PROJECTS—HI-FI—COMPUTERS

Radio-Electronics

$1.25 ■ JAN. 1979

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

600-MHz COUNTER

A battery-powered 600-MHz frequency counter that's small enough to fit in the palm of your hand. Build it for less than 17 cents per MHz. Turn to page 39.

VIDEO MOTORCYCLE GAME

Rev your engine, hang a wheelie, accelerate up the ramp and see how many obstacles you can jump. Construction starts on page 44.

DIGITAL CIRCUIT DESIGN

Part 2. How to design digital circuits from scratch. The walk through sequential and combinational circuits and circuit reduction techniques starts on page 47.

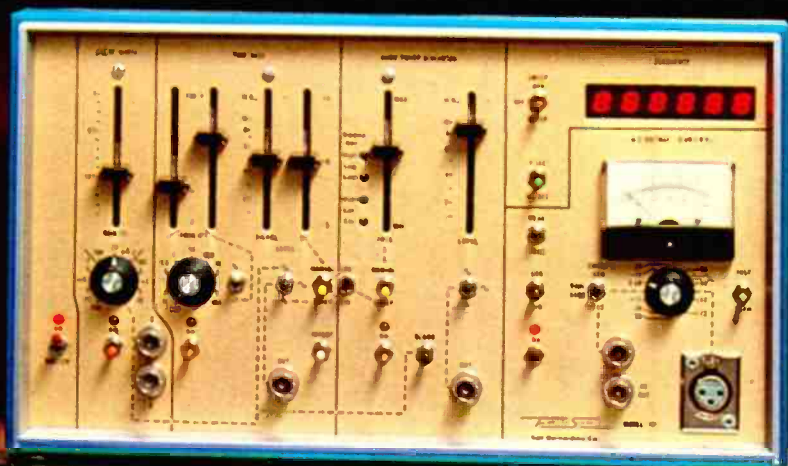
4-CHANNEL FM

A look at the different broadcast systems under consideration by the FCC and what it will mean to you. For the complete story, turn to page 51.

PLUS:

- ★ Build a NOM card for an 1802-based computer
- ★ Hobby Corner
- ★ Computer Corner
- ★ Jack Darr's Service Clinic
- ★ 2 Hi-Fi Lab Test Reports

A GERNSBACK PUBLICATION



COVER STORY
AUDIO TEST STATION

Professional-quality test instrument you can build combines several important test instruments into a single cabinet. Construction starts on page 35.

LX303

ALL THE MOST WANTED FEATURES AT A MOST WANTED PRICE...

BIG ½" HIGH LCD DISPLAY
USE INDOORS OR OUT
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Here is the handfull of accuracy you've been waiting for. Handsomely encased. Compact. Efficient. Only 8 ounces. Hickok's exciting, new LX 303, 3½ digit Mini-Multimeter with high quality components, one year guarantee and rugged Cycolac® case offers features previously found only in expensive units. . .at a price under $75.00! So why wait any longer? The amazing LX 303 is here, NOW! Another American made test equipment breakthrough from Hickok, The Value Innovator. Order today!

SPECIFICATIONS:

DC VOLTS (5 RANGES): 0.1mV to 1000V; Accuracy ±0.5% rdg ±0.5% f.s.; Input imped: 10MΩ; Max. input 1kV except 500V or 200mV range.
AC VOLTS (40Hz to 5kHz): 0.1V to 600V; Accuracy: ±1.0% rdg ±0.5% f.s. (−2dB max. at 5kHz); Max. input: 600V.
RESISTANCE (6 LOW POWER RANGES): 0.1Ω to 20MΩ; Accuracy: ±0.5% rdg ±0.5% f.s. (±1.5% rdg on 20MΩ range); input protected to 120VAC all ranges.
DC CURRENT (6 RANGES): .01nA to 100mA; Accuracy: ±1.0% rdg ±0.5% f.s.
DIMENSIONS AND WEIGHT: 5-7/8" x 3-3/8" x 1-3/4", 8 oz.; POWER: 9V battery (not included) or Hickok AC adapter; READ RATE: 3/sec.

See your nearby Hickok distributor. Call toll free 800-321-4664 (outside of Ohio) for your local distributor's name.

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the value innovator

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CIRCLE 29 ON FREE INFORMATION CARD

The Age of Affordable Personal Computing Has Finally Arrived.

Ohio Scientific has made a major breakthrough in small computer technology which dramatically reduces the cost of personal computers. By use of custom LSI micro circuits, we have managed to put a complete ultra high performance computer and all necessary interfaces, including the keyboard and power supply, on a single printed circuit board. This new computer actually has more features and higher performance than some home or personal computers that are selling today for up to $2000. It is more powerful than computer systems which cost over $20,000 in the early 1970's.

This new machine can entertain your whole family with spectacular video games and cartoons, made possible by its ultra high resolution graphics and super fast BASIC. It can help you with your personal finances and budget planning, made possible by its decimal arithmetic ability and cassette data storage capabilities. It can assist you in school or industry as an ultra powerful scientific calculator, made possible by its advanced scientific math functions and built-in "immediate" mode which allows complex problem solving without programming! This computer can actually entertain your children while it educates them in topics ranging from naming the Presidents of the United States to tutoring trigonometry all possible by its fast extended BASIC, graphics and data storage ability.

The machine can be economically expanded to assist in your business, remotely control your home, communicate with other computers and perform many other tasks via the broadest line of expansion accessories in the microcomputer industry.

This machine is super easy to use because it communicates naturally in BASIC, an English-like programming language. So you can easily instruct it or program it to do whatever you want, *but you don't have to.* You don't because it comes with a complete software library on cassette including programs for each application stated above. Ohio Scientific also offers you hundreds of inexpensive programs on ready-to-run cassettes. Program it yourself or just enjoy it; the choice is yours.

Ohio Scientific offers you this remarkable new computer two ways.

Challenger 1P $349
Fully packaged with power supply. Just plug in a video monitor or TV through an RF converter to be up and running.

Superboard II $279
For electronic buffs. Fully assembled and tested. Requires +5V. at 3 Amps and a video monitor or TV with RF converter to be up and running.

Standard Features

- Uses the ultra powerful 6502 microprocessor
- 8K Microsoft BASIC-in-ROM
  Full feature BASIC runs faster than currently available personal computers and all 8080-based business computers.
- 4K static RAM on board expandable to 8K
- Full 53-key keyboard with upper/lower case and user programmability
- Kansas City standard audio cassette interface for high reliability
- Full machine code monitor and I/O utilities in ROM
- Direct access video display has 1K of dedicated memory (besides 4K user memory), features upper case, lower case, graphics and gaming characters for an effective screen resolution of up to 256 by 256 points. Normal TV's with overscan display about 24 rows of 24 characters; without overscan up to 30 X 30 characters.

Extras

- Available expander board features 24K static RAM (additional), dual mini-floppy interface, port adapter for printer and modem and an OSI 48 line expansion interface.
- Assembler/editor and extended machine code monitor available.

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Radio-Electronics®

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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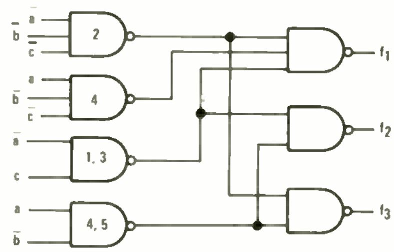
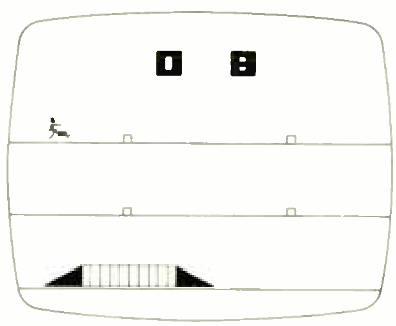
ON THE COVER

Harvey Sound's midtown Manhattan store provides the backdrop for a complete audio test bench in a single instrument. It combines a digital AC multimeter, digital frequency counter, two sine/square/triangle wave generators and a pulse generator. It's "the" instrument for audio testing. Turn to page 35 for all the details.



SIMPLIFIED LOGIC CIRCUIT is just one type of circuit design covered in this article. **Turn to page 47.**



RACE MOTORCYCLES across your TV screen. New TV game built around General Instruments chip makes it work. **Story starts on page 44.**

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looking ahead

Digital audio standards: Fearing a profusion of different types of digital audio disc systems, 29 Japanese, American and European firms have formed an informal organization to establish voluntary standards for a single system. Philips, Matsushita, JVC, RCA and others already have demonstrated or developed pulse code modulation (PCM) systems based on their videodisc developments. The advantage of digital recording is reduction in noise, expansion of dynamic range, decreased distortion and complete elimination of wow and flutter. Unfortunately, none of the PCM systems developed so far is compatible with any other.

Mindful of the lack of standardization in videocassette recorders, the 29 companies have agreed to work to develop a single standard within two years, presumably tacitly agreeing not to introduce any commercial systems until a standard is developed. The group was organized in Japan, but its members include RCA and MCA Disco-Vision of the U.S., Philips of Holland, Thomson-CSF of France, A.E.G. Telefunken of Germany, in addition to Japanese hi-fi equipment and record manufacturers. The group will attempt to reconcile differences in record size, recording methods and rotation speed of the various proposed systems, and to develop standard sampling rates, technology, encoding, decoding and error correction systems. The group agreed to explore the possibility of interchangeability between laser-beam and needle-in-groove types of disc, compatibility with videodisc systems and measures to help prevent piracy.

The group was established in Tokyo not only because the majority of its members are Japanese firms, but also presumably because Japanese law is more tolerant of standard-setting meetings of competing firms than that of some other countries, including the U.S. The audio disc standardization group, known as "Digital Audio Disc Standardization Conference," is expected to set a pattern for a similar effort to standardized videodisc systems.

One for one: The United States has lost one TV manufacturer and gained one. Lost is Admiral, one of the first U.S. manufacturers to produce black-and-white, and later color, television. In 1974, Admiral was sold to Rockwell International, which announced last fall that it was leaving the TV business because of continued losses. The phaseout will come gradually during the first quarter of 1979. Admiral will continue to produce appliances. It's possible the brandname may be sold for a private-label TV line. Admiral offered its Chicago and Taiwan TV plants for sale. The new U.S. manufacturer is Sharp, the last of the Japanese TV majors to establish a plant here. Sharp's TV plant will be in the Memphis area and will produce microwave ovens as well as color TV sets.

Other Japanese TV makers with U.S. plants are Sony, Toshiba, Mitsubishi (MGA), Sanyo, Matsushita (Panasonic and Quasar). American TV brands which have ended production in recent years include Emerson, Philco (name purchased by Sylvania) and Motorola (whose TV set operation was sold to Matsushita and re-named Quasar). Warwick, controlled by Whirlpool, was sold to Sanyo. Magnavox was purchased by Philips of Holland. General Electric has agreed to sell its TV and picture-tube manufacturing facilities to a new firm, General Television of America, to be jointly owned by GE and Hitachi, pending approval by the U.S. and Japanese governments.

More color cameras: Just a year ago, the home color camera was a curiosity, the cheapest one was $1,500 stripped down and well over $2,000 for a version with electronic viewfinder and zoom lens. Black-and-white cameras chalked up impressive sales and have been in short supply all year, and the public snapped up whatever color cameras it could find. Starting this fall, color cameras are being produced by mass-production techniques for the first time and there's a good selection starting under $1,000 despite the drop in the value of the dollar in comparison to the yen (the cameras are all Japan-made).

JVC and Magnavox are offering similar JVC-made cameras. Panasonic, Quasar and RCA feature a different model made by Matsushita. Zenith has one made by Hitachi, and GBC has cut the price of a Toshiba-made camera to slightly below $1,000. New color cameras which start slightly above $1,000 are offered by Hitachi and Sony, the latter with such deluxe features as through-the-lens viewfinder and 3-1 zoom lens. Meanwhile, an RCA official said the company hoped to offer an all-solid-state CCD color camera in about a year at around $500.

Flat-screen progress: Working with a team of former Zenith research engineers, GTE is confident that it is only a few years away from a giant flat-screen non-CRT color TV display using the principle of cathodoluminescence. The joint program is being conducted with Lucitron Inc., headed by Joseph Markin, formerly head of Zenith's display systems R&D operation. GTE owns TV set producers Sylvania and Philco in the United States and Saba in Europe and is a major manufacturer of picture tubes.

Lucitron has already developed monochrome gas-discharge displays and sees no major problems in developing color. A top GTE engineer predicted that large color TV displays would be ready for commercialization in three to five years. Lucitron officials are more conservative and talk in terms of five to ten. GTE envisions its first color TV panels to be larger in viewing area than the biggest picture tube, somewhere between 35 and 50 inches measured diagonally by about three inches thick. The Lucitron panels are claimed to provide good grey scale, have high efficiency, good brightness and potential economy and long life. Among their major advantages are the fact that they're "self-scanning," eliminating the need for complex drive circuitry; they use conventional color phosphors and in other respects employ technology similar to that required in the manufacture of picture tubes. Initial Lucitron developments will be alphanumeric displays for airports, stock brokerages and computer terminals, expected by 1981 at the latest.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

new & timely

Blaupunkt car radios checked out by traveling van

The Blaupunkt Car Radio Division of Robert Bosch Corporation has devised a traveling tech shop on wheels called the Tech Van. In use since early 1978, the van has been traveling throughout the U.S. testing Blaupunkt car radios in major marketing areas.

A sophisticated control panel uses a quick connect/quick release feature that allows up to four radios to be tested simultaneously; it also incorporates facilities for checking speakers, power amps and CB's. Company engineers use the van to test out new car radio concepts in the field, make car radio installation tests and gather technical data.

Breach of computer security is a serious threat

An elevator-sized computer that is now commercially available can store three trillion bits. This is equivalent to a 500 page dossier on every man, woman and child in the U.S., a fact that is becoming a cause of concern to many. A report released by IBM Corporation officials to a panel investigating computers' potential abuse of privacy indicates their concern that such an invasion of privacy is a very real threat. More and more government and private agencies depend on computers for data storage and quick retrieval. The number of computers used by government agencies alone has increased considerably over a 13-year period, which raises the question of how to maintain security on the data in the computers' memory banks.

Although it would rarely be practicable to achieve absolute security with complete effectiveness, the report states: "reasonable protection can be provided . . . by increasing the cost of subverting the system to an unacceptable level." Other federal studies of the problem indicate that sensitive information should be isolated from routine data stored in memory. However, to curtail abuses effectively would seriously affect the efficiency of the data-retrieval system. For example, to reduce the possibility of some unscrupulous programmer penetrating and using the data, a computer system must be designed that can only *process* transactions and have no programming capability; airline reservation systems are examples of such limited operations.

Another report to Congress by the U.S. Comptroller General urges that "the President's top staff should move to have all federal agencies assess their roles in computer use and security," and indicated that a cost-effective approach to computer security should be sufficient to combine the necessity for data and the equally pressing need for privacy.

CO_2-based cycle aids in electricity storage

A research team from RCA Laboratories has determined that solar- or wind-generated electricity could be stored by applying the same chemical reactions inherent in a new CO_2-based energy-storage cycle.

In this cycle, surplus electricity (generated during maximum sun and wind conditions) is directed to electrodes that are immersed in water through which carbon dioxide (CO_2) gas is bubbled. The water is then broken down into its hydrogen and oxygen components; the hydrogen combines with the CO_2 to produce *formic acid*, a fuel that can be stored in tanks and used in electricity-producing cells. Additionally, palladium can be introduced as a catalyst into the formic acid to convert it into hydrogen gas; this can take place at room temperature. The RCA team point out that formic acid is safer to store and easier to transport than pure hydrogen gas because it is in non-explosive liquid form.

Using the CO_2/formic acid/hydrogen cycle has a long-range advantage in that it can supply hydrocarbons to be used as fuel instead of petroleum and as raw material for products that are presently based on petroleum. The fuel cycle could also serve to mitigate against the "greenhouse effect" that many scientists fear will result in the earth's atmosphere from continuous CO_2 emissions using present combustion methods.

Electrolert's Fuzzbuster "goes to court"

Electrolert, Inc., manufacturers of the Fuzzbuster radar detector have instituted legal proceedings against what the company terms "libelous and defamatory" statements made by several groups concerning the device.

One of the defendants is the Pennsylvania Turnpike Commission, which operates the state's toll roads. Evidently, the Commission has been distributing leaflets to motorists stating that the Pennsylvania State Police radar is immune to "the Fuzzbuster and other radar detectors." Another target for litigation is the Better Business Bureau of Miami, which was accused of distributing a letter to all South Florida newspapers, radio and TV stations requesting they not accept advertising for "Fuzzbusters."

Additionally, an unnamed radar manufacturer has been distributing brochures claiming its radar is "detector proof." (There are actually several radar companies that make this claim.)

Legal action has started against the turnpike commission and the Better Business Bureau. The Commission has been asked to stop handing out the flyers and issue new ones retracting the erroneous information contained in the first ones. Electrolert has also written the Miami Better Business Bureau asking that they retract their previous press statement alleging that anyone who purchases a radar detector is being encouraged to evade the law.

Crystal-layering technique improves semiconductor efficiency

Scientists at Bell Telephone Labs have developed a technique that is expected to double the speed with which electrons pass through semiconductor crystals at room temperature, thereby increasing the efficiency of such semiconductors used as IC's.

BELL LABS SCIENTIST prepares to test experimental two-layer gallium arsenide/aluminum gallium arsenide semiconductor crystal (shown to the right of the light). New crystal technique increases the speed at which electrons move through the crystal. Such a breakthrough in solid-state technology could lead to faster, more efficient semiconductor devices.

The electrons in semiconductor materials tend to be slowed down by the positively and negatively charged "impurities" that are added to create new electrons. In gallium arsenide, for example, the impurity is silicon, which releases electrons to travel through the semiconductor as current. This silicon, when it loses electrons, becomes positively charged. Other electrons en-

continued on page 12

Now NRI makes it TV/Audio home

Side-by-side equipment comparison of NRI and two other leading schools shows what you get for what you pay. When you have to pay as much as $985 more for another school's course, you should carefully consider your tuition investment.

When you sit down and try to pick out the school that's best for you, it gets to be a problem. Catalogs are radically different and some are not too clear as to what you actually get for your money. So NRI has done a lot of the work for you. And put the prices right up front so you can make your own judgment.

Of course, we can't compare everything. Lesson clarity and content vary. What one covers here, another covers there...or not at all. The material one school breaks down into eight lessons may be four at another. And the qualifications and abilities of instructors are another question.

	NRI	SCHOOL A	SCHOOL B
COURSE TITLE	Master Course in TV, Audio, and Video System Servicing	Master Course in Color TV Servicing	Electronics Technology and Advanced Troubleshooting I & II
CASH PRICE (terms available)	$1295	$1539	$2280
TV SET	NRI designed-for-learning kit. Dual speaker 25" (diagonal) color TV with cabinet	Heathkit GR-2001 25" (diagonal) color TV (cabinet extra)	Zenith model G4020W 19" (diagonal) color TV (fully assembled)
OSCILLOSCOPE	NRI designed-for-learning kit. 5" (8 x 10 cm) triggered sweep	Heathkit IO-4541 5" (8 x 10 cm) triggered sweep (not given until after graduation)	Heathkit IO-4541 5" (8 x 10 cm) triggered sweep
COLOR BAR GENERATOR	NRI designed-for-learning kit. 10 patterns	Elenco SG-200 (kit) 10 patterns	Elenco SG-200 (fully assembled) 10 patterns
FREQUENCY COUNTER	NRI designed-for-learning kit. Complimentary metal oxide semiconductor digital type		
METER	NRI designed-for-learning kit. Transistorized AC/DC volt-ohm meter	Heathkit (part of TV kit) DC only; 1K Ohm/volt	Private label multimeter
AUDIO	NRI designed-for-learning kit. Four-channel high-fidelity AM/FM tuner with speakers	Private label pocket transistor AM radio kit and AM-FM-SW solid-state portable radio kit	
TRAINER	NRI Discovery Lab	Breadboard	Experimental Electronics Lab
MISCELLANEOUS EQUIPMENT		EICO Digital Logic Probe	

All data as shown in each school's catalog as of September 1, 1978.

