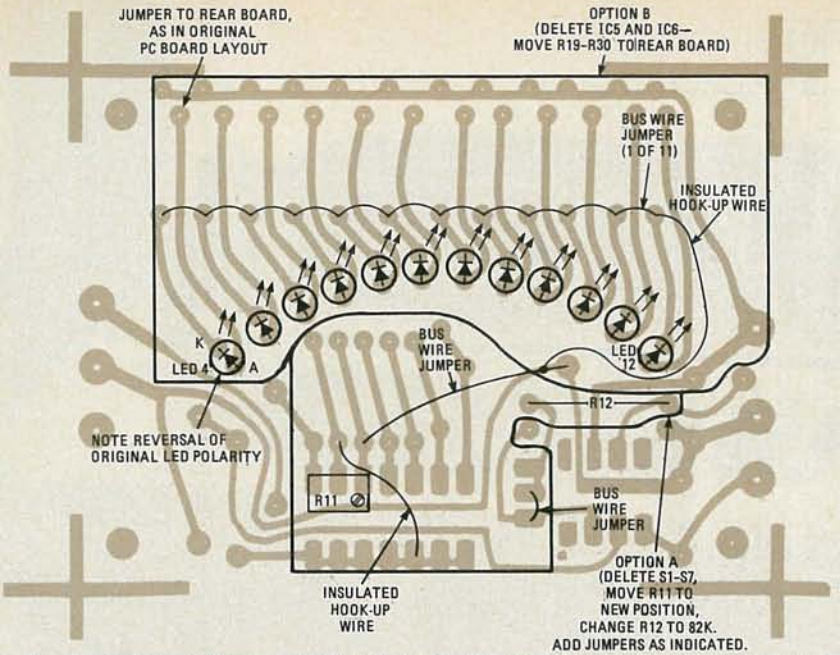


FIG. 13—COMPONENT LAYOUT GUIDES for the front panel when using Options A and B. Note that the LED polarity has been reversed in Option B.

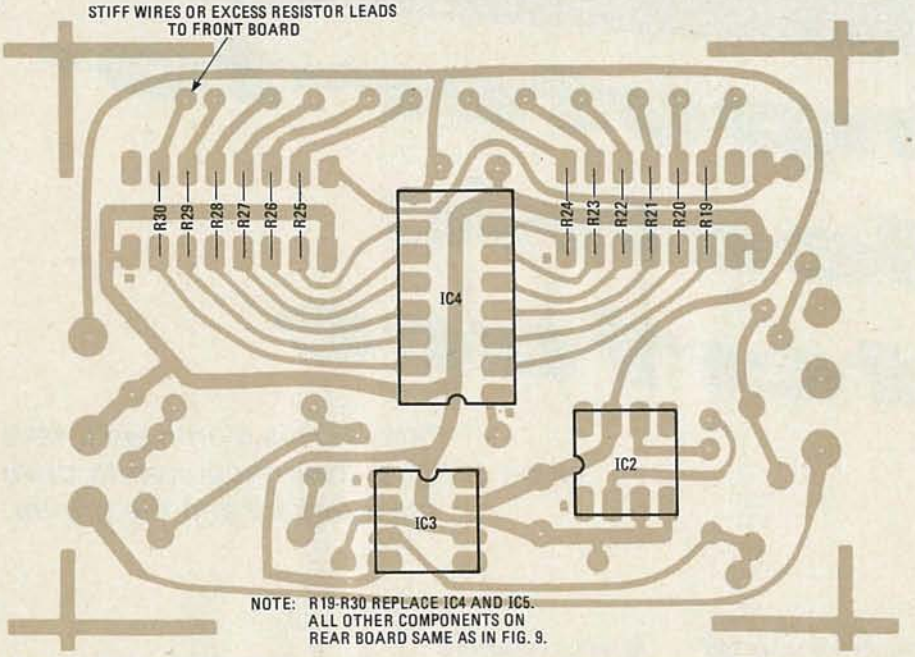


FIG. 14—THIS PARTS LAYOUT is used for the rear board when Option B is taken. Note that IC's 5 and 6 have been completely eliminated and replaced by resistors R19 to R30.

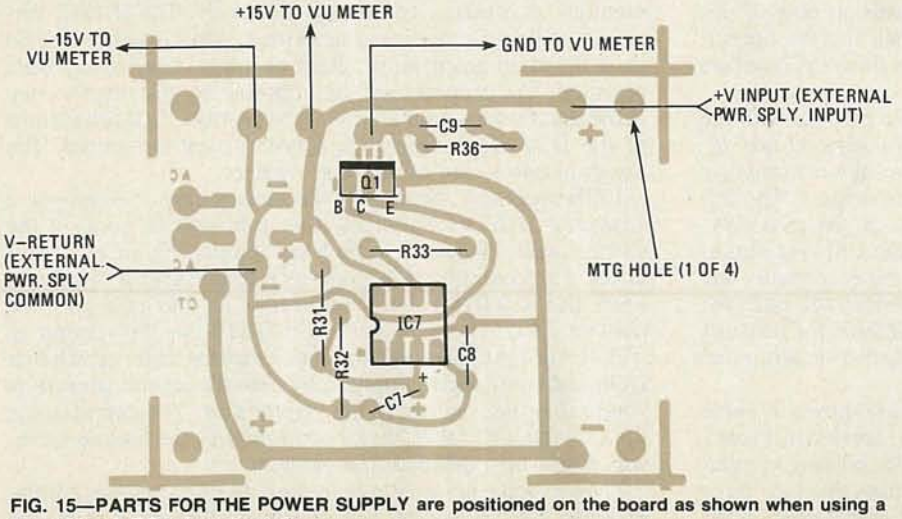


FIG. 15—PARTS FOR THE POWER SUPPLY are positioned on the board as shown when using a 24-to-30-volt DC external supply.

PARTS LIST

All resistors 5%, ¼ watt unless otherwise specified

R1—10,000 ohms,
R2—12,000 ohms,
R3—3000 ohms,
R4—2000 ohms,
R5—1200 ohms,
R6—1300 ohms,
R7—430 ohms,
R8—200 ohms,
R9—470,000 ohms
R10—5100 ohms
R11—100,000 ohm, single or multi-turn trimmer (Bourns 3352W-1-104, 3299W-1-104 or equivalent)
R12—36,000 ohms
R13—10,000 ohms, 1%, 1/10 watt
R14—6980 ohms, 1%, 1/10 watt
R15—470,000 ohms
R16—39,200 ohms, 1%, 1/10 watt
R17—62,000 ohms
R18—1000 ohms
R19–R30—560 ohms
R31, R32—47,000 ohms*
R33—1000 ohms*
R34—68,000 ohms
R35—100,000 ohms
R36—3300 ohms

Semiconductors

LED1–LED12—H-P 5082-4684 or equivalent T-1 LED
D1, D2—1N914
Rect1—50-volt, 1 A bridge rectifier**
Q1*—2N6111 (National) or equivalent
IC1-IC3—CA3140E (RCA)
IC4—XR2276CP (Exar)
IC5, IC6—ULN 2003A (Sprague, TI, Signetics)
IC7*—LM741CN (National) or equivalent

Capacitors

C1—0.1 μF, 100 volts Mylar
C2-C4, C6, C7*-C9*—0.01 μF, 25-volt ceramic disc
C5—0.47 μF, 10 volts, Mylar
C11**—100 μF, 25-volt aluminum electrolytic
C10**—1000 μF, 25-volt aluminum electrolytic
S1–S7—7-position DIP switch
S8—SPDT switch
T1**—20-volt, 1-amp CT transformer Stancor P8604 or equivalent)
F1**—½-amp 3AG fuse

*Used only with DC input option
**Used only with 117 VAC option

Note: The quantities shown above are for a single-channel unit. With the exception of the power-supply components, two of each will be required for a stereo meter.

"Option A" section of Fig. 13. It shows how attenuator resistors R2 through R8 are eliminated and replaced by R11 and a few jumpers. Refer to Fig. 11 for the locations of all other components on this board.

If you can get along with lower brightness from the LED indicators, do not install IC5 and IC6 on the rear board. In their places install resistors R19 through R30 across the IC terminal pads as in Fig. 14. Refer to the

continued on page 90

BUILD THIS

Computer-to-Selectric Interface

Part 2—This month we'll take a look at the software required to drive the interface and the printer.

E. G. BROONER

IN PART 1 OF THIS ARTICLE ON CONVERTING AN IBM *SELECTRIC* terminal/printer for use with a microcomputer, we covered the hardware end of the project, a four-IC interface board that is connected to the parallel- or expansion port of the computer—wherever eight-bit parallel data can be output. Now we'll consider the software needed to drive the interface (and the printer).

We stated earlier that the software would provide both the translation from ASCII and the time delay needed by the different functions. The software will vary from one computer to the next, unless they are alike in every respect. The differences are the ORG (starting address) of the assembly-language or machine-language program, the CPU register in which the character is stored, up to the time of printing, and other minor differences. The timing can remain the same for any processor running at 2 MHz or thereabouts; for faster or slower machines, the values of the timing words will need changing.

The software is presented in two versions, shown in Table 1 and Table 2. The 8080 assembly-language version in Table 1 can be used with any 8080 or Z-80 system, bearing in mind only the timing, ORG, and register differences that may have to be changed. The computer's I/O port assignments must also be considered.

The BASIC program (Table 2) is specifically for the TRS-80, Model 1, and simply POKE's the numerical data into memory as a means of loading the driver. The BASIC version, needless to say, is easier to load from a disc than would be a machine-language program on tape. After it has been POKE-ed, the program will be accessed by the LPRINT command each time a character is to be printed. To do that some of the DOS (*D*isk *O*perating *S*ystem) must be altered. The program takes care of all those matters.

Both programs accomplish the same purpose. Whenever a character is to be output, (either printable or control) the CPU's accumulator must be freed temporarily of any other tasks. The contents of the various registers are all "pushed" onto the stack for later recovery. At the last possible moment, the character will be passed from the register in which it is contained (such as the B register under North Star DOS and the C register under CP/M) to the accumulator, from where it will be output to the printer port. The correct code for the character will have been found in the lookup table, which will be explained in a moment.

The software has a unique feature which saves some time, and also some wear and tear on the mechanism: it saves the

TABLE 1

```
;
;
;       DRIVER PROGRAM FOR DATEL SELECTRIC
;       WITH COMLABS INTERFACE (TRS-80 VERSION)
;
;
;       DATA LINE ASSIGNMENTS:
;
;       D0 = ROTATE 1/BACKSPACE
;       D1 = ROTATE 2/TAB
;       D2 = ROTATE 2A/INDEX
;       D3 = ROTATE 5/RETURN
;       D4 = TILT 1/SPACE
;       D5 = TILT 2
;       D6 = SHIFT
;       D7 = NORMAL/SPECIAL SELECT
;
;
;       CHARACTER TO PRINT IS IN C REGISTER
;
;
        ORG     7F00H       ;FOR 16K RAM
;       ORG     0BF00H      ;FOR 32K RAM
;       ORG     0FF00H      ;FOR 48K RAM
DATEL:  PUSH    PSW         ;SAVE REGISTERS
        PUSH    B
        PUSH    D
        PUSH    H
        MOV     A,C         ;REMOVE PARITY
        ANI     7FH
        MVI     B,BSCODE    ;CHECK FOR BACKSPACE
        CPI     08H
        JZ      NORM
        MVI     B, HTCODE   ;CHECK FOR TAB
        LXI     H,LONG      ;DELAY FOR TAB AND CR
        CPI     09H
        JZ      CYCLE
        MVI     B,CRCODE    ;CHECK FOR CR
        CPI     0DH
        JZ      CYCLE
        MVI     B,SPCODE    ;CHECK FOR SPACE
        SUI     20H
        JZ      NORM
        JC      DONE        ;IGNORE OTHERS
        MOV     E,A         ;CONVERT TO SELECTRIC CODE
        MVI     D,00H
        LXI     H,TABLE
        DAD     D
        MOV     B,M         ;CODED CHAR IN B
        LXI     H,SHIFT
        MOV     C,M         :OLD SHIFT IN C
        MOV     A,B
        ANI     40H
        MOV     M,A         ;SAVE NEW SHIFT
        XRA     C           :SAME AS OLD?
        JZ      NORM        ;YES, NO SHIFT CHANGE
        MOV     A,M         ;CHANGE SHIFT
        STA     PORT
        LXI     D,SHDLAY
        CALL    WAIT
NORM:   LXI     H,SHORT     ;NORMAL DELAY
CYCLE:  LDA     SHIFT
        ORA     B           ;COMBINE WITH CHAR
        STA     PORT
        LXI     D,HOLD
        CALL    WAIT        ;IMPULSE DELAY
        LDA     SHIFT       ;PRESERVE SHIFT STATUS
        STA     PORT
        XCHG
        CALL    WAIT
DONE:   POP     H           ;RESTORE REGISTERS
        POP     D
        POP     B
        POP     PSW
        RET
;
;
;       DELAY FOR 2 MHZ CLOCK IS 35 USEC/UNIT OF D,E
;
WAIT:   MOV     A,D         ;DELAY LOOP
        ORA     E
        RZ
        XTHL
        XTHL
        NOP
        DCX     D
        JMP     WAIT
;
SHIFT:  DB      00H         ;INITIALLY LOWERCASE
;
;
;       CONVERSION TABLE
;
TABLE:  DB      00H,0FFH,0D5H,0FEH,0F9H,0F5H,0FDH,95H
        DB      0F0H,0F1H,0FCH,0C6H,8CH,80H,0D6H,89H
        DB      0B1H,0A9H,0B6H,0BEH,0B9H,0B3H,0B4H,0BBH
        DB      0BAH,0B0H,0CDH,8DH,0D7H,86H,97H,0C9H
        DB      0F6H,0DCH,0E0H,0ECH,0EDH,0E5H,0CEH,0CFH
        DB      0E1H,0D4H,0C7H,0E4H,0E9H,0DFH,0E6H,0D9H
        DB      0C5H,0C4H,0DDH,0D1H,0E7H,0EEH,0DEH,0D0H
        DB      0EFH,0C1H,0F7H,00H,0F4H,00H,00H,0C0H
        DB      00H,9CH,0A0H,0ACH,0ADH,0A5H,8EH,8FH
        DB      0A1H,94H,87H,0A4H,0A9H,9FH,0A6H,99H
        DB      85H,84H,9DH,91H,0A7H,0AEH,9EH,90H
        DB      0AFH,81H,0B7H,00H,00H,00H,00H,00H
;
PORT    EQU     37E8H       ;OUTPUT PORT ADDRESS
;
BSCODE  EQU     01H         ;BACKSPACE CODE
HTCODE  EQU     02H         ;TAB CODE
CRCODE  EQU     08H         ;CARRIAGE RETURN CODE
SPCODE  EQU     10H         ;SPACE CODE
;
HOLD    EQU     0400H       ;HOLD TIME = 33 MSEC
SHORT   EQU     0600H       ;NORMAL DELAY = 50 MSEC
LONG    EQU     6000H       ;CR/TAB DELAY = 0.85 SEC
SHDLAY  EQU     0D00H       ;SHIFT DELAY = 110 MSEC
        END
```

TABLE 2

```
1000 REM PROGRAM TO POKE SELECTRIC DRIVER INTO MEMORY
1010 ON ERROR GOTO 1030
1020 PRINT
1030 INPUT "SYSTEM SIZE (16, 32 OR 48)";M$
1040 M=VAL(M$)
1050 IF M<>16 AND M<>32 AND M<>48 THEN 1030
1060 D=4*(M-16)
1070 M=(M + 16)*1024-256
1080 POKE 16421,2
1090 POKE 16422,0
1100 POKE 16457,255
1120 POKE 16458,M/256-1
1130 IF MV32767 THEN M=M-65536!
1135 REM "!" INDICATES SINGLE PRECISION VARIABLE
1140 ON ERROR GOTO 1200
1150 READ B
1160 IF B<0 THEN B=ABS(B)+D
1170 POKE M,B
1180 M=M+1
1190 GOTO 1150
1200 PRINT
1210 NEW
1220 REM PROGRAM DATA
1230 DATA 245,197,213,229,121, 230,127,6,1,254
1240 DATA 8,202,71,-127,6,2,33,0,96,254
1250 DATA 9,202,74,-127,6,8,254,13,202,74
1260 DATA -127,6,16,214,32,202,71,-127,218,97
1270 DATA -127,,95,22,0,33,113,-127,25,70,33
1280 DATA 112,-127,78,120,230,64,119,169,202,71
1290 DATA -127,126,50,232,55,17,0,13,205,102
1300 DATA -127,33,0,6,58,112,-127,176,50,232
1310 DATA 55,17,0,4,205,102,-127,58,112,-127
1320 DATA 50,232,55,235,205,102,-127,225,209,193
1330 DATA 241,201,122,179,200,227,227,0,27,195
1340 DATA 102,-127,0
1350 REM TABLE DATA
1360 DATA 0,255,213,254,249,245,253,149
1370 DATA 240,241,252,198,140,128,214,137
1380 DATA 177,169,182,190,185,179,180,187
1390 DATA 186,176,205,141,215,134,151,201
1400 DATA 246,220,224,236,237,229,206,207
1410 DATA 225,212,199,228,233,223,230,217
1420 DATA 197,196,221,209,231,238,222,208
1430 DATA 239,193,247,0,244,0,0,192
1440 DATA 0,156,160,172, 173,165,142,143
1450 DATA 161,148,135,164,169,159,166,153
1460 DATA 133,132, 157,145,167,174,158,144
1470 DATA 175,129,183,0,0,0,0,0
```

SHIFT bit from the last character that was transmitted. The SHIFT bit will have been a "one" if the last character was upper case and "zero" if it was lower case. Before printing the next character, the program checks to see if the "case" has changed. Since the shift mechanism stays locked, either in upper or lower case, it is only necessary to send the shift bit again when the case changes!

If a shift bit is required, it is sent first and held for a certain time period, after which the rest of the character follows. After the character has been sent, and the data held for an appropriate length of time, a "zero" is output to the port. That completes the print cycle for each printable or control character. The contents of the stack are now "popped" back into the appropriate registers and control returns to the operating system.

Whether you use the 8080 assembly-language version or the TRS-80 disk BASIC version, great care should be exercised in entering the programs; they modify the DOS, and just one wrong byte can prevent the entire system from working.

TABLE 3

```
100 REM MODIFIES PRINT TABLE FOR BALL 185
110 INPUT "TABLE ADDRESS IN DECIMAL",T
120 FOR X=T+33 TO T+58
130 Y=PEEK(X)-64: REMOVE SHIFT BIT
140 POKE X,Y: REM NEW U.C. CODE
150 NEXT X
160 POKE T+14, 150: REM PERIOD
170 POKE T+17,191: REM NUM. 1
180 POKE T+28,237: REM < SYMBOL
190 POKE T+30,206: REM > SYMBOL
200 POKE T+60,208: REM \ SYMBOL
210 POKE T+62,222: REM UP-ARROW
```

TABLE 4

ASCII	CHARACTER	BALL NO. 185	BALL NO. 134	ASCII	CHARACTER	BALL NO. 185	BALL NO. 134
32				81	Q	132	196
33	!	255	255	82	R	157	221
34	"	213	213	83	S	145	209
35	#	254	254	84	T	167	231
36	$	249	249	85	U	174	238
37	%	245	245	86	V	158	222
38	&	253	253	87	W	144	208
39	'	149	149	88	X	175	239
40	(	240	240	89	Y	129	193
41	)	241	241	90	Z	183	247
42	*	252	252	91			
43	+	198	198	92	\	208	244
44	,	140	140	93			
45	–	128	128	94	^	222	0
46	.	150	214	95	–	192	192
47	/	137	137	96			
48	0	177	177	97	a	156	156
49	1	191	169	98	b	160	160
50	2	182	182	99	c	172	172
51	3	190	190	100	d	173	173
52	4	185	185	101	e	165	165
53	5	179	179	102	f	142	142
54	6	180	180	103	g	143	143
55	7	187	187	104	h	161	161
56	8	186	186	105	i	148	148
57	9	176	176	106	j	135	135
58	:	205	205	107	k	164	164
59	;	141	141	108	l	169	169
60	<	237	215	109	m	159	159
61	=	134	134	110	n	166	166
62	>	206	151	111	o	153	153
63	?	201	201	112	p	133	133
64	@	246	246	113	q	132	132
65	A	156	220	114	r	157	157
66	B	160	224	115	s	145	145
67	C	172	236	116	t	167	167
68	D	173	237	117	u	174	174
69	E	165	229	118	v	158	158
70	F	142	206	119	w	144	144
71	G	143	207	120	x	175	175
72	H	161	225	121	y	129	129
73	I	148	212	122	z	183	183
74	J	135	199	123			
75	K	164	228	124			
76	L	169	233	125			
77	M	159	223	126			
78	N	166	230	127			
79	O	153	217	128		111	111
80	P	133	197				

Changing typing elements

It should be noted that the portion dealing with the translation table can be modified as needed. For some balls and/or character sets many changes may have to be made. For example, IBM ball (IBM calls them "typing elements") 185 is a desirable type for use with BASIC programs. Several table changes are necessary to use that ball. It has upper-case letters where the lower-case letters would normally be; the codes for upper-case letters must be changed, in the table, to be the same as those for lower case. The codes for the additional characters, for which that ball was recommended, must be added to the table in the correct places. To illustrate how simple those changes are, see Table 3, a simple BASIC program that will make the necessary changes in Table 2 in a few seconds. The table is changed in memory by that routine and you can then save the changed version, or simply run the "change" program whenever using the second ball.

Once you have mastered the tilt/rotate patterns, and understand the method of assigning numbers to each character, you should have no particular problem in doing that for your own system. The programs as presented are correct in most details for balls used in normal typing.

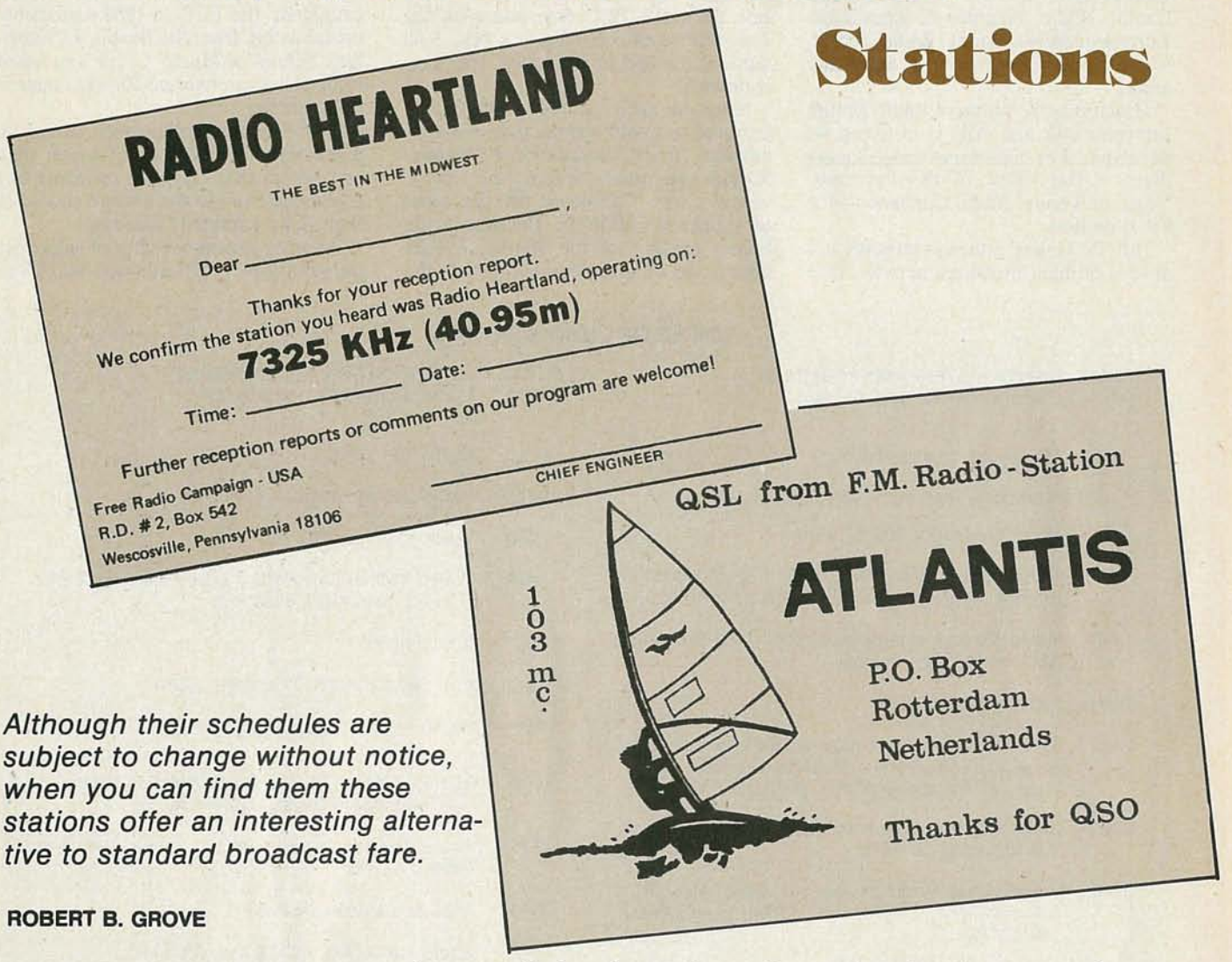
The use of the lookup table is described for those who may be unfamiliar with them. The "codes" are the numeric value that must be output for each character. In the ASCII table, characters come in a certain order. The table in the program is made up of the *new* values for the corresponding characters, and the actual ASCII code is used to access the table codes. The twenty-third ASCII character, then, will direct the program to the twenty-third code in the translation table. That code may or may not be the same as the ASCII value, but in any event it is the table code that is finally sent to the printer. If you change to a ball with characters located differently, you simply determine where in the table to make the change, and change the code for those characters.

Table 4 illustrates the correspondence between the ASCII table and the translated code. That code is only correct for the assignments we made to the tilt/rotate and other lines, as shown at the beginning of the assembly-language program. You can make up your own code if the data lines are assigned differently, or if you use a ball that does not have characters positioned as did ours, which were an IBM 134 and 185.

One more peculiarity of that software needs pointing out for thse who use other machines and are not familiar with the *TRS-80* (for which the sample programs were written). In those listings, the character to be output is handled by an STA instruction rather than an OUT instruction. That was done because the *TRS-80* printer port is not a port in the true sense, but, rather, is treated as a memory location, into which successive characters are written. That part of the program can easily be changed for computers using more conventional I/O standards.

Our converted *Selectrics* have been satisfying in many ways. The low price of the finished product was more than welcome, and anyone who loves to tinker with hardware cannot help buy enjoy such an activity. As stated earlier, those machines are not fast, and 100 to 150 words per minute (comparable to a *Teletype*) is inadequate for many of the purposes a computer might be used for. Nevertheless, these converted terminals are a good alternative for anyone trying to save money on hardware, particularly if word processing is to be the major consideration. **R-E**

Pirate Broadcast Stations



Although their schedules are subject to change without notice, when you can find them these stations offer an interesting alternative to standard broadcast fare.

ROBERT B. GROVE

IN OUR JUNE, 1980 ISSUE WE EXPLORED the fascination of monitoring "spy" numbers stations. At this writing, the riddle as to the origin of those mysterious transmissions is still unresolved.

But the numbers stations are not the only unlicensed signals on the airwaves. Pirate and clandestine broadcasters populate the radio spectrum from medium-frequency wavelengths (200-1600 kHz) through shortwave. Even listeners to the FM and TV bands encounter those phantom signals occasionally.

Who are the perpetrators, and what are their motivations? To answer those questions, we must first separate the pirates and clandestines into their own categories.

The pirates

Operating a radio transmitter without a license is hardly new in the United States. Many CB'ers have been doing it for years! So have hams who would rather not spend the time and energy needed to take the amateur radio examination or learn the required Morse code.

Pirate broadcasting began early this century when radio regulations were very loosely structured and enforcement was virtually non-existent. Perhaps the best documented pirate station was that of David Thomas, owner of unlicensed station WUMS ("*W*as *U*nlicensed *M*arine *S*tation").

Originally built to operate on 1235 kHz, WUMS' homemade transmitter was switched to 2004 and 1560 kHz in 1938. Messages were sent to Ohio River vessels in the ferry service, and the station broadcast entertainment as well.

In 1939 WUMS was hauled into Federal Court on charges of operating an amateur radio station without a license. Since WUMS was obviously not in the amateur service—not operating in the amateur-frequency bands—the charges were dropped.

In 1948, following a series of transmissions monitored by stations as far away as China, WUMS was cited again by the FCC. After the Commission reportedly spent some $10,000 for prosecution, the case was once again thrown out of court.

After more than 50 years of virtually continuous operation, WUMS has finally gone off the air for good after establishing a world's record for perpetual piracy! Its transmitter has been accepted by the Smithsonian Institution, joining the company of names like Edison and Marconi, to be enshrined with other artifacts of our nation's memorabilia.

Needless to say, unlicensed pirate stations drive the FCC bonkers. Schedules are erratic, locations are rarely given, and transmission times are often short.

The United States is not as saturated

with those stations as is Great Britain, unofficially the home of pirate broadcasting. Long wave, medium wave, shortwave, FM, and even TV pirates flood the airwaves over the Isles. A large number of them are in Ireland, such as Radio Dublin, Weekend Muzick Radio, Radio Nautilus International, European Music Radio, Radio Zenith, Radio Condor International, and many more.

Holland is the home of Radio Dolfijn International, and AIR is in Glasgow, Scotland. For additional entertaiment there is the Voice of the Pyramids, Voice of Venus, Radio Confusion—the list is endless.

But the United States is certainly not devoid of illicit broadcast activity. One of the most famous in recent history is the Voice of the Voyager, a pirate broadcaster in Minneapolis who constantly gave a Houston, TX mailing address over the air. To compound the obfuscation, return mail was sent to listeners from Ann Arbor, MI. That one gave the FCC fits, and took the cooperative efforts of all 13 FCC field stations to locate it finally, and shut it down!

Even as early as 1933, stations attempted to avoid prosecution by transmitting from international waters. RXKR operated aboard the motor vessel *City of Panama* off the coast of southern California. Basking in the balmy breezes of the Pacific, RXKR conducted its programming right in the middle of the standard broadcast band.

Fairlawn, NJ, was the home of pirate station WBBH. Operating on an arbitrarily-chosen frequency of 4970 kHz, operator "Mr. Fisk" claimed to be using a Gates BFE-50 C commercial broadcast transmitter. When finally caught by the FCC in 1966, ostensibly broadcasting from the fictitious "Courtland School of Music", Fisk was found to be using a converted 50-watt amateur transmitter.

Fisk's programming was unusually professional, quite possibly better than any others that Fairlawn residents had to choose from in the normal course of their daily legitimate listening!

Another recent casualty of relentless pursuit by FCC officials was WDAB of

UNDERGROUND STATIONS

FREQ. (kHz)	IDENTIFICATION AND SCHEDULE (Time: Universal Coordinated)
1128	Mersey Alternative Radio
1187	Alternative Radio 2200-0200 Sat. eve./Sun.
1271	Radio City 1100-1500 Sat./Sun.
1320	Radio Jackie 0800-1700 Sat./Sun. (going to court; longest record for operating on land in Britain)
1463	Radio Condor International 0900-1400 Sun. Also 6243, 11463 kHz; Ireland.
1620	PRN; New England
2460	Radio Watergate International/RWI Abscam. East coast, 0500 weekends; 35 watts. Operator "Jack Cass, Mr. Personality." Also on 2340, 2630 kHz.
2390	Radio Nautilus International 0400 winter months; "Danny King" 35 watts.
3240	Voice of the Pyramids; not yet active. Also 4670, 5825, 6240, 6250, 7470, 9330, 11850, 15020, 15030, 11615 kHz.
3405	WHY Radio 0700. 90 watts.
3885	WBLO 2330 and 1500. Also 4020-kHz Sun.
4004	Radio Indiana 0400-0530. Also 6990, 7315, 7360 kHz. 21600 kHz at 2200. "Voice of Indiana"; Johnson Valiant II transmitter, 200 watts into 60 foot longwire.
5930	Radio Dublin (c/o Disk-It, Finglas Village, Dublin 11, Ireland.) Also 6210, 6250, 6275, 6310, 6350 kHz.
6204	Radio Iris; Holland.
6235	ABC International; Radio Zenith; European Music Radio; Radio Zodiac 49. Sundays.
6260	Radio Cill Dara International (Ireland); Sun. 1000-1300. Radio Cavendish (Scotland); Sun. 0800 (also 7320 kHz).
6265	Radio Krypton; Sun. 1200-1300.
6279	Syncom International; Sat./Sun. 0100-0600; Sun. 0800-1100. Also 6248, 7430 kHz. 21522 kHz; Fri./Sat. 2300-0100.
6420	KVHF Sun. 0945
6955	Radio Nautilus International 0300
6960	Voice of Venus 0330
6965	WARG/WONS 0400-0500 "Your Free East Broadcaster." Also 6980, 6988 kHz.
7050	XR705 0600.
7053	Voice of Alpha 66; 0115-0149 (Miami)
7082	Radio Abdala (Miami) 0100-0200
7090	Radio Libertad Cubana/Radio Rebelde (Miami); "Commandante David." 0100-0330
7325	Radio Zodiac; European Music Radio Sun. 0630-0845
7340	Weekend Muzick Radio
7342	Radio Impact 0600-0800. Also 7325 kHz.
7350	Moonshine Radio; "Alderaan Broadcasting Company;" 0455-0537. Sister station: Green River Radio
7365	Radio Confusion 0003
7400	The Voice of the Cuban Patriotic Junta. 0200
7420	The Voice of Revolutionary Vinco
7570	The Voice of the Burmese People. 1130
9615	Radio Noticias del Continente (TIRL); (Costa Rica)
9585	Voice of the Communist Party of Turkey. 0555-0629
9730	Voice of the Egyptian People; 1900-2000 (Anti-Begin; anti-Sadat)
11615	La Voz de la Resistencia Chilena; 0100-0137. Also 7246, 7195 kHz
15045	Radio Free Grenada; ostensibly broadcasts coded messages as obituaries weekends at 2230

Daytona Beach, FL. Run by two local disc jockeys, the Commission threatened them with heavy fines if they resumed operation. Capitulating against those odds, they now operate a legal FM cable service and stay out of trouble!

Why pirate?

Just what is it that motivates someone to start a pirate broadcasting operation? Frustration with the cumbersome licensing procedure? Indignation against authority? A keen sense of the thrill of the chase? Perhaps all of those and more. Let's ask Mr. "Guy Wire", operator of Radio Liberation in the quaint Plaquemines parish town of "Putrid," LA.

Q. Why did you decide to put a pirate station on the air?

A. Why not? It seemed like it would be fun ... it was my way of thumbing my nose at FCC censorship.

Q. What kind of programming did you do?

A. We had a staff of about 20; we got our idea of taping on cassette from Radio Havana. We were probably heard in all the states east of the Mississippi. Programs included "The Pol Pot Exile Show," rebroadcasts of The Voice of Free Grenada, some Spanish-language programming, and even an entire evening of barking dogs!

Needless to say, the FCC had fun with that one. When they finally located the neighborhood, the FCC engineers had considerable trouble finding "Guy Wire" who had spotted the suspicious vehicle and buried his transmitter!

Eventually, at the urging of his parents, the culprit exhumed the corpse of the illegitimate transmitter and put on one last demonstration for the FCC officials.

Threatened with a $10,000 fine, "Guy Wire" promised never to repeat his escapade.

In the United States, a spokesman for pirate stations is Al Muick. An informative copy of his "Free Radio Campaign" newsletter is available postpaid for $1 by writing: Free Radio Campaign, RD#2, Box 542, Wescosville, PA 18106.

Not all is in fun

As amused as we may become with the antics of some pirates, many transmissions have a definite purpose. During World War II, a British pirate attempted to damage Nazi morale by broadcasting stories that Field Marshal Rommel was a homosexual!

And that takes us to the second group of unlicensed broadcasters.

The clandestines

Some stations prefer to maintain their anonymity because of the nature of their broadcasting contents. Often

A CONVERTED CB TRANSCEIVER and two portable phonographs are the mainstays of WJAM, "The Free Radio Service of Connecticut."

politically-motivated, their transmissions are intended to persuade listeners to take drastic action against the ruling authority.

One of those, Radio Noticias del Continente (TIRL) is in Costa Rica and probably Cuban supported. It is suspected that the station was formerly called Radio Sandino, an anti-Somoza operation.

Also Communist-inspired, Radio Magallanes espouses its anti-Chilean messages, and the Voice of the Communist Party of Turkey lets its will be known.

The revolutionaries

Few American pirates or clandestines are Anti-American. Most are merely critical of certain government policies, often using the airwaves to voice their disenchantment.

But there are a few prominent anti-Castro broadcasters, sending their counter-revolutionary messages from, not surprisingly, south Florida.

Judging from the length of time those stations have been active, coupled with their blatant admission of location (mostly Miami or Key West), it would appear that the Federal Communications Commission is not particularly concerned with their presence. That may be in part due to the recent appearance of a powerful Radio Moscow relay station, beamed toward the United States from Cuba, on 600 kHz.

All of the anti-Castro Miami stations operate at the low end of the amateur 40-meter band, causing considerable grief for legitimate users. The Voice of Alpha 66 can be heard on 7053, usually between 0115 and 0150 hours daily. Radio Libertad Cubana (Radio Rebelde) is nearby on 7090 kHz, featuring the unique programming of Comandante David, usually between 0100 and 0330. Radio Abdala is just a fraction of a dial turn away at 7082 kHz, operating from 0100-0200.

Recently, nationwide publicity was given to a "raid" on one of the stations, the identity of which was not disclosed by FCC officials. A day or two later, another group, the Bay of Pigs Veterans Association's *Radio Giron* issued a news release claiming to be the operation that was shut down. Since no one had ever heard of Radio Giron, considerable question was raised as to the validity of the claim.

Was the Radio Giron statement issued to satisfy public demand to know which operation had been shut down? Was the FCC news release an unfortunate snafu which should have never been issued? Was the entire incident contrived, ostensibly to satisfy the many hams who had reported the illegal interference in their coveted 40-meter band?

At this writing, the south Florida clandestines are still alive and well, broadcasting their anti-Castro messages with apparent impunity.

Operating frequencies and schedules

Here we present an extensive list of the more frequently reported pirate and clandestine broadcasters. Because of the tenuous nature of their operation, frequencies and schedules change frequently. We cannot be held responsible for the accuracy of this list, but the basic ranges of times and frequencies are typical. Most of the broadcasters are in the British Isles, and many are reported by American and European listeners.

It would seem that the best time to look for the pirates is from 0900-1400 hours, and the best frequency ranges are 6235-6280 and 7325-7370 kHz. They are invariably low power, so some persistence and patience will be necessary.

Is pirate radio a wave of the future? Yes! says Al Muick of Free Radio Campaign. Especially in England where at least three new stations are expected to be operational shortly.

Radio Europe (Radio del Mare) will be afloat in the English Channel serving the Dutch and Belgian listeners of Radio Mi Amigo. According to Muick, the operator of this endeavor is "Ferry Eden."

Another operation will be conducted in the shortwave bands by ex-ABC England personnel. All three operations are expected to utilize medium-wave and VHF as well.

Pirate/clandestine radio is alive and well. Next time you casually tune across your shortwave dial and happen to discover a weak signal arguing with the establishment, the chances are good that you are listening to a fresh breath of individuality adrift in a sea of drivel. Let us know what you hear! **R-E**

The author would like to thank John Santosuosso and Al Muick for their contributions in preparing this article.

NEW DOLBY NOISE REDUCTION SYSTEM

Dolby B is certainly the best known noise reduction system on the market, but it isn't the only one. New Dolby C is Dolby Laboratories' answer to the competition.

LEONARD FELDMAN
CONTRIBUTING HI-FI EDITOR

AFTER MORE THAN TEN YEARS OF BEING the acknowledged leader in the field of noise-reduction systems for use in consumer-type cassette tape recorders, Dolby Laboratories, under the direction of Dr. Ray Dolby, has announced a new noise-reduction technique, to be known as *Dobly C*. (*Dolby A* is the professional noise-reduction system used by many recording studios, and *Dolby B* the well known consumer-product system.)

Before the development of *Dolby-B* noise-reduction and its commercial acceptance in the early 1970's, about the best signal-to-noise ratio that you could expect from even the best cassette tape decks was perhaps 40 or 45 dB. Adding a full 10 dB of noise-reduction or hiss reduction above 5 kHz was considered to be (and still is) one of the most important contributions to the high-fidelity field by any single inventor.

Virtually every important manufacturer of high-fidelity component stereo cassette decks signed license agreements with Dolby Laboratories and incorporated *Dolby-B* noise-reduction circuitry in its products. Today, it would be difficult, if not impossible, for a manufacturer to sell a stereo cassette deck priced above $150.00 if it did not incorporate *Dolby B* or an equivalent system.

But *Dolby B*, while certainly the best known electronic noise-reduction system in use today, is not the only one. Since its introduction we have seen a variety of noise-reduction systems developed. Many of them offer greater decreases in audible tape noise reduction than *Dolby B*. Among those are the well known linear companding (compression-expansion) system developed by dbx, Inc. In addition to increasing the available dynamic range on cassettes by applying 2 dB:1 dB compression during recording and the reciprocal, 1 dB:2 dB expansion during playback, the dbx system delivers more than 30 dB of noise reduction in the process.

Nakamichi, the well known maker of high-quality cassette decks, in cooperation with Telefunken of West Germany has come up with a two-band noise-reduction system that it calls *High-Com II*. It is a variation of Telefunken's professional noise-reduction system and, though frequency-selective, it provides approximately 20 dB of noise reduction at mid- and high frequencies.

Meanwhile, in Japan, Sanyo and Toshiba have developed their own noise-reduction systems: *Super-D* and *ADRES* respectively. Each one offers considerably more noise-reduction capability than *Dolby B*. Here, in the U.S., CBS Records has hinted that it has developed a noise-reduction system that not only provides more noise reduction than Dolby, but produces recordings that sound good even when played without any special circuitry or decoding device.

Other noise-reduction systems that are directly competitive with *Dolby B* include *ANRS*, developed by JVC and, more recently, *Super ANRS*. In addition to providing noise reduction, those systems also deal with the problem of high-frequency tape saturation.

Many audiophiles were beginning to wonder whether Dolby would come up with a new noise-reduction system to compete with all of the newer systems that have been gaining increased acceptance and popularity. Instead, about two years ago Dolby Laboratories came up with a headroom-extension system that they called *Dolby HX*. That circuit varied instantaneous recording bias and equalization to provide better headroom when recording high-level, high-frequency signals. When such signals occur in the program material, the bias is automatically lowered. When mid- or low-frequency signals predominate, the bias is increased to provide the best recording conditions for those frequencies. And because dynamic alteration of record-bias levels changes the overall flatness of frequency response, recording equalization is dynamically varied as well.

Very few companies use *Dolby HX* in their cassette decks. Some have expressed fears that the instantaneous lowering of bias during moments when high-frequency, high-level, passages

THE NEW NAKAMICHI 700ZXL computing cassette deck and its accessory NR-100 *Dolby C* noise reduction processor.

are recorded would have an adverse effect upon the distortion of low and mid-frequency signal content being recorded at the same instant. Accordingly, many companies have not used *Dolby HX* despite the fact that all Dolby licensees were offered the new innovation without having to pay additional royalty fees.

Now, Dolby has come up with a new noise-reduction system. It was demonstrated at the Winter Consumer Electronics Show in Las Vegas. Rumors concerning that new system were widely circulated long before Dolby disclosed its details. Back in October 1980, while attending the Tokyo Audio Fair, I learned that the rumors were true and that the new noise-reduction system would be called *Dolby C*. Many Japanese licensees of Dolby are already working on cassette decks that contain the new noise-reduction circuitry and will introduce those models by mid-1981.

How *Dolby C* works

In many respects, *Dolby C*-type noise reduction works like *Dolby A* and *Dolby B*. Like those earlier systems, C-type noise-reduction is a dual-path

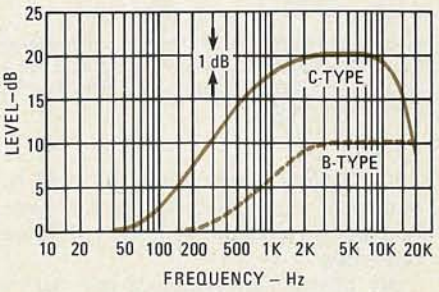


FIG. 1—THE BAND of frequencies over which noise reduction takes place is extended two octaves lower in *Dolby C* as compared with *Dolby B*.

system that reduces noise using a low-level side-chain (a level-sensing mechanism in the Dolby system). In addition, the sliding-band technology of the B-type noise-reduction system is used in the new system, although the band of frequencies over which noise reduction takes place has been extended two octaves downward, as illustrated in the comparison graphs of Fig. 1. *Dolby C*-type noise reduction required other new developments to achieve its 20 dB of noise reduction while, like *Dolby A* and *Dolby B*, still retaining freedom from side effects like "breathing" and "pumping."

According to Dolby Laboratories, the *Dolby C* noise-reduction system solves the problem of achieving high levels of compression (during recording) and expansion (during playback), without introducing undesirable side effects, by using two processing stages in series. Each stage supplies 10 dB of compression during recording and the same amount of expansion during playback decoding. Furthermore, each circuit operates at its own independent level.

One stage, identified as the high-level stage in Fig. 2, is sensitive to signals at about the same levels as in *Dolby-B* noise reduction, while the second stage, a lower-level stage, operates on signals of lower amplitude. Since the two stages are in series, their net effect is to multiply the signals, which is the same as adding or subtracting decibels. In that way, a total of 20 dB of compression and expansion is obtained, and that is the equivalent of 20 dB of noise reduction.