One Million Students, Over 60 Years' Experience

So we can only tell you what NRI has to offer. We've been in education since 1914, starting as a radio school six years before commercial broadcasting was even on the scene. Since then, we've kept right up with the times, improving techniques, adding material, creating new courses to help people improve their skills and income.

Early on, we learned to keep our lessons compact...thoroughly covering a subject, but not so much that students would be overwhelmed. We call them "bite-size" lessons because they're easy to digest.

Learn by Doing with "Hands-on" Training

And, we pioneered the concept of "hands-on" training. NRI goes far beyond theory and textbooks to give our students actual bench experience and prepare them for the realities of electronic servicing. Every piece of equipment in our Master Course in TV and Audio Servicing is designed for learning. As you assemble the kits we supply, you build a highest-quality, up-to-date 25" (diagonal) color TV, a 4-channel amplifier and tuner with speakers, your own oscilloscope,

Learn as you build with "hands-on" training.

easy to compare study courses.

digital frequency counter, and other instruments you'll use in your course, use later to earn good money as a TV/ Audio technician.

The point is, none of this equipment is hobby-kit or commercial assembly line units with lessons "retro-fitted" to what was at hand. NRI has designed each so you get invaluable training and experience you just can't get any other way. As you build, you study operation of circuitry, see how sections interact, perform "power-on" experiments only possible with NRI. This total training is exclusive with NRI...no other school, home study or resident, offers it.

Instructors Who Know Their Business

NRI instructors are thoroughly qualified, with both technical and educational experience. Most of them helped develop NRI courses, lessons, and equipment, so they really know what they're talking about. They're interested in their students, always ready to help with a question, a problem...give good advice to help you reach your goals.

It's instructors and training like this that have made NRI the choice of professional TV servicemen who have taken home study courses. As a national survey shows (summary on request), they recommend NRI by a majority of three to one over any other school.

So how does NRI give you all this and still cost so little? We keep costs down by designing our own training kits, eliminating the middleman's profit on hobby kits or commercial units. And by offering our training by mail only. We have no sales force, no commissions to pay. You make up your mind in your own time, without pressure, let the facts speak for themselves. We pass these savings on to you in the form of lower tuitions, more equipment, carefully designed courses and effective lessons.

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Send for our free catalog today and get all the details. See every piece of equipment and kit you get...a complete listing of fully described lessons...explanations of each and every experiment you perform. Read about NRI's background and qualifications...career opportunities ...what NRI graduates say about their training...costs and monthly payment plans for the courses that interest you. Then compare NRI value and results and make your decision. Like the million that have gone before you, we think you'll choose NRI. Send the card today.

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Or check out NRI value-training in Computer or Communications/CB Equipment Servicing.

If you're interested in learning how to service and maintain digital computers, check out our NRI course. You learn at home, in your spare time, and actually build a programmable, integrated circuit, digital computer with expanded memory. Or maybe your interest is CB or the expanding world of communications... mobile radio, microwave, TV broadcasting, and much more. NRI can help you there, too, as you build and experiment with your own digitally synthesized 2-meter transceiver. For these and other NRI home study courses, just check the postage-paid card and mail today. If card is missing, write to:

NRI McGraw-Hill

NRI Schools
McGraw-Hill Continuing Education Center
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Washington, D.C. 20016

continued from page 6

countering the silicon are attracted to its positive charge, sometimes combine with it and stop moving along completely.

The Bell Lab technique isolates the electrons from the impurities by layering two semiconductor materials to form a single crystal, using a crystal-growing process molecular beam epitaxy (MBE) that allows layers of crystal atoms to be constructed one at a time. The scientists created a two-layer crystal using 50 layers of gallium arsenide and 50 layers of aluminum gallium arsenide, and silicon was added to the aluminum gallium arsenide layer only. Once in different layers, the silicon impurities have little chance to prevent electrons from moving freely. The technique can be used for any combination of semiconductor material having the same properties as gallium arsenide.

Using this technique, it is possible to greatly increase the capacity of communications systems as well as hastening the appearance of ultra-high-speed computers and the creation of new devices.

Bozak, Kloss and Marantz receive audio industry awards

Three pioneers of the audio industry were honored recently at the annual Audio Hall of Fame Awards dinner at the Hilton Hotel in New York. The awards are presented to those who have made significant contributions to the reproduction of music. This year's recipients were Rudolph Bozak, Henry Kloss and Saul Marantz.

Mr. Bozak was honored for his work in loudspeaker design. Mr. Kloss both developed and was instrumental in the popularization of the acoustic suspension speaker. Mr. Marantz (founder of the Marantz Company) won his award for his part in transforming hi-fi from a post World War II hobby into today's multibillion dollar industry.

Proceeds from the Awards Dinner this year will go to the Metropolitan Opera.

RCA transmission service extended to Hawaii, Cuba and Hong Kong

The RCA Corporation (and its subsidiaries) has expanded its data transmission service to Cuba and Hong Kong, as well as an additional link-up to Hawaii.

NASA will use the data transmission facilities at RCA Americom's Kokee Park station on the island of Kauai in Hawaii, in addition to the RCA services already being used at Barking Sands Naval Air Station on Kauai. The link-up is to the Goddard Space Flight Center in Maryland, and will be used in connection with several on-going NASA programs, such as Mars photography, the space shuttle and the Voyager mission to the outer planets.

The recent agreement reached between mainland U.S. and Cuba will use cable circuits to provide *Telex*, telegram and leased-channel services between the two countries.

RCA has also established the first commercial international digital facsimile service between this country and Hong Kong. The service, called *Q-Fax*, permits you to send and receive messages, legal briefs, graphics, contracts, etc., in Japanese (or Chinese) characters without translation. In the U.S., messages are sent by messenger or by local facsimile transmission to RCA operating centers in New York, Washington or San Francisco. In Hong Kong, the messages are delivered by messenger service to local post offices. Return messages are transmitted from Hong Kong to the U.S. via the mails, a domestic facsimile service or by messenger to the RCA centers.

1979 HI-FI CONVENTION

NEW CONVENTION CENTER in St. Louis will be the site of the second annual International High Fidelity Convention to be held April 20—22. The $96 million convention center complex covers four square blocks in downtown St. Louis.

New York City anti-radiation proposal causes concern

An amendment to the New York City Health Code that would set even stricter limits to the "field strength" of radio transmissions has been causing concern among the metropolitan area's amateur radio operators and CB'ers, not to mention commercial TV and radio broadcasters. Until recently, the high-level radiation was considered relatively harmless.

Dr. Leonard Solon of the New York City Department of Health drafted the proposal, and a public hearing has taken place, although no definite action has yet been taken by the Board of Health. At the public meeting, area broadcasters stated that if the amendment were adopted, they would be forced to move their transmitters elsewhere, since radio and TV reception would be reduced to mere "gibberish." However, amateur radio buffs would be even more seriously hit by the proposal since their maximum legal 2000-watt output would violate the Solon proposal's standards.

On the other hand, while objections were raised by the commercial broadcasters, they were muted. This has led to some speculation that the broadcasters privately believe the new standards, if adopted, would pave the way to increased cable service—thus cutting the considerable costs of operating regular transmitters.

FCC inquiry on fee refunds does not cover CB licensees

The Federal Communications Commission's inquiry on fee refunds and future fee schedules does *not* apply to CB owners. The present action deals only with fees greater than $20 collected between August 1, 1970 and January 1, 1977.

The FCC urged that CB owners not make inquiries now about either refunds of fee schedules, since any action on fees of $20 or less would be taken only in the near future. **R-E**

editorial

Electronics Tomorrow

With this issue another new year begins. At the outset of all new years, there is always that temptation to start making predictions. The only trouble with predictions is that you can either predict things you know will happen, or you can predict things so far out that they won't happen. . . . this year!!

So I'll spare you the predictions. Instead, let's deal with facts. Video tape recording in the form of VCR's and projection TV will show great growth this year. If the video disc ever escapes the laboratory, it will become an instant success—assuming the price can be held to the $600 level.

Hi-fi sound for the car has already arrived. The only hazard is that it is so good that the driver won't be able to concentrate on driving. Digital wristwatches, calculators and electronic games are already drugstore-rack items. The yen/dollar relationship may cause the price of many consumer electronics items to go up, but it may also spur a resurgence of Made In U.S.A. labels on consumer electronics gear.

No matter how you look at electronics, it's going to be another great year. There will be dozens of exciting new devices that are built around new circuitry and IC's. Believe it or not, we are now seeing just the beginning of the electronics revolution.

LARRY STECKLER
Editor

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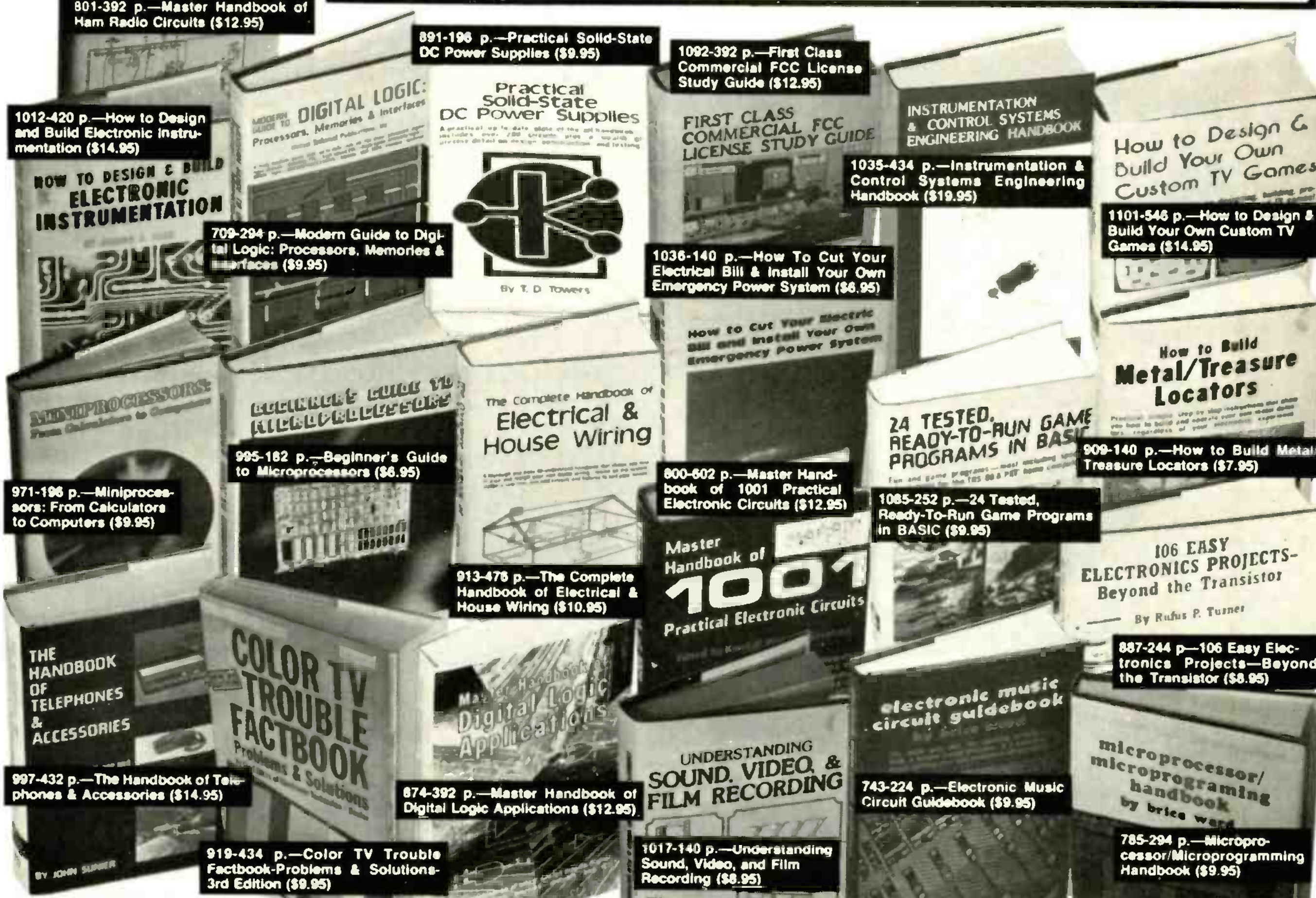

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CIRCLE 24 ON FREE INFORMATION CARD

letters

HYDROGEN—NEW ENERGY SOURCE?

With reference to your editorial, "The Real Energy Crisis," in the April 1978 issue, I am enclosing a diagram of an energy system that is similar to one presently being tested by a company in a new home in Provo, UT.

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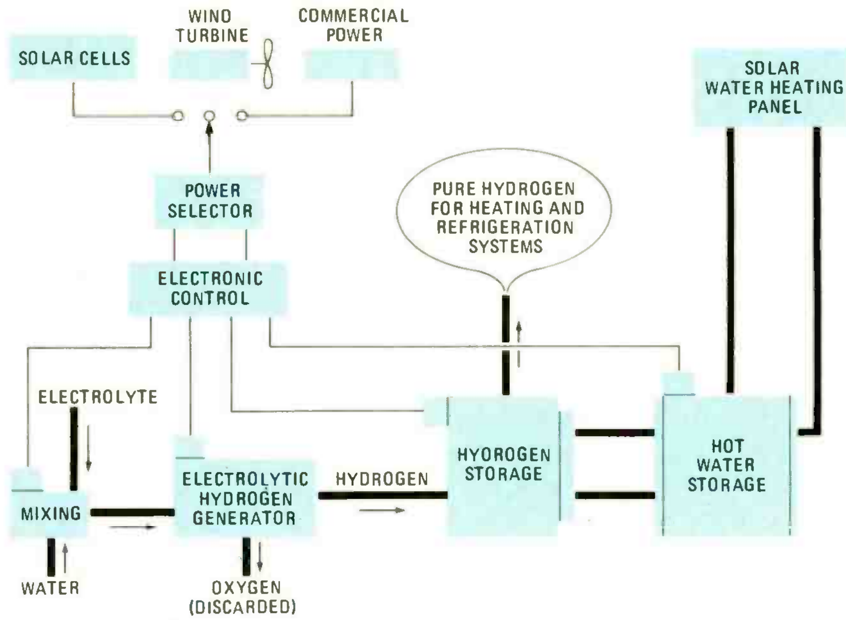
Since we have an inexhaustible supply of water, wind and sunlight, hydrogen could just be our future source of fuel. And this colorless, odorless gas is pollution-free!

DARRELL E. TOMLINSON
Odessa, TX

continued on page 22



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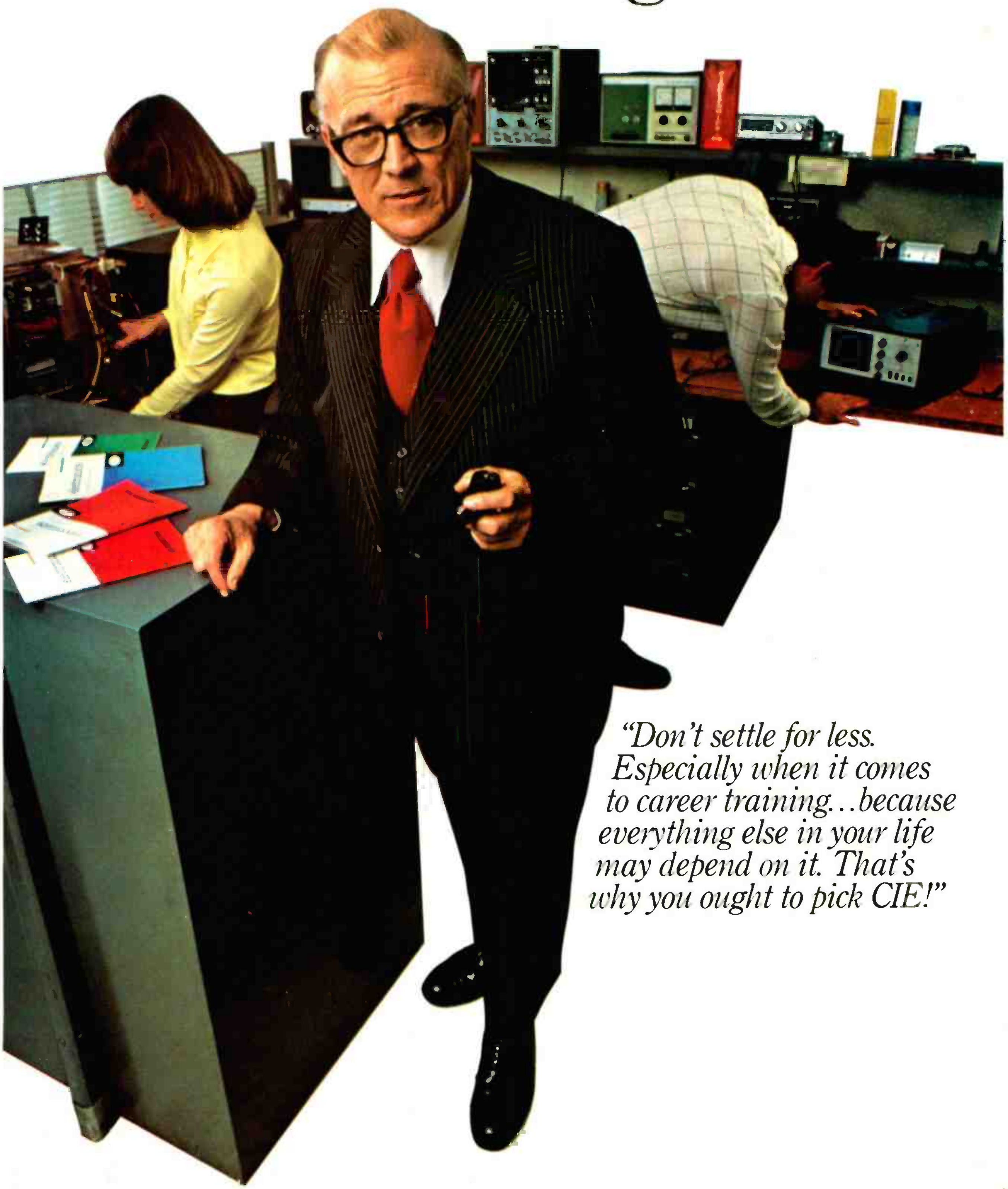

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ENERGY CRISIS

I read your editorial in the April 1978 with great interest. Ever since the energy crisis began, a lot has been said about it. I am in strong agreement with you as far as the cost of energy is concerned. It does not appear that this cost will go down . . . unless there is a *major change in the status of the national economy.*

I do not think it would be wise to encourage the use of nuclear power. In fact, you should discourage the use of this particular source of energy because it represents a action in trying to cope with the energy crisis, it will be necessary to continually remind its members that "time is running out."

As far as I'm concerned, the lack of *motivation*, not the lack of imagination, is the only reason the nation has not been able to come to grips with this problem. I believe that the basic attitude among Americans is universal—they all feel that a lot more needs to be done in order to reduce or eliminate the adverse social, as well as economic, effects of the energy crisis on the nation. This is where Congress and the political leadership does not meet the ex- it comes to solving the energy crisis, "we have failed."

So, no single editorial dealing with this subject will have a great impact. What I can suggest is: publish in the *Congressional Record* the letter your magazine considers to be the most interesting response to your editorial.

DOUGLAS JAN MILLER
San Francisco, CA

WHERE ARE THE ELECTRONIC DESIGNERS?

I think that the most important property of the IC is that it has freed us from the drudgery of solving hundreds of little interacting network equations, and has allowed us to get down to the real business of designing useful working systems.

My field for the past six years has been medical instrumentation, and because of the IC we are building instruments today that no sane person would have undertaken to build 20, or even 10 years ago.

The good instrument designer constantly scans the new IC release announcements, carefully reads about the properties of a new device and then thinks about ways to use it that the manufacturer never thought to suggest.

For example, a problem has been perplexing our design group for a long time. Just recently, however, one of the members of the group obtained some IC samples of a new device. We are testing it for an entirely different application from any the manufacturer has suggested, and it appears that the device will inexpensively and efficiently solve a problem that could have been solved by use of a combination of IC's and discrete components but at a prohibitive cost in terms of energy, space, weight and money.