Because of the independent-stage arrangement, the program signal is never subjected to the problems associated with a single 20-dB compression or expansion stage. The in-

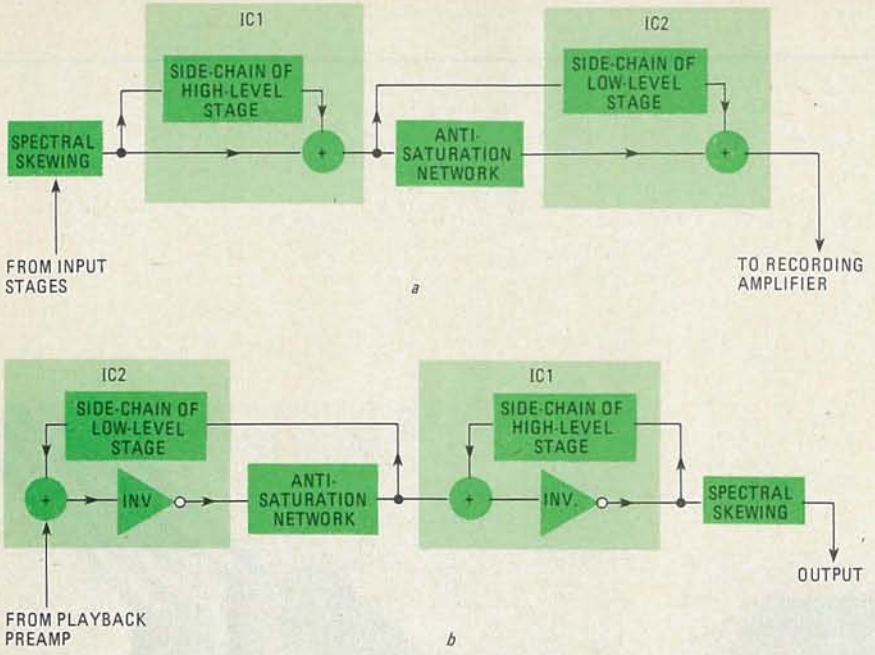


FIG. 2—BLOCK DIAGRAM of the *Dolby C* encoder (*a*) and decoder (*b*) circuits. Side chains are Dolby's level-sensing mechanism.

dependent and cumulative action of the two compression/expansion stages can best be understood by referring to Fig. 3. Dolby maintains that the two-level, two-stage, configuration provides more accurate control of the program signal than is possible with a single compander circuit.

To execute the two-level, two-stage configuration for *Dolby-C* noise reduction, two conventional IC's are used, according to Dolby Labs. That means that a *Dolby-C* noise-reduction system can initially be built using readily available parts. In the future it is expected that integrated-circuit manufacturers will produce a single, dedicated, *Dolby-C* integrated circuit to make it easy to add that system to new products. One of the two stages of *Dolby C* can easily be configured to provide the well-known *Dolby-B* noise-reduction characteristic at the push of a front-panel switch, for example, so that cassette decks incorporating C-type noise reduction can also deliver *Dolby-B* noise reduction for compatibility with existing *Dolby B*-type recordings as well as the new *Dolby-C* recordings.

Overall compatibility

An important consideration in the development of *Dolby C* was the compatibility of recordings made with the new system. Just as *Dolby B* had to be compatible with recordings that had no noise-reduction encoding in them (consumer noise reduction did not exist, for all practical purposes, at the time that *Dolby-B* was first introduced), *Dolby-C* noise reduction has been designed on the premise that *Dolby B* is now in universal use. As a result, recordings made

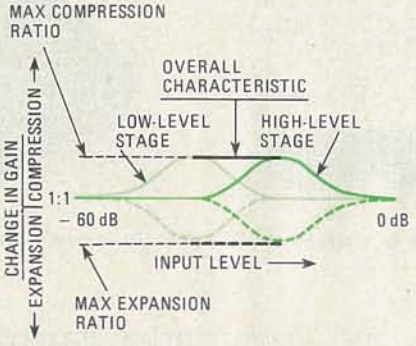


FIG. 3—THE EFFECT of the two compression/expansion stages on a program signal. The two stages work together to achieve the full 20 dB of processing required.

with *Dolby-C* noise reduction will be listenable on high-fidelity cassette machines equipped with B-type noise reduction.

Of course, reproduction will not be perfect under those conditions, just as the reproduction of *Dolby-B* recordings on machines not equipped with any Dolby circuitry is not perfect. They are listenable, however, especially if the amplifier's treble control is adjusted to compensate for the Dolby effect. Dolby maintains that *Dolby-C* recordings would even be tolerable when played back on lower-fidelity portable cassette units not equipped with any type of noise-reduction circuitry. Accordingly, Dolby Laboratories will develop professional-grade C-type noise-reduction *encoders* for use in cassette duplication.

Other features of *Dolby C*

Besides the two stages of companding, *Dolby-C* noise reduction incorporates several other circuit innovations. Two of those circuit innovations, designated in Fig 2 as the anti-saturation and spectral-skewing networks, introduce precisely calculated frequency-response modifications during recording and compensate for them during playback.

Those response modifications are introduced as a further safeguard against audible side effects. Specific benefits of those additional circuits include the reduction of encode-decode errors and a reduction of upper-middle and high-frequency tape saturation and attendant side effects, such as high-frequency losses and intermodulation distortion.

While the new system uses readily available components including Dolby-IC processors, the complexity of the C-type noise-reduction system is said to be between two and three times that of a conventional B-type circuit. Furthermore, according to Dolby, to take full advantage of the noise-reduction capabilities of the *Dolby-C* system, the recorder using it must have a very high level of mechanical and electrical performance and sophistication, including low-noise circuitry surrounding the noise-reduction processor itself. Because of those cost and quality considerations, it is likely that the new system will appear first as a supplement to standard *Dolby B* in high-performance, higher-priced cassette decks. In the future, the use of *Dolby-C* circuitry may be simplified somewhat by the development of specific-purpose *Dolby-C* IC's. When that happens, we may see some lower- or mid-priced cassette decks incorporating the new noise-reduction system.

As was the case with *Dolby HX*, Dolby Labs will provide C-type noise reduction to its licensees under their existing Dolby license agreements without imposing an additional royalty for using the new system.

It is evident that Dolby, the first developer of noise-reduction systems for consumer tape recorders, is not about to resign from its position of supremacy in the highly competitive noise-reduction field just because others have come up with noise-reduction schemes that are claimed to be superior to the one originally developed by Dolby! **R-E**

LINEAR COMPRESSION/EXPANSION is used to reduce noise in the *model 3BX* from dbx, Incorporated.

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Get a coupon good for a $25 rebate when you purchase a *Bearcat* 300, 250, 220 or 210XL; $20 rebate on model 160; $10 rebate on model Four-Six Thin Scan and $5 rebate on the *Bearcat* 5. To get your rebate, mail this coupon with your original dated sales receipt and the *Bearcat* model number from the carton to Electra. You'll receive your rebate in four to six weeks. Offer valid only on purchases made betwen April 1, 1981 and May 15, 1981. All requests must be postmarked by May 30, 1981. Limit of one rebate per household. Coupon must accompany all rebate requests and may not be reproduced. Offer good only in the U.S.A. Void where taxed or prohibited by law. Resellers, companies, clubs and organizations-both profit and non-profit-are not eligible for rebates. Employees of Electra Company, their advertising agencies, distributors and retailers of *Bearcat* Scanners are also not eligible for rebates. Please be sure to send in the correct amount for your scanner. Pay the listed **CE** price in this ad. *Do not* deduct the rebate amount since your rebate will be sent directly to you from Electra. Orders received with insufficient payments will not be processed and will be returned.

Bearcat® 250

List price $429.95/**CE price $279.00/$25.00 rebate**

Your final cost is a low $254.00

50 Channels • Crystalless • Searches Stores • Recalls • Digital clock • AC/DC Priority Channel • 3-Band • Count Feature.

Frequency range 32-50, 146-174, 420-512 MHz.

The *Bearcat* 250 performs any scanning function you could possibly want. With push button ease you can program up to 50 channels for automatic monitoring. Push another button and search for new frequencies. There are no crystals to limit what you want to hear. A special search feature of the *Bearcat* 250 actually stores 64 frequencies and recalls them, one at a time, at your convenience.

Bearcat® 220

List price $449.95/**CE price $289.00/$25.00 rebate**

Your final cost is a low $264.00

Aircraft and public service monitor. *Frequency range 32-50, 118-136 AM, 144-174, 420-512 MHz.*

The *Bearcat* 220 is one scanner which can monitor all public service bands plus the exciting AM aircraft band channels. Up to twenty frequencies may be scanned at the same time.

Not only does this new scanner feature normal search operation, where frequency limits are set and the scanner searches between your programmed parameters, it also searches marine or aircraft frequencies by pressing a single button.

Bearcat® 210XL

List price $349.95/**CE price $229.00/$25.00 rebate**

Your final cost a low $204.00

18 Channels • 3 Bands • Crystalless • AC/DC

Frequency range: 32-50, 144-174, 421-512 MHz.

The *Bearcat* 210XL scanning radio is the second generation scanner that replaces the popular *Bearcat* 210 and 211. It has almost twice the scanning capacity of the *Bearcat* 210 with 18 channels plus dual scanning speeds and a bright green fluorescent display. Automatic search finds new frequencies. Features scan delay, single antenna, patented track tuning and more!

NEW! Bearcat® 160

List price $299.95/**CE price $189.00/$20.00 rebate**

Your final cost is a low $169.00

16 Channels • 3 Bands • AC only • Priority Dual Scan Speeds • Direct Channel Access

Frequency range: 32-50, 144-174, 440-512 MHz.

Would you believe...the *Bearcat* 160 is the least expensive *Bearcat* crystalless scanner.

This scanner presents a new dimension in scanning form and function. Look at the smooth keyboard. No buttons to punch. No knobs to turn. Instead, finger-tip pads provide control of *all* scanning operations, including On/Off, Volume and Squelch. Of course the *Bearcat* 160 incorporates other advanced *Bearcat* features such as Priority, Direct Channel Access, Dual Scan Speeds, Automatic Channel Lockout, Scan Delay and Auxiliary. All this performance in sleek, contemporary styling. And at a price so low, it astounds even us!

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List price $134.95/**CE price $94.00/$5.00 rebate**

Your final cost is a low $89.00

8 Crystal Channels • 3 Bands • AC only

Frequency range: 33-50, 146-174, 450-508 MHz.

The *Bearcat* 5 is a value-packed crystal scanner built for the scanning professional — at a price the first-time buyer can afford. Individual lockout switches.

Bearcat® Four-Six ThinScan™

List price $189.95/**CE price $124.00/$10.00 rebate**

Your final cost is a low $114.00

Frequency range: 33-47, 152-164, 450-508 MHz.

The incredible, *Bearcat* Four-Six Thin Scan™ is like having an information center in your pocket. This three band, 6 channel crystal controlled scanner has patented Track Tuning on UHF. Scan Delay and Channel Lockout. Measures 2¾ x 6¼ x 1" Includes rubber ducky antenna. Order crystals for each channel. Made in Japan.

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Test any scanner purchased from **Communications Electronics™** for 31 days before you decide to keep it. If for any reason you are not completely satisfied, return it in original condition with all parts in 31 days, for a prompt refund (less shipping/handling charges and rebate credits).

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List price $169.95/**CE price $109.00**

Low cost 6-channel, 3-band scanner!

The *Fanon* Slimline 6-HLU gives you six channels of crystal controlled excitement. Unique Automatic Peak Tuning Circuit adjusts the receiver front end for maximum sensitivity across the entire UHF band. Individual channel lockout switches. Frequency range 30-50, 146-175 and 450-512 MHz. Size 2¾ x6¼ x 1." Includes rubber ducky antenna. Order crystal certificates for each channel. Made in Japan.

Fanon Slimline 6-HL

List price $149.95/**CE price $99.00**

6-Channel performance at 4-channel cost!

Frequency range: 30-50, 146-175 MHz.

If you *don't* need the UHF band, get this model and save money. Same high performance and features as the model HLU without the UHF band. Order crystal certificates for each channel. Made in Japan.

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Regency® M100 Scanner..... $199.00
Regency® R1040 Scanner..... $169.00
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SP51 Battery Charger..... $9.00
SP58 Carrying Case for *Bearcat* 4-6 ThinScan™ ... $12.00
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- 3½-digit resolution
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  conductance (1/R)
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  ac voltage
  dc current
  ac current
  resistance
  diode test
  conductance (1/R)
  logic level and continuity detect
  temperature (K-type thermocouple)
- Peak hold on voltage and current functions
- Selectable audible indicator for continuity or level detection
- 3½-digit resolution
- 0.1% basic dc accura
- LCD display
- Overload protection

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BENCH/PORTABLE DMM

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Model 6100

- 5 Range audible signaling function
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ADVANCE ELECTRONICS

hobby corner

Here's a look at negative-ion generators, and other tidbits,

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

IN JUNE 1980, I PASSED ALONG A REQUEST from Russ Lane for some information about building a negative-ion generator. Thanks for your responses.

For the uninitiated, there are those who maintain that exposure to air that contains negative ions promotes physical and mental well-being. I simply don't know whether it does or doesn't, so I can only say, "To each his own!"

In any case, there is general agreement that breathing ozone (O_3) for an extended period is unhealthy. Further, an ion generator will produce ozone if it is not adjusted properly. So, if you build your own, be sure to have all the information you will need and make the adjustments that prevent ozone formation.

Negative ions are introduced into the atmosphere when a negatively charged object "leaks" them into the air. To get an appreciable quantity of ions, you need several thousand volts—at least 5,000.

There are four convenient methods of producing the required high voltage. One is to begin with 110 volts AC or more from a transformer and add on a long series of voltage-doubler circuits. Another is to use a "firing transformer" designed to produce an arc (normally to ignite an oil furnace).

Very little current is needed to produce ions. Safety precautions with either of the above methods include placing a very high resistance between the supply and the charged object in order to limit the current in case you accidentally come into contact with it.

Two ways that are more satisfactory for producing high voltage require a little more circuitry. They are to use either an automobile ignition coil or a TV flyback transformer to change a low input-voltage into 5-to 20-thousand volts. For increased efficiency, the low voltage should be interrupted DC (square wave) rather than AC. That is usually done with heavy-duty switching transistors driven by a square-wave generator (a 555 IC) or by a feedback winding added to the flyback transformer.

There are two advantages to those last two methods. One is that the current is automatically limited. The other is that those systems are more readily adjusted to prevent ozone formation.

Of course, the final high-voltage must be rectified; the usual approach is to use a solid-state diode designed for TV high-voltage supplies. The negative output lead is connected to the "charged object."

Unit charges (electrons) disperse over the surface of an object with a concentration proportional to the radius of curvature at any given point. What that means is that the electrons collect around sharp angles and points (see Fig. 1). So, if you want them to leak off into the air, your object must have one or more sharp points. Then, with a good high voltage, the electrons "spray off" the charged object and ionize the air molecules.

That shape factor is the reason why builders of ion generators often use one (or more) sewing needles as the charged object. The negative output of the high-voltage supply is simply connected to the needle.

Because of the shape factor, you should be careful when you hook-up and route the high-voltage lead. Avoid leaving wire ends sticking out. Watch for sharp projections that may be left on a solder blob. Avoid sharp bends in the wires—use gentle curves when changing direction. After all, you want to lose as few electrons as possible before reaching the needle(s).

There you have the basics for building your own negative-ion generator. Special thanks to Dennis Doonan (Racine, WI), Istvan Mohos (Phoenix, AZ), Richard Kaufman (New York, NY) and others who came up with much of the foregoing information.

Magazine index

How often does this happen to you? You remember an article with information that you need but you can't remember what issue it was in—maybe not even the year it appeared or in what magazine. You tackle the annual indexes if you have them or worse yet, the table of contents in each individual issue.

That process can be a real headache; it can take from hours to days. And that is only when you can remember the article—what about those articles that you have forgotten?

I have some magazine files that go back more than 25 years. Searching for something vaguely recalled used to be a chore, but not any longer—my *TRS-80* does the searching for me.

What does your microcomputer do for *you* besides play games? Put your computer to work keeping and searching a master index—one or more depending upon your needs.

An 8K or 16K computer can hold a surprisingly large index if you are careful about how you arrange the data. That is especially true if you use your imagination to create a coding system that will reduce memory requirements. Here's an example:

```
IDENTIFY UNMARKED IC'S
Radio-Electronics
P. 45, JAN 80
```

can become

```
ICIDXMARK/RE0450180
```

Of course you should use your own system, but it is obvious that the second entry takes less memory but conveys the same information.

Well . . . yes, it *did* take time to create the index files for the several magazines—especially for the ones that go back a number of years. Once done however, it takes only a few minutes every month or two to stay current.

Now my searches are quick and complete. The reference mentioned above will turn up in a long list if I key in "IC" and on a much shorter one under "ICID."

Don't let your computer just play around—put it to work. And if you don't have one yet, here is one more reason to get one.

Help!

Pat Hazen of New Orleans is asking for help in designing an alarm circuit to substitute for an output-meter indicator in a detection device. He is speaking specifically of the gas detector in the July 1976 issue of **Radio-Electronics.**

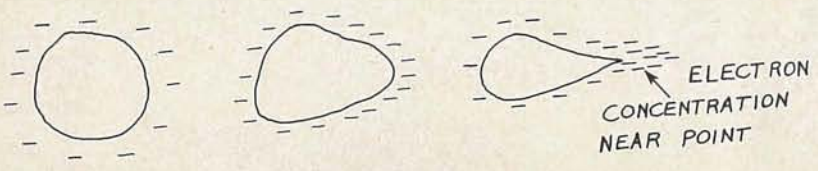


Fig. 1

Apparently, Pat does not wish to use a mechanical device, but that still leaves transistor switches, flip-flops, and other possibilities. Can you come up with a suitable alarm circuit to help Pat out.

Recently available

PanaVise Products, Inc. (2850 East 29th Street, Long Beach, CA 90806) has a comprehensive catalog of their heads, bases, mounts, and accessories. With all the possible combinations, they have a holder/vise for almost any application.

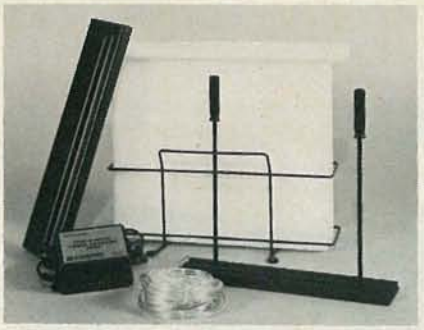
An extensive listing of general and computer-related parts, equipment, and accessories is to be found in the Advanced Computer Products, Inc. catalog (PO Box 17329, Irvine, CA 92713).

Digi-Key Corp. (PO Box 677, Thief River Falls, MN 56701) has a catalog with a very broad listing of parts for the builder. The chances are good that Digi-Key has what you may need, including books. You can get their catalog by calling, toll-free, 1-800-346-5144. **R-E**

new products

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

POWER ETCHING SYSTEM & ETCHING SOLUTION HEATER, *GC Cat. No. 22-394 and GC Cat. No. 22-392* includes an etching tank, pump, and heater, and is designed to handle two single-or double-sided boards up to 8 × 10 inches in size at the same time.



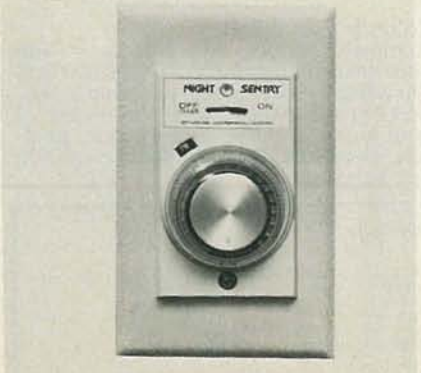
CIRCLE 151 ON FREE INFORMATION CARD

The basic tank system, *GC Cat. No. 22-394,* includes a 1.25-gallon molded polyethelene tank with lid, agitating pump, hose, wire base PC-board holder, and instructions. The base can be mounted on a bench, left portable, or mounted as a bench well. The pump keeps acid agitating for faster, more even etching. PC boards fit into a submersible rack, with handles, that keeps boards separate and hands away from the acid. The tank lid can also be used as an auxiliary lab tray.

The Etching Solution Heater, *GC Cat. No. 22-392,* greatly reduces etching time. The heater attaches easily to the tank and its thermostat quickly adjusts to solution temperature.

The price of the basic tank system is $55.98; the heater costs $10.25.—**GC Electronics,** 400 South Wyman St., Rockford, IL 61101.

TIMED LIGHT CONTROL, the *Night Sentry,* is designed to give your home a "lived-in" look while you're away. This wall-model, solid-state light timer provides automatic control of indoor or outdoor light fixtures—including porch, post, kitchen, bathroom, and bedroom lights—using a microprocessor. Its "memory" permits automatic self-programming; you use it as a conventional light switch and after 24 hours of use, your pattern of light-use will be repeated daily.



CIRCLE 152 ON FREE INFORMATION CARD

The *Night Sentry* can be programmed in a matter of seconds, and up to 48 ON-OFF settings per 24-hour period are possible. It can be installed in minutes with only a screwdriver. The suggested retail price for the *Night Sentry* is under $25.00.—**Dynascan Corporation,** 6460 W. Cortland St., Chicago, IL 60635.

DUAL-TRACE OSCILLOSCOPE, *model HM312,* offers precise, drift-free performance over varying conditions. Both vertical amplifiers have a bandwidth of DC to 20 MHz, with a maximum sensitivity of 5 mV-per-cm. Full X–Y operation is available by switching channel 2 into the horizontal-deflection system.

CIRCLE 153 ON FREE INFORMATION CARD

The *model HM312* will trigger on as little as a 4-mm signal up to 30 MHz. Triggering is auto or variable level, with the source being channel 1, 2, or external. A TV-frame sync filter is also provided. Sweep speeds range from 0.2 seconds to 40 nanoseconds. All of the critical DC voltages are regulated.

The input-line transformer can be connected to operate from 110 to 237 volts AC, 50 to 60 Hz. There is a built-in 1-kHz, 0.2-volt (± 1%) square-wave generator that is used for checking probe compensation.

The *model HM312* comes in an all-metal case (9.3 × 8.3 × 15 inches) that is particularly suited for lab and field use. There is a handy carry handle and retractable tilt-up stand that pulls down from under the unit. The price of the *model HM312* is $610.00.—**Hameg, Inc.,** 191 Main St., Port Washington, NY 11050.

DMM, *model 467,* is a hand-portable combination of digital and analog LCD displays to analyse both steady and pulsing signals, plus differential + and − peak-holding capability and fast-pulse detection and indication.

In the differential mode, the *model 467* can make percent modulation and signal-tracing measurements. In the pulse-detection mode, it can give visual and/or audible indication of pulse presence and logic states. Other standard features include 26 AC/DC voltage, current and resistance ranges, true RMS AC voltage and current measurements, 0.1% DC accuracy on the

voltage ranges, continuity detection with both visual and audible indications, high-voltage transient protection, and excellent overload capabilities.

CIRCLE 154 ON FREE INFORMATION CARD

The *model 467* is cordless and gives up to a year of service on a single 9-volt alkaline battery. It measures 2 × 5.6 × 4.6 inches, weighs 1½ pounds, and comes with a 9-volt battery, U.L.-approved test leads with screw-on alligator clips, and an instruction manual. The price is $239.00.—**Simpson Electric Company,** 853 Dundee Ave., Elgin, IL

AC POWER-LINE TESTER KIT, *model 3600-K,* features a new hand-size battery-operated 3½-digit AC power-line tester, a *model 10-L* clamp-on AC ammeter, a *model 101* line separator, man-made leather top opening hand-and-shoulder carrying case, two 4½ foot long test leads, and a 9-volt battery.

The digital *3600* AC power-line tester has a single-selector switch for AC volt ranges, 0-200 volts and 0-600 volts. Accuracy is ± 0.5% of reading. AC-current range (requires the use of the *model 10-L* clamp-on ammeter) is 0-20-200 amps. Accuracy is ± 3% of reading.

CIRCLE 155 ON FREE INFORMATION CARD

The *model 10-L* clamp-on AC ammeter adapter is used to make current measurements without circuit interruption when clamped around a single conductor, and 0-20-200 amps may be read directly as AC amperes on the *model-3600* display. If conductors cannot be separated, the Triplett *model 101* line separator is provided in the kit to make fast and accurate measurements.

A large, easy-to-read 0.5-inch, 3½-digit liquid-crystal display with low-battery alert and over-range indication, is provided. The *model-3600* tester is compact and weighs 10 ounces with its 9-volt battery. Typical battery life is 500 hours in usage and the display indicates when eight hours of battery life remain. It also has auto-zeroing, inherent protection (up to 600 volts on all ranges) from overloads without damage, and meets ANSI C39.1 specifications. The price is $150.—**Triplett Corporation,** One Triplett Drive, Bluffton, OH 45817. **R-E**

ALL NEW!

ALBIA ELECTRONICS

DM-10 LOW OHM METER MODULE

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

- Resistance range 10 milliOhms to 20 Ohms
- Zero Calibration control
- Battery powered (push to read battery saver circuit). Requires 1 9 Volt Battery (not included).
- Size 6.25" x 3.75" x 2" (Input cables not included or available)

Completely assembled and tested! Ready to use!

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

Measure frequencies from 5Hz to 100MHz on your digital voltmeter with a resolution of 3½ digits — easy to use — perfect for field service — lab testing — home hobbyist! Connect the DM-11 to your DVM, set the DVM to the 2VDC range, connect a signal to the DM-11 via a BNC cable (not included) and measure the frequency of any source. Hi Lo Range LED's insure fast accurate readings.

- Frequency Range 5Hz to 100MHz
- Input Impedance 1 MegOhm
- Input Sensitivity: < 100Hz < 80MV
  100Hz – 60MHz < 30MV
  > 60MHz < 70MV
- Size 6.25" x 3.75" x 2"
- External 9V DC power supply included. (Model MMAC-2)
- BNC Input Cable Accessory (Model PSA-2 add $14.95)

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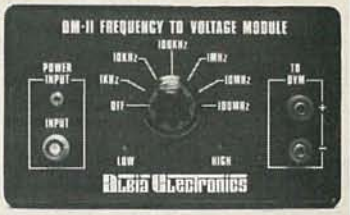

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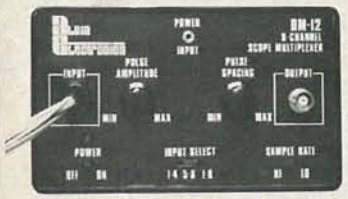

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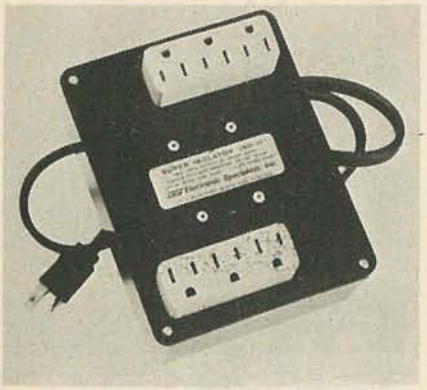
SUPER ISOLATOR, *model ISO-11,* is designed to curb problems in microprocessor installations resulting from severe AC powerline spikes, surges, and hash—those unexplained crashes, memory losses, or other glitches. (Disks, printer, and processor often interact, aggravating such problems.)



CIRCLE 156 ON FREE INFORMATION CARD

The *model ISO-11* features two individually dual-pi filtered AC socket banks (six sockets in all). Heavy-duty spike/surge suppression is incorporated in the design. Equipment interactions are eliminated; and disruptive and damaging line spikes and hash are controlled.

The model *ISO-11* is priced at $85.95.—**Electronic Specialists, Inc.,** 171 South Main Street, Natick, MA 01760.

PROGRAMMABLE DMM, *model 192,* "smart" DMM offering 0.005% accuracy, 1-μV sensitivity, 6½-digit resolution, front-panel math functions, and data-storage capability. Additional features include fast autorange (150 ms per range change), one-button zero, a speed of over 25 readings per second at 4½-digit resolution (or 20 readings per second at 5½-digit resolution), and high-input impedance of 10^9 ohms up to the 20-volt range.

CIRCLE 157 ON FREE INFORMATION CARD

An optional AC-volts function, which uses AC averaging, is priced at $175.00. For an additional $395.00, the user may opt for full IEEE-488 interfacability.

The *model 192's* math programs include scale factor and offset modifications (Y=sX+b), percentage deviation from an entered nominal value, storage of minimum/maximum values (also serving as a peak-hold memory), and HI/LO pass limits. There is also a choice of multiple or single-input connectors. Separate inputs for DC volts, AC volts, and ohms on the front-panel enhance system accuracy by allowing the optimum cable type to be used for each function. A rear-input adapter allows multiple and single rear inputs when used with the IEEE-488 option.

The *model 192* also is a high-performance, low-cost datalogger, due to its data-storage feature. Ten different readings may be programmed from the front panel, allowing up to 100 readings to be stored over a period of up to four days. The *model 192* is priced at $995.00.—**Keithley Instruments. Inc.,** 28775 Aurora Road, Cleveland OH 44139. **R-E**

What's News

Quality service instruments to be available locally

The John Fluke Mfg. Co., long known as a leading builder of high-class electronic instrumentation, has announced a new plan of broad marketing and distribution to meet the needs of service technicians, and hobbyists, as well as educational and personal users.

In the first six months of the program, Fluke will have at least 400 local dealers throughout the country, ranging from electronics distributors to automotive stores and hobby shops. The program will make a complete line of high-quality handheld and bench low-cost digital multitesters available locally. The user will be able to inspect the meters at the store and purchase them locally, while still being assured of any needed service from Fluke. Fluke is the first large instrument manufacturer to mount such a program.

The program is being initiated with the Fluke Series D, a group of five digital multimeters, with prices ranging from $125 to $299, meter accuracy from 0.5 percent to 0.1 percent, and a corresponding range in meter functions. **R-E**

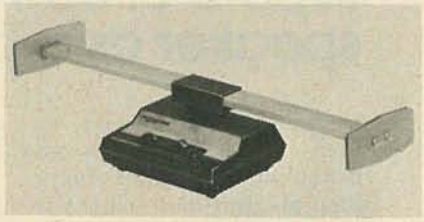
stereo products

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

STEREO HEADPHONE, *model 60A,* offers high quality sound at an affordable price. It features individual volume and balance controls, a sensitivity of 110 dB at 1,000 Hz with 1 mW, a matching impedance of 8 to 16 ohms, and a maximum input of 0.5 watt. Other features are leathery soft ear cushions and a 10-foot coiled connecting cord with a 3-circuit phone plug. It's packaged in a 3-color display carton. Suggested retail price of *model 60A* is $14.95. **—BP Electronics,** 855 Conklin St., Farmingdale, NY 11735.

CIRCLE 131 ON FREE INFORMATION CARD

FM STEREO ANTENNA, the *Stereo-Ceptor model FM-4400,* is an indoor antenna featuring a built-in amplifier that boosts and cleans up weak FM signals, therefore adding more stations in most areas. Operating on 110-117 VAC, the unit eliminates multi-path distortion and optimizes signal-to-noise ratio for clear reception. It also has a bi-directional signal element that turns 90 degrees to receive FM stations in all directions for maximum capture area. Measuring 19 in. wide by 3½ in. deep, this compact unit is housed in a deep brown enclosure and can sit on a shelf or on top of a stereo receiver. Coaxial cable and transformer are included. Price is $71.95. **—Winegard Co.,** 3000 Kirkwood St., Burlington, IA 52601.



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CASSETTE DECK, *model KX-500,* has Dolby and metal tape capability and features fast, efficient fluorescent peak-meters. The four-position tape selector is combined with a variable bias-adjust control to optimize the performance of each tape.

CIRCLE 133 ON FREE INFORMATION CARD

The deck's drive system has a dual-belt design and an extra-wide flywheel that results in a wow-and-flutter of less than 0.05% WRMS. Other features are new "soft touch" controls, automatic shutoff in all modes, a single RECORD button, a

RECORD MUTE switch, PAUSE control, two microphone jacks with built-in preamps, a headphone jack, and LED recording and pause indicators. With Dolby on and chrome, ferri-chrome or metal tape in use, the frequency response is 30 to 16,000 Hz and the signal-to-noise ratio is 64 dB. The *Model KX-500* is priced at $225. **—Kenwood Electronics, Inc.,** Dept. P, 1315 E. Watsoncenter Rd., Carson, CA 90745.

RECORD CLEANER, the *Cecil Watts Record and Stylus Care Kit,* is a three-piece starter kit designed to introduce the user to this basic non-liquid system of record care. The principle behind

CIRCLE 134 ON FREE INFORMATION CARD

this record cleaning device is that it is used in a semi-dry or slightly moist state and therefore does not leave a film or residue on the record that can result in a lack of stylus contact and subsequent distortion. The kit includes *Parastatik Disc Preener, Parastatik* Anti-Static Fluid and *Watts* Stylus Cleaner. Price is $13.95. **—Empire Scientific Corp.,** 1055 Stewart Ave., Garden City, NY 11530.

AM/FM STEREO, *Concept model CD-82,* is both an AM/FM stereo and cassette player featuring automatic reverse and has normal bias as well as metal tape capabilities. Other features are a line-output preamplifier that makes the unit compati-

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ble with most power amplifiers, and a stereo high-blend capability that helps provide clearer reception in low-signal areas. The *model CD-82* is also compatible with a variety of equalizers and boosters. Price is $299. **—J.I.L.,** 737 West Artesia Blvd., Compton, CA 90220.

CASSETTE DECK, *RT-30,* is a metal-capable DC-controlled motorized deck and features a 12-LED *Sharpscan* peak level display, damped eject,

CIRCLE 136 ON FREE INFORMATION CARD

and an automatic program search system. Specifications of this model include a signal-to-noise ratio of 66 dB (Dolby on over 5 kHz), a frequency response of 30 to 14,000 Hz for normal, 30 to 15,000 Hz for CrO_2/FeCr, and 30 to 17,000 Hz for metal tapes. Suggested retail price is $199.95. **—Sharp Electronics Corp.,** 10 Keystone Pl., Paramus, NJ 07652.

SPEAKER SYSTEM, *model B450T10,* is a 3-way wedge-shaped system designed for use in autos, recreational vehicles, boats, and homes. It can sit on any flat surface or can be secured over a 6 × 9-inch mounting hole. Each speaker includes a 4-inch air suspension woofer with a 10-ounce magnet, 2-inch midrange, and a 1½-inch tweeter.

Manufacturer's specifications include a power rating of 50 watts, impedance of 4 to 8 ohms and a frequency response of 65 to 20,000 Hz.

The *model B450T10P,* that includes a built-in amplifier, is also available. The *B450T10* series speakers are housed in aluminum die cast enclo-

CIRCLE 137 ON FREE INFORMATION CARD

sures that measure 8¾ × 5 × 7 inches. Comes with adjustable mounting brackets, mounting hardware, 5-feet heavy-duty hook-up wires and installation instructions. The *B450T10* sells for $198, the *B450T10P* sells for $238. **—International Components Corp.,** 105 Maxess Rd., Melville, NY 11747. **R-E**

new ideas

ELECTRONIC VOICE SUBSTITUTE

DID YOU EVER LOSE YOUR VOICE BECAUSE of laryngitis, or for some other reason? This device will give you a new "voice" of variable volume and pitch. It can also be used on Halloween, or other occasions, and it's a lot of fun just to play with, in order to see how many different voices you can create.

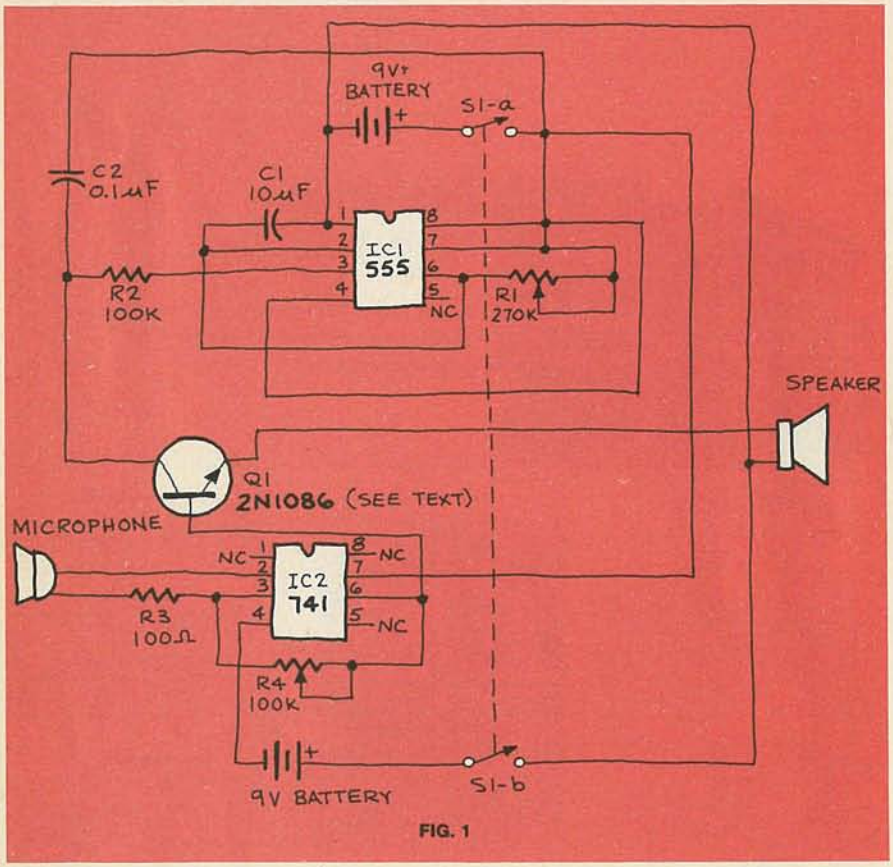


FIG. 1

As shown in Fig. 1, your voice—or even a whisper—is amplified up to 1000 times by the 741 op-amp. That op-amp requires a dual-polarity power supply (positive and negative voltages of equal magnitude). Thus, it needs two 9-volt batteries. If you look carefully you'll notice that two batteries are used for the 741 and that one of them is shared with the 555 IC.

If additional amplification is desired, as many op-amps as you feel are necessary can be added. Another option would be to use one of the many IC's that contain two or more op-amps.

The 555 acts as the tone generator, and it's configured in the astable mode. Its pin-3, square-wave output is transformed into a triangle wave by R1 and C2. The pitch of your "voice" is controlled by R1.

Now we get to the heart of the circuit: Q1. Transistor Q1 can be a 2N1086, 2N1091, or any other equivalent NPN germanium-type such as a Radio Shack 276-2001. Sounds picked up by the microphone are amplified by the 741 and that IC's output drives the transistor to saturation. When the transistor is in the saturated state, the triangle wave is able to reach the speaker, and your new "voice" is heard.

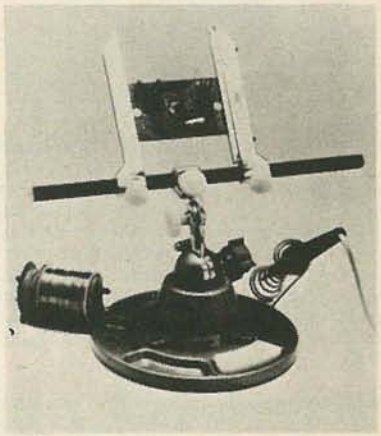
Unwanted noise may occasionally trigger your "voice" due to the high gain of the 741 op-amp. If this gets to be a problem there are several simple solutions you can try. One would be to use a higher-impedance microphone. Another would be to substitute a higher value for resistor R3. A potentiometer may also be used so that the value can be adjusted to fit the ambient conditions. On-off switch S1 is a DPDT type.

Any technique can be used in building this circuit. I hope that the device will be useful or fun for you—or both!—*J. Paul Sturgis*

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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service clinic

If all else fails, look for a leaky transistor. Here's what they're all about.

JACK DARR, SERVICE EDITOR

A FEW DAYS AGO I GOT A LETTER FROM A technician in Maryland who was having trouble with an RCA *CTC-53*. The set had all kinds of symptoms; weak color, intermittent drive-lines on the raster, very poor sync, and so on. He tried everything he could think of, including replacing all of the IF transistors and even the video detector diode. The key clue he gave me was that the DC voltages were all off around the AGC stage.

If you have problems in a "controlled stage" like the IF, be sure that the *control* circuit isn't causing the problem. In this case the control circuit is the AGC (Fig. 1). The symptoms sounded familiar. I'd had almost exactly the same problem some time ago, and I've heard of several similar cases. The cause in mine, and, I suspected, in his, was a leaky transistor in the AGC stages. The keying pulse was present, but the DC voltage was far off. This is one of the RCA chassis that uses a comparatively high AGC voltage (from +50 to +55 volts). He measured only about +25 volts, so that excessive bias was evidently holding down the IF gain to the point where many things were upset. Leakage in any keyed stage, such as AGC or sync can cause it to stay on too long, among other things.

Leaky transistors aren't all that common. However, that is one possibility we must consider whenever we run into one of those mysterious multiple-symptom cases. (A more common cause, of course, for multiple symptoms is a bad filter capacitor that allows feedback between all stages. If the B+ lines are clean on the scope, though, that isn't it.)

Don't try to measure transistor leakage with anything but a good transistor tester. You can *not* identify a leaky transistor with a VOM. Leakage in silicon transistors may be as little as 10-15 microamperes and still upset circuit operation. I've seen it happen. The older germanium-types have a normal leakage higher than that, but we see very few of those in signal circuits any more.

There are quite a few good transistor testers on the market. I have one that's been around for a while, a Sencore *CG-151*. It reads actual leakage on an analog meter. It also tests FET's. I've heard that FET's can be very tricky with leakage, though I haven't run into that as yet.

Leakage causes problems in any circuit. Not long ago, a friend and I found a puzzling problem in a very complex DC voltage-regulator circuit in an imported set. The trouble turned out to be a leaky control transistor in an error-amp circuit. That fouled up the regulator stage, and as a result there was no regulation to speak of. The key clue here, as in all cases like it, is that the circuit simply does not work as it should! Resistors, supply voltages, etc. seem to be OK but the set still does not work. So, the active device—the transistor—would be a good suspect. One good check, if you have a duplicate of the suspicious device, is to replace it and recheck the operation. Since it's usually necessary to take the transistor out to get a definitive leakage test (with no shunts), you may as well try a new one anyhow. If no substitute is available, test the original. If it shows leakage, you'd better order a replacement.

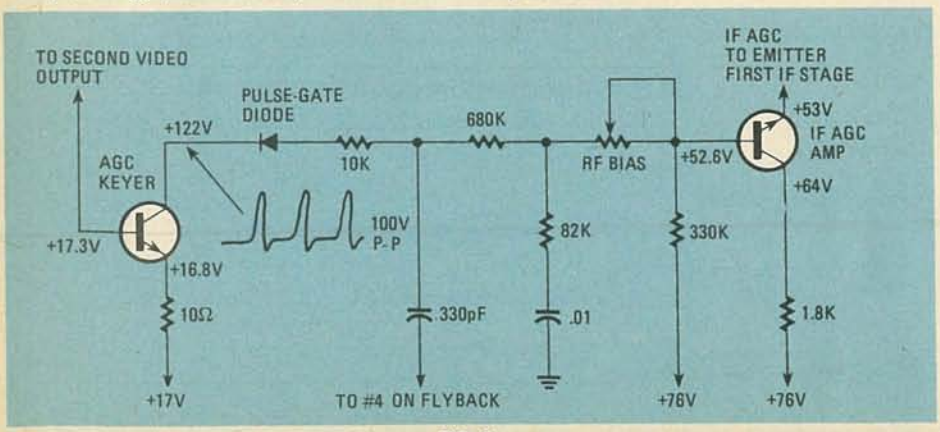

FIG. 1

I've noticed that quite a few of the new sets are coming out with fairly complex voltage-regulator circuits. Those circuits include not only the regulator itself, but the error-amps, etc. Some also include a "start-up" circuit that develops a pulse of DC to kick the horizontal oscillator into action. If you find one with poor regulator action, or anything else that isn't normal, suspect the possibility of leakage in one of the transistors.

Here's another oddball that came in the last batch of letters. The symptom was an odd horizontal line that floated up and down, and varied in width. Checking through the circuit to see where the vertical blanking was, I found that it came through a blanker transistor. I suggested that the transistor be checked for possible leakage since the variable nature of the symptom made that quite a possibility.

The triplets

A great many solid-state sets use the RGB circuit. There are three video output stages, one for each color: red, green, and blue. In most sets, those stages are identical triplets. This is one time when plug-in transistors or small modules can be very helpful. If you see odd one-color symptoms, try interchanging two of the three output stages/transistors. If the problem is in the blue, for instance, swap the red and blue output stages and see if you now have the same problem in the red. If so, that output stage is bad; leakage here may be the cause.

A letter came in a while back concerning a "blue smear" around objects, especially light-colored ones. I suggested swapping two of the three output transistors, with the idea that a leaky blue output transistor might be causing a "blue blooming". (I did tell him to check the convergence first, but that wasn't it!)

Transistors can do some strange and interesting things. I've had one on my bench for a long time that was removed from the third IF stage of a Zenith. On the curve tracer, at room temperature, it makes a beautiful "set of fingers." Cool it off a bit with a short puff of freeze spray, and the pattern collapses. Warm it up by holding your fingers on it, and the pattern comes back. Warm it up a bit more by holding a soldering iron near it, and the pattern collapses again. The transistor will work only over a very narrow range of temperatures. Leakages are often temperature-sensitive so freeze spray and a

continued on page 88

By Netronics

ASCII/BAUDOT, STAND ALONE

Computer Terminal

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The Netronics ASCII/BAUDOT Computer Terminal Kit is a microprocessor-controlled, stand alone keyboard/terminal requring no computer memory or software. It allows the use of either a 64 or 32 character by 16 line professional display format with selectable baud rate, RS232-C or 20 ma. output, full cursor control and 75 ohm composite video output.

The keyboard follows the standard typewriter configuration and generates the entire 128 character ASCII upper/lower case set with 96 printable characters. Features include onboard regulators, selectable parity, shift lock key, alpha lock jumper, a drive capability of one TTY load, and the ability to mate directly with almost any computer, including the new Explorer/85 and ELF products by Netronics.

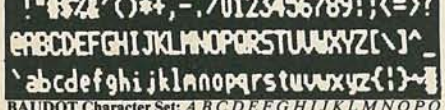
The Computer Terminal requires no I/O mapping and includes 1k of memory, character generator, 2 key rollover, processor controlled cursor control, parallel ASCII/BAUDOT to serial conversion and serial to video processing—fully crystal controlled for superb accuracy. PC boards are the highest quality glass epoxy for the ultimate in reliability and long life.