I do not believe that the last remaining designers are the IC designers. They have relieved the rest of us of the dog work of figuring biases, temperature coefficients, stage gains . . . and a host of other annoying details so that we can get down to the real business of designing working systems to improve the quality and length of life.

The IC designers provide us with neat packages of gain, fast switches, comparators, voltage references and a multitude of other functions. It is up to the rest of us to apply our ingenuity to find the broadest spectrum of uses for these excellent reliable, low-cost devices.

Part of the usefulness of the IC is derived from its small size, not because it makes equipment smaller but because its smallness places all its components in the same physical environment, reducing temperature drift problems almost to the vanishing point in some cases.

I think the IC is the greatest invention since sliced bread!

W. Q. COCHRAN
Chalfont, PA R-E

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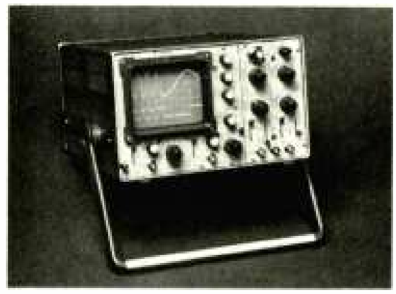

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CIRCLE 11 ON FREE INFORMATION CARD

equipment reports

F. W. Bell Model CG-100A Current Gun

CIRCLE 110 ON FREE INFORMATION CARD

THERE ARE CERTAIN EFFECTS IN ELECTRONICS that we've known about for some time. One is the "Hall Effect," which was discovered by E. H. Hall in 1879! He discovered that "if a conductor is placed in a magnetic field perpendicular to the direction of current flow, a voltage will develop across it."

Semiconductor materials can be made to do tricks. It was found that a small bar made of semiconductor material (indium arsenide, gallium arsenide, etc.) could be placed in a magnetic field, and would develop a voltage on its opposite sides. This is the "Hall voltage," which is used in scientific instruments, for a while confined mainly to gaussmeters used primarily in labs.

F. W. Bell, Inc., (4949 Freeway Drive East, Columbus, OH 43229) has developed a versatile Hall-effect instrument. This little jewel uses a semiconductor Hall-effect sensor and is called the *model CG-100A* Current Gun. It's a clamp-on instrument—the jaws can be opened and clamped around a conductor and the conductor current read out.

Clamp-on instruments have been used to read alternating currents for a while. The *model CG-100A* not only reads AC, it reads *DC* and composite alternating and direct currents (you can read the direct current in a wire and the AC ripple too, separately). This compact device can be operated with one hand, and is powered by four AA cells located in the handle. The readout can be made on any accurate digital AC or DC voltmeter.

Using the *model CG-100A* is very simple. The gun is connected to a standard multimeter by a four-foot dual cable with a dual banana plug on each end. The meter is set for 0–1 volt, or 0–2 volts. Selecting AC or DC operation is easy. To read DC set the meter to DC volts; for AC, set it to AC volts. Press the thumbwheel ON switch on top of the handle of the *model CG-100A* and the gun is adjusted for a zero reading. Release the switch, open the jaws, hook the conductor in them and close the jaws. Now, pressing the ON switch reads out the current on the meter. If one-handed operation is needed, you can lock the switch on by sliding the LOCK button under the handle.

The current gun has two ranges—0–10A, and 0–100A. *Both* of these ranges has a 1.0 volt output, with a 100% overrange capability. This instrument is ideal for use with DVM's, most of which are calibrated in this way. You select the desired range by using a slide switch on top of the handle. All you do is mentally move the decimal point on the readout one place to the right; for example, a reading of 1.0 volt is 10.0 A, and so on.

continued on page 26

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The *model CG-100A* has a rated accuracy of ± 2% of rated output. (A full set of performance characteristics, curves and calibration data can be obtained from Bell.) If ever needed, calibration requires only four adjustments, which are sealed under the metal decals on the gun handle. The *model CG-100A* has an AC frequency response to 1.0 kHz, which makes it useful for audio measurements such as in telephone systems, etc.

Battery life should be good, since the battery isn't on until you press the trigger, which draws only a small amount of current. The instruction book cites only one precaution: "Don't let the jaws snap shut. This may the handle glows. Also included is a little arrow on the tip; a positive DC voltage reading means that the current in the conductor is flowing in the direction of the arrow.

This unit should be very handy for electrical measurement applications. Alternating current readings have been used for a good while. The DC readings would be useful in automotive electronics and electrical work, as well as in other fields. The gun's jaws can fit around any conductor up to ¾-inch (19-mm) diameter; but must be fully closed for best results. For maximum accuracy in reading currents in small conductors, the gun should be centered in the hole; however, the maximum error introduced by off-centering is very small.

The *model CG-100A* is $169. **R-E**

CIRCLE 111 ON FREE INFORMATION CARD

DIGITAL TECHNIQUES ARE SHOWING UP IN CONsumer products more frequently than ever before, especially in entertainment devices. Electronic games that only a few years ago were considered fiction today are a reality. An example of this is *CompuChess* (Data Cash Systems, Inc., Box 65, Largo, FL 33540) an electronic digital chess game packed with features and versatility.

The unit is housed in a wood-grain enclosure that measures 4½ W × 7½ D × 1½-inches H with power supplied via a calculator-type line-plug/transformer combination. The metallic front panel contains a 4-digit 7-segment LED display, two slide switches (a power ON/OFF switch and a RESET/RUN switch) and a 16-key touchpad.

CompuChess does not display nor is it supplied with a chessboard. The location of the pieces are displayed via a coordinate system, which is obtained by labeling the columns of a standard board A through H and labeling the rows 1 through 8. For easy coordinate reference, *CompuChess* is supplied with a set of self-sticking decals with the coordinates of each square of the chessboard. Simply cut out each coordinate with a razor blade and attach it to the appropriate square of your chessboard.

CompuChess can play at any one of six levels. Level 1 is classified as an elementary level with an instant response to a move. Level 2 is for the practiced beginner, with *CompuChess* responding to a move within 15–20 seconds after entering it. Level 3 is for an average player and has a 20-second to 15-minute response time. Level 4 also has a 20-second to 15-minute response time and is intended for an above-average player. Level 5 has an 18-hour response time, and level 6 has up to a 2-day response time. According to the owner's manual, levels 5 and 6 are intended to solve mate-in-two problems. The think times are long because the algorithm is a brute-force all-possible combination calculation of black's move, white's response, black's response, white's response, black's response on level 5 and an additional white's response on level 6. The response times for levels 5 and 6, however, apparently only apply to solving mate-in-two problems. For a populated board, as is the case for standard mid-game play, the response times are much, much longer.

To play a game, first turn *CompuChess* on and then reset it by placing the reset switch first in the RESET position and then in the RUN position. The unit responds by displaying an L.

continued on page 32

ANNOUNCING ... A New CREI Program: Minicomputer & Microprocessor Technology Including A Microprocessor Laboratory

The microprocessor has ushered in the age of microtechnology and electronics will never again be the same. The microprocessor has made possible the placing of an entire computer on a silicon chip one quarter inch square. The microprocessor "miracle chip" is in the process of changing the world. Soon all technical personnel in electronics will have to understand and work with the microprocessor. It is invading virtually every area of electronics. And it is profoundly affecting your electronics career.

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CREI has a brand new program to help you learn how to work effectively with this revolutionary electronics development. CREI's new program in Minicomputer and Microprocessor Technology is designed to prepare you for this field by giving you the education and practical experience you need.

The program provides solid preparation in electronics engineering technology with a specialization in minicomputers and microprocessors. In addition, it includes a microprocessor laboratory which features a fully programmable microcomputer which utilizes the Motorola 6802 microprocessor chip. This is an extremely important element of your program.

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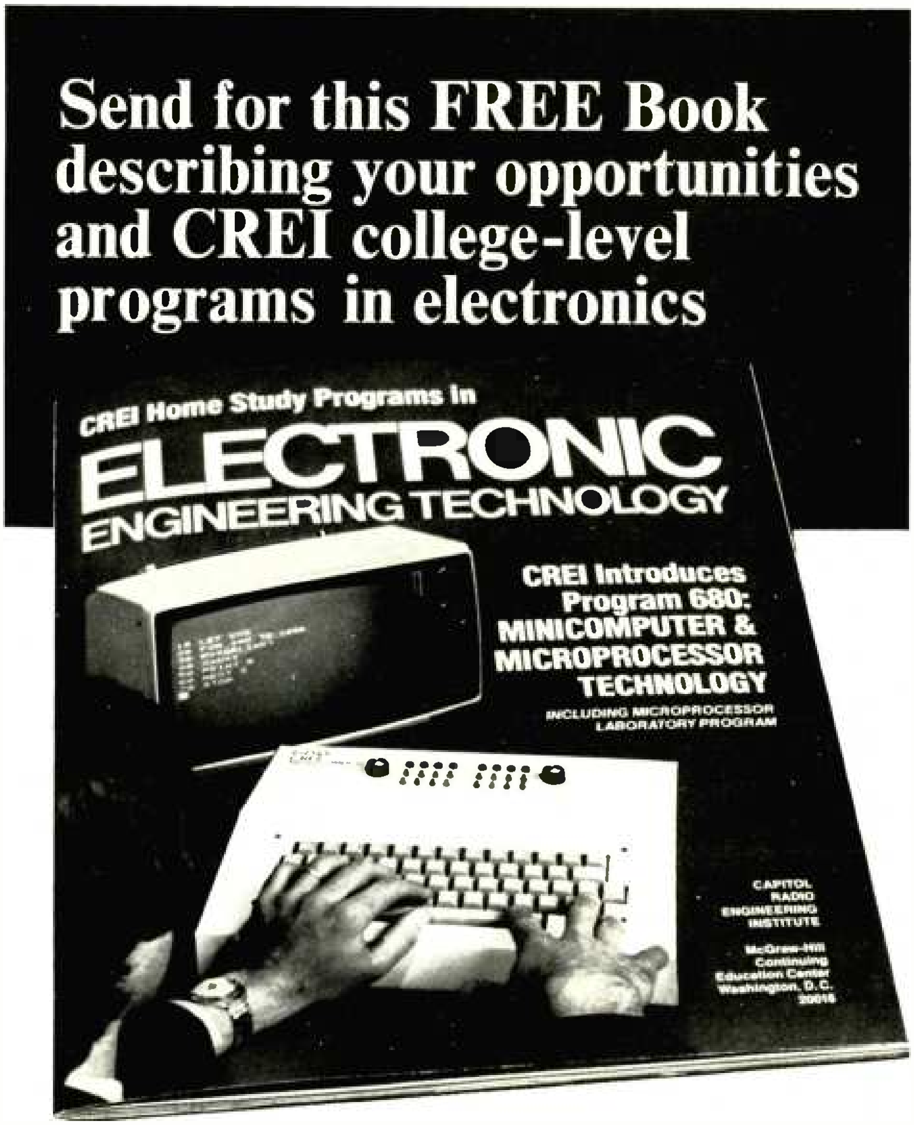

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EQUIPMENT REPORTS

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Now you must select a level of play by depressing one of the keys numbered 1 through 6. *CompuChess* now responds by displaying BP. Depress the key labeled A for a beginning game with *CompuChess* playing black. The display will now show a series of flashing dots. Enter your opening move by entering the letter-number coordinates of the piece to be moved and the letter-number coordinates of its destination. So, a move is made by entering a letter-number-letter-number combination. The move is confirmed on the display as it is entered. Now depress the key labeled PLAY to instruct *CompuChess* to make a move. The time it takes *CompuChess* to respond to a move depends on the level of play. While a move is being calculated, the level of play is flashed in the display.

Every key on the 16-key touchpad is a two-function key. Eight keys are labeled A through H, and eight keys are labeled 1 through 8 to correspond to the coordinate system. Each key is also labeled with its secondary function. The secondary functions for eight of the keys are a two-letter abbreviation corresponding to the eight chess pieces. For example, WK stands for white king and BN stands for the black knight. The secondary function of the four remaining keys are PLAY, which commands *CompuChess* to make a move; MD, which instructs *CompuChess* to wait for more data or command inputs from the keyboard; EP, which enables you to place any piece anywhere on the keyboard; and FP, which enables you to display the location of all the pieces on the board.

For example, to confirm that the location of the pieces on your chessboard corresponds to the location of the pieces within *CompuChess*'s memory, depress FP. Then, to locate the position of, let's say, the white king, depress the key labeled WK. The position of the white king will then be displayed. You can do this for every piece on the keyboard.

You can also start with any board position you'd like. After resetting and entering the level of play, *CompuChess* responds by displaying BP. Entering A starts a new game with *CompuChess* playing black. You can also enter B, which blanks the entire board.

By using the EP key, you can locate pieces wherever you'd like on the board and then confirm the location of all the pieces using the FP key. You can force *CompuChess* to make the first move by depressing PLAY, or you can enter a move by depressing the MD key, enter a move and then depress PLAY.

You can also change the level of play in the middle of a game. First reset *CompuChess* (never reset while it's calculating a move) and then enter the new level of play. When *CompuChess* responds by displaying BP, enter C. This instructs *CompuChess* to continue the game presently in progress (resetting the *CompuChess* does not change the position of the pieces within its memory). You can now make a move by depressing MD or force *CompuChess* to calculate a move by depressing PLAY.

In the standard game, *CompuChess* plays black. You can make *CompuChess* play white. After selecting the level of play and entering an A in response to the BP display, interchange

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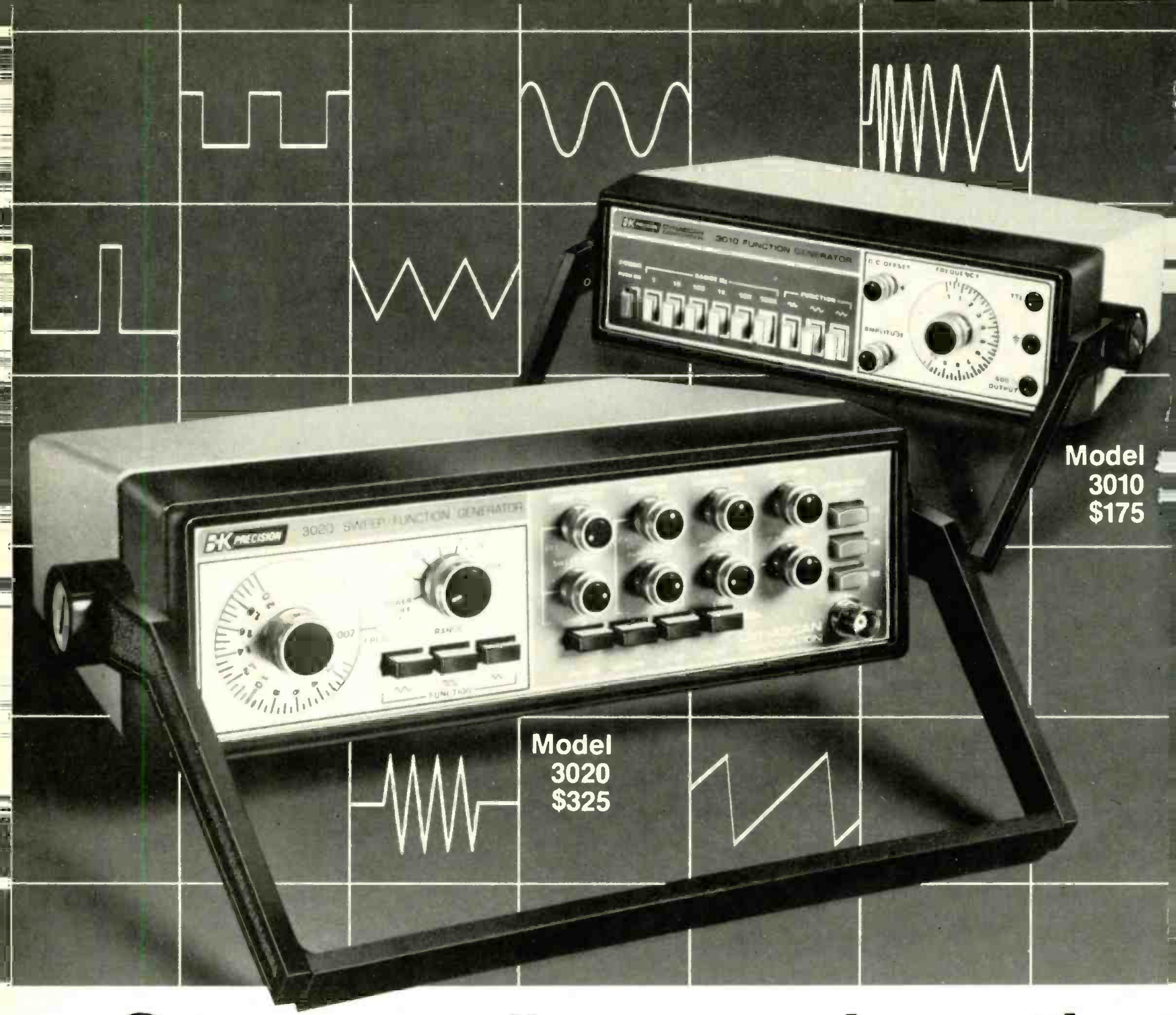

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A low-distortion, high-accuracy signal source, the 3020 has the versatility to generate almost any waveform. Examples include sine waves, square waves, TTL square waves, tone-burst, pulses and ramps. All waveform types can be inverted. Internal linear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

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

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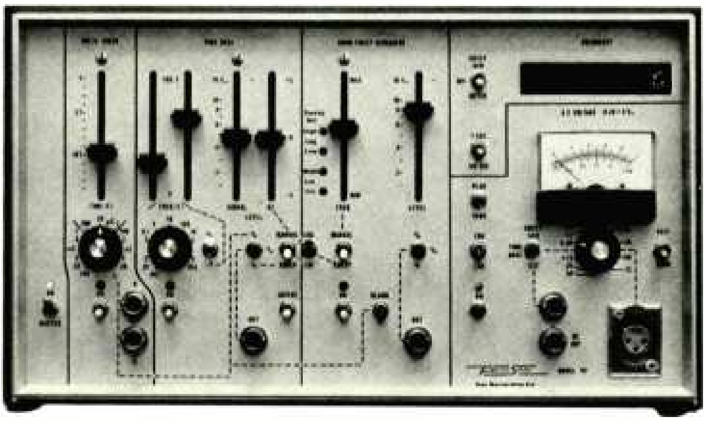
CIRCLE 59 ON FREE INFORMATION CARD

BUILD THIS

Audio Test Station



A host of precision instruments are required by anyone wanting to put high-quality audio equipment through its paces. This test station has everything you'll need. You can build it from a kit.

RAY DAVISON

THIS IS THE FIRST IN A SERIES OF ARTIcles describing the operation, design and construction of Fidelity Sound's *model 101* Audio Test System. This first article presents the functions that are available and gives detailed information on the power supplies. Subsequent articles will cover the other major circuit blocks. A kit of all components is being offered.

The unit consists of a power supply, two sine/square/triangle function generators, pulse generator, frequency counter and AC voltmeter. In its simplest form it can be thought of as several pieces of independent test equipment in a common cabinet. They are all basically familiar test equipment and can be used in the normal manner. In addition, when the various sections are properly connected to each other and to an X–Y plotter or scope, the system will generate a frequency-response plot.

The controls and the Audio Test System are grouped within solid black lines on the front panel as can be seen in Fig. 1. Each of the areas should be thought of as a separate piece of equipment with the capability of being internally connected. Each section has its own power switch. Figure 2 is a block diagram that shows the various circuits and their interrelationships.

Basic to audio testing is a three-decade, three-function generator. This is contained in the area labeled Audio Sweep Generator. This basic generator has three controls besides the power switch: Slide pots for frequency and amplitude and a toggle switch to select one of the three available waveforms. The amplifier output impedance is less than one ohm and it will supply 15 volts peak-to-peak into 500 ohms or 10 volts peak-to-peak into 8 ohms. By having the output impedance very low the user can add resistance either internally or externally where necessary to match a particular application. The other three toggle switches in the sweep generator section are used to interface to the timebase section that will be discussed next.

The next step of sophistication beyond a basic function generator is generally a sweep generator. This requires some type of second oscillator to generate a sweep signal for the primary generator. Often the secondary oscillator is a simple fixed or possibly selectable frequency ramp generator.

In the case of the *model 101* we decided to give you wide latitude in the choice of both sweep and return times. The basic waveform of the timebase is a triangle. The two slide pots (R1 and R2) on the left side of the timebase section control the leading and trailing sides of that triangle independently. A switch (S4) deactivates one of the pots and allows the remaining one to control the frequency of a symmetrical triangular waveform. Use of the two frequency control pots allows the leading or trailing side to be up to 100 times as long as the other side. Rotary switch S3 steps the frequency range. In the slowest setting, with the slide pots at their minimum, the timebase will produce a triangular waveform of three minutes on each ramp. This would be used for maximum resolution for such things as plotting standing waves in an auditorium on an X–Y recorder.

Slide pot R3 is the amplitude adjustment and R4 is a ±5-volt DC offset. Below the DC offset pot there are two toggle switches. The one to the left (S5) selects one of the three waveforms. The timebase is capable of providing the three basic waveforms and hence, rather than merely a secondary oscillator to sweep the audio generator, it is a complete second function generator. The separate leading and trailing edge frequency controls allow it to produce nonsymmetrical waveforms. Combining the frequency, amplitude and DC offset controls will provide wide latitude in generating a pulse train.

Toggle switch S8 inverts the output, while S9 provides for manual setup of the timebase/sweep generator system.

The triangle output from the timebase generator (independent of the setting of the output waveform switch) sweeps the audio generator through the LOG/LINEAR sweep select switch (S12) of the sweep generator section when SWEEP/MANUAL switch S9 in the timebase section is set on SWEEP. When this switch is set to MANUAL the DC offset pot replaces the triangle timebase generator. This allows the timebase signal, which would drive the X-axis of a plotter and simultaneously sweep the audio generator, to be manually moved to any point and stopped. While the timebase signal is stopped, the audio generator frequency can be read off the counter. This mode provides for setting of the sweep end points and calibrating the chart paper.

The sweep frequency end points are set by multiturn trimmers with a screw driver through the four small holes to the left of R6, the sweep generator manual frequency slide pot.

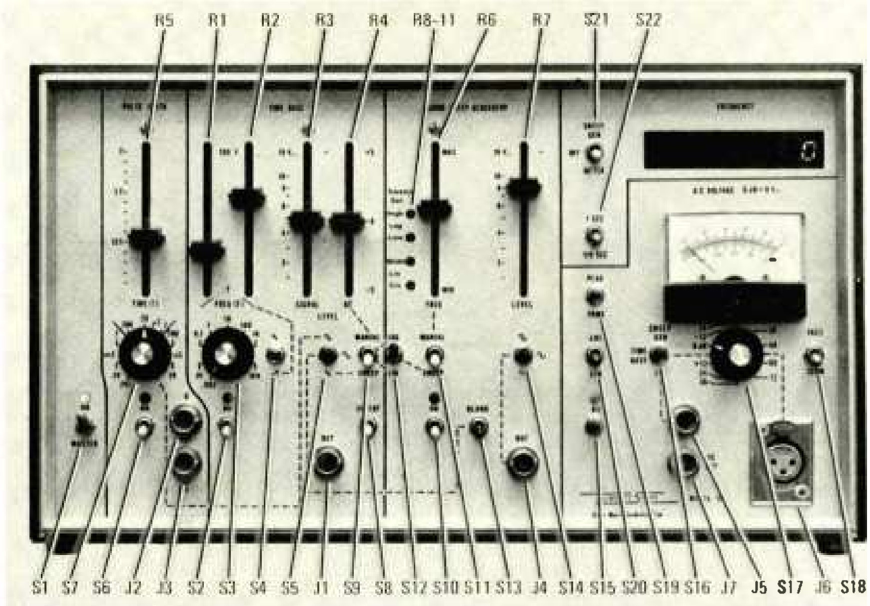


FIG. 1 THE MODEL 101 AUDIO-PLUS SYSTEM consolidates several audio test instruments.

The timebase also triggers the blanking mode of the audio sweep generator. In the blanking mode when the timebase is on the negative-going side of the ramp, the audio oscillator is turned off. Also, the holding capacitors in the AC to DC converters of the voltmeter are discharged. This results in a zero reference line during retrace. The purpose of this will be more apparent when the unit is discussed as a system.

With the sweep generator SWEEP/MANUAL switch S9 set to MANUAL and blanking mode activated, the sweep generator functions as a tone-burst generator. The left-hand timebase frequency select pot controls the on-time of the

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Radio-Electronics

WITH MORE AND MORE AUDIO SERVICE centers, dealers and design laboratories making repetitive and comprehensive measurements of audio equipment (including everything from preamplifiers to loudspeakers and tape decks), their goal is to make such measurements as quickly as possible, with as few pieces of test equipment as practical. For this reason, The Fidelity Sound *model 101*, shown in Fig. 1, combines various signals and test

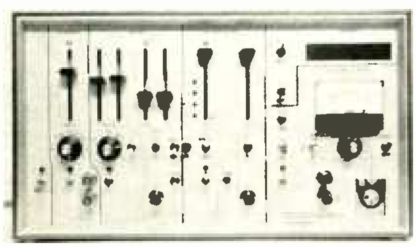


FIG. 1

functions into a single, compact instrument. It won't tell you everything you ever wanted to know about a piece of audio equipment but, when combined with a decent oscilloscope and/or an X–Y plotter, it produces some very excellent response measurements of virtually any kind of audio gear where frequency response is important. Its many signal outputs, built-in frequency counter and built-in audio voltmeter can prove useful in making a variety of other tests besides frequency response.

The *model 101* consists of two sine/square/triangle-wave function generators, a pulse generator, a frequency counter and an AC voltmeter. In its simplest form, the unit can be thought of as several pieces of independent equipment in a compact cabinet. In addition, when these various sections are properly interconnected (many of these interconnections are internal, thanks to the front-panel switching arrangements) and if an X–Y plotter or scope is used, the system generates a frequency-response plot. When the unit is combined with an efficient speaker, a quality microphone and a hard-copy plotter, it will produce a written record of room acoustic analysis including standing waves, which, because of their low spectral energy, are often missed by other types of sweep analysis.

There are several applications for which the unit is *not* suitable. For example, its sinewave output is too high in distortion to be used to check preamplifier or power amplifier distortion, although the amplitude response of the sweep generator, used in either its manual or sweep mode, is certainly flat enough for meaningful frequency-response measurements.

The frequency-counter section, shown in Fig. 2, is a useful addition. The counter

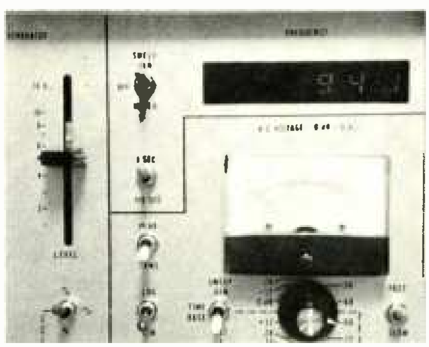


FIG. 2

reads the repetition rate of whatever signal is selected from the sweep-signal generator section. It would have been more useful if the counter could also read externally connected signal frequencies.

The functions and controls of the different sections are described in the article dealing with the construction of the *model 101*. Our purpose here was to check out

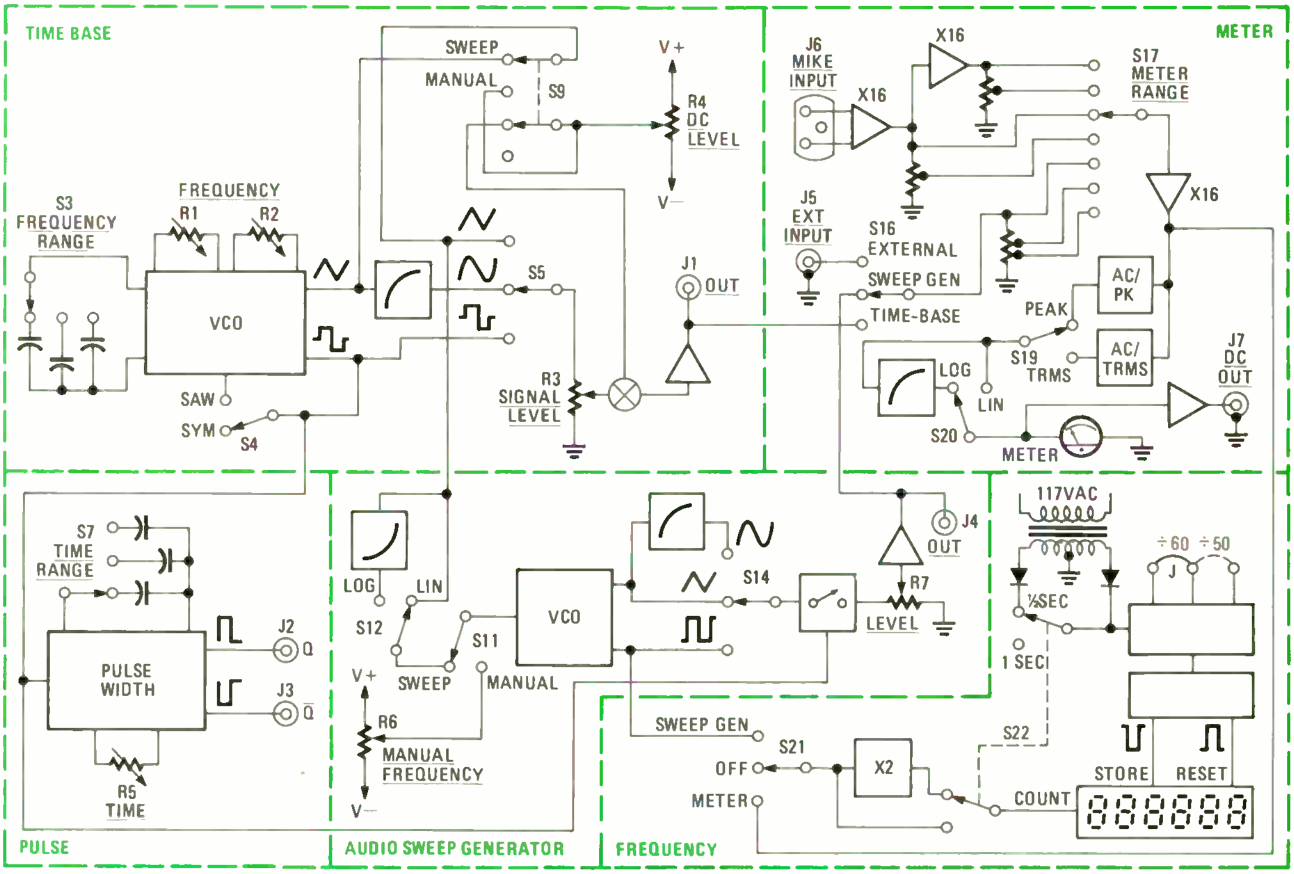


FIG. 2—BLOCK DIAGRAM shows inter-relationship of the different instrument sections. Use it along with Fig. 1 to follow text description of the system's operation.

Tests It

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

the various specifications of the instrument and to examine some of the output waveforms it is able to deliver. Table 1 summarizes the manufacturer's specification claims as well as our own measurements and results. In general, most of the published specifications were either met or exceeded. One notable exception was the total harmonic distortion of the

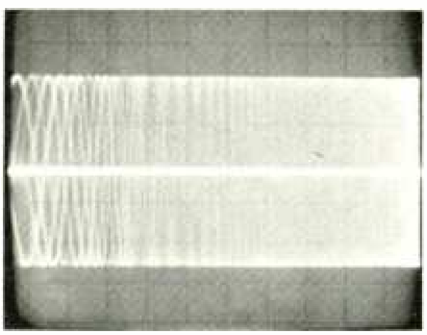


FIG. 3

sweep-generator sinewave output. This THD measured 1.8% for a 1-kHz output signal, as opposed to the 1.0% claimed by the manufacturer.

Output signal waveforms

We photographed several types of waveforms that can be taken from the various output terminals of the *model 101*. Figure 3 shows a sweep-frequency signal output, logarithmically swept from 20 Hz to 20 kHz. The center line seen from left to right is the retrace signal between successive sweeps and is, of course, adjustable as to duration. The total sweep time can be adjusted from its slowest speed of around 3½ minutes for a full sweep to about 4 seconds—the minimum time required to "get all the frequencies in" for at least one cycle of each.

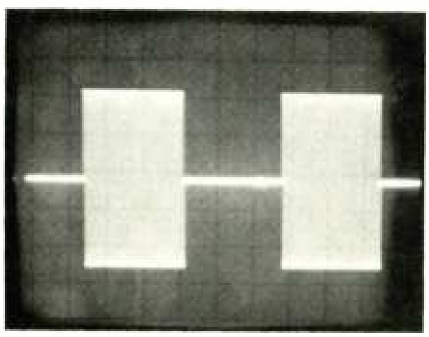


FIG. 4

Figure 4 shows how a wide variety of tone bursts can be generated with the combined use of the timebase generator and the audio sweep generator operated in its manual mode (under which conditions any frequency within the audio range can be selected and remains fixed).

Figure 5 shows positive- and negative-going sharp pulses. Besides being useful in and of themselves, these pulses are also timed to occur at the start of a timebase

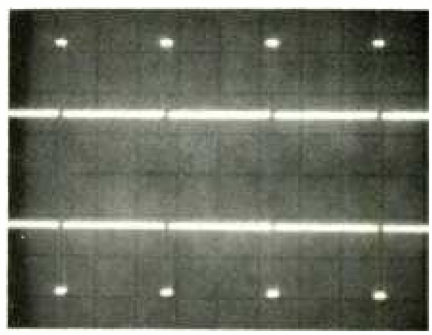


FIG. 5

ramp generated by the timebase section. Since the ramp voltage generated by the timebase section also sweeps the frequencies generated by the sweep-generator section, these dual-polarity pulses provide a ready means for triggering a scope burst and the right-hand pot controls the off-time. The blanking circuit is coordinated with the zero crossing of the sweep generator waveform; therefore, the tone burst produces only integral cycle waveforms, beginning and ending at zero.

To the left of the timebase section is a pulse output and pulse-width control. Each time the timebase begins its positive-going ramp the pulse section provides a single pulse. The width is controlled independent of timebase frequency by range switch S7 and slide pot R5. The outputs are complementary TTL.

An AC voltmeter is in the lower right-hand corner of the unit. Rotary switch S17 under the meter is the range switch. The high-sensitivity ranges (−36 to −72 dB) apply only to the mike connector. Toggle switch S16 selects either the sweep or timebase function generators or the external BNC connector (J5) below it. The other three toggle switches provide fast or slow tracking rate (large or small damping), peak or true RMS, and linear or log scales.

A six-digit frequency counter is above the voltmeter. Toggle switch S21 is the power switch and also selects the signal to be counted. It will count either whatever signal is selected by the voltmeter select switch, or it will count the audio generator internally. This latter selection allows stable counting of the audio generator when the signal coming from the system under test may be distorted or of very low amplitude. The second toggle switch (S22) selects either a one-second or a one-half-second counter update. The counter is line-triggered and may be programmed for either 50 or 60 Hz.

Next month, we will present an in-depth discussion of the power supply and timebase circuits as well as the construction details for these two circuits. **R-E**

TABLE I

PERFORMANCE SPECIFICATIONS

	Manufacturer's Claim	R-E Measurement	Comments
TIMEBASE SECTION			
Timebase frequency range	0.002 Hz–800 kHz	Confirmed	
Vernier control of ± ramp side	100 X	Confirmed	
Sinewave THD	Less than 1.5% at 1 kHz	0.9%	
Squarewave rise & falltime	0.5 μs, 8 volts P-P	0.7 μs	
Timebase amplitude	16 volts P-P	Confirmed	Includes DC offset
DC offset	±5.0 volts	Confirmed	
PULSE SECTION			
Pulse-width total range	40 ns–4 seconds	Confirmed	In 10X steps
Pulse-width vernier	14 X per range	Confirmed	
SWEEP-GENERATOR SECTION			
Manual frequency range	20 Hz–20 kHz	18 Hz–20.2 kHz	
Sinewave THD	Less than 1.0%, 8 volts P-P	1.8%	At 1 kHz
Squarewave rise & falltime	0.5 μs	0.7 μs	0–90% at 8 volts P-P
Output level	16 volts P-P/500 ohms; 10 volts P-P/8 ohms	17.0 volts P-P, 500 ohms; 12 volts P-P/8 ohms	
AC VOLTMETER SECTION			
0-dB reference	8.0 volts P-P = 0 dB	Confirmed	
Internal or line-in range	+36 dB to -24 dB	Confirmed	In 12-dB steps
Microphone input range	-36 dB to -72 dB	Confirmed	In 12-dB steps
External input impedance	1 megohm	Confirmed	
Microphone input impedance	600 ohms	Confirmed	
Voltmeter output impedance	100 ohms	Confirmed	
Meter system response	20 Hz–100 kHz, +0, -¼ dB	18 Hz–110 kHz, ±0.25 dB	
FREQUENCY-COUNTER SECTION			
Sensitivity	10% of selected meter scale	Confirmed	
Reading update	0.5 or 1.0 seconds	Confirmed	Switch-selectable
GENERAL SPECIFICATIONS			
Dimensions	14 W × 8 H × 3-inches D	Confirmed	
Shipping weight, assembled	9 lbs.	Confirmed	
Price	$650		

sweep or initiating the action of an X–Y plotter in sync with the frequency sweep to be plotted.

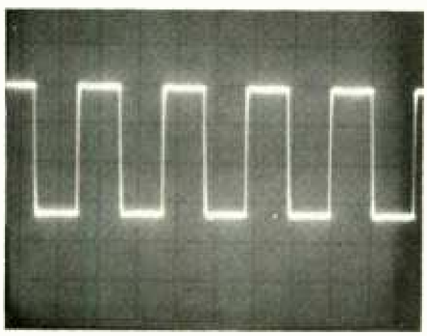


FIG. 6

Figure 6 shows a 20-kHz squarewave output. This particular squarewave was observed at the output terminal of the timebase generator section, but equally steep squarewaves can be obtained at the sweep-generator output terminals.

Figures 7 and 8 are scope photos taken of the triangular and ramp-shaped waveforms at the output jack of the timebase generator section. A sinusoidal timebase is also available from this output terminal.

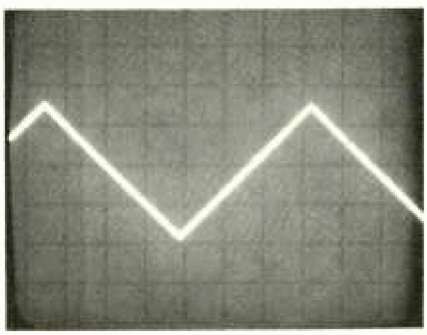


FIG. 7

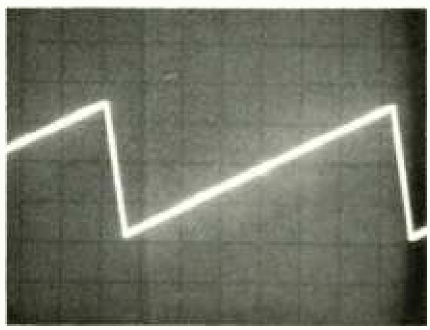


FIG. 8

Based on our tests and measurements, we conclude that the *model 101* Audio-Plus Test System would be a useful addition to anyone's audio test bench. **R-E**

BUILD THIS

600-MHz Portable Frequency Counter

Here's a frequency counter that's compact, battery powered, counts to 600 MHz and costs less than 17 cents per MHz

JIM COLBURN AND BILL OWEN*

CONTINUING ADVANCES IN LARGE-SCALE integrated-circuit (LSI) technology have made possible the development of low-cost, high-performance digital test equipment. The OPTO-7000 Frequency Counter requires only five integrated circuits to achieve its rather remarkable performance specifications that would have been impossible just a few years ago. An additional benefit of LSI IC's is apparent when you consider that this 7-digit, 600-MHz frequency counter requires only 200 mA of current (at 5V) making battery operation practical. In general the counter's low cost (about 15¢ per MHz), high performance, small size and minimal power consumption is a direct result of LSI integrated circuits incorporated into the design.