VIDEO DISPLAY SPECIFICATIONS

The heart of the Netronics Computer Terminal is the microprocessor-controlled Netronics Video Display Board (VID) which allows the terminal to utilize either a parallel ASCII or BAUDOT signal source. The VID converts the parallel data to serial data which is then formatted to either RS232-C or 20 ma. current loop output, which can be connected to the serial I/O on your computer or other interface, i.e., Modem.

When connected to a computer, the computer must echo the character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the screen.

Video Output: *1.5 P/P into 75 ohm (EIA RS-170)* • **Baud Rate:** *110 and 300 ASCII* • **Outputs:** *RS232-C or 20 ma. current loop* • **ASCII Character Set:** *128 printable characters—*



BAUDOT Character Set: *A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? : • 3 $ # ( ) . , 9 0 1 4 ! 5 7 ; 2 / 6 8* • **Cursor Modes:** *Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing* • **Cursor Control:** *Erase, End of Line, Erase of Screen, Form Feed, Delete* • **Monitor Operation:** *50 or 60Hz (jumper selectable.*

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For just $129.95 (plus the cost of a power supply, keyboard/terminal and RF modulator, if you don't have them already), Explorer/85 lets you begin *computing* on a significant level . . . *applying* the principles discussed in leading computer magazines . . . *developing* "state of the art" computer solutions for both the industrial and leisure environment.

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

(Level "A" makes a perfect OEM controller for industrial applications and is available in a special Hex Version which can be programmed using the Netronics Hex Keypad/Display.)

Level "A" at $129.95 is a complete operating system, perfect for beginners, hobbiests, or industrial controller use.

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 . . . provision for 24-pin DIP socket for hex keyboard/display . . . cassette tape recorder input . . . cassette tape recorder output . . . cassette tape control output . . . speaker output . . . LED output indicator on SOD (serial output) line . . . printer interface (less drivers) . . . total of four 8-bit plus one 6-bit I/O ports • **Crystal Frequency:** 6.144 MHz • **Control Switches:** reset and user (RST 7.5) interrupt . . . additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard • **Counter/Timer:** programmable, 14-bit binary • **System RAM:** 256 bytes located at F8ØØ, 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 FØØØ leaving ØØØØ free for user RAM/ROM. Features include 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, 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 . . . variable display line length control (1-255 characters/line) . . . channelized I/O monitor routine with 8-bit parallel output for high speed printer . . . serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex 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 the *Hex Version* makes a perfect controller for industrial applications and can be programmed using the Netronics Hex Keypad/Display.

Hex Keypad/Display.

Hex Keypad/Display Specifications

Calculator type keypad with 24 system defined and 16 user defined keys. 6 digit calculator type display which displays full address plus data as well as register and status information.

Level "B" Specifications

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

Explorer/85 with Level "C" card cage.

Level "C" Specifications

Level "C" expands Explorer's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and cards 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 which plugs into the motherboard. Just add required number of S-100 connectors

Level "D" Specifications

Level "D" provides 4k or RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from ØØØØ 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 soon to be available RAM IC's (allowing for up to 12k of onboard RAM).

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continued from page 86

heat gun can be valuable tools in finding a bad transistor.

I'm reminded of something I got from my friend Bob Lucas. After telling some horror stories like the ones above in an article for TESA News, he ended by asking:

"Remember when transistors first came out? They told us they'd never short, open, or get intermittent, and would last forever! I wonder when the engineers are going to get around to *making* these immortal transistors?"

So do I, Bob, and so do we all!

service questions

OOOOOPS!

In your diagram of the Hitachi NP4-SX chassis in the Dec 1980 issue of* Radio-Electronics, *TR-901 is shorted gate to anode! That wouldn't help.—C.H., Tinton Falls, NJ

Thanks; you're right, and we're sorry. A line has been added from the junction of R906/C322 to the TR901's gate; this should be deleted. Correct that on your copy of the article, people.

MORE BROADMOOR

Robert L. Grow of Philadelphia, PA has found a new address for Broadmoor parts. World Wide Systems, 342 W. Touhy Ave., Chicago, IL 60645 has bought up the company and has whatever parts are left. The telephone number is (312) 982-9340. Bob says, "Thanks," to Sams, who spent half a day digging up that information.

HORIZONTAL SHADING

This Quasar CTS-942 came in with no high-voltage output and bad horizontal transistor and damper diode. Now I get a picture, but it is shaded from left to right. It starts out dim and brightens as it goes to the right. When the set is turned on, the horizontal waveform is normal, but after warmup the peak is distorted. Also, there is excess current on the +99.5-volt DC supply; it is 1 amp but it should only be 0.5 amp. The vertical sync is erratic but that may not be related. Got anything on the crystal ball?—J.F., Furlock, CA

The crystal ball shows one thing; a horizontal-frequency *sawtooth* signal is managing to get into the video circuitry! That causes the shading. I remember at least one set with that symptom; one of the flyback-derived DC-voltage supplies had an open filter capacitor. Check all of the DC-voltage supply lines with an oscilloscope and look for that sawtooth pulse. Any kind of pulse you find on a DC supply line is wrong! Get rid of it by checking the filtering.

EQUIPMENT REPORTS

continued from page 42

metallic objects with a moisture content give a slight "metallic" reading due to their capacitive conductivity. A metal locator of this type is very sensitive to small objects. As a stud finder, it does a creditable job detecting nails behind wallboard. Coins were readily detectable with the unit held three or four inches above ground. Buried objects may be detected at slightly greater depths due to the ionization of the surrounding soil. Maximum depth penetration on large masses is about three feet. That is handy if you happen to stumble on a buried locomotive.

Most competitive transmitter-receiver metal locators are substantially more expensive than the *model 63-3001*. Considering its low cost, it is a good value and will provide endless hours of fun at the beach or playground. Beer cans and pop-tops are available by the thousands. Who knows, you might even find something of value!

The *model 63-3001* Metal Locator sells for $39.95 at your Radio Shack dealer. **R-E**

continued from page 63

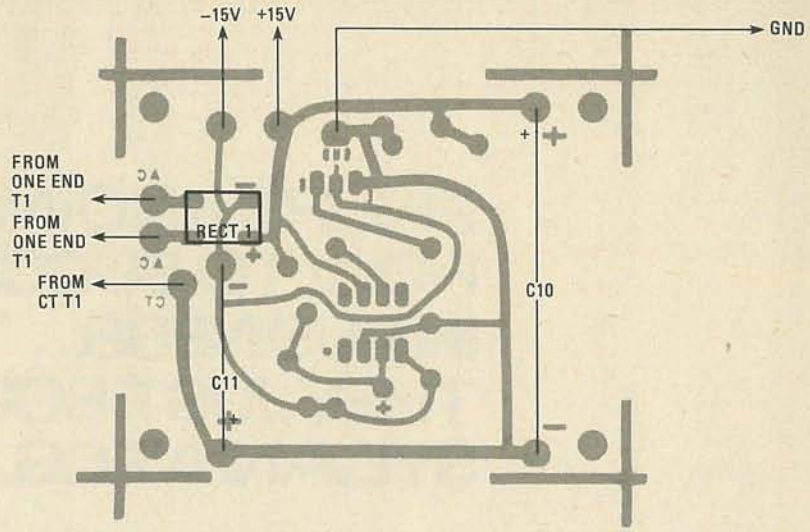

FIG. 16—POWER-SUPPLY LAYOUT when the VU meter is designed to operate from AC power lines. Only the rectifier bridge and filter capacitors are on the PC board. The transformer is bolted to the bottom of the enclosure.

TABLE 1

Switch Setting	0 VU Point	Approximate Voltage Level for 0 VU Reading	Corresponding Power Developed Into Various Load Impedances 600 Ω	8 Ω	4Ω
S1	−10dB	0.32V	0.167mW	0.01w	0.02w
S2	0 dB	0.77V	1.0mw	0.08w	0.15w
S3	+4dB	1.23V	2.5mw	0.19w	0.38w
S4	+8dB	1.95V	6.7mw	0.48w	0.95w
S5	+12dB	3.08V	15.8mw	1.19w	2.37w
S6	+22dB	9.75V	158mw	11.9w	23.7w
S7	+32dB	30.8V	1.58w	119w	237w

"Option B" section of Fig. 13 for the other changes. Note that the LED polarity has been reversed; the anodes have been jumpered together and returned to a common ground.

The VU meter can be operated from either an external source of 24-to-30 volts DC as shown in Fig. 3-a or a 20-volt center-tapped as in Fig. 3-b. When using the external supply, a 741 op-amp and 2N6111 power transistor are used as the voltage splitter and regulator to develop the dual-polarity voltages (+ and − 12-to-15 volts DC). The component layout for that version of the power supply is shown in Fig. 15. Figure 16 shows the location of the bridge rectifier and filter capacitors when using the power-supply option in Fig. 3-b.

Operation

After inspecting the PC Boards for mistakes, omissions, solder bridges, and the like, apply power and supply an input signal. The signal can come from the LINE output or TAPE output jacks of the stereo system or tapped from the input jacks of the tape deck, or, in the case of an audio console, a spare LINE output. If a signal generator is available, apply a signal to the system and increase its level until the tape deck's VU meters indicate 0 VU. Set one *and only one* rocker switch (S1-S7) for an 0 VU reading (i.e., the 0 VU LED just starts to light). Use R11 as a vernier to "fine-tune" that adjustment. If the VU meter is being used to establish the point where a power amplifier starts to clip, perform the setup as before, while monitoring the speaker output with the VU meter and an oscilloscope. When clipping is seen, set the appropriate rocker switch and adjust R11 as before. See Table 1 for power levels versus switch setting. If Option A is used (simple potentiometer for input attenuator; no switches), simply rotate the control for the appropriate reading with any given input, as explained above.

When recording, levels should generally be kept below 0 VU with occasional peaks above 0 VU. The more peaks that occur above 0 VU, the greater the distortion. The user's needs and equipment will dictate the acceptable amount of program material allowed to exceed 0 VU. **R-E**

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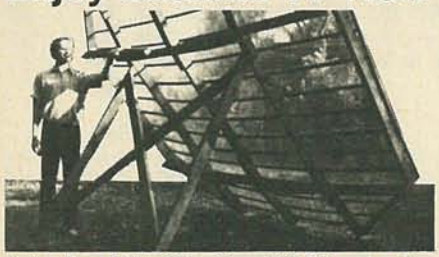

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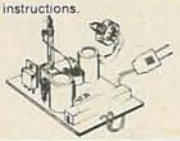

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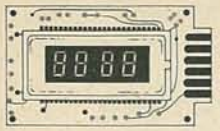

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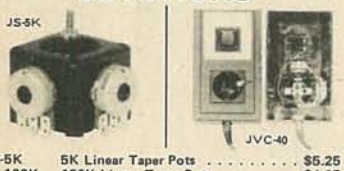

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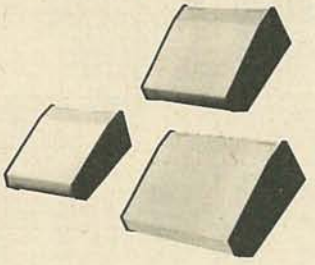

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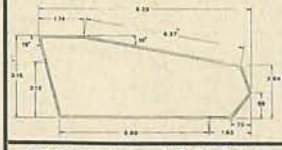

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JE610/DTE-AK (as pictured above) . . . $124.95
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LATCHED OUTPUT
19-KEY KEYBOARD

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82S115	6.95
82S123	4.95
82S126	2.95
82S129	3.25
82S130	3.45
82S131	3.95
AM9218C	6.96

INTERFACE & DRIVERS

1488	.90
1489	1.10
8130	2.50
8131	2.50
8830	2.50
8833	2.50
8834	2.00
8837	2.00
8838	2.00
BT380	2.00

SHIFT REGISTERS

MM1402	1.75
MM1403	1.75
MM1404	1.75
MM5013	2.50
MM5016	2.50
MM5055	2.50
MM5056	2.50
MM5057	2.50
MM5058	2.50
MM5060	2.50

PRINTED CIRCUIT BOARD
4" x 6" DOUBLE SIDED
EPOXY BOARD 1/16" thick
$.60 ea. ..... 5/$2.60

EPOXY GLASS VECTOR BOARD
1/16" thick with 1/10" spacing
4½" x 6½" $1.95

DATEL'S DAC-08EQ
8 bit DAC — $7.95

74S00	.30	74S74	.70	74S158	1.25
74S02	.30	74S86	.60	74S161	1.10
74S03	.30	74S89	1.90	74S169	1.75
74S04	.40	74S112	.85	74S174	1.40
74S05	.40	74S133	1.40	74S175	1.40
74S08	.40	74S135	1.50	74S194	1.10
74S10	.30	74S138	1.25	74S257	1.50
74S11	.36	74S139	1.10	74S258	1.40
74S15	.40	74S140	1.00	74S280	1.50
74S20	.40	74S153	1.10	74S280	1.90
74S30	.40	74S173	2.25	74S373	2.25
74S32	.40	74S157	1.25	74S374	2.50

7 WATT LD 65 LASER DIODE IR $8.95

25 watt Infra Red Pulse (SG 2006 equiv.)
Laser Diode (Spec sheet included) $24.95

2N3820 P FET	$ .45
2N 5457 N FET	$ .45
2N2646 UJT	$ .45
ER 900 TRIGGER DIODES	4/$1.00
2N 6028 PROG. UJT	$ .65

TTL REED RELAY — SPST 5V 20ma $1.00

CLOCK CHIPS

MM5387AA	$5.95
MM5314	$4.75
MM5316	$4.95

TANTALUM CAPACITORS

.22UF 35 V	5/$1.00	10UF 10V	$ .40
.47UF 35 V	5/$1.00	22UF 10V	$ .30
.68UF 35 V	5/$1.00	15UF 16V	3/$1.00
1UF 35V	5/$1.00	30UF 6V	5/$1.00
2.2UF 20V	5 $1.00	33UF 20V	$ .60
3.3UF 20V	4/$1.00	47UF 20V	$ .85
4.7UF 15V	5/$1.00	100UF 15V	$ .70
6.8UF 35V	3/$1.00	150UF 15V	$ .95

SANKEN AUDIO POWER AMPS

Si 1010 G 10 WATTS .. $ 7.50
Si 1020 G 20 WATTS .. $11.00
Si 1030 G 30 WATTS .. $13.50
Si 1050 G 50 WATTS .. $25.00

200 PRV 1A LASCR .95

RS232 CONNECTORS

DB 25P male $3.25
DB 25S female ... $4.25
HOODS $1.50

C/MOS

4001	.25	4027	.45	4081	.25	74C74	.50
4002	.25	4028	.60	4082	.25	74C76	.70
4006	.85	4029	.95	4093	.75	74C83	1.30
4007	.25	4030	.35	4099	1.75	74C85	1.40
4008	.80	4034	2.25	4501	.95	74C86	.50
4009	.45	4035	.97	4510	.75	74C90	.90
4010	.45	4040	.90	4511	.75	74C93	.95
4011	.25	4042	.65	4514	1.95	74C151	1.75
4012	.25	4043	1.00	4515	1.95	74C157	1.75
4013	.37	4044	.90	4518	1.00	74C160	1.20
4014	.70	4046	.90	4518	1.20	74C161	1.15
4015	.65	4049	.45	4520	.70	74C163	1.15
4016	.37	4050	.45	4553	2.75	74C165	1.25
4017	.70	4051	.80	74C00	.27	74C173	1.30
4018	.60	4052	1.10	74C02	.27	74C174	1.30
4019	.45	4053	1.10	74C04	.40	74C175	1.20
4020	.70	4066	.70	74C08	.30	74C192	1.30
4021	.90	4069	.35	74C10	.27	74C901	.50
4022	1.00	4071	.25	74C14	1.20	74C926	6.95
4023	.25	4072	.25	74C20	.27		
4024	.55	4076	.80	74C32	.45		
4025	.25	4077	.35	74C73	.75		

SPECIALS

4116-3 RAM'S — 8/$24.00
15% ALL 74LS SERIES

LEADER OSCILLOSCOPES
WE CARRY A FULL LINE OF HIGH QUALITY, LOW PRICED OSCILLOSCOPES WITH A TWO YEAR WARRANTY. COMPARE PRICE & FEATURES.
LBO517 50 MHz D.T. CAL. DELAY
$1950.00

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LBO-310A	4 MHz, S.T. Recur. Sweep	775.00
LBO-507A	20 MHz, S.T., 5"	610.00
LBO-508A	20 MHz, D.T., 5"	835.00
LBO-511	10 MHz, S.T., 5"	420.00
LBO-513	10 MHz, S.T., 1mV Sens.	495.00
LBO-514	10 MHz, D.T., 1mV Sens.	645.00
LBO-515B	30 MHz, D.T. Cal. Delayed Sweep	1,530.00
LBO-520	30 MHz, D.T. w/Delay Line	1,100.00

SPECIALS GOOD THRU MAY 1981

CRYSTALS $3.45 ea.

2.000 MHz	6.144 MHz
4.000 MHz	8.000MHz
3.000 MHz	10.000 MHz
3.57 MHz	18.000 MHz
5.000 MHz	18.432 MHz
6.000 MHz	20.000 MHz

RIBBON CABLE FLAT (COLOR CODED) #30 WIRE
16 cond. - .40/per foot
40 cond. - .75/per foot
50 cond. - .90/per foot

MINIATURE MULTI-TURN TRIM POTS
100, 5K, 10K, 20K, 250K, ... $.75 each ... 3/2.00

NO. 30 WIRE WRAP WIRE SINGLE STRAND
100' $1.40

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MTA 106 SPDT	$1.05
MTA 206 DPDT	$1.70
MTA 206 P-DPDT CENTR OFF	$1.85
MSD 206 P-DPDT CENTER OFF LEVER SWITCH	$1.85

SCR's

	1.5A	6A	35A	110A
100	.45	.60	1.40	
200	.70	.80	1.90	9.00
400	1.20	1.40	2.60	12.00
600		1.80	3.60	15.00

TRIAC's

	1A	10A	25A
100	.45	.80	1.55
200	.84	1.30	2.10
400	1.30	1.90	3.10
600	2.00	2.75	4.30

FP 100 PHOTO TRANS	$ .50
RED, YELLOW, GREEN OR AMBER LARGE LED's .2"	6/$1.00
RED/GREEN BIPOLAR LED's	$ .55
MLED92 R LED	$ .75
MRD148 PHOTO DARL. XTOR	$ .75
TIL-118 OPTO-ISOLATOR	$ .75
IL-5 OPTO-ISOLATOR	$ .80
1 WATT ZENERS: 3.3, 4.7, 5.1, 5.6, 6.8, 8.2, 9.1, 10, 12, 15, 18, or 22V	6/$1.00

SFC 3301 — 50 PRV 30A
FAST RECOVERY DIODE (35ns) ..$2.25
20KV 250MA DIODE $1.90

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PRV	1A	3A	12A	50A	125A	240A
100	.06	.14	.35	.90	3.70	8.00
200	.07	.20	.40	1.30	4.25	12.00
400	.09	.25	.65	1.50	6.50	15.00
600	.11	.30	.80	2.00	8.50	18.00
800	.15	.35	1.00	2.50	10.50	22.00
1000	.20	.45	1.25	3.00	12.50	26.00

IN 4148 (IN914) ..... 15/$1.00
.1 or .01 uf 25V ceramic disc. caps.
16/$1.00, 100/$5.00

7 SEGMENT DISPLAYS

FSC 8024-4 digit C.C. .8" display	$5.95
FND 503 C.C. .5"	$ .85
DL-704-.3" C.C.	$ .85
DL-707 C.A. .3"	$.75
DL 747 C.A. .6"	$1.50
HP3400 .8" CA	$1.95
HP3405 .8" CC	$1.95

TRANSISTOR SPECIALS

2N1307 PNP GE TO-5	$ .40
2N404A PNP GE TO-5	3/$1.00
HEP G6014 — PNP GE TO-3	$ .85
TIP 121 — NPN Si SWITCHING	$ .95
2N6233 NPN SWITCHING POWER	$1.95
MRF-8004 a CB RF TRANSISTOR NPN	$ .75
2N3772 NPN SI TO-3	$1.00
2N4908 PNP Si TO-3	$1.00
2N5086 PNP SI TO-92	4/$1.00
2N3137 NPN Si RF	$ .55
2N3919 NPN SI TO-3 RF	$1.50
2N1420 NPN SI TO-5	3/$1.00
2N3767 NPN SI TO-66	$ .70
2N2222 NPN Si TO-18	5/$1.00
2N2907 NPN SI TO-18	4/$1.00
2N3055 NPN SI TO-3	$ .60
2N3904 NPN SI TO-92	6/$1.00
2N3906 PNP SI TO-92	6/$1.00
2N5296 NPN SI TO-220	$ .55
2N6109 PNP S. TO-220	$ .55
2N6308 NPN SI TO-3	$1.95
TIP 31B NPN SI TO-220	$ .60
TIP 32B PNP SI TO-220	$ .65
TIP 34 PNP Si	$ .95
TIP PNP SI UB4	$ .00

TTL IC SERIES

7400	.17	7472	.35	74162	1.30
7401	.17	7473	.36	74163	.95
7402	.17	7474	.42	74164	.85
7403	.17	7475	.49	74165	.85
7404	.24	7476	.45	74166	1.05
7405	.24	7480	.45	74167	1.35
7406	.33	7483	.60	74170	1.60
7407	.35	7485	.75	74173	1.30
7408	.27	7486	.42	74174	.85
7409	.24	7489	1.60	74175	.75
7410	.17	7490	.50	74176	.75
7411	.22	7491	.55	74177	.75
7412	.22	7492	.50	74180	.75
7413	.42	7493	.50	74181	1.90
7414	.90	7494	.60	74190	1.20
7416	.33	7495	.60	74191	1.20
7417	.37	7496	.60	74192	.79
7420	.17	74107	.36	74193	.79
7425	.36	74121	.35	74194	.85
7426	.33	74122	.39	74195	.65
7427	.36	74123	.42	74196	.85
7430	.17	74125	.45	74197	.87
7432	.27	74126	.45	74279	.95
7437	.27	74145	.75	74325	2.25
7438	.27	74148	1.50	74365	.80
7440	.17	74150	1.10	74367	.80
7441	.85	74151	.85	74368	.65
7442	.50	74153	.55	74390	1.50
7445	.70	75154	1.10	75325	1.50
7446	.75	74155	.75	75491	1.05
7447	.75	74157	.65	75492	1.05
7448	.75	74160	.85	BT98	1.10
7450	.17	74161	.80	9312	.60
				9601	.75