Figure 1 shows the counter's excellent sensitivity from 10 Hz to over 600 MHz, covering low-end audio through the UHF amateur and commercial communications bands. These bandwidth/sensitivity specifications compare with those found in state-of-the-art commercial test-bench instruments. A complete listing of the specifications appears in Table 1. The OPTO-7000 will provide you with what amounts to a sophisticated test-bench instrument that is rugged enough and small enough to be carried in a tool box and ready to go anywhere anytime.

How it works

The unit of frequency measurement is the hertz, which is equivalent to cycles-per-second. The basic digital frequency counter uses a pulse with a precisely generated width called a gate interval in conjunction with an electronic counter that counts cycles of the input signal during the time period in which the gate is open. If the gate period is 1 second then the number displayed by the counter is cycles-per-second. If the gate period is 0.1 second then the displayed count is corrected by multiplying by 10 (moving the decimal point one position to the right).

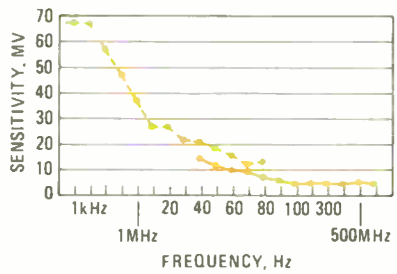
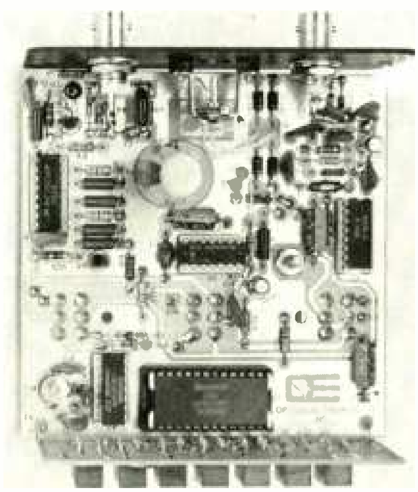


FIG. 1—PLOT OF COUNTER'S SENSITIVITY in the range of 10 Hz to 600 MHz demonstrates that this compact portable instrument compares favorably with some of the best bench-type instruments.



INTERIOR VIEW shows the component side of the frequency counter's main PC board.

The counter—The OPTO-7000 block diagram is shown in Fig. 2. The gate and the decade counter are contained in the 7208 IC. The gate signal is generated by the 7207-A IC that divides the crystal oscillator frequency to obtain a squarewave with either a 2-second or 0.2-second period. Therefore, gate signal is low for either 1 second or 0.1 second. This opens the gate for the passage of the input signal to the counter. As the gate signal goes from low to high to close the gate, a store pulse—generated by the 7207-A—causes the contents of the counter to be transferred to the latch and then displayed. A reset pulse follows the store pulse to reset the counters to zero to be ready for the next negative gate interval.

Prescaler—The maximum signal frequency that the 7208 can handle is between 6 and 7 MHz. The input signal must be prescaled or divided to count higher frequencies. The 74196 IC generates a BCD output and we use the 2^2 bit to drive transistor inverter Q5 (see the Fig. 3 schematic) to obtain a 60–40 duty-cycle squarewave suitable for driving the 7208 counter.

In order to count frequencies as high as 600 MHz, the 11C90 UHF divide-by-10 prescaler is used so that input signals above 60 MHz are divided by 100 before reaching the 7208 counter. The decimal point is switched to the correct location by the gate-select switch.

Input amplifiers—Dual inputs and amplifiers are used for the 10-Hz and 60-MHz and 10–600-MHz ranges. Both inputs have back-to-back signal diode clamps for overvoltage protection.

*Product Engineers, Optoelectronics, Inc., Ft. Lauderdale, FL

The 1-megohm (60-MHz) input uses an FET/bipolar pair to provide a high input impedance and low output impedance along with a small amount of voltage gain. Resistor Rx is matched with the FET to set the voltage at IC2 pin 9 to ½ the supply (2.3 to 2.7 volts). The MC10116 is an ECL (*E*mitter-*C*oupled *L*ogic) triple line receiver. The first two stages are connected as differential input/output amplifiers while the third stage has positive feedback to act as a Schmitt trigger to square up the waveform. Transistor Q4 (MPS6516) converts the ECL logic levels to TTL.

Several low-cost frequency counters on the market economize by having a lower than 1-megohm input impedance on their low-frequency (less than 60 MHz) range. The advantages of having a 1-megohm input impedance are well worth the additional parts cost. The counter's input impedance is seen as a load by the circuit being measured. An oscillator may shift frequency or stop when loaded by only a few thousand ohms. Oscilloscope accessories such as 10:1 probes and terminators can be used because most scopes have 1-megohm inputs. This counter's input impedance can always be lowered to match a different source impedance by using a terminator or adding a shunt impedance; but it is not as easily increased.

The 11C90 prescaler has good sensitivity (typically less than 200 mV) without preamplification. However, we decided that the OPTO-7000 should have at least one stage of preamplification in order to meet a wider range of applications. A 2N2857 NPN RF amplifier is used in a common-base configuration to provide voltage gain all the way to 600 MHz. The PC layout is critical at high frequencies and good soldering techniques are important. The ceramic disc capacitors used should have low self-inductance such as the Sprague 5GA series. Component leads must be kept as short as possible to prevent attenuation due to lead inductance.

If you don't expect to be counting frequencies above say 450 MHz, then additional sensitivity and significant power savings can be made possible by lowering the supply voltage to the 11C90. Resistor R6 can be increased until the counter will count 450 MHz but no higher. The 11C90 will operate with as little as 3.5 volts and the only sacrifice is bandwidth.

At very high frequencies, a high input impedance cannot be maintained. The internal shunt capacitance in coax input cables at high frequencies reduces the input impedance. A nominal 50-ohm input impedance is therefore used on the

TABLE I
FREQUENCY COUNTER SPECIFICATIONS

Frequency Range: (Switch Selectable)	10 Hz to 60 MHz (65 MHz Typical) 10 MHz to 600 MHz (700 MHz Typical) Guaranteed
Input Impedance:	1 meg shunted by 20 pf (60 MHz input) 50 ohm (600 MHz input)
Input Protection:	1 meg/60 MHz input—100V up to 10 MHz 50V up to 60 MHz 50 ohm/600 MHz input—2V max.
Gate Times: (Switch Selectable)	100 millisecond 1 second
Resolution:	1 Hz (10 Hz to 6 MHz) with direct-counting option 10 Hz (10 Hz to 60 MHz) 100 Hz (10 MHz to 600 MHz)
Sensitivity:	10 MV to 60 MHz 25 MV to 150 MHz 50 MV @ 450 MHz typ. <75 MV Guaranteed
Timebase:	Quartz Crystal, 5.24288 MHz, TCXO, first order linear compensation
Counter Accuracy:	± 1 count, temperature stability and aging
Temp. Stability:	.08PPM/C° (<± 1 PPM 20° to 40°C, Typ.)
Aging:	< PPM/year
Display:	7, .4" Red LED Digits
Decimal Point:	Auto Placement
Power Requirement:	1.5 Watts 7.5-15V AC/DC @ <250 MA
Batteries:	4—AA NiCad, Constant Current Charger
Size:	1¾ H × 4¼ W × 5¼-Inches D
Weight:	14 oz. (17 oz. with batteries & charger)

PARTS LIST

Resistors ¼ watt, 5% unless otherwise noted
R1, R20—47 ohms
R2—100 ohms
R3—470 ohms
R4—680 ohms
R5, R11, R19—150 ohms
R6—15 ohms
R7—100,000 ohms
R8—1 megohm
Rx—Especially selected value between 100 and 500 ohms. See text.
R10—270 ohms
R12, R14–R17, R25—510 ohms
R13, R18, R23, R26—1000 ohms
R21—10 megohms, ½ watt
R22—2200 ohms
R24—330 ohms
R27–R36—10 ohms

Capacitors
C1—2200 μF, 16 volts, electrolytic
C2–C4, C7, C10, C15, C18—.001 μF disc
C5—47 to 150 pF
C6—470 pF disc
C8—100 pF silver mica
C9, C16, C17—47 μF, 10 volts, electrolytic
C11—29 μF, 10 volts, tantalum
C12—33 pF disc
C13—20 or 22 pF
C14—2-30 pF, ceramic trimmer

Semiconductors
D1–D4—1N4002
D5–D14—1N914
IC1—11C90 UHF prescaler (Fairchild)
IC2—MC10116 ECL triple line receiver
IC3—74196 decade counter
IC4—7207 crystal oscillator controller
IC5—7208 7-decade counter-display driver
IC6—7805 voltage regulator
Q1—2N2857
Q2—E304 N-channel JFET
Q3, Q4—MPS6516
Q5—2N7369

Miscellaneous
L1—3.9 μH RF choke
L2—82 μH RF choke
XTAL1—5.24288-MHz quartz crystal
DIS1–DIS7—FND 357/356 7-segment LED displays
J1, J2—panel-mount BNC connectors
J3—3-circuit miniature phone jack
S1–S3—DPDT miniature slide switches
PC boards, IC sockets, cabinet components, assorted hardware.

Note: The OPTO-7000 frequency counter is available as a kit for $99.95 or assembled for $139.95 from Optoelectronics, Inc., 5821 NE 14 Ave., Ft. Lauderdale, FL 33334. A kit, No. 7000-PCB, containing the two circuit boards is available for $14.95.

Accessories available for the OPTO-7000 in both the kit and assembled versions: Power pack for 117 VAC line operation, model AC-70, $4.95. Rechargeable battery pack for internal installation; includes Ni-Cad cells, holder, constant-current charger and mounting hardware, model NiCad-70, $19.95. Optional switch for 1-Hz resolution to 6 MHz, model S-4, $4.95. Optional precision crystal oscillator, model TCXO-70 ±0.1 PPM from 17 to 40°C, precalibrated, $79.95.

Add 5% to all orders to cover shipping, handling and insurance. Florida residents add state and local taxes as applicable.

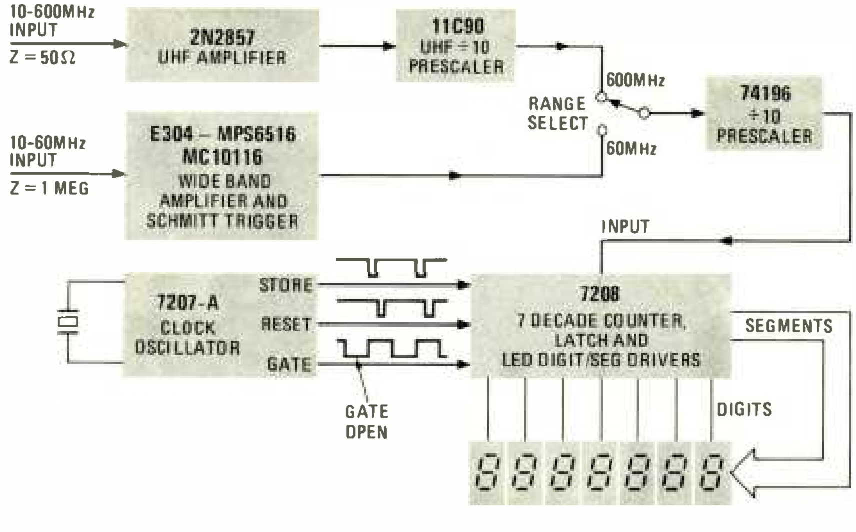


FIG. 2—BLOCK DIAGRAM of the OPTO-7000 counter. Note the signal conditioning circuits ahead of the prescaler.

600-MHz input.

Timebase—A frequency counter's accuracy is a function of its timebase stability. The quality of the quartz crystal used is of paramount importance. The inexpensive and readily available color-burst TV crystal (3.59545 MHz) was found unsuitable as a counter timebase. Color-burst crystals are manufactured to loose specifications (in a TV set they are phase-locked to the network signal). While suitable color-burst crystals can be hand-picked from batches they still have what crystal manufacturers refer to as "glitches." When temperature-cycled they behave erratically and depart from a smooth temperature/frequency curve.

The 7207A timebase generator is designed to use a 5.24288-MHz crystal. This frequency falls within the inherently stable 4–10-MHz range for quartz crystals. The crystal used in the OPTO-7000 counter is guaranteed to meet or exceed 5-

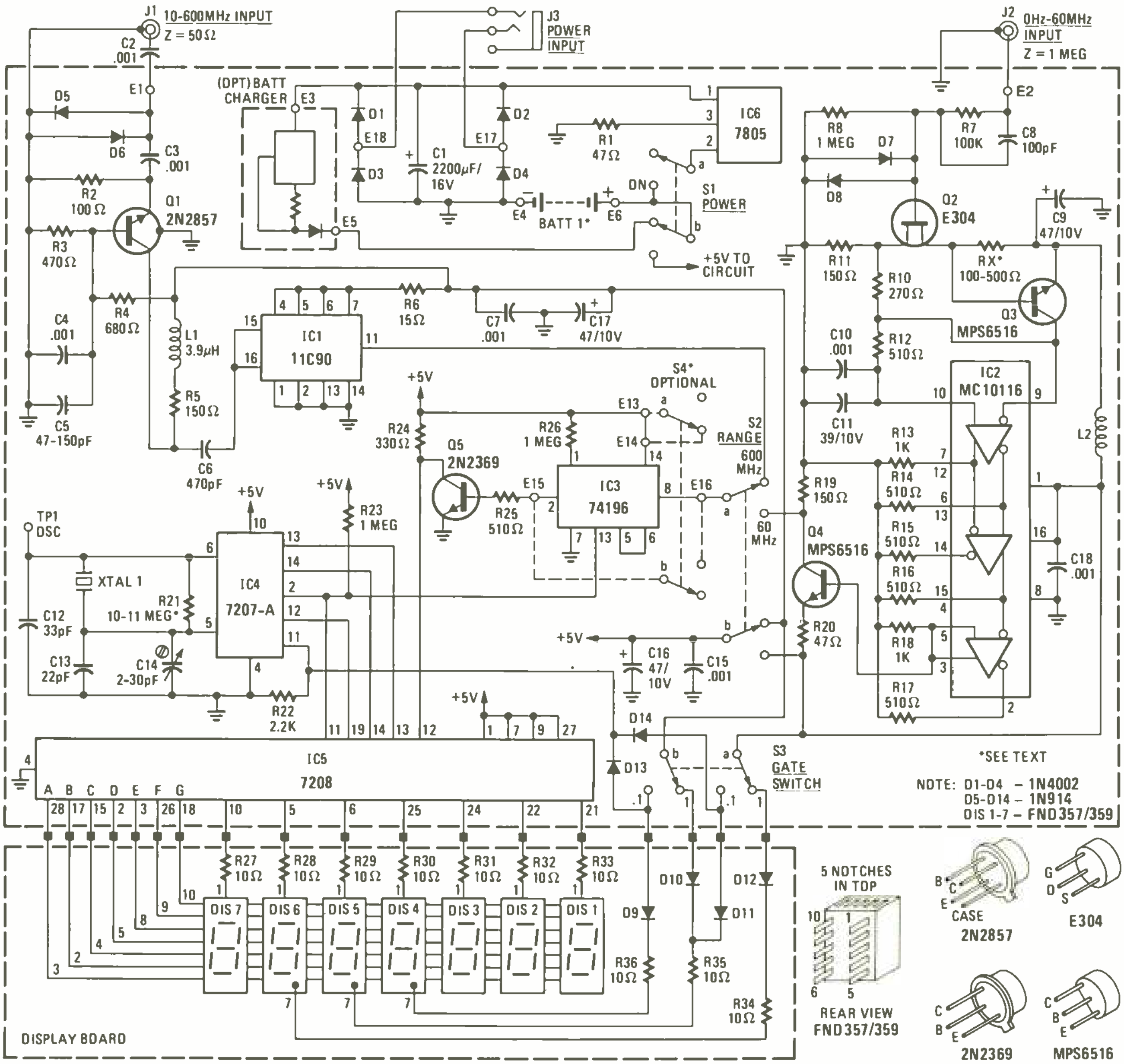


FIG. 3—SCHEMATIC DIAGRAM OF THE OPTO-7000 indicates its simplicity. The sensitivity and bandwidth are due partly to the careful design of the PC board.

ppm stability from 20° to 60°C. Industry specs for the color-burst crystal is 30 ppm from 20° to 60°C. Over the more realistic range of 20° to 40°C, the typical stability of the OPTO-7000's crystal is on the order of 1 ppm and 0.5 ppm close to room temperature. The oscillator uses first-order linear temperature compensation to improve temperature stability over the crystal specs. Each crystal's temperature frequency curve is plotted and a pair of temperature compensating capacitors are selected to provide compensation. Good long-term stability is achieved by pre-aging the crystal. The 7207A in conjunction with the crystal generates all clock signals as well as the display multiplex frequency.

Assembly details

As in any valuable project, each design phase must enhance the other. Especially in sensitive electronic equipment where a good, solid circuit design could either be complemented or destroyed by its physical layout. The mechanical design of this frequency counter has many features that are the result of user considerations.

As a note, the specifications shown in Table 1 are typical for the frequency counter shown in this article, using the PC boards designed with the proper impedance and should not be compared with results obtained from one built by other means.

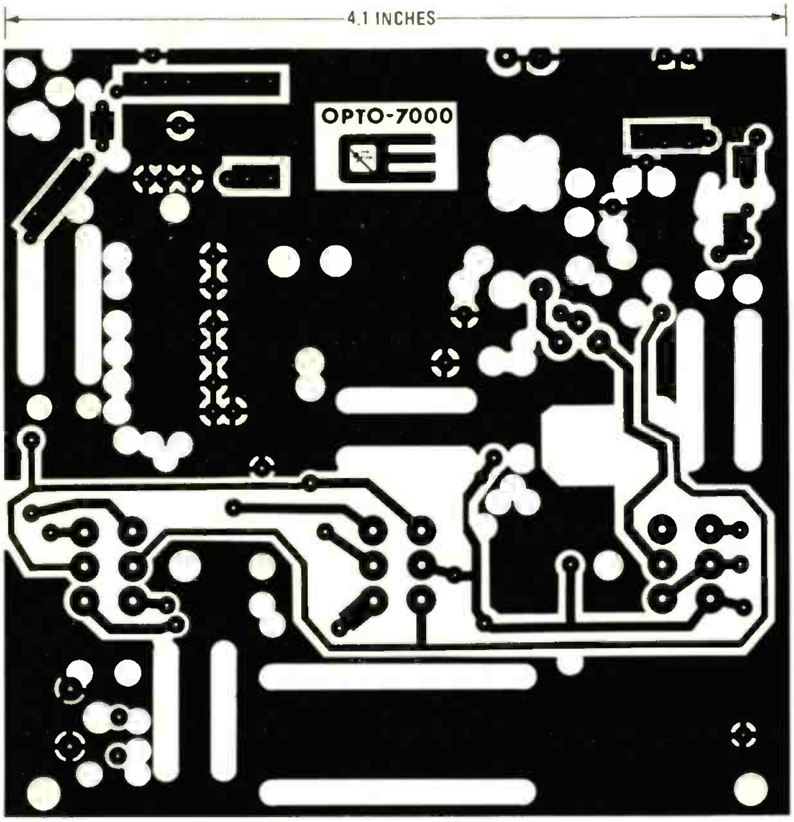


FIG. 4—FOIL PATTERN of the component side of the main board.

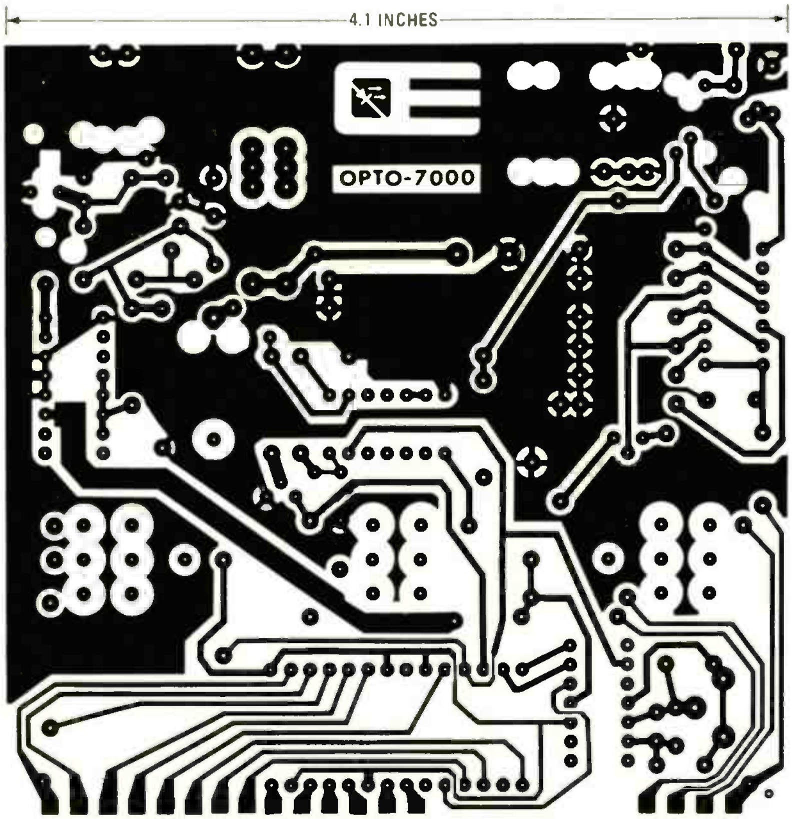
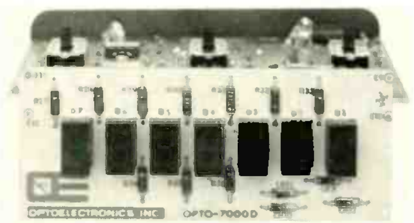


FIG. 5—MAIN BOARD ground-plane pattern. UHF signal attenuation is minimized by using short component leads and micro-strip printed-circuit transmission lines where needed.



THE DISPLAY BOARD with its components is shown in this head-on view of the counter.

As for assembling the unit, you couldn't ask for anything simpler. Of course, your best soldering techniques will pay off here. Positions of most components are silk-screened on the boards (if you etch your own boards you'll have to follow Figs. 4, 5, 6, 7 and 8). The two BNC connectors and the power input jack, J1, J2 and J3, are mounted on the rear panel. By referring to Figs. 6 and 8 and the parts list, install all components in the boards, except the three DPDT slide switches. Make sure to orient all diodes and polarized capacitors as indicated by the component layouts. Solder all component leads (top, bottom, or both sides) wherever a pad is provided and trim the excess leads.

There are four pads on the main board, marked with boxes (□), which require a piece of excess resistor lead inserted through each of them and soldered on both sides of the board. Trim the excess leads after soldering. Sockets are provided for all IC's with the exception of IC2, the MC10116, which is exceptionally reliable and performs a little better when not socketed. The voltage regulator is bolted to the top side of the PC board with a mica insulator. The crystal is also mounted on top of the PC board using a double-stick foam pad as an insulator and shock mount over IC4.

Align the display board at right angles to the main board with two pieces of excess resistor lead passing through pads

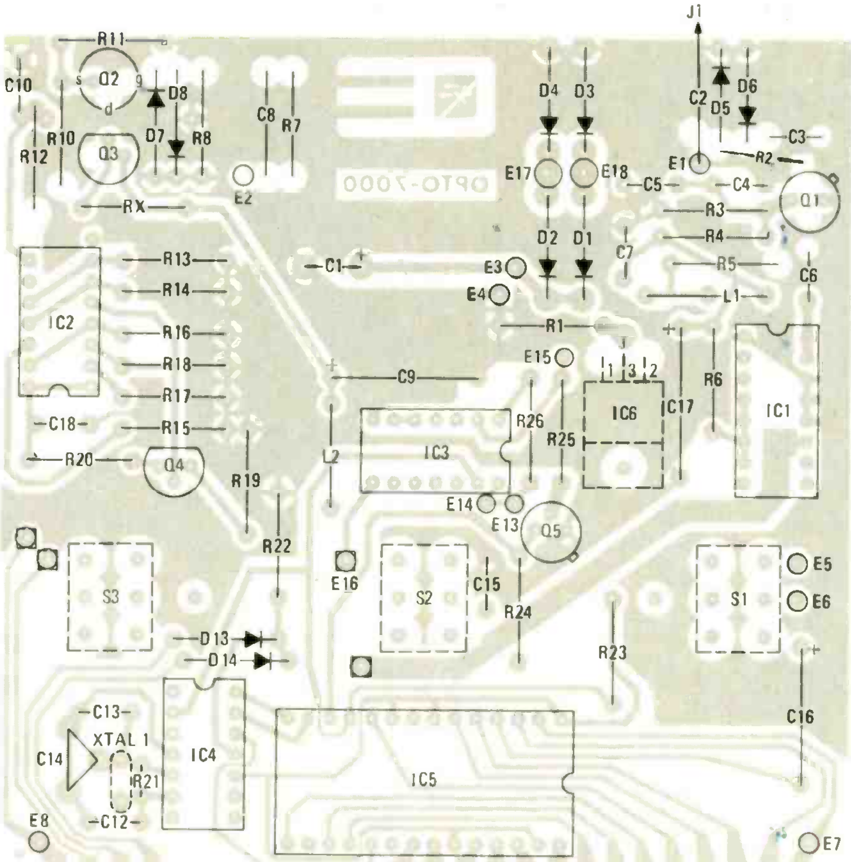


FIG. 6—PARTS PLACEMENT DIAGRAM for the main board. When board is installed most parts are toward the inside or bottom side of the case. Ground plane with switches faces upward.

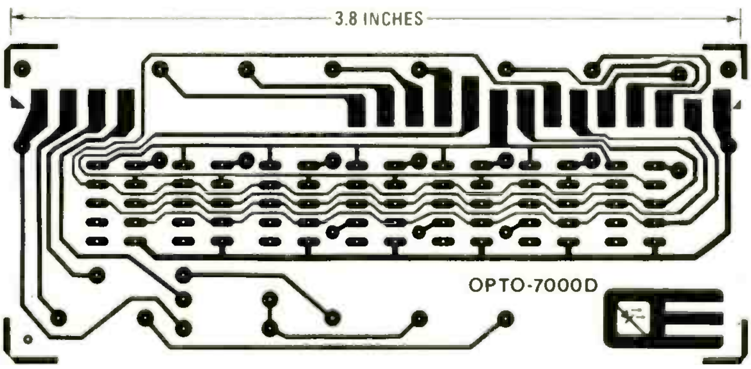


FIG. 7—DISPLAY BOARD foil pattern. You may want to make several and adapt them for use in other digital instruments using the FND357 or similar 7-segment LED displays.

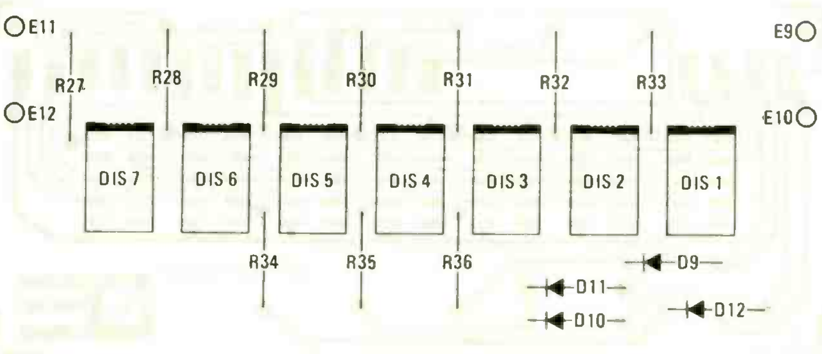


FIG. 8—COMPONENT SIDE of the display board. Leads through pads E9—E10 and E11—E12 form right-angle bracing when display board and main board are mated.

E9–E10 and E11–E12. Make sure the triangle marks on the sides of the display board foil line up with the ground-plane surface of the main board before soldering these two wires. This insures the correct mechanical positioning of the display board for interconnection soldering. Solder the 18 interconnections, being careful not to short any adjacent pads.

Next, install the three DPDT slide switches in the top cover, using six 4-40 × ⅛-inch flat-head machine screws. Place the main board flush over the switches, with the display board facing forward and the switch terminals extending up through the component side of the main board. Solder all switch terminals to the main board. This insures the correct mechanical relationship between the main and display boards, switches and top cover, so there will be no stress on any solder connections during final assembly. Remove this assembly from the top cover by removing the six switch screws.

In preparation for hooking up the rear panel, solder two 1½-inch pieces of hook-up wire in E17 and E18 on the main board. Next, solder a 1-inch piece of excess resistor lead in E2 and one end of C2 in E1. Install the two BNC connectors and the power input jack on the rear panel. Solder a ½-inch piece of excess resistor lead to the solder lugs on J1 and J2. Place the rear panel assembly against the rear edge of the main board. Solder the loose end of the wire, in E2, to the center conductor of J2 above it. Now solder the loose end of C2 to the center conductor of connector J1. Solder the two ½-inch pieces of wire on the ground lugs to the ground plane of the main board. Solder the stranded hook-up wire from pad E17 to the center terminal of the power input jack and the wire from pad E18 to the outside terminal of the power input jack.

Install this assembly in the top cover as before, using the six 4-40 × ⅛-inch flat-head machine screws. Carefully place the bottom cover over this assembly so that the press nuts are in the forward position and the rear panel fits outside the corner brackets. Secure the top and bottom covers together with two 4-40 × ⅛-inch machine screws in the rear holes. Attach the rear panel with two 4-40 × ⅛-inch machine screws and the display window with two 4-40 × ¼-inch machine screws. Install the bracket/stand using two 6-32 × 5/16-inch machine screws and two rubber washers. Place the washers next to the case. Finally, apply the self-stick rubber feet and you're ready for check-out and calibration.

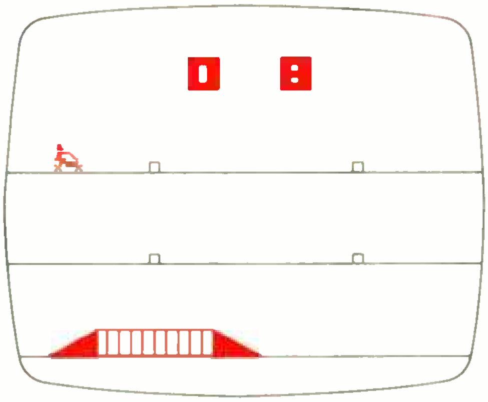
Direct counting

If you are going to be doing a lot of audio and low-frequency counting in the 10-Hz to 6-MHz range then there is a simple modification you can make to the OPTO-7000. The 74196 IC can be re-

continued on page 90

BUILD THIS

Video Motorcycle Game



Keep up with the advance in video game sophistication by building this single-player game for lots of fun and excitement.

L. STEVEN CHEAIRS

THIS ARCADE-QUALITY VIDEO GAME IS A follow-up to the "Tank Battle" described in the November and December issues. The heart of this game is one LSI IC that contains a complex audio sound generator, a complete timing circuit (thus allowing for unique point identification anywhere on the television screen), the motion logic, a number of ROM image arrays, chip buffering and color video circuits. The video circuit includes the horizontal and vertical blanking, the horizontal and vertical sync circuits, the color circuits, the field intensity circuit, and logic for both the American NTSC and the European PAL screen format.

It doesn't require much imagination for the operator to find himself or herself upon the back of an iron stallion, with a faint taste of dust and a distant roar of the elated crowd; that sound is only surpassed by the mechanical snorting of the throbbing steed. With but a wrist's twitch the ultimate of freedom and adventure is realized.

This is made possible by another new dedicated IC introduced by General Instruments Corporation. There is as much difference between this game and the common pong-type units as there is between an earthworm and man. This is the second IC in a new generation of video games; the first is GI's AY-3-8710-1 battle game.

This single-player game begins when a mode of play is selected; reset is automatic when power is first turned on. Four games are provided; each with two levels of complexity. The four games are *Drag Race*, *Enduro*, *Stunt Cycle* and *Motorcross*. A single motorcycle and rider is displayed on a tri-segmented road that, in most of the games, contains obstacles that the rider must jump. As with the tank game, realistic engine and crashing sounds are provided. As the motorcycle changes its speed or when it shifts gears, the engine sounds change to reflect these conditions. Realistic wheel rotation is displayed.

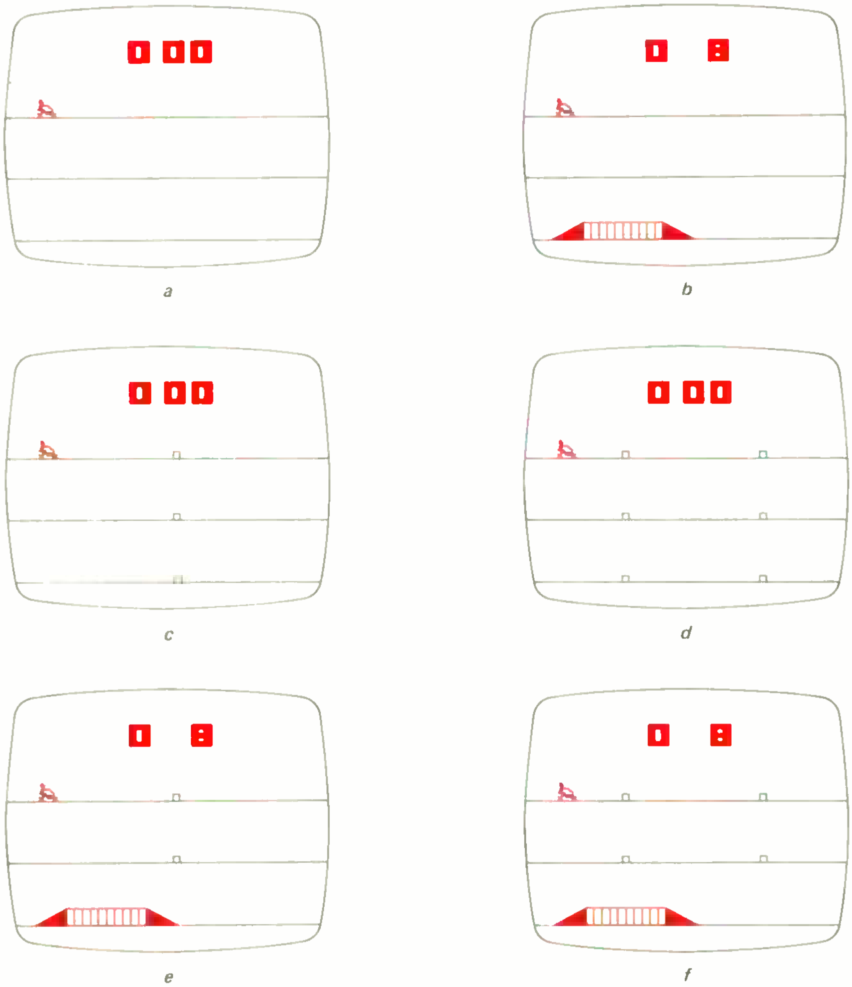


FIG. 1—TYPICAL VIDEO IMAGES as they appear on the TV screen. The Drag Race at *a*, Stunt Cycle at *b*, Motorcross, the easy way at *c* and the hard way at *d*. Enduro the easy way (*e*) has single obstacle on first and second rows; the hard way (*f*) has two obstacles in the first and second rows.

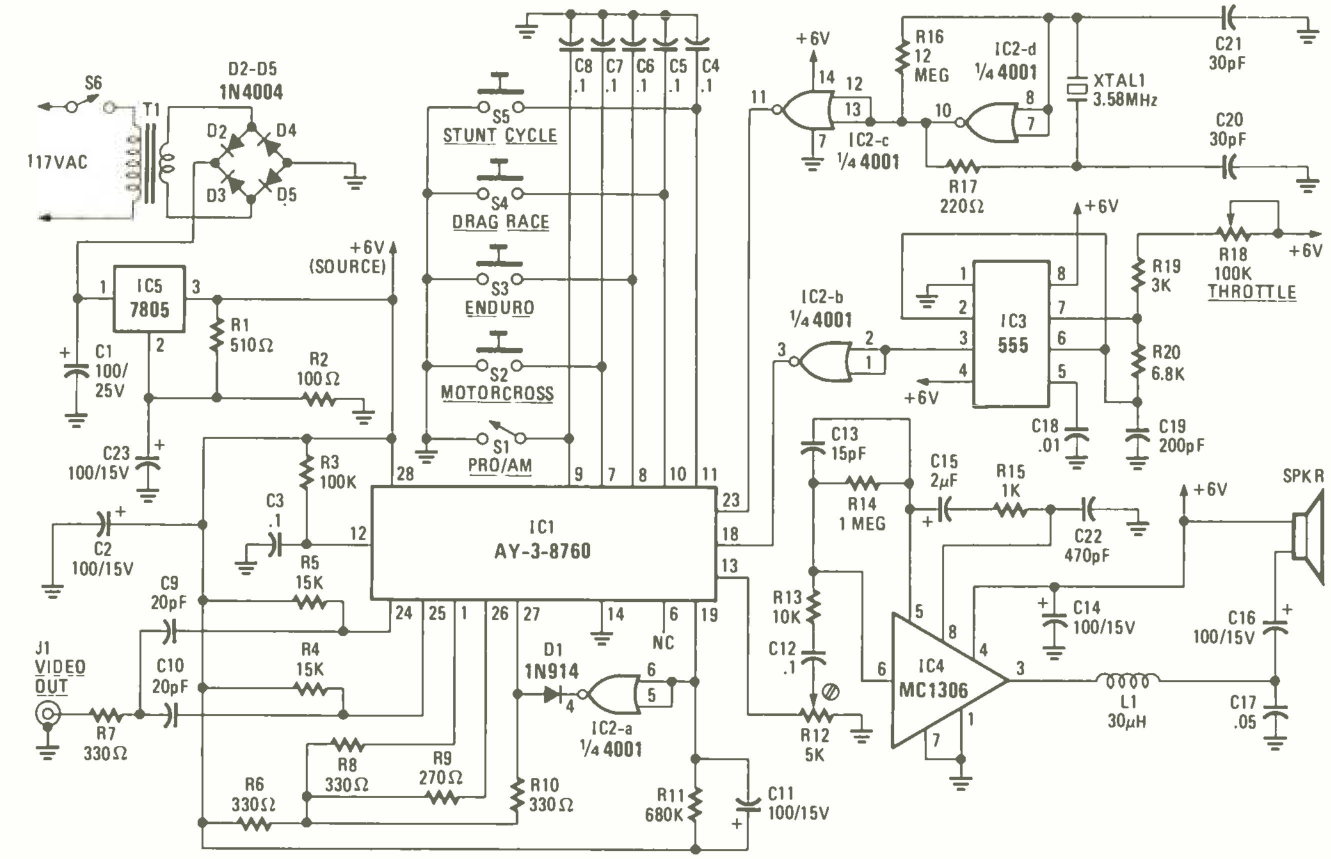


FIG. 2—SCHEMATIC OF THE MOTORCYCLE GAME. Object of the games is to traverse the three roads without accident in the shortest possible time.