FULL WAVE BRIDGE

PRV	2A	6A	25A
100			1.40
200	.80	1.30	2.20
400	1.00	1.65	3.30
600	1.30	1.90	4.40

DIP SOCKETS

8 PIN	.17	22 PIN	.30
14 PIN	.20	24 PIN	.35
16 PIN	.22	28 PIN	.40
18 PIN	.25	40 PIN	.60

74LS SERIES

74LS00	.22	74LS151	1.19
74LS01	.22	74LS153	1.19
74LS02	.22	74LS155	1.19
74LS03	.22	74LS156	1.19
74LS04	.27	74LS157	.85
74LS05	.27	74LS160	1.00
74LS08	.27	74LS161	1.00
74LS09	.27	74LS162	1.00
74LS10	.25	74LS163	1.00
74LS11	.35	74LS164	1.00
74LS12	.35	74LS168	1.35
74LS13	.60	74LS169	1.75
74LS14	.80	74LS170	1.70
74LS15	.35	74LS173	.90
74LS20	.30	74LS174	1.00
74LS21	.25	74LS175	1.00
74LS22	.25	74LS181	2.50
74LS26	.35	74LS190	1.25
74LS27	.45	74LS191	1.15
74LS28	.45	74LS192	.90
74LS30	.30	74LS193	.90
74LS32	.40	74LS194	1.10
74LS37	.35	74LS195	.90
74LS38	.35	74LS196	1.00
74LS40	.40	74LS197	.90
74LS42	.65	74LS240	1.60
74LS47	.75	74LS241	1.60
74LS51	.25	74LS242	1.60
74LS54	.25	74LS243	1.60
74LS73	.60	74LS244	1.60
74LS74	.35	74LS245	2.25
74LS75	.75	74LS251	1.29
74LS76	.45	74LS253	1.00
74LS83	.95	74LS257	.90
74LS85	1.10	74LS258	.90
74LS86	.45	74LS259	1.50
74LS90	.90	74LS266	.70
74LS92	.90	74LS273	1.25
74LS93	.90	74LS279	.70
74LS95	.90	74LS283	.80
74LS96	.90	74LS290	.80
74LS107	.47	74LS293	.80
74LS109	.45	74LS295	.80
74LS112	.45	74LS367	.80
74LS113	.45	74LS368	.80
74LS114	.55	74LS373	1.50
74LS123	.75	74LS375	.95
74LS125	.90	74LS377	1.50
74LS126	.90	74LS386	.50
74LS132	.80	74LS393	1.50
74LS136	.80	74LS670	2.50
74LS138	.75		
74LS139	.70		

LINEAR CIRCUITS

LM301	.75	LM348	.90	709	.25
LM301/748	.30	LM358	.70	710	.45
741CV	.30	LM361	1.75	711CH	.40
741C	.35	LM377	1.60	LM1808	1.75
747	.50	LM382	.80	LM1810	2.20
1458	.50	LM386	.80	LM1889	1.95
4136	.95	LM387	1.25	CA758	1.75
3900	.55	LM553	2.25	CA3018	1.95
LM307	.30	LM555	.45	CA3046	.85
LM309	.75	LM563	.85	CA3076	1.50
LM324	.95	565	.95	CA3080	.95
LM339	1.10	566	1.25	CA3086	.95
LF355	1.25	567	1.10	CA3094	2.25
LF356	1.35	702	.95	8038CC	3.90
LM311	.75	703	.85	N5596A	1.50
LM318	1.20				

REGULATORS

LM317T	$2.50	LM305G	$ .75
LM337	$2.50	340K-12, 15 or 24V	$1.50
323K-5V 3A	$5.75	340T-5, 6, 8, 12, 15	
79HGKC-5V at 5A	$6.95	18 or 24V	$1.10
723	$ .50	320M5	$ .75
320T 5, 12, or 15V	$1.10	LAS1412 + 12V 3A	$3.95

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STAR #CMB-12
• Fits dip socket
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• Max. current: 14mA
• Sound output: 70dB @ 20 cm.
$1.25 each

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Litronix FRL-4403
diffused red led with built in flashing unit T 1 ¾ package · pulse rate 3hz @ 5v 20 ma.
2 for $1.70

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1,700mfd 150 VDC	$2.00
2 1/2" DIA X 4 3/4"	
6,400mfd 60 VDC	$2.50
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11,500mfd 18 VDC	$1.50
1 3/8" DIA X 3 1/4" HIGH	
22,000mfd 15 VDC	$2.50
2" DIA X 2 1/2" HIGH	
52,000mfd 15 VDC	$3.00
2" DIA X 4 1/2" HIGH	

CLAMPS TO FIT CAPACITORS 50¢ ea.

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RATED 6 AMPS @ 125 V
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100 for $75.00

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LARGE QUANTITIES AVAILABLE
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VHF, RF, AMP, MIX
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$2.50

40 MFD 350 VOLTS
2 1/8 INCH X ¾ INCH
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SENS: -64 DB ± 3 DB
FEQ RESP: 50 HZ — 20 KHZ
OUT IMP: 2.2 K OHM (MAX)
SUPER SMALL SIZE
SIZE: 6 MM X 5 M M LONG
MAX OP VOLT: 10 VDC
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600 MFD. 100 VDC $1.00 ea.
2-11/16" long x 1" diameter
SALE PRICED
8,000 MFD 15VDC
3-7/8" long x 1-1/16" diameter
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ONE RED ONE BLACK QUICK CONNECT TERM.
IDEAL FOR SPEAKER SYSTEMS. BLACK PHENOLIC BASE
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10 for $1.50
GREEN JUMBO DIFFUSED
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YELLOW JUMBO DIFFUSED
10 for $2.00

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USED ON 100 WATT SPEAKER SYSTEMS AS A TWEETER FADER CONTROL
2 FOR $1.50 5 OHM W.W.
10 FOR $6.00

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10 AMP KUH SERIES
CONTACTS available with no flange. can be socketed.
$3.00 EACH
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INTEGRATED CIRCUITS

7400 TTL		74LS00 LS TTL		4000 CMOS		LINEAR I.C.'S	
7400N	[illegible]	74LS00N	[illegible]	4000	[illegible]	LF347N	3.17
7401N	[illegible]	74LS01N	[illegible]	4001	[illegible]	LF351N	.78
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

74C CMOS | INTERFACE I.C.'S | A/D & D/A CONVERTERS & MISCELLANEOUS | MEMORY | MICROPROCESSORS: [illegible]

TEXAS INSTRUMENTS I.C. SOCKETS

SOLDER TAIL DIP SOCKETS

- Low profile
- Four grip design for maximum contention force
- Redundant contact points
- YOUR CHOICE — TIN OR GOLD (*Minimum of 30 microinches gold inlay on gold sockets)
- TEXAS INSTRUMENTS QUALITY

TIN INLAY SOLDER TAIL Min. 200 Microinches Tin

Part No.	Description	1	10	100
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

GOLD INLAY SOLDER TAIL Min. 30 Microinches Gold

Part No.	Description	1	10	100
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WIRE WRAP DIP SOCKETS

- Standard profile
- Universal mounting and packaging capabilities
- Contacts accommodate .015" through .031" rectangular or round dual in line leads
- Wire wrap posts held to true position of .015" providing a true position of .020" on boards for efficient automatic wire wrapping
- YOUR CHOICE — TIN OR GOLD (*Minimum .30 microinch gold inlay on gold sockets)
- TEXAS INSTRUMENTS QUALITY

TIN PLATED WIRE WRAP Min. 200 Microinches Tin

Part No.	Description	1	10	100
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

GOLD INLAY WIRE WRAP Min. 30 Microinches Gold

Part No.	Description	1	10	100
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SILICON TRANSISTORS

	1	10	100	1000
2N3904	.20	1.79	16.25	146.25
2N3906	.20	1.79	16.25	146.25
2N4124	.21	1.93	17.50	157.50
2N4126	.22	2.01	18.25	164.25
2N4401	.21	1.93	17.50	157.50
2N4403	.21	1.93	17.50	157.50
2N4410	.30	2.70	24.38	219.38
2N5087	.24	2.20	20.00	180.00
2N5089	.24	2.20	20.00	180.00
2N5210	.27	2.48	22.50	202.50
2N5457	.54	4.86	43.88	394.88
92PU01A	.38	3.42	30.88	277.88
92PU10	.38	3.42	30.88	277.88
92PU45A	.41	3.69	33.37	299.82
92PU51A	.38	3.42	30.88	277.88
MJ2955	1.47	13.45	122.50	1102.25
MJE172	.74	6.66	60.13	541.13
MJE182	.72	6.48	58.50	526.50
MJE3439	.56	4.80	40.00	360.00
MJE344	.68	6.12	55.25	497.25
MJE370	.89	8.01	72.32	650.82
MJE371	1.10	9.90	89.38	804.38
MJE520	.86	7.74	69.88	628.88
MJE521	.86	7.74	69.88	628.88
MJE703	1.13	10.17	91.82	826.31
MJE712	.74	6.66	60.13	541.13
MJE722	.74	6.66	60.13	541.13
MJE803	1.01	9.09	82.07	738.57
MPF102	.54	4.95	45.00	405.00
MPS2222A	.21	1.93	17.50	157.50
MPS2369A	.24	2.20	20.00	180.00
MPS2907AJ	.24	2.20	20.00	180.00
MPS3392	.23	2.07	18.75	169.00
MPS3393	.21	1.93	17.50	157.50
MPS3394	.24	2.20	20.00	180.00
MPS3395	.24	2.20	20.00	180.00
MPS3563	.21	1.93	17.50	157.50
MPS3565	.21	1.93	17.50	157.50
MPS3638A	.21	1.93	17.50	157.50
MPS3641	.21	1.93	17.50	157.50
MPS3643	.21	1.93	17.50	157.50
MPSF18	.22	1.98	17.88	160.68
MPS930	.21	1.93	17.50	157.50
MPSA13	.27	2.48	22.50	202.50
TIP112	.98	8.40	70.00	630.00
TIP117	1.12	10.08	91.00	819.00
TIP120	1.17	10.73	97.50	877.50
TIP122	1.54	13.20	110.00	990.00
TIP127	1.54	13.20	110.00	990.00
TIP132	2.32	20.88	188.50	1696.50
TIP125	2.32	20.88	188.50	1696.50
TIP29C	.81	6.90	57.50	517.50
TIP30C	.81	6.90	57.50	517.50
TIP31C	.98	8.40	70.00	630.00
TIP32C	1.02	8.70	72.50	652.50
TIP61C	.81	6.90	57.50	517.50
TIP63C	.81	6.90	57.50	517.50

DIP IC INSERTION TOOLS WITH PIN STRAIGHTENER

K152-ND	14-16 Pin Cip IC Inserter	$3.49
K154-ND	14-16 Pin CMOS Safe Inserter	$7.95
K155-ND	24-28 Pin CMOS Safe Inserter	$7.95
K156-ND	36-40 Pin CMOS Safe Inserter	$7.95
K157-ND	Extractor Tool	$1.49

CMOS-SAFE DIP IC EXTRACTOR TOOL

K158-ND	Extractor Tool	$7.95

INSERTION & EXTRACTION KIT

K159-ND	Insertion & Extraction Kit	$29.95

5% CARBON FILM RESISTORS

¼ WATT RESISTOR ASSORTMENTS

- **RS125** Set of 5 each of the 73 standard 5% ¼ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2 etc., through 1.0 megohm (365 total pcs.) **$9.90**
- **RS225** Set of 5 each of the 73 standard 5% ¼ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4 etc., through 910 kilohm (365 total pcs.) **$9.90**

½ WATT RESISTORS ASSORTMENTS

- **RS150** Set of 5 each of the 73 standard 5% ½ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2 etc., through 1.0 megohm (365 total pcs.) **$9.90**
- **RS250** Set of 5 each of the 73 standard 5% ½ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4 etc., through 910 kilohm (365 total pcs.) **$9.90**

E.F. JOHNSON ALUMINUM SPACERS

Round Tubular | Round Threaded | Hex Threaded

Cat. No.	I.D./Thread	O.D.	Len.	10	100
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

MOLEX I.C. SOCKET PINS

.95/C	9.10/M	42.00/5M	300.00/50M

ITT RECTIFIERS

Cat. No.	Description	Pkg.	10	100	1000	10,000
1N4001	1 Amp 50 PIV Silicon Rectifier	DO-41	[illegible]	[illegible]	[illegible]	[illegible]
1N4002	1 Amp 100 PIV Silicon Rectifier	DO-41	[illegible]	[illegible]	[illegible]	[illegible]
1N4003	1 Amp 200 PIV Silicon Rectifier	DO-41	[illegible]	[illegible]	[illegible]	[illegible]
1N4004	1 Amp 400 PIV Silicon Rectifier	DO-41	[illegible]	[illegible]	[illegible]	[illegible]
1N4005	1 Amp 600 PIV Silicon Rectifier	DO-41	[illegible]	[illegible]	[illegible]	[illegible]
1N4006	1 Amp 800 PIV Silicon Rectifier	DO-41	[illegible]	[illegible]	[illegible]	[illegible]
1N4007	1 Amp 1000 PIV Silicon Rectifier	DO-41	[illegible]	[illegible]	[illegible]	[illegible]
1N4148	Ultra Fast Switching Diode (1N914 equiv.)	DO-41	[illegible]	[illegible]	[illegible]	[illegible]

ITT SILICON ZENER DIODES

Catalog Number	Description	Unit Price	10
[illegible]	500mW Zener	.34	1.80

Call or Write for your Free DIGI-KEY Catalog

HOBBY-BLOX

THE NEW MODULAR CIRCUIT BUILDING SYSTEM

Whether you're a beginner or an advanced hobbyist, Hobby Blox is the right system for you. The Hobby Blox System takes you as far as your imagination will go. Begin at the beginning with a Hobby Blox starter pack. You can expand the Hobby Blox System with a complete line of modules.

BASIC INTEGRATED CIRCUIT STARTER PACK — The IC Starter Pack includes two terminal strips, two distribution strips and a spacer support strip, already in a Hobby Blox tray, ready for use. A free project booklet containing ten IC projects, with step by step instructions completes the pack. Purchase of the IC Starter Pack saves you one dollar over price of modules purchased separately. Part No. 921400 **$5.97**

INTEGRATED CIRCUIT STARTER PACK COMPONENTS Order Part No. 921401 **$11.86**

BASIC DISCRETE COMPONENT STARTER PACK — This starter pack contains a tray, discrete component strip, battery holder and connector (battery not included) and project booklet with ten projects. Purchase of the Discrete Component Starter Pack saves you one dollar over price of modules purchased separately. Part No. 921480 **$6.57**

DISCRETE COMPONENT STARTER PACK COMPONENTS Order Part No. 921481 **$6.35**

TRAY Part No. 921300 **$1.99** — All modules fit easily into the Hobby Blox tray which is the basis for the entire Hobby Blox system.

DISTRIBUTION STRIPS Part No. 921310 **$1.99** — Includes two distribution strips, each of which has two continuous 26 tie-point terminals. With the Hobby Blox distribution strips, it's easy to connect your circuitry to power and ground.

2x36 TERMINAL STRIPS Part No. 921320 **$2.99** — Two terminal strips and a spacer support strip make up this pack. Each terminal strip contains 36 5 tie-point terminals.

BLANK PANEL PACK Part No. 921330 **$1.69** — A custom piece for any hobbyist. The blank panel allows you to drill holes in any manner of configuration to suit any mounting you desire.

BUS STRIP Part No. 921330 **$2.99** — This Hobby Blox module contains two continuous rows of 40 tie-point terminals for easy power and ground busing the entire length of the tray and also between trays with its unique tray interlocking feature.

3x16 TERMINAL STRIP Part No. 921325 **$2.99** — Consists of three patterns of terminals with each pattern containing two rows of eight contacts. This strip will accept three each 7 segment displays. 14 or 16 pin DIPS.

L.E.D. STRIP Part No. 921508 **$1.99** — Accepts six LEDs and includes a common bus for current limiting resistor.

DISCRETE COMPONENT STRIP Part No. 921515 **$2.99** — This module is the answer to breadboarding circuits with larger components. It contains 14 terminals, each with five tie points. The tie points are spaced .5" apart both vertically and horizontally.

BINDING POST STRIP Part No. 921560 **$2.59** — Includes three five way binding posts. Each binding post is electronically connected to a solderless plug-in tie point.

TRAY EXTENDER CLIPS Part No. 921570 **$1.29** — Expandability is not only side by side with the Hobby Blox system. The tray extender clips allow you to attach trays end to end also! Includes four clips.

CONTROL PANEL PACK Part No. 921545 **$1.69** — Includes two control panels and two spacer support strips. Accepts a wide variety of switches and indicators.

SPEAKER PANEL PACK Part No. 921540 **$1.69** — Includes two speaker panels and two spacer support strips. Readily accepts a 2" or smaller diameter speaker.

BATTERY HOLDER PACK Part No. 921550 **$2.59** — Includes battery holder and connector for a 9-volt battery. (Battery not included.)

VERTICAL TRAY PACK Part No. 921535 **$1.69** — Includes a smaller tray and an adapter strip that allows you to mount the tray perpendicular to the horizontal tray.

SUPER-STRIPS

UNIVERSAL BREADBOARDING ELEMENTS WITH SOLDERLESS PLUG-IN TIE POINTS

The A P Super Strips combine a power signal distribution system with a matrix of 128 terminals, each with 5 tie points. The distribution system consists of eight buses, each individual bus consisting of a line of 25 tie points. All tie points are the solderless plug in type of the same design used on A P terminal Strips and A P Distribution Strips.

923252	(Alloy 770 Terminals)	$18.50
923748	(Gold plated Terminals)	$23.95

POWERACE

For faster and easier prototyping. They have built in power supplies.

- **Powerace 101** — With plus 5 to plus 15 VDC adj. power supply. No. 923101 **$ 96.95**
- **Powerace 102** — Triple output power supply for digital & linear. No. 923102 **$149.95** — Other equipment, too numerous to mention, available.
- **Powerace 103** — A digital lab including a logic probe & clock. No. 923103 **$149.95**

For complete AP Products specifications get your FREE DIGI-KEY catalog today

TEXAS INSTRUMENTS GOLD EDGEBOARD CONNECTORS

Solder Tab — Solder Eye — Wire Wrap

RELIABLE, COST-EFFICIENT CONTACT DESIGN

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

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

H4 SERIES .100"x.200" EDGEBOARD CONNECTORS

Positions/Contacts	Part No. Wire Wrap	1	10	100	Part No. Solder Tail	1	10	100
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

For polarizing keys order P. N081144-2 — 10 ea. 7.50 100

H4 SERIES .125"x.250" EDGEBOARD CONNECTORS

Positions/Contacts	Part No. Wire Wrap	1	10	100	Part No. Solder Tail	1	10	100
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

For polarizing keys order P. N081144-2 — 10 ea. 7.50 100

H4 SERIES .156"x.200" EDGEBOARD CONNECTORS

Positions/Contacts	Part No. Wire Wrap	1	10	100	Part No. Solder Tail	1	10	100
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

For polarizing keys order P. N081144-3 — 10 ea. 7.50 100

ELECTRONIC HARDWARE KIT

CAT. NO. 1400 KIT **$14.95**

NEW MA1032 Clock

Digital LCD Clock Module

- Operates from a single 1.5V Battery
- 0.5" LCD Display

Instructions Included in All Orders

- User selectable 12 or 24 hour mode
- 24 hour alarm with ON-OFF control
- Presettable 59 minute sleep timer with reset to zero
- 7 minute snooze timer
- Fast/Slow setting controls
- Seconds display
- 90 mA hour battery will typically last one year
- Minimum external parts required for travel clock/clock radio
- Backlighted Display

Catalog No.	Description	Cost
MA1032M	LCD Clock Module only	$24.95
MA1032C	Switch for MA1032M	$2.85
MA1032R	MA1032M, MA1032C, & AA battery holder	$28.20

TIME-TEMPERATURE PROGRAMMABLE MODULE

USER PROGRAMMABLE FOR:

- 12 or 24 Hour Display
- F and or C as well as circuits any number of temperature sensors
- Fixed or Flashing colon format
- 50, 60 Hz line frequency operation

MA 1026 by National Semiconductor

instruction included with all orders

FEATURES

- Giant 0.7 inch — 4 digit LED display with red lens
- PM, colon, degree and alarm ON LED indicators
- 6 display modes: temperature, time, seconds, alarm, sleep and temp tool
- Exclusive Digi-Key switching panel available to simplify hook-up
- Leading zero blanking
- Time is normal display mode, with temperature display at push of switch
- displays temperatures in range of -40°C to 90°C
- Power fail condition indicated by flashing
- Addition of simple circuit will allow switching of small to medium 60 loads

Cat. No.	Description	Cost
MA1026M	MA1026 Clock Module (Assembled and tested)	$19.95
MA1026P	Digi-Key Switching Panel Kit for MA1026M (includes P.C. Board, switches, hardware, two temperature sensors, two potentiometers)	11.95
MA1026T	Special transformer for MA1026M	3.95
MA1026B	Alarm buzzer for MA1026M	3.00
MA1026K	Includes MA1026M P, T, and B	34.95
MA1026X	3.58 Megahertz Crystal	3.95
MA1026C	Conventional Switch Set for applications where MA1026P is not used includes one 501PB and ten 502PB switches	3.95
MA1026R	Includes MA1026M, MA1026C, MA1026T, two temperature sensors and two potentiometer	29.95

For each additional sensor unit, the following are suggested:

LM334	Temperature transducer for MA1026M Module	1.33
KD632	200 ohm potentiometer for LM334 transducer	.32
502PB	Normally open switch	.45

THE "PROGRAMMABLE" CLOCK MODULES

USER PROGRAMMABLE FOR:

- 12 or 24 hour display
- Fixed or flashing colon
- 50, 60 Hz line frequency operation

NEW! Two Giant Sizes — 0.7" and 0.84"

FEATURES:

- Display brightness can be controlled by introduction of potentiometer
- Back up time keeping with introduction of 9V potentiometer & 9V battery
- Alarm involves adding buzzer — no interfacing circuitry
- Your Choice — 0.7" or 0.84" red LED display
- Low power consumption
- Leading zero blanking
- Optional switching panel to simplify hook-up

MA1023 — 0.7" HIGH DIGITS

Cat. No.	Description	Cost
MA1023M	MA1023 Clock Module Only (Assembled and tested)	$ 9.95
MA1023P	Digi-Key Switching Panel Kit for MA1023 (includes P.C. Board, Switches, Hardware and Components)	4.95
MA1023T	Special Transformers for MA1023	2.95
MA1023B	Alarm Buzzer for MA1023	3.00
MA1023K	Includes MA1023M, P, T, & B	19.95
MA1023C	Conventional switch set for applications where MA1023P is not used, includes one 501PB and 502PB	2.10
MA1023R	Clock Module, Conventional Switches, Transformer	14.95

MA1020 — 0.84" HIGH DIGITS

Cat. No.	Description	Cost
MA1020M	MA1020 Clock Module (Assembled and tested)	$12.95
MA1020P	Digi-key Switching Panel kit for MA1020 (includes P.C. Board, Switches, Hardware, Components)	7.95
MA1020T	Special Transformer for MA1020M	3.25
MA1020B	Alarm Buzzer for MA1020M	3.00
MA1020K	Includes MA1020M, P, T, & B	26.95
MA1020C	Conventional switch set for applications where MA1020P is not used. Includes one 501PB and six 502PB and a 3M ohm resistor, trimmer, battery snaps	2.30
MA1020R	Includes MA1020M, MA1020C & MA1020T	19.95

DIGITAL CLOCK BEZEL

THE J.M.J. DIGITAL DISPLAY BEZEL

WITH RED FILTER Part No. 400

UNIVERSAL SIZE — HANDLES MOST REQUIREMENTS

Be Sure to Order the Proper Adapter for Your Digital Clock

Part	Description	Price
400	Digital Display BEZEL with Red Filter	$ 4.95
430	Mounting Adapters for MA1001, MA1002, etc.	.69
431	Mounting Adapters for MA1010, MA1020, MA1026	.69
432	Universal PC Board Mounting Adapters	.69
433	Mounting Adapter for MA1023	.69

DIGI-CLOCK KIT

- 12 VDC — Ideal for Car, Van or Boat!
- Trouble Free. No drift!
- 270° Swivel Mount
- Inlaid Walnut Chrome Trim Bezel
- Ideal for Car, Van or Boat!
- 3 3/8" x 2 3/16" Tall x 2 1/8" Deep
- Quick and Easy to Install!

Part No. 5001K ONLY **$24.95**

Do you need spacers, Banana plugs and jacks, or tip plugs and jacks? You can get these and more E. F. JOHNSON products from DIGI-KEY.

HEAT SINKS from TO-92 2W coolers to TO-3 100W sinks.

PANASONIC ELECTROLYTIC CAPACITORS

Value µF	WV D.C.	Axial 1	Axial 10	Axial 100	Radial 1	Radial 10	Radial 100
22	6.3	.18	1.54	12.83	—	—	—
33	6.3	.20	1.68	14.04	.14	1.12	9.21
47	6.3	.21	1.74	14.48	.14	1.16	9.59
100	6.3	.22	1.83	15.22	.16	1.32	11.05
220	6.3	.28	2.34	19.53	.21	1.78	14.80
330	6.3	.29	2.46	20.48	.23	1.92	15.95
470	6.3	.33	2.78	23.15	.23	1.97	16.34
1000	6.3	.49	4.20	35.00	.36	3.08	25.62
2200	6.3	.60	5.13	42.75	.54	4.56	37.95
3300	6.3	.81	6.94	57.83	.75	6.38	53.10
4700	6.3	1.04	8.89	74.07	.93	7.95	66.20
6800	6.3	1.27	10.87	90.58	1.13	9.68	80.62
10000	6.3	1.54	13.17	109.77	1.54	13.13	109.40
22	10	.18	1.54	12.83	.13	1.08	8.94
33	10	.21	1.74	14.48	.14	1.16	9.59
47	10	.21	1.77	14.78	.14	1.19	9.90
100	10	.24	2.00	16.65	.17	1.39	11.58
220	10	.29	2.46	20.48	.23	1.92	15.95
330	10	.33	2.78	23.15	.24	2.06	17.10
470	10	.44	3.72	30.97	.35	2.97	24.69
1000	10	.55	4.63	38.62	.41	3.42	28.45
2200	10	.78	6.63	55.28	.70	5.93	49.42
3300	10	.99	8.45	70.38	.90	7.71	64.22
4700	10	1.28	10.94	91.18	1.13	9.68	80.62
6800	10	1.55	13.26	110.52	1.54	13.26	109.40
10000	10	1.99	17.00	141.63	—	—	—
10	16	.18	1.54	12.83	.13	1.08	8.94
22	16	.21	1.74	14.48	.14	1.15	9.52
33	16	.21	1.77	14.77	.14	1.19	9.90
47	16	.24	2.00	16.65	.16	1.36	11.31
100	16	.28	2.34	19.53	.21	1.78	14.80
220	16	.33	2.78	23.15	.24	2.06	17.10
330	16	.44	3.72	30.97	.35	2.97	24.69
470	16	.50	4.22	35.14	.38	3.19	26.58
1000	16	.60	5.09	42.45	.50	4.21	35.08
2200	16	.92	7.85	65.39	.87	7.46	62.10
3300	16	1.16	9.91	82.62	1.17	10.01	83.48
4700	16	1.57	13.40	111.68	1.57	13.43	111.87
6800	16	1.99	17.00	141.63	—	—	—
2.2	25	.18	1.54	12.83	—	—	—
3.3	25	.18	1.54	12.83	.13	1.08	8.94
4.7	25	.18	1.54	12.83	.13	1.08	8.94
10	25	.18	1.54	12.83	.14	1.15	9.52
22	25	.22	1.83	15.22	.15	1.22	10.17
33	25	.24	2.00	16.65	.17	1.38	11.50
47	25	.28	2.34	19.53	.31	1.73	14.42
100	25	.33	2.78	23.15	.33	1.90	15.77
220	25	.44	3.75	31.24	.40	3.42	28.45
330	25	.52	4.26	35.47	.52	4.45	37.08
470	25	.58	4.95	41.24	.64	5.42	45.13
1000	25	.84	7.18	59.84	.83	7.06	58.78
2200	25	1.16	9.91	82.62	1.17	10.02	83.47
3300	25	1.61	13.77	114.77	1.66	14.17	118.03
4700	25	1.99	17.00	141.63	—	—	—
2.2	35	.18	1.54	12.83	—	—	—
3.3	35	.18	1.54	12.83	.13	1.11	9.20
4.7	35	.18	1.54	12.83	.13	1.11	9.20
10	35	.21	1.77	14.78	.14	1.19	9.90
22	35	.24	2.00	16.65	.19	1.60	13.20
33	35	.28	2.34	19.53	.21	1.78	14.80
47	35	.33	2.78	23.15	.23	1.90	15.77
100	35	.43	3.65	30.40	.24	2.06	17.10
220	35	.51	4.34	36.17	.40	3.42	28.45
330	35	.57	4.85	40.40	.52	4.45	37.08
470	35	.65	5.51	45.89	.64	5.42	45.13
1000	35	.98	8.38	69.80	.92	7.84	65.32
2200	35	1.61	13.77	114.71	1.66	14.17	118.03
3300	35	1.99	17.00	141.63	—	—	—
4700	35	2.61	22.31	185.88	—	—	—
0.47	50	.18	1.54	12.83	.13	1.08	8.94
1	50	.18	1.54	12.83	.13	1.08	8.94
2.2	50	.18	1.54	12.83	.13	1.08	8.94
3.3	50	.18	1.54	12.83	.14	1.15	9.52
4.7	50	.21	1.77	14.77	.14	1.18	9.78
10	50	.24	2.00	16.65	.16	1.35	11.30
22	50	.28	2.34	19.53	.21	1.83	15.19
33	50	.32	2.69	22.43	.22	1.90	15.77
47	50	.36	3.04	25.33	.24	2.05	17.03
100	50	.45	3.78	31.54	.36	3.08	25.62
220	50	.61	5.18	43.15	.52	4.45	37.08
330	50	.76	6.50	54.14	.83	7.06	58.78
470	50	.92	7.87	65.55	.92	7.84	65.32
1000	50	1.25	10.71	89.27	1.31	11.16	92.93
2200	50	1.99	17.00	141.63	—	—	—
0.47	63	.18	1.54	12.83	.13	1.12	9.32
1	63	.18	1.54	12.83	.13	1.12	9.32
2.2	63	.18	1.54	12.83	.14	1.15	9.52
3.3	63	.21	1.77	14.77	.15	1.25	10.35
4.7	63	.24	2.00	16.65	.16	1.34	11.13
10	63	.28	2.34	19.53	.18	1.50	12.43
22	63	.33	2.78	23.15	.24	2.02	16.79
33	63	.37	3.12	26.04	.27	2.24	18.60
47	63	.53	4.51	37.62	.38	3.18	26.45
100	63	.56	4.76	39.64	.50	4.24	35.27
220	63	.76	6.50	54.14	.78	6.61	55.02
330	63	.92	7.87	65.55	.92	7.84	65.32
470	63	1.05	8.94	74.52	.99	8.43	70.19
1000	63	1.64	13.99	116.55	1.66	14.17	118.03
2200	63	2.61	22.31	185.89	—	—	—
0.47	100	.18	1.54	12.83	.14	1.19	9.90
1	100	.18	1.54	12.83	.14	1.19	9.90
2.2	100	.22	1.83	15.22	.15	1.25	10.35
3.3	100	.24	2.00	16.65	.17	1.38	11.50
4.7	100	.28	2.34	19.53	.17	1.41	11.70
10	100	.33	2.78	23.15	.22	1.83	15.19
22	100	.43	3.65	30.40	.27	2.27	18.90
33	100	.45	3.85	32.12	.34	2.88	24.00
47	100	.54	4.62	38.49	.41	3.33	29.14
100	100	.74	6.29	52.43	.57	4.83	40.22
220	100	1.09	9.26	77.18	.96	8.22	68.47
330	100	1.30	11.15	92.53	1.25	10.70	89.12
470	100	1.81	15.46	128.80	1.78	15.25	127.04
1000	100	3.16	27.09	225.77	—	—	—

PANASONIC METALLIZED POLYESTER CAPACITORS

250 VDC plus minus 10% TOLERANCE

NEW! KIT 170 METALLIZED POLYESTER CAPACITORS — Price includes convenient divided plastic box with bin guide for easy storage and quick access. ASSORTMENT OF 15 POPULAR VALUES PANASONIC QUALITY. CAT. NO. E-KIT ONLY **$54.95**

PART NO.	CAP (µF)	1	10	100	1000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PANASONIC K-SERIES CAPACITORS

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 3µA
ALL K-SERIES CAPACITORS WE CARRY ARE RADIAL

DIGI-KEY PART NO.	CAPACITANCE µF	WORKING VOLTAGE DC	1	10 PAK
P800	33		.24	2.03
P801	22	6.3	.23	2.13
P802	47		.26	2.18
P803	100		.30	2.36
P804	22		.23	2.13
P805	33	10	.26	2.23
P806	47		.28	2.37
P807	10		.25	2.07
P808	22	16	.27	2.28
P809	33		.29	2.43
P810	47		.33	2.77
P811	2.2		.24	2.03
P812	4.7		.24	2.03
P813	10	25	.25	2.13
P814	22		.29	2.45
P815	33		.33	2.76
P816	3.3		.24	2.03
P817	.47	35	.25	2.07
P818	10		.26	2.23
P819	22		.33	2.23
P820	.1		.24	2.73
P821	.22		.24	2.03
P822	.33		.24	2.03
P823	.47		.24	2.03
P824	1.0	50	.24	2.03
P825	2.2		.24	2.03
P826	3.3		.25	2.07
P827	4.7		.25	2.12
P828	10		.28	2.38

PANASONIC POLYESTER CAPACITORS

100 VDC plus minus 10% TOLERANCE

NEW! KIT 150 POLYESTER CAPACITORS — Price includes convenient divided plastic box with bin guide for easy storage and quick access. ASSORTMENT OF 13 POPULAR VALUES PANASONIC QUALITY. CAT. NO. M-KIT ONLY **$34.95**

PART NO.	CAP (µF)	PRICES 1	PAK OF 10	PAK OF 100	PAK OF 1000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PLESSEY MINI-BOX

140 CAPACITORS — Price includes convenient divided plastic box with bin guide for easy storage and quick access. ASSORTMENT OF 14 POPULAR "MINI-BOX" CAPACITORS. CAT. NO. 3050P-Kit ONLY **$35.95**

PANASONIC ELECTROLYTIC KIT

150 CAPACITORS — Price includes convenient divided plastic box with bin guide for easy storage and quick access. ASSORTMENT OF 15 POPULAR CAPACITORS. Cat. No. P6200-Kit ONLY **$35.95**

E. F. JOHNSON PLUG & JACK KIT

150 COMPONENTS — Price includes convenient divided plastic box with bin guide for easy storage and quick access. ASSORTMENT OF 150 POPULAR JACKS & PLUGS. Cat. No. J100-Kit ONLY **$69.95**

PANASONIC DISC CAPACITORS

NEW! KIT 310 DISC CAPACITORS — Prices includes convenient divided plastic box with bin guide for easy storage and quick access. ASSORTMENT OF 18 POPULAR VALUES PANASONIC QUALITY. CAT. NO. DH-KIT ONLY **$24.95**

Part Number	Capacitance	Tolerance	Voltage	10	100	1000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PANASONIC RESIN DIPPED TANTALUM CAPACITORS

NEW! KIT 180 TANTALUM CAPACITORS — Prices includes convenient divided plastic box with bin guide for easy storage and quick access. ASSORTMENT OF 15 POPULAR VALUES PANASONIC QUALITY. CAT. NO. F-KIT ONLY **$79.95**

Part No.	Cap (µF)	Voltage (V. DC)	Prices 1	Pak of 10	Pak of 100	1000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

DIGI KEY Precut/Prestripped Wire

Precut Prestripped 100 Wire Package — Bulk Wire Wrap Wire

Wire Assortment No. WK-1-A — 400 Precut Prestripped No. 30 Wire Wrap Wire. Assortment consists of following lengths and quantities: 250—2", 100—4½", 250—3½", 100—5", 100—4", 10—6". Catalog No. WK-1-A $17.95

Wire Assortment No. WK-2-A — 2800 Precut prestripped No. 30 Wire Wrap Wire. Assortment consists of following lengths and quantities: 250—2½", 250—3", 500—3", 100—5½", 500—3½", 250—6", 500—4", 100—6½", 250—4½", 100—7". Catalog No. WK-2-A $42.95

Wire Stripped 1" both ends

PRECUT/PRESTRIPPED WIRE 100 Wires/Package

Part No.	Color	Length	Cost
B2	30 AWG Blue Wire, 2" Overall Length		$2.25
Y2	30 AWG Yellow Wire, 2" Overall Length		2.25
W2	30 AWG White Wire, 2" Overall Length		2.25
R2	30 AWG Red Wire, 2" Overall Length		2.25
B4	30 AWG Blue Wire, 4" Overall Length		2.40
Y4	30 AWG Yellow Wire, 4" Overall Length		2.40
W4	30 AWG White Wire, 4" Overall Length		2.40
R4	30 AWG Red Wire, 4" Overall Length		2.40
B5	30 AWG Blue Wire, 5" Overall Length		2.65
Y5	30 AWG Yellow Wire, 5" Overall Length		2.65
W5	30 AWG White Wire, 5" Overall Length		2.65
R5	30 AWG Red Wire, 5" Overall Length		2.65
B6	30 AWG Blue Wire, 6" Overall Length		2.90
Y6	30 AWG Yellow Wire, 6" Overall Length		2.90
W6	30 AWG White Wire, 6" Overall Length		2.90
R6	30 AWG Red Wire, 6" Overall Length		2.90
B7	30 AWG Blue Wire, 7" Overall Length		3.20
Y7	30 AWG Yellow Wire, 7" Overall Length		3.20
W7	30 AWG White Wire, 7" Overall Length		3.20
R7	30 AWG Red Wire, 7" Overall Length		3.20
B8	30 AWG Blue Wire, 8" Overall Length		3.75
Y8	30 AWG Yellow Wire, 8" Overall Length		3.75
W8	30 AWG White Wire, 8" Overall Length		3.75
R8	30 AWG Red Wire, 8" Overall Length		3.75

30 AWG Kynar Insulated in Bulk Continuous Length

Part No.	Color	Length	Cost
100 RD	Red	100 feet	$ 3.18
100 BK	Black	100 feet	3.18
100 BU	Blue	100 feet	3.18
500 RD	Red	500 feet	13.30
500 BK	Black	500 feet	13.30
500 BU	Blue	500 feet	13.30
1000 RD	Red	1000 feet	23.75
1000 BK	Black	1000 feet	23.75
1000 BU	Blue	1000 feet	23.75

The Digi-Key volume discount and Service charges are simple to apply. Most items sold by Digi-Key may be combined for a volume discount. Items that are not discountable are identified by the suffix-ND following the part number. After writing your order, total all of the discountable items and apply the appropriate discount. To this subtotal, add the non-discountable items. Then add the Service charge. We pay all shipping and insurance to addresses in the U.S.A., Canada and Mexico when payment accompanies order.

WHEN ORDERING BY PHONE, CALL: 1-800-346-5144 (Mn., Ak., Hi., call 218-681-6674) By mail send your order to: DIGI-KEY, Highway 32 South, Thief River Falls, MN 56701

You may pay by check, money order, Master Charge, VISA or C.O.D. ***DIGI-KEY GUARANTEE:*** Any parts or products purchased from Digi-Key that prove to be defective will be replaced or refunded if returned within 90 days from receipt with a copy of your invoice.

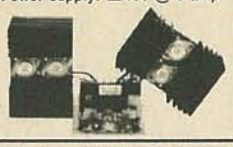
SERVICE	CHARGES	VOLUME DISCOUNT	
$ 0.00-$ 9.99	Add $2.00	$ 0.00-$ 99.99	NET
$ 10.00-$25.00	Add $0.75	$ 100.00-$249.99	Less 10%
$ 25.00-$49.99	Add $0.50	$ 250.00-$499.99	Less 15%
$ 50.00-$99.99	Add $0.25	$ 500.00-$999.99	Less 20%
$100.00 & Up	No Charge	$1000.00 & Up	Less 25%

CIRCLE 35 ON FREE INFORMATION CARD

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: IV max.
- Power supply: ±40V @ 5 amp



TA-1000 KIT $51.95
Power transformer $18.00 each

REGULATED VARIABLE D.C. POWER SUPPLY KIT

Uses UA723 I.C. and 2N3055 power transistor as regulator. Output voltages can be adjusted from 0~30V at an internal resistance of less than 0.005 ohm; ripple and noise less than 1 MV; with built on board LED and audible overload indicator. Kit comes with P.C. board; all electronic components, transformer; connectors; 2 panel meters for voltage and amp; a professional look metal cabinet and instructions.

Model TR-88A 0~15V D.C. 3 amp
Model TR-88B 0~30V D.C. 2 amp

$59.50 per kit NEW

NEW WHISTLE ACTIVATED SWITCH BOARD

All boards are pre-assembled and tested. Your whistle to its FET condenser microphone from a distance, as far as 30 feet away (sensitivity can be easily adjusted) will turn the switch on, then latched you whistle to it again then it turns off. Ideal for remote control toys, electrical appliance such as lights, coffee pots, TV, Hi-Fi, radio or other projects. Unit works on 9V D.C.

Model 968 $4.50 each

SUB MINI SIZE FET CONDENSER MICROPHONE

Specification:
Sensitivity: — 65dB ± 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

2 WATT AUDIO AMP

Pre assembled units. All you need is to hook up the speaker and the volume control. Supply voltage from 9~15V D.C. measures only 2" x 3½", making it good for portable or discrete applications. Comes with hook up data.

BUY 2 FOR **$4.99**

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

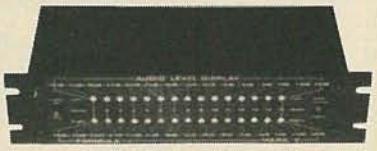
This new stereo level indicator kit consists of 36 4-color LED (15 per channel) to indicate the sound level output of your amplifier from —36dB ~ +3dB. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is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

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

MARK IV KIT **$31.50**

NEW MARK V 15 STEPS LED POWER OUTPUT INDICATOR KIT

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



$41.50 EACH KIT

BATTERY POWERED FLUORESCENT LANTERN

MODEL 888 R

$10.50 EA

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.

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

5W AUDIO AMP KIT

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

TWO IN ONE PANEL METER D.C. VOLTAGE AND AMP IN ONE

D.C. Volts reads 0-50
D.C. Amp reads 0-3
Meter case made of black plastic with a white scale plate and glass window.

#ST-680 $12.50 EACH

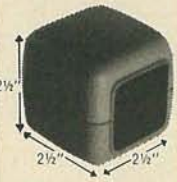
SPECIAL 0.5" LED SALE ALARM CLOCK MODULE

ASSEMBLED! NOT A KIT!

Features: • 4 digits 0.5" LED Displays • 12 hours real time format • 24 hours alarm audio output • 59 min. countdown timer • 10 min. snooze control.

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

CUBO CLOCK CASES



All brand new top quality plastic cases, originally designed for Cubo clocks. Case comes with top and bottom cover with a detachable front red filter for LED readouts. This can be used for many projects such as LED CLOCK, VU METER, LIGHT BOX, FREQ. COUNTER, ETC.
3 Attractive Colors (white, lime green or orange)

BUY 3 FOR ONLY $2.50

TV GAME BOARD

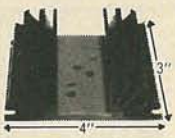
PLAYS 4 GAMES: TENNIS; HOCKEY; HANDBALL AND JAI-ALAI.

All boards complete with all parts ready to play. Requires 6C size batteries and a small speaker for sound effects. The boards were surplus from a famous game manufacturer. They will play on all US standard black and white or color TV sets.

Regular price for these games were $39.50 each
OUR PRICE ONLY $6.50 EACH

PART #57456

MULTI-FINS HEAT SINK



Ideal for high power output. Holes predrilled for 1 to 3 transistor. Made of aluminum with ten radiating fins.

2 FOR $4.50

PROFESSIONAL FM WIRELESS MICROPHONE

TECT 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 6¼" long. With a standard FM radio, can be heard anywhere on a one-acre lot; sound quality was judged very good.

$16.50

FOR DECODER BUILDERS

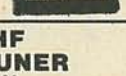
Pre-Drilled PC Board			**$17.50**
Tolriod Coils (Set of 4)			**$ 3.00**
Multi Turn Trim-Pots 10K ohm			**$ 2.50**
Trimmer Capacitor 6-35pF			**$ 0.60**
MC1358	**$ 2.50**	RC1458	**$ 1.00**
MC1350	**$ 2.00**	LM380	**$ 1.80**
MC1330	**$ 3.50**	LM340T-15	**$ 1.20**
		NE565	**$ 2.00**

We also have transformer, capacitors set, resistors set antenna transformer. Please call for price.

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) ON SALE
NIC2400 (24 hr) $16.99 EACH



SANYO UHF VARACTOR TUNER

For UHF CH 14~83

Tuning voltage + 1V~+ 28V D.C. Input impedance 75 OHM. I.F. band width 7~16 MHZ. Noise figure 11.5 dB MAX. Size 2⅜" x 1¼" x ¾". Supply voltage 15V D.C. Sound I.F. = 58.0 MHZ. Video I.F. = 62.5 MHZ

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

FLUORESCENT LIGHT DRIVER KIT

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!

With Case Only $6.50 Per Kit

SUPER FM WIRELESS MIC KIT — MARK III

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.

FMC-105
$11.50 PER KIT

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
$6.75 EA.

"FISHER" 30 WATT STEREO AMP

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.

Super Buy Only $18.50

SPACE WAR SOUND GENERATOR BOARD

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

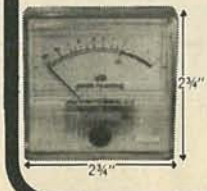
ELECTRONIC PIEZO BEEP BUZZER

Unique surplus ⅞" Dia. piezo ceramic disc on circuit board gives a distinct high freq. buzz. Unit contains an I.C., 2 caps, 6 resistors and is already preassembled. Requires 9V battery to operate.
SPECIAL 2 FOR **$2.99**

2 BIT COUNTER, WARBLE PULSE ALARM BOARD

This new assembly easily converts to a counter, stop watch, warble and pulse alarm generator by adding a few components. We supply the data and typical applications. Requires 9V battery to operate.
SPECIAL 2 FOR **$1.99**

AUDIO OUTPUT dB METER



Meter made of clear plastic with a silver white face plate. Scale reads from −20 +3dB. Meter also comes with an internal dial light.
MODEL: 6F-3
$6.50 EACH

BATTERIES

PK/$10.00
2 PKS/$19.00
ILLUSTRATED LESS COVER

NICKEL CADMIUM BATTERY PACK 'D' SIZE

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: 1¼" dia. x 7" long. New. Shpg. Wt. each pack, 1 lb.