PARTS LIST

All resistors ¼ watt, 5%.
R1—510 ohms
R2—100 ohms
R3—100,000 ohms
R4, R5—15,000 ohms
R6-R8, R10—330 ohms
R9—270 ohms
R11—680,000 ohms
R12—5000 ohms trimmer pot
R13—10,000 ohms
R14—1 megohm
R15—1000 ohms
R16—12 megohms
R17—270 ohms
R18—100,000 ohms
R19—3000 ohms
R20—6800 ohms
C—100 μF, 25 volts, electrolytic
C2, C11, C14, C16, C23—100 μF, 15 volts, electrolytic
C3-C8, C12—0.1 μF ceramic disc
C9, C10—20 pF
C23—15 pF
C15—2 μF, tantalum
C17—0.05 μF ceramic disc
C18—0.01 μF ceramic disc
C19—200 pF
C20, C21—30 pF
C22—470 pF
L1—30 μH RF choke
XTAL1—3.58 MHz quartz crystal
D1—1N914
D2-D5—1N4004
IC1—AY-3-8760 video game IC
IC2—4001 or 4011 CMOS quad 2-input gate
IC3—555 timer
IC4—MC1306 ¼-watt audio amplifier
IC5—7805 5-volt regulator (TO-220 case)
T1—power transformer, 12 VAC, 1A secondary
F1—1 amp fuse
S1—SPST toggle or rotary switch
S2-S5—SPST normally open pushbutton switch
S6—SPST toggle switch
SPKR1—8-16-ohm speaker, 0.25 watt or higher

The following are available from Questar Engineering Co., 50 S. McDonald St., Mesa, AZ 85202: PC board $9.75; AY-3-8760 $25.50; and kit of all parts listed above $61.75. Add $1.75 to all orders for shipping, handling and insurance.

The games begin with the rider at the top left-hand side of the screen. The cycle begins to move when the throttle pot is turned. The cycle and rider move across the first track from left to right, it exits the screen and reappears on the left side of track number two; it likewise transverses this track in the same direction and exits the screen; only to reappear on the left-hand side of track number three, which again it transverses from left to right. When it exits the screen on track number three, it is replaced at the starting position and remains stationary. The throttle must be reset to the minimum speed position and again increased. See Fig. 1 for typical video images as seen using this game.

About the circuit

The AY-3-8760 was designed for both color and black-and-white operation using a standard domestic 525-line NTSC receiver or foreign 625-line PAL units.

The complete game unit is shown schematically in Fig. 2. In addition to automatic reset at turn-on, reset also occurs when any game is selected by pressing one of the four momentary contact SPST pushbutton switches (S2–S4). Also, an SPST switch (S1) is used to select either the pro or amateur skill level; I use a rotary switch that protrudes from the left side of the case—acting as one handle bar. The THROTTLE pot protrudes from the right side of the case, thus, forming another handle bar.

Upon pressing the DRAG RACE select pushbutton the screen takes on the form as seen in Fig. 1-a. The score is automatically reset to zero upon pressing a game-select switch. The object of the Drag Race game is to reach the right side of the third (bottom) track segment in the shortest possible time, the minimum score. At the end of each game return the pot to the slow position; when it is increased again the score will be reset and

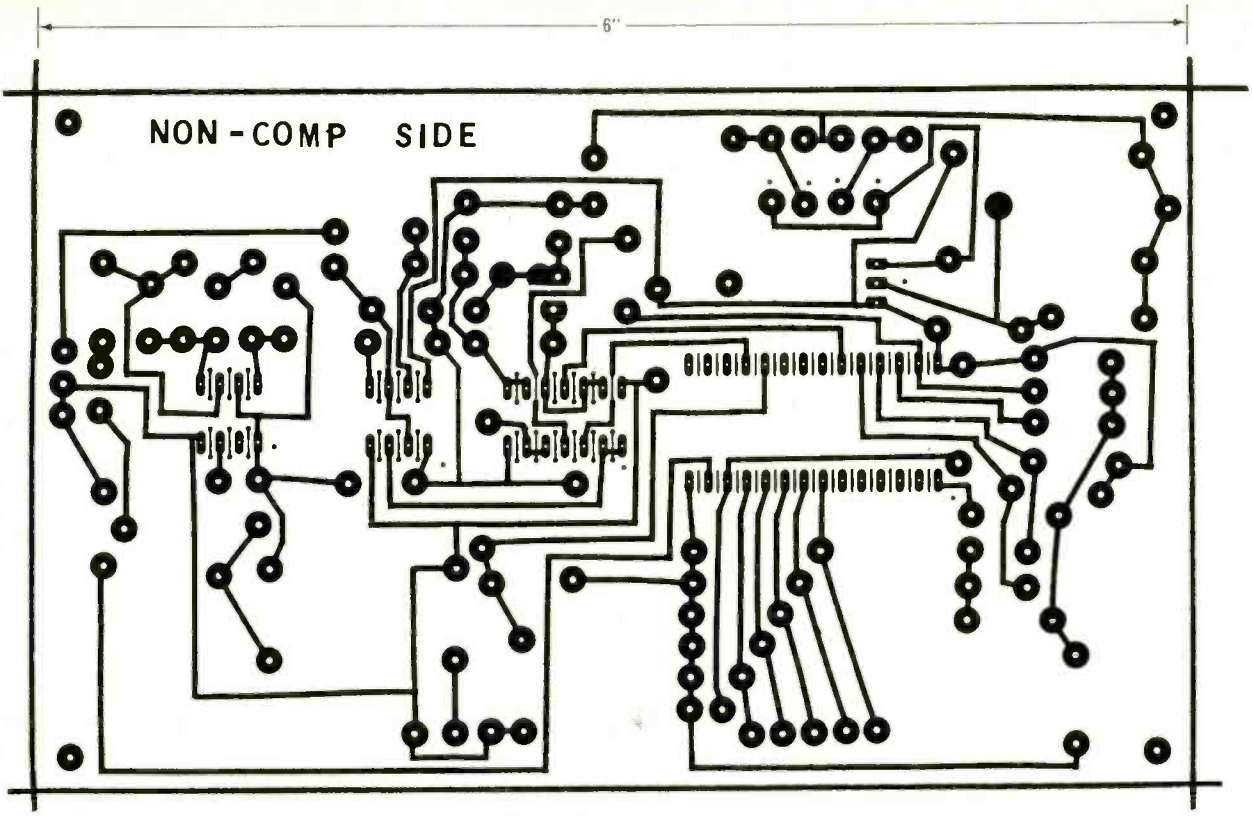


FIG. 3—FOIL PATTERN for the single-sided printed-circuit board.

a new game will begin. The score—a three-digit number centered at the top of the screen—is advanced at a fixed rate throughout the game. At the end of each game the score remains static until the beginning of the next game.

This game requires the development of speed-shifting skills in order to minimize one's score. When the game begins, the motorcycle is in low gear and will move down the track at a fixed rate. The only way the cycle may be accelerated is to shift into the next gear, by returning the throttle to a "slow" position and then turning it back to a "fast" position. The cycle now moves across the screen at a higher rate of speed. If the above process is repeated the motorcycle will shift into third gear; this results in the maximum possible velocity. Thus, a minimum score is obtained when the highest gear is obtained in the shortest period of time.

When the amateur mode is selected by the PRO/AM switch, the game proceeds just as described above. But when the professional mode is chosen, then when the user twists the throttle too rapidly, the motorcycle's front end raises off the ground and the cycle flips upside down. When a crash occurs a high-pitched screeching sound is generated. At the end of the screech the game is reset with the bike reappearing at the beginning of track 1. No crashes occur in the easy mode. If the game is being displayed on a black-and-white television set then the cycle and score are white; the track is black; and the background is gray. On a color set the cycle and score are also white. Also, the road is black; only the background is changed—it is red. For all

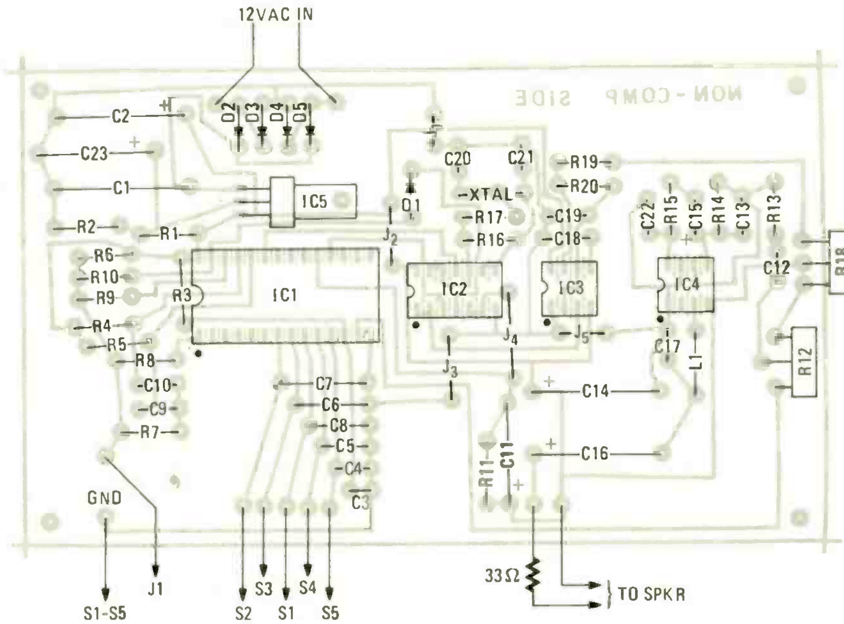


FIG. 4—HOW PARTS ARE LOCATED on the PC board. Don't overlook the five jumpers.

games included on the motorcycle-game IC only the background is in color.

Upon pressing the STUNT CYCLE select switch, the screen will be as seen in Fig. 1-b. The score is preset, the left digit is set to zero and the right digit will be an eight. The right digit (or digits as the game proceeds) equals the number of buses between the ramps. The left digit represents the number of crashes; the maximum amount possible depends on the setting of the PRO/AM switch. In the amateur mode a total of seven crashes may occur. But in the professional mode three crashes only are permitted.

Crashes can occur due to a number of factors. As in the Drag Race game, if the motorcycle is accelerated too rapidly it will flip upside down and a screeching sound is generated. Another method of crashing is to have an insufficient speed upon jumping the buses. This causes the cycle to land on either the second ramp or on one of the buses. A collision is also recorded if the cycle lands too far past the end of the last ramp and an appropriate crash sound is generated. Every time an accident occurs the left digit is advanced and the cycle and rider are placed back at

continued on page 69

How To Design Digital Circuits

Part 2—With digital circuitry becoming an increasingly important factor in our everyday lives, it's time that we learn how to design logic circuits. Here the author discusses digital logic design—including sequential circuits and multiple output functions.

JERRY WOOLSEY

LAST MONTH WE WENT THROUGH THE BASICS of digital circuit design, using Karnaugh maps and Quine-McCluskey tables. Now, we'll look at multiple-output functions and those where the output depends on sequential input events.

Multiple-output functions

It is often the case that we wish to design a circuit with not only multiple inputs, but also multiple outputs, all of which are dependent on the same inputs. In the truth table of Fig. 17-a, we show such an example, with three inputs, a, b and c, and three outputs, f_1, f_2 and f_3. Each of these functions could be treated separately, and designed using Karnaugh maps, as shown in Figs. 17-b and 17-c. However, this type of design does not lead to optimum gate use. Some gates are repeated, and combinations of gates to perform several functions cannot be taken into account. To resolve this, we resort to a modified Quine-McCluskey method.

The workings are similar to the method described for a single-output function, but all three functions are combined into one table, and each entry is subscripted with the functions (f_1, f_2 or f_3) that it covers. Refer to Figs. 17-a and 18-a. Since an input of all zeroes produces no 1-outputs, we have no 0-bit group in the input column of the Q-M table. An input of 1 (abc = 001) causes a 1-output for functions f_1 and f_2, so we enter a 1 subscripted with these functions in the 1-bit group. We continue in this manner, filling the input column as we did for a single-output function, subscripting each with the functions that produce a 1-output for the given input.

INPUTS a	b	c	OUTPUTS f_1	f_2	f_3
0	0	0	0	0	0
0	0	1	1	1	0
0	1	0	1	0	1
0	1	1	1	1	0
1	0	0	1	1	1
1	0	1	0	1	1
1	1	0	0	0	0
1	1	1	0	0	0

a

a \ bc	00	01	11	10
0	0	1	1	1
1	1	0	0	0

f_1

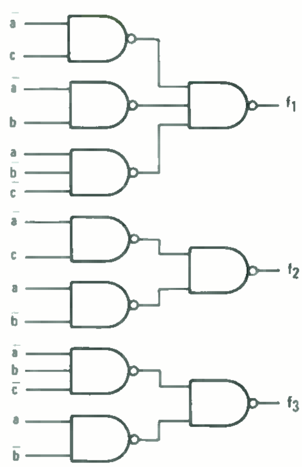
a \ bc	00	01	11	10
0	0	1	1	0
1	1	1	0	0

f_2

a \ bc	00	01	11	10
0	0	0	0	1
1	1	1	0	0

f_3

b



c

FIG. 17—MULTIPLE INPUTS AND OUTPUTS can also be handled. Truth table with three inputs and three outputs is shown in *a*. Resulting Karnaugh maps are shown in *b*; logic circuit is shown in *c*.

1 – f_1f_2
2 – f_1f_3
4 – $f_1f_2f_3$
———
3 – f_1f_2
5 – f_2f_3

a

1 – f_1f_2	1, 3(2) – f_1f_2
2 – f_1f_3	1, 5(4) – f_2
4 – $f_1f_2f_3$	2, 3(1) – f_1
3 – f_1f_2	4, 5(1) – f_2f_3
5 – f_2f_3	

b

FIG. 18—MODIFIED QUINE-McCLUSKEY method is used to simplify circuit shown in Fig. 17.

We now proceed to form 1-cubes as before, except now we must make sure that at least one subscript is common to each of the lower cubes being combined. (See Fig. 18-b.) Inputs 1 and 3 are adjacent, and also have the same subscripts, so we enter this in the next column as a 1-cube, also entering the subscripts. The 1 and 3 entries in the input column can be checked off, since the 1-cube just formed covers both of these inputs for all outputs. Inputs 1 and 5 are adjacent and have a common subscript, f_2, so we enter this as a 1-cube, but the subscript is only entered for f_2, since this is the only common subscript and hence the only function which contains this 1-cube.

We do not yet check the 1 or 5 in the input column, since the higher cube does not cover either input for all functions. The input 5 is checked off when we combine it with input 4, since the cube formed has the same subscripts as 5. We continue as in the case of single-output functions, until there are no more cubes that can be formed. The completed table appears in Fig. 18-b.

	F_1				F_2				F_3		
	✓ 1	✓ 2	✓ 3	✓ 4	✓ 1	✓ 3	✓ 4	✓ 5	✓ 2	✓ 4	✓ 5
* 2—$f_1 f_3$		✓							✓		
* 4—$f_1 f_2 f_3$				✓			✓			✓	
*1,3—$f_1 f_2$	✓		✓		✓	✓					
1,5—f_2					✓			✓			
2,3—f_1		✓	✓								
*4,5—$f_2 f_3$							✓	✓		✓	✓

FIG. 19—COVER MAP is generated from table shown in Fig. 18-b.

A cover map is now made as in Fig. 19, which includes the inputs that will produce a 1-output for each separate function as column headers and the unchecked entries of Fig. 18-b as row headers. Since the row labeled 2 is subscripted with f_1 and f_3, we check the columns labeled 2 under f_1 and f_3, and so on for all the rows. Following the covering procedure outlined previously, we find that the rows marked with an asterisk are essential to cover all columns. The circuit can now be drawn.

A gate is drawn for each row with an asterisk, again with the inputs to the gates corresponding to the nonchanging coordinates of the cube formed by the row header. We then draw three output gates with no input connections, and the result is as in Fig. 20.

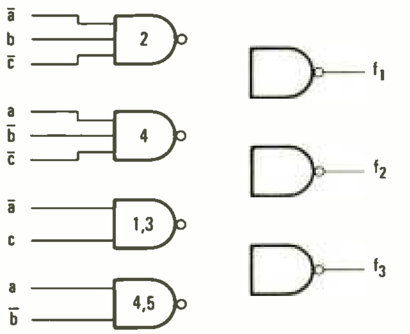


FIG. 20—PARTIAL CIRCUIT is drawn showing the outputs and inputs.

Returning to Fig. 19, we now take a minimum cover for each separate function. For f_1, we see we need the rows labeled 2, 4 and (1,3) to cover the columns under that function. The gates corresponding to these rows are thus fed to gate f_1. For f_2, we need only (1,3) and (4,5) to cover all 1-outputs, so we feed these gates to gate f_2. Note that the row labeled 4 is not needed for f_2 even though it is checked in f_2, because this is covered by the 1-cube (4,5). Similarly, f_3 requires rows 2 and (4,5). The completed circuit now appears as in Fig. 21, and is a substantial savings over the circuit shown in Fig. 17-c.

Sequential circuits

Up to this point, we have concerned ourselves only with circuits whose output depends solely on its input at a given time. However, it is often the case that a circuit must produce an output that depends not only on the present inputs to the circuit, but also on previous inputs (or outputs). To perform this, we must make use of a "memory" circuit to hold the previous information. For the experimenter, the simplest type of memory circuit is the flip-flop. When fed a clock pulse, it will store information according to its input, and hold it until the next clock pulse. This implies we must have a clock running the circuit, which we will consider later.

We can thus hold information from one clock pulse to the next. But suppose we need to know not only what happened on the previous clock pulse, but a string of several before that. We could store the entire string in a series of flip-flops, i.e., a shift register, but this could be costly for long strings and wasteful of gates, since we do not really need to look at every bit in the string as it comes in.

Instead, we can assign to each unique string of bits that may appear at the input a *state number* that corresponds to that string. We know what the string was if we know what the state number is. Thus, the input string 0000 could be assigned a state number of 0, the string 0001 a state number of 1, etc. At first glance, this does not seem to help matters much, since a 4-bit input string can have 16 possible states, which requires 4 bits for saving the state number, which is the same number required to hold the input string. But this is not necessarily so, depending on the function, and if it is so, methods have been devised for reducing the number of states. What we need to do, then, is store the state number, and update it as each bit enters.

In implementing sequential functions, we make use of two tools known as the state diagram and state table. These merely show us the possible states that our function may assume. We start first with the state diagram.

As an example, let us assume that we have a string of bits entering our circuit, and we want to know when the pattern 1101 enters. It may come at any bit time, i.e., it may start at the first bit entered, or the third, etc. We start the state diagram by assuming an initial state which we call state A, and write this down in a circle. See Fig. 22-a. There are two possible occurrences at state A; we may receive either a 0 or a 1. If we receive a 0, we have not detected the start of the string 1101, so we draw an arrow from A back to itself and label it 0/0 (applied input/generated output). This means we follow this arrow if we are at state A and receive a 0-input, and the output of the circuit is to be 0. The arrow, of course, brings us back to state A to look for the first bit of the string.

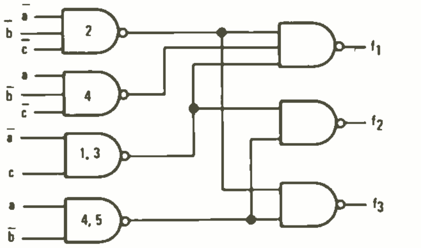


FIG. 21—SIMPLIFIED LOGIC CIRCUIT for three inputs and three outputs requires less gates than circuit shown in Fig. 17-c.

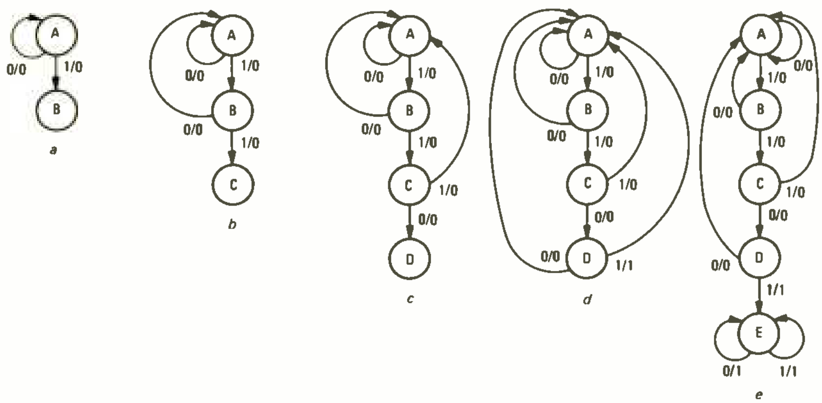


FIG. 22—STATE DIAGRAM is used in designing sequential logic circuits.