9V RECHARGEABLE NI-CD BATTERY

Replace all 006P type 9V battery
Model: GC9
BRAND NEW **$4.50 EACH**

NI-CD BATTERY SALE

12V Pack 450 MZ/HR Size 3" x 1" x 2"
$8.00 PER PACK

4 AA Pack 450 MA/HR
$3.50 PER PACK

All above batteries are used but late date code and we guarantee to take back all bad ones for exchange.

GELCELL 6V 9AMP/HR SEALED LEAD ACID RECHARGEABLE BATTERY

Sealed construction permits this battery to be operated in any position. Recharge rate 2.15 amp max. for 14-16 hours. All brand new. Limited quantities. Size of battery 4⅛" x 2¾" x 5½".

$16.50 each

ELECTRONIC PIN BALL MACHINE

That sounds and plays like the real thing. All units are brand new but without the case Functions of the game include double flipper control, kicker control, 1-4 players, 3 speed ball control, tilt switch, automatic score, extra bonus cave and many more. All solid state with LED panel, no moving parts. Requires 9V battery to operate, speaker not included.

A perfect gift for yourself or friends.
SPECIAL **$8.99** EACH
SPEAKER **$1.25** EACH

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

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.

$1.75 ea. **2 for $3.00**

REGULATED DUAL VOLTAGE SUPPLY KIT

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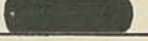

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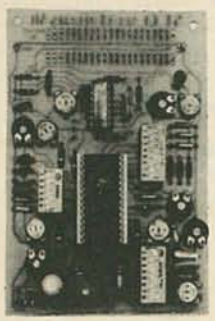

The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477 Sound Chip,** the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One 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 3¼" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains,** or almost an infinite number of **other sounds.** The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included). **76477 is included.** Available separately for **$3.15** each.

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74LS51	.25	74LS241	1.65	SN7443N	.78
74LS54	.35	74LS243	1.45	SN7445N	.78
74LS74	.38	74LS244	1.45	SN7451N	.20
74LS75	.60	74LS245	2.25	SN7454N	.20
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74LS85	.95	74LS257	.95	SN7475N	.32
74LS86	.95	74LS258	.95	SN7482N	1.05
74LS90	.69	74LS259	2.85	SN7492N	.50
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74LS107	.45	74LS283	1.00	SN7495N	.60
74LS112	.38	74LS293	1.85	SN7496N	.70
74LS113	.48	74LS298	1.20	SN74122N	.39
74LS122	.48	74LS366	.95	SN74136N	.95
74LS123	.95	74LS367	.55	SN74140N	.65
74LS126	.69	74LS368	.55	SN74141N	.69
74LS138	.69	74LS373	1.39	SN74142N	.65
74LS151	.44	74LS374	1.39	SN74153N	.65
74LS153	.44	74LS386	.65	SN74154N	1.25
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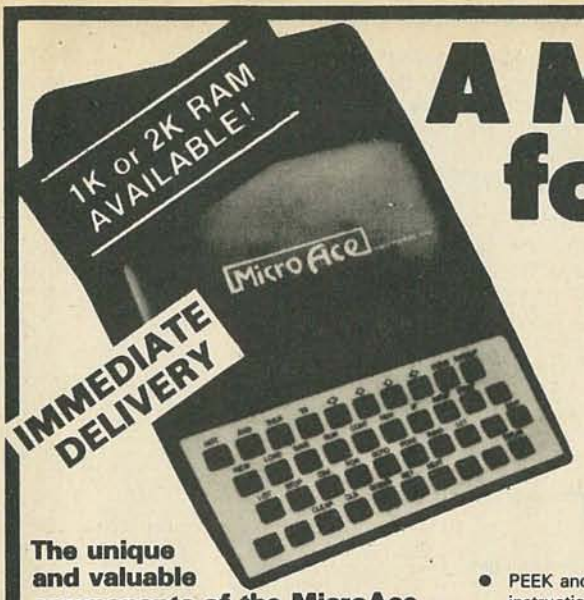

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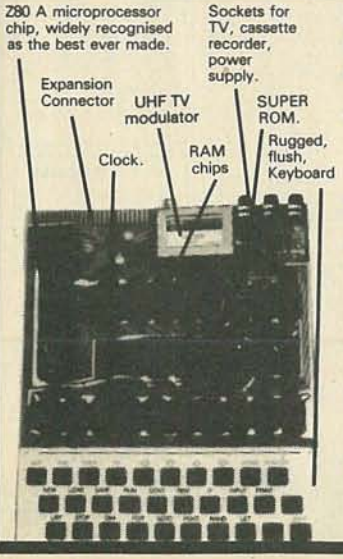

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SN7475N	.38	SN74193N	.85
SN7476N	.36	SN74194N	.85
SN7479N	4.60	SN74195N	.85
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SN7481N	1.10	SN74197N	.85
SN7482N	1.10	SN74198N	1.39
SN7483N	.55	SN74199N	1.39
SN7485N	.65	SN74221N	1.39
SN7486N	.39	SN74251N	.95
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SN7491N	.65	SN74283N	2.15
SN7492N	.52	SN74284N	3.90
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SN7495N	.65	SN74298N	.95
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SN74107N	.32	SN74368N	.79
SN74109N	.53	SN74390N	1.90
SN74116N	1.95	SN74393N	1.90
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SN74122N	.39		

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74LS01N	.28	74LS165N	.89
74LS02N	.28	74LS166N	2.48
74LS03N	.28	74LS168N	1.89
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74LS12N	.39	74LS190N	1.15
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74LS26N	.39	74LS197N	.89
74LS27N	.39	74LS221N	1.49
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74LS51N	.26	74LS251N	1.79
74LS54N	.35	74LS253N	.98
74LS55N	.35	74LS257N	.98
74LS73N	.45	74LS258N	.98
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74LS90N	.75	74LS283N	1.10
74LS92N	.75	74LS290N	1.29
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74LS109N	.45	74LS347N	1.95
74LS112N	.49	74LS348N	1.95
74LS113N	.49	74LS352N	1.65
74LS114N	.55	74LS353N	1.65
74LS122N	.55	74LS363N	1.49
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74LS124N	1.35	74LS366N	.99
74LS125N	.89	74LS367N	.73
74LS126N	.89	74LS368N	.73
74LS132N	.79	74LS373N	2.75
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74LS139N	.89	74LS377N	1.95
74LS145N	1.25	74LS385N	1.95
74LS148N	1.49	74LS386N	.65
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9 DIGITS 600 MHz $129.95 WIRED

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!

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

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 $99.95 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 $79.95 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 $159.95 WIRED

NEW READ RECEIVER FREQUENCY

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 $99.95 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

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7403	.18	7472	.32	74158	.75
7404	.20	7474	.18	74160	.70
7405	.25	7475	.49	74161	.79
7406	.20	7476	.49	74162	.85
7407	.20	7480	.35	74163	.85
7408	.27	7482	.25	74164	.85
7409	.27	7483	.65	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	74S200	3.75
7451	.22	74150	1.35	74279	.65
7453	.18	74151	.50		
7454	.18	74153	.35		
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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		

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LM320T-5	Negative 5 V reg (7905)	1.19
LM320T-12	Negative 12 V reg (7912)	1.19
LM320T-15	Negative 15 V reg (7915)	1.19
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LM340T-15	Positive 15 V reg (7815)	1.19

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LM301CN	.28	LM565H	1.39
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LM307CN	.32	LM567CN	1.19
LM307H	.40	LM703H	.59
LM308CN	.45	LM703CN	.39
LM309H	1.05	LM709N	.29
LM309K	1.15	LM709H	.39
LM310CN	.75	LM710N	.45
LM310H	.75	LM711N	.35
LM311CN	.39	LM723H	.59
		LM723N	.49
LM318CN	1.45	LM733H	.45
LM319N	1.20	LM739N	.45
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LM320K-5.2	.95	LM741	.29
LM320K-15	.95	LM741CH	.45
LM322N	.45	LM747H	.79
LM324N	1.19	LM747N	.69
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LM340K-8	.95	LM1456CN	1.29
LM340K-12	.95	LM1458CN	.65
LM340K-15	.95	LM1496N	.89
LM340K-24	.95	ULN2208	.79
LM370N	.95	ULN2209	.79
LM372N	1.25	CA3046N	1.29
LM376CN	.30	CA3081N	1.25
LM380N	1.19	CA3082N	1.25
LM380CN	.45	LM3900N	.45
LM381N	1.75	LM7524N	.45
LM382N	1.75	LM7525N	.45
LM385K	.49	LM7535	.89
LM386CN	.99	8038B	3.79
LM387CN	.99	75450N	.35
NE546A	1.79	75451CN	.35
NE550A	1.25	75452CN	.35
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8 pin	.20	.18 pk-10	.16ea
14 pin	.25	.21 pk-10	.19
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18 pin	.32	.28 pk-8	.26
24 pin	.48	.45 pk-3	.38
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MINIATURE SOLID STATE ELECTRONIC BUZZER

6V 15mA ± 1.5 4-9 VDC (OPER. V)

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CERAMIC CAPACITORS

1pf	22pf	56pf	120pf	270pf			.0047uf	.030uf	
5pf	27pf	68pf	150pf	390pf	.001uf		.01uf	.050uf	
7pf	33pf	82pf	180pf	470pf	.0015uf		.015uf	.1uf	
10pf	47pf	100pf	220pf	600pf	.003uf		.022uf		
1pf - .050uf					.1uf				
Total	EA.	PK-10	PK-100		EA.	PK-10	PK-100		
1-1000	$.20	$ .95	6.50		.25	1.25	9.00		
1000-	.20	.85	6.00		.25	1.10	8.00		

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CK-c2 5ea. of the above values $11.50
CK-c3 10ea. of the above values 20.50

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.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
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TOTAL QTY. 1000 pcs. -10%, 5000 pcs. -15%

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.1uf/35V	.30	.25	4.7uf/16V	.38	.30	22uf/16V	.50	.40
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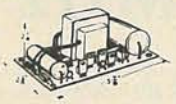
.33uf/35V	.30	.25	6.8uf/6V	.35	.28	33uf/6V	.55	.45
1uf/20V	.30	.25	6.8uf/16V	.45	.39	33uf/10V	.60	.50
1.5uf/20V	.30	.25	10uf/20V	.42	.35	47uf/6V	.60	.50
2.2uf/20V	.35	.25	15uf/6V	.42	.35	47uf/15V	.65	.55
2.2uf/35V	.38	.28	15uf/20V	.50	.40	56uf/6V	.85	.75
3.3uf/35V	.40	.30						

TANTALUM CAPACITOR ASST.
5 ea. of above - $37.50

POWER SUPPLY KIT

+5V, +12V, +15V
A regulated power supply using a 115V/29V CT transformer, 3-Lm340T and 1-LM320T regulators to supply the above voltages. Heat sink provided for +5V

PARTS INCLUDED
Transformer
5 regulators
PC board
4 diodes
Capacitor 1000 uf
Capacitor 500 uf
3 capacitors 10 uf



ea $17.50
10- 16.00
25- 15.00
+ shipping

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PARTS INCLUDED
MC5369 divider
4049 buffer
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3-12pf var. cap
47pf cap
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2-10Mohm res
1Kohm res
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Produces accurate 1hz, 10hz and 60hz outputs--three of the most popular frecuencies for any piece of test equipment.

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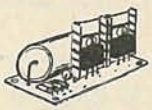

REGULATED POWER SUPPLY KIT PS-2

Uses +5V and +12V TO-220 regulators Kit includes PC Board(1 11/16" X 3"), Rectifiers, 7805 & 7812 Regulators, , Capacitors & Heat Sinks. Transformer not included, Fits PCB slots of Hammond Case 1591DGY.

$6.00ea
10- 5.50ea
25- 5.00ea

WALL MOUNT TRANSFORMER
117V/12VAC 250ma 60hz $3.75
117V/12VAC 1 amp 60hz 4.95

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Uses +5V and +12V TO-220 Regulators. Kit includes PC Board (1 1/4" X 2 3/8"), Rectifier Bridge, 7805 & 7812 Regulators, Capacitors and Heat Sinks. Transformer not included. Fits PCB slots of Hammond Case 1591CBU.

$7.50ea
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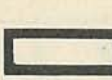
1591BGY	4.40" X 2.44" X 1.22"	grey	$3.35
1591CBU	4.75" X 2.56" X 1.56"	blue	4.10
1591DGY	6.00" X 3.15" X 2.00"	grey	4.85



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Black bezel - red filter

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Cut out 1.125" x 2.375"
(Up to .062" panel thickness)
Viewing area 2" x .8125"

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BREADBOARD $1.25ea
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5316 4 digit, 12-24hr, alarm
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JUMBO LED
.20"dia, diffused

Red, Clear or White	10/$1.00	25/$2.25	100/$8.00
Green or Yellow	7/$1.00	25/$3.25	100/$10.45

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.125"dia, diffused

Red or Clear	10/$1.00	25/$2.25	100/$8.00
Green or Yellow	7/$1.00	25/$3.25	100/$10.46

LED MOUNTING CLIP & RING
FOR .20" - JUMBO LED
10/$ 1.25
25/$.2.75
100/$ 7.00

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.4" ORANGE LED DISPLAY 7 segment RHD	$1.19ea 10/$7.95
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MAN4640 - common cathode	100/$65.00
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MAN4630 - common anode	10/$3.50
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XAN72(MAN72 equiv) common anode	25/$17.50 100/$65.00
.6" RED LED DISPLAY 7 segment LHD	$1.25ea 10/$11.50
XAN6940 - common cathode	25/$26.50 100/$98.00

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2N2222A	.45	3.50	8.00	29.00	265.00
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2N3904	.25	1.65	3.25	12.00	100.00
2N3906	.25	1.65	3.25	12.00	100.00

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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

CARBON FILM RESISTORS,

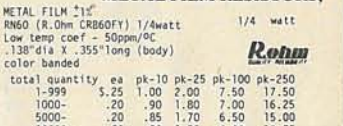
CARBON FILM ±5%
1/4watt (R.Ohm R25) 1/4 & 1/2 watt
.095"dia X .250"long (body)
1/2watt (R.Ohm R50)
.146"dia X .354"long (body)

Rohm

PRICING

total quantity	ea	pk-10	pk-100	pk-1000
1-999	$.10	.45	2.00	
1000-	.10	.40	1.80	15.00
5000-	.10	.30	1.70	14.50
10000-	.10	.25	1.55	13.00

25 or more resistors - not individually packaged - mixed - specify any assortment of values $.04ea



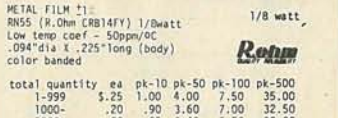
METAL FILM RESISTORS,

METAL FILM ±1%
RN60 (R.Ohm CRB60FY) 1/4watt 1/4 watt
Low temp coef - 50ppm/°C
.138"dia X .355"long (body)
color banded

Rohm

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



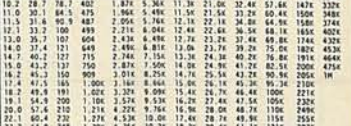
METAL FILM RESISTORS

METAL FILM ±1%
RN55 (R.Ohm CRB14FY) 1/8watt 1/8 watt
Low temp coef - 50ppm/°C
.094"dia X .225"long (body)
color banded

Rohm

total quantity	ea	pk-10	pk-50	pk-100	pk-500
1-999	$.25	1.00	4.00	7.50	35.00
1000-	.20	.90	3.60	7.00	32.50
5000-	.20	.85	3.40	6.50	30.00
10000-	.20	.80	3.10	6.00	27.50

10 or more resistors - not individually packaged - mixed - specify any assortment of values $.15ea



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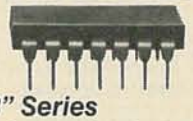

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- *Pin-Out Diagram & Specs Included*

Type	Cat. No.	Each
4001	276-2401	.99
4011	276-2411	.89
4013	276-2413	1.19
4017	276-2417	1.99
4027	276-2427	1.19
4511	276-2447	1.99
4059	276-2449	.99
4050	276-2450	.99
4066	276-2466	1.59
4070	276-2470	.99

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Type	Cat. No.	Each
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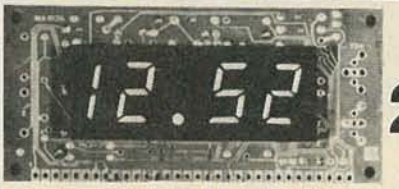
74LS02	276-1902	.79
74LS04	276-1904	.79
74LS08	276-1908	.79
74LS32	276-1915	.89
74LS73	276-1918	.99
74LS74	276-1919	.79
74LS75	276-1920	.99
74LS90	276-1923	1.19
74LS123	276-1926	1.49
74LS151	276-1929	1.09
74LS157	276-1930	1.19
74LS161	276-1931	1.59
74LS164	276-1932	1.59
74LS175	276-1934	1.39
74LS193	276-1936	1 69
74LS367	276-1835	1.59



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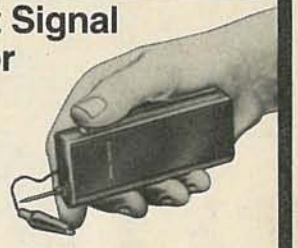

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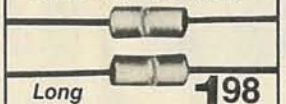

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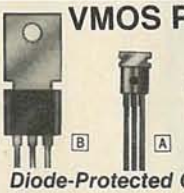

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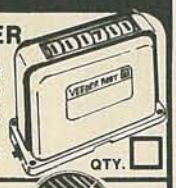

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7430	.19	7490	.49	74164	.89
7432	.29	7491	.69	74173	1.39
7440	.19	7492	.59	74174	.89
7442	.49	7493	.49	74175	.89
7445	.69	7496	.74	74176	.89
7446	.69	74100	1.19	74192	.79
7447	.59	74107	.34	74193	.79
7448	.69	74121	.34	74196	.79

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14 pin ST	10/1.29	14 pin WW	.69
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20 pin ST	10/1.29	20 pin WW	1.09
22 pin ST	10/1.29	22 pin WW	1.39
24 pin ST	10/1.29	24 pin WW	1.49
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40 pin ST	10/1.29	40 pin WW	1.99

ST = SOLDERTAIL WW = WIREWRAP

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7824T	.99	7924T	1.19
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7812K	1.39	7912K	1.49
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78L12	.69	79L12	.79
78L15	.69	79L15	.79

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4007	.25	4027	.65	4072	.49
4009	.49	4040	1.29	4081	.39
4010	.49	4042	.99	4093	.99
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4012	.29	4047	2.49	4503	.69
4013	.49	4049	.49	4508	3.95
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LM555v	.39	LM1458v	.69		

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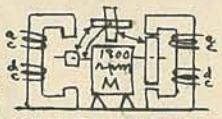

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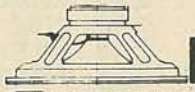

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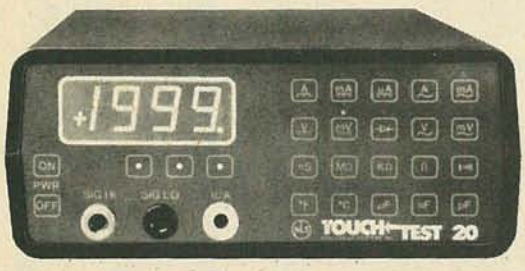

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A16ZT-TI	.22	.21	.20	.19
A18ZT-TI	.29	.28	.27	.26
A20ZT-TI	.33	.32	.31	.30
A22ZT-TI	.36	.35	.34	.33
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A24T	.52	.51	.50	.49
A28T	.78	.77	.76	.75
A36T	.83	.82	.81	.80
A40T	1.08	1.07	1.06	1.05

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A14G	.55	.54	.53	.52
A16G	.63	.62	.61	.60
A18G	.69	.68	.67	.66
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A40G	1.55	1.54	1.53	1.52

WIRE WRAP Level 3

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A16WG	.73	.72	.71	.70
A18WG	1.01	1.00	.99	.98
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A22WG	1.35	1.34	1.33	1.32
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74LS37N	.36
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74LS73N	.38
74LS74N	.54
74LS86N	.45
74LS90N	.44
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74LS109N	.52
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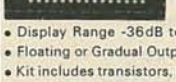

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ADVERTISING INDEX

RADIO-ELECTRONICS does not assume any responsibility for errors that may appear in the index below.

Free Information Number		Page
11	AMC Sales	110
—	ATV Research	104
28	Active Electronics	93
61	Advanced Electronics	90
—	Advanced Electronics	25,42, 74-75
8	Advanced Computer Products.	102-103
49	Albia Electronics	80
37	All Electronics	96
13	American Antenna	Back Cover
45	Ampower	85
34	Ancrona	111
46	B & K Precision	13
—	Bagnall Electronics	91
—	Karel Barta	104
2	Bearcat	2
—	Bullet Electronics	100
—	CIE, Cleveland Institute of Engineering	18-21
29	CFR, Associates	108
33	Cambridge Learning	83
20	Channellock	36
10	Chaney Electronics	92
—	Cascade Labs.	112
44	Communications Electronics	73
—	Command Productions	92
—	Cook's Institute	92
38	Concord Electronics	100
18	Jan Crystals	77
—	Dage Scientific	104
35	Digi—Key Corp.	97
—	JW, Ecklin	110
—	Edu Cal Publications	82
22	Electronics Book Club.	27
—	Electronic Technology Today	85
3	Etco	110-112
—	Fair Radios	112
39	Fluke	7
51,52	Fordham	26,77
7	Formula International	98-99
54	Global Specialties	37
—	Global TV	91
40	Godbout	110
—	Grantham College of Engineering	78
55	Hal-Tronix	112
14,15	Heath	17, 39-41
—	Information Unlimited	110
21	International Components Corp.	88
24	International Crystal Mfg. Co.	38
47	International Electronics Unlimited	106
4	JDR, Microdevices	109
5	Jameco Electronics	94-95
62	Keystone Electronics	38
56	MCM, Electronic Parts.	104
64	Magnavox	43
12	Meshna Inc.	108
—	McGee Radio	110
27	Micro Ace	101
—	Micro Management	92
—	Microtenna	104
63	Midland Electronics	81
—	NRI, Schools	8-11
—	NTS, National Technical Schools	28-31
58	Netronics R & D Ltd.	87
41	Non-Linear Systems	15
59	Omega Sales	24
17	Paccom	78
36	Panasonic	33
19	Paia Electronics Inc.	90
—	Philips ECG Inc.	89
26,30	Poly Paks	77, 108
25	Quietrole Company	38
53	RCA	22-23, 32, 44
9	Radio Shack	107
6	Ramsey Electronics Inc.	105
23	HW, Sams	79
—	Sabtronics	1
57	Shure Brothers	Cover 3
32	Solid State Sales	96
31	Sony Video	35
—	Spacecoast Research	91
—	Surplus Center	91
42	Trio-Kenwood Communications Inc.	34
43,60	Triplett	Cover 2
16	Vaco	5
—	Wersi	79

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