This loop will continue until a 1-bit is received. At this point, we must "remember" that we have found the first bit of the string, so we draw an arrow to a new state which we name B. The arrow is labeled 1/0, and indicates that if we are at state A and a 1 is received, we are to go to state B and output a 0. Since we have covered both input conditions for state A, we move to state B. If we are at state B, we have received the first 1 of the string. If we now receive a 0, we must go back to state A, and start searching for the beginning of the string again.

If a 1 is received, we have received the first two bits of the desired string, so we

Present State (PS)	Next State (NS)		Output	
	x=0	x=1	x=0	x=1
A	A	B	0	0
B	A	C	0	0
C	D	A	0	0
D	A	A	0	1

FIG. 23—STATE TABLE listing present state, next state and output is generated from state diagram.

PS	NS		Output	
	x=0	x=1	x=0	x=1
00	00	01	0	0
01	00	10	0	0
10	11	00	0	0
11	00	00	0	1

FIG. 24—BINARY NUMBERS are assigned to present states and next states in state table.

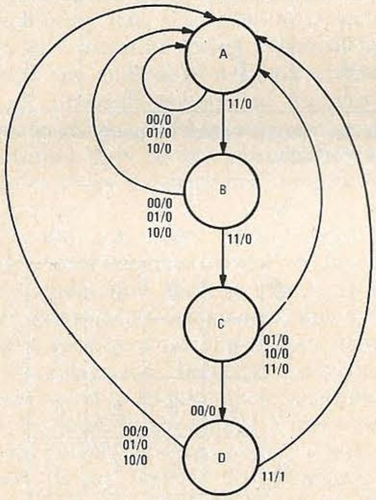


FIG. 25—STATE DIAGRAM of circuit with multiple inputs.

go to a new state, called C, which tells us that we have received a 11 so far, and a 0 is to be output. See Fig. 22-b. We follow the same procedure with state C. At state D, if we receive a 0, we have received the string of 1100 instead of 1101, so we return to state A and output a 0. If we receive a 1, however, we have received the desired 1101 string. We now have two alternatives. If we wish to continue checking for the string, we can output a 1 and return to state A, as in Fig. 22-d, or we could go to a new state, E, which simply ignores the remainder of the incoming data and outputs a constant 1 (or it could output a constant 0 or follow the incoming data). See Fig. 22-e.

Now, using Fig. 22-d, we put the diagram down in a state table, as shown in Fig. 23. The "Present State" (PS) column lists all the states that appear on the state diagram. The "Next State" (NS) column lists the next state to go to when the input is 0 (x = 0) or 1 (x = 1). For example, if we are at state A and receive an input of x = 0, the next state is A. If we receive an input of x = 1, the next state is B. The output column specifies the output to be produced when at the present state and an input of x = 0 or x = 1 is received. For example, the only time a 1 is output is when we are at state D and the input x = 1 is received.

We can now assign numbers to the state, letting A = 0, B = 1, C = 2 and D = 3, and obtain the Transition Table shown in Fig. 24. Note that with only four possible states, we need only two flip-flops to "remember" the 4-bit sequence. This table will be used later to construct the actual circuit.

Multiple input circuits can also be designed using this method. For example, Fig. 25 shows the state diagram for a circuit which is to produce a 1-output only when two input lines simultaneously input the string 1101. The NS and OUTPUT columns of the state table would then have four sub-columns, for inputs x = 00, x = 01, x = 10 and x = 11.

As another example, suppose we wished to design a circuit that would compute odd parity for a 3-bit data word, and set a flag when the parity bit was ready, after which it would compute parity on the next three bits, etc. Figure 26 shows the state diagram for the circuit. The first bit of the output is the parity bit, and the second is a flag indicating when the parity bit is ready to sample. The state table is shown in Fig. 27. Looking at the state table, we see that both states D and G advance to the same state (A) when x = 0 is input, and advance to the same state (A) when x = 1 is input. Also, the outputs of the two states are the same when x = 0 is input and when x = 1 is input.

Since the entire row D (except, of course, the PS column) is identical to G, the two states are equivalent, and we can strike out state D and replace all references to it with state G. States E and F are also equivalent, so we can eliminate state E and replace references to it with state F. Our reduced state table now appears as in Fig. 28, and we number the states to obtain the transition table shown in Fig. 29.

We are now ready to design the actual circuitry, using the table of Fig. 29. We will use D-type flip-flops as memory elements, since these have only one input, as opposed to two for the J-K flip-flop. When a clock pulse occurs on a D-type flip-flop, it merely stores the value present at its input at the time of the pulse, and makes this available at the Q-output, while the inverse is available at the $\overline{Q}$-output. Three flip-flops are needed to hold the current state numbers.

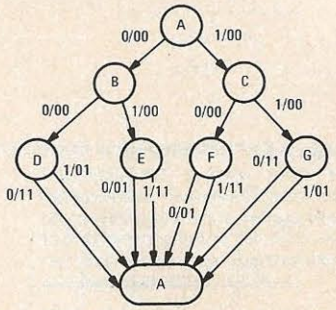


FIG. 26—STATE DIAGRAM for a circuit that derives odd parity for a 3-bit data word.

PS	NS		Output	
	x=0	x=1	x=0	x=1
A	B	C	00	00
B	D	E	00	00
C	F	G	00	00
D	A	A	11	01
E	A	A	01	11
F	A	A	01	11
G	A	A	11	01

FIG. 27—STATE TABLE derived from state diagram shown in Fig. 26.

PS	NS		Output	
	x=0	x=1	x=0	x=1
A	B	C	00	00
B	G	F	00	00
C	F	G	00	00
F	A	A	01	11
G	A	A	11	01

FIG. 28—REDUCED STATE TABLE is obtained by eliminating redundant states.

PS	NS		Output	
	x=0	x=1	x=0	x=1
000	001	010	00	00
001	100	011	00	00
010	011	100	00	00
011	000	000	01	11
100	000	000	11	01

FIG. 29—BINARY NUMBERS are assigned to the present states and next states.

Suppose we have the PS = 000 stored in the Q-outputs of flip-flop 1 (FF1), FF2 and FF3, and at the next bit time the input is x = 0. We then wish to set the flip-flops so that the Q-output of FF1 is 0, FF2 is 0, and FF3 is 1, so we know we are now at state 001. From state 001, if x = 1 is applied, we want to set FF1 to 0, FF2 to 1 and FF3 to 1 to indicate the new state, 011, etc.

We need three combinational circuits for this, one for each flip-flop, to place a 0 or a 1 at the input of each flip-flop. The input to the combinational circuits will be

P_1P_2 \ P_3x	00	01	11	10
00	0	0	0	1
01	0	1	0	0
11	d	d	d	d
10	0	0	d	d

$N_1 = \overline{P_2}\, P_3\, \overline{x} + P_2\, \overline{P_3}\, x$

a

P_1P_2 \ P_3x	00	01	11	10
00	0	1	1	0
01	1	0	0	0
11	d	d	d	d
10	0	0	d	d

$N_2 = \overline{P_1}\, \overline{P_2}\, x + P_2\, \overline{P_3}\, \overline{x}$

b

P_1P_2 \ P_3x	00	01	11	10
00	1	0	1	0
01	1	0	0	0
11	d	d	d	d
10	0	0	d	d

$N_3 = \overline{P_1}\, \overline{P_2}\, \overline{x} + \overline{P_2}\, P_3\, x$

c

FIG. 30—A KARNAUGH MAP is drawn for each flip-flop.

P_1P_2 \ P_3x	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	d	d	d	d
10	1	0	d	d

$O_1 = P_1\, \overline{P_3}\, \overline{x} + P_2\, P_3\, x$

a

P_1P_2 \ P_3x	00	01	11	10
00	0	0	0	0
01	0	0	1	1
11	d	d	d	d
10	1	1	d	d

$O_2 = P_2\, P_3 + P_1\, \overline{P_3}$

b

FIG. 31—OUTPUT FUNCTIONS are derived from the Karnaugh maps.

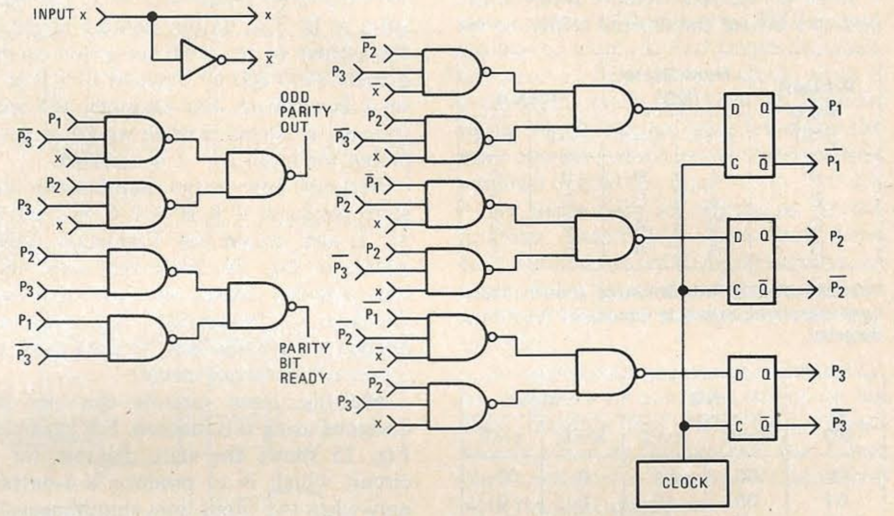


FIG. 32—COMPLETE LOGIC CIRCUIT for deriving odd parity using D-type flip-flops.

the outputs of the flip-flops, i.e., the PS, and the input x. We can label the PS-bits as p_1, p_2 and p_3, so a PS of 011 indicates $p_1 = 0$, $p_2 = 1$ and $p_3 = 1$, where p_i is the Q-output of FF_i. Now we can see that our combinational circuits have four inputs, p_1, p_2, p_3, and x, and one output, which we can label n_i to correspond to the bits of the number of the next state.

It is thus an easy matter to draw a Karnaugh map for each flip-flop input. Figure 30-a shows the map for FF1. If the PS is 000 and x = 0 is applied, then n_1, the first bit of the NS, is to be a 0, so in the box with coordinates $p_1p_2p_3x$ = 0000, we place a 0. Similarly, for a PS of 000 and x = 1 ($p_1p_2p_3x$ = 0001), we must have $n_1 = 0$, so a 0 is placed in box 0001. When the PS is 001 and x = 0 is applied, n_1, the first bit of the NS, is to be a 1, so a 1 is placed in box 0010. This procedure is repeated up to $p_1p_2p_3x$ = 1001. Since there is no state 101, we can enter a "d" (don't-care) in boxes 1010 through 1111. Using the d-labeled boxes, we get the resultant equation for n_1, which is also shown in Fig. 30-a. The same procedure is repeated for bits n_2 and n_3 of NS, as shown in Figs. 30-b and 30-c. With these outputs applied to the inputs of the flip-flops, they will assume the correct next state after the next clock pulse.

The output functions are also designed in this way, since they depend on only the PS = $p_1p_2p_3$ and the input x. Labeling the first output bit o_1 and the second o_2, the equations are written from the Karnaugh maps as shown in Figs. 31-a and 31-b.

Each of the five functions may now be easily implemented, as shown in Fig. 32. The outputs p_i of the flip-flops are fed back to the NAND gates as shown. In actual operation, the circuit would be set to the initial state before use by toggling the CLEAR inputs on the flip-flops by a computer command or a manual switch.

This circuit could also have been realized using J-K flip-flops, using two input circuits to each flip-flop instead of one. Thus, we would need eight Karnaugh maps, one for each J-input, one for each K-input, and one for each output. These would be derived from the truth table of a J-K flip-flop, shown in Fig. 33.

As an example, referring to Fig. 29, if we wish to find the J-input of FF1 to obtain the next state (call this J_{n1}), we draw the Karnaugh map as in Fig. 34. For $p_1p_2p_3x$ = 0000, we change the first state bit from 0 to 0, which requires a J-input of 0, so we enter a 0 in box 0000. With the PS = 001 and an input of x = 0, we must change the first bit of the state from a 1 to a 0, which requires a J-input of 1. If PS = 100 and x = 0 or x = 1, we must change the first NS bit from 1 to 0, so J = d. Due to the increased number of don't-cares, the circuits feeding the J- and K-inputs are often simpler than those feeding D-inputs, though there are twice as many. (For example, the map for the K-input of FF1 from Fig. 29 will show K is merely equal to 1, or always high.)

One item essentially ignored here has been the clock pulse. In actual circuits, the clock pulse is very important.

The frequency of the clock depends on the data transmission (baud) rate of the data line, and must be synchronized so that the clock pulse occurs as close to the middle of the bit time as possible. The clock pulse must not begin until all gates have had time to settle after the new input bit has arrived and must end before the next data bit arrives.

We have now gone through the basics of logic design, and you should be able to design most common types of circuits using methods that will produce a more efficient circuit. **R-E**

To Change		Input	
From	To	J	K
0	0	0	d
0	1	1	d
1	0	d	1
1	1	d	0

FIG. 33—TRUTH TABLE for parity circuit using J-K flip-flops.

P_1P_2 \ P_3x	00	01	11	10
00	0	0	0	1
01	0	1	0	0
11	d	d	d	d
10	d	d	d	d

FIG. 34—KARNAUGH MAP for J-input of flip-flop FF1.

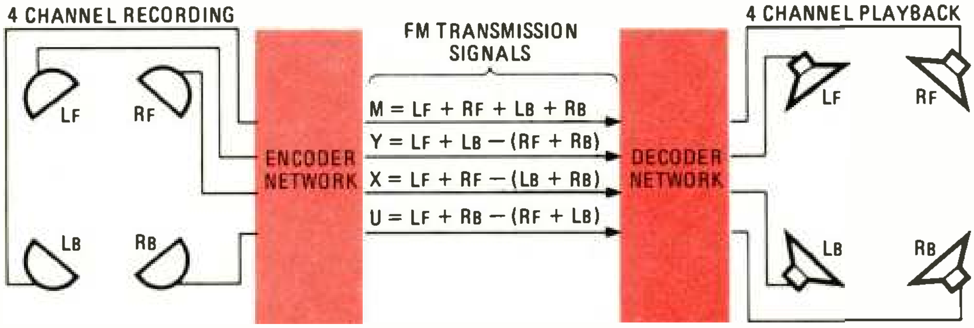


FIG. 1—DISCRETE 4-CHANNEL BROADCAST system uses four transmission channels. To maintain compatibility with existing stereo and mono receivers, the four channels are encoded at the transmitter and decoded at the receiver.

4-Channel FM

With discrete and matrixed 4-channel tape and phono formats dormant, the fight for 4-channel programmming continues on the broadcasting front.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

IT HAS BEEN SOME TIME SINCE WE DIScussed quadriphonic sound; indeed, superficially at least, it would seem that the audio industry and consumers alike have all but turned their backs on 4-channel sound. Very few, if any, 4-channel records are presently being released (although the number of available releases in all formats—matrix or discrete—exceeds 1000), and hi-fi component manufacturers have all but abandoned production of any quadriphonic reproducing equipment.

There is one aspect of the 4-channel scene that is very much alive—4-channel FM broadcasting. Back in March, 1972, when interest in quadriphonics was at its height, the Consumer Electronics Group of the Electronics Industry Association (EIA) voted to sponsor the organization of a National Quadriphonic Radio Committee (NQRC) whose objective was to report to the Federal Communications Commission its final technical conclusions regarding 4-channel FM sound broadcast standards. The FCC endorsed the study project and the NQRC plunged into its complex task of analyzing, evaluating and, finally, field-testing five proposed systems for discrete 4-channel FM broadcasting.

The work continued until late 1975 and, in November of that year, the final NQRC report was submitted to the FCC. Nearly two years later, on July 6, 1977, the FCC released its formal Notice of Inquiry (Docket 21310) on quadriphonic FM radio broadcasting, in which all interested parties were asked to comment on whether the FCC should adopt standards for 4-channel broadcasting. The Commission said that the purpose of the inquiry was to determine whether there was sufficient public and industry interest to warrant the adoption of standards and, if so, to assist the FCC in formulating such standards. The comment period, originally scheduled to end on September 15, 1977, was extended to December 15, 1977; and, from all accounts, more than a thousand letters were received by the time the comment period ended.

Several other events occurred almost simultaneously, two of which tended to complicate the issue. First, coincident with issuing the 4-Channel FM Notice of Inquiry, the FCC also issued a second Notice of Inquiry (Docket 21313) regarding AM stereophonic broadcasting. A growing interest has been shown on the part of AM broadcast stations for this type of service, largely because of the competitive advantage gained by FM stations over the last decade. This advantage has been attributed by many to the fact that FM stations can transmit stereo program material while AM stations must transmit monophonic programs. Many industry experts feel that the FCC is more likely to pay attention to AM stereo broadcasting before it ever considers the problem of 4-channel FM transmission.

The second event that occurred was sponsored by the FCC itself. The Commission was concerned that the NQRC had only included one matrix system in its report, and had *not* involved subjective listening evaluations of either the QS matrix system (developed by Sansui Corporation of Japan) or the SQ matrix system (originated by CBS in the U.S.). As they pointed out, since the work of the NQRC was completed, much-improved logic and phase cancellation decoders were designed and developed for the QS- and SQ-systems. As a result, the FCC felt that available test data comparing localization and musical preference for 4-4-4 (discrete), 4-3-4 (semidiscrete, using three channels of transmission to broadcast four channels of information) and 4-2-4 (matrix-encoded using two channels for transmission) quadriphonic systems is not complete with respect to presently available technology.

The FCC Lab decided to conduct its own listening tests, including the best implementation (based upon the listener's choice) of the QS format, SQ format and the British-sponsored BBC Matrix H systems, as well as the discrete 4-channel tapes. The results of these tests were issued by the FCC in August, 1977. In addition to judging quadriphonic performance, listeners were asked to evaluate the compatibility of the different formats—that is, how well the music was reproduced stereophonically and even monophonically—an important criterion in any decision affecting quadriphonic broadcasting standards.

The results of these tests have been interpreted by different listeners in different ways. Since, on an overall basis, listeners agreed that the direct 4-channel tape reproduction was the best, supporters of discrete 4-channel broadcasting are claiming a victory. Since, of all matrix systems tested, the CBS-developed SQ system (with its sophisticated logic decoder) was favored, CBS has also claimed a victory and has, in fact, suggested that the FCC not only *refrain* from enacting discrete 4-channel broadcast standards but actually set quadriphonic standards specifically endorsing the SQ format as the *only* matrix suitable for broadcast over FM channels.

Before we examine the logic (excuse the pun) of this argument, let's briefly review how the five proposed discrete 4-channel FM systems operate. All five systems are very similar. In fact, insofar as monophonic and stereophonic performance on existing FM tuners is concerned, the systems are identical. This similarity is a basic requirement of any quadriphonic system, since they must present uncompromised FM stereophonic and FM monophonic performance. Where the systems differ slightly is in their treatment of SCA (*S*ubsidiary *C*ommunications *A*uthorization) services, such as background music channels now broadcast as piggy-back subcarriers on FM stations on a private, point-to-point subscription basis, which, according to the FCC, should be provided for in any new standards to be proposed.

Monophonic compatibility

Assume that there are four inputs: Left-front (L_f), Right-front (R_f), Left-back (L_b) and Right-back (R_b). To preserve monophonic compatibility, the monophonic channel or baseband of the FM transmission (the region from 30 Hz to 15 kHz) must contain an equal summation of these four input signals designated as $M = L_f + R_f + L_b + R_b$. For stereo compatibility, the four signals are grouped as follows: $L_t = L_f + L_b$ and $R_t = R_f + R_b$. The values of L_t and R_t correspond to the left-total and right-total signals that should be heard in stereo. Just as in stereophonic broadcasting, they are also assigned to a difference subcarrier channel, as follows: $Y = (L_f + L_b) - (R_f + R_b)$. When these two signals are received by a standard stereophonic tuner or receiver, they are decoded as follows:

$$L_t = \frac{M + Y}{2} = L_f + L_b$$

$$R_t = \frac{M - Y}{2} = R_f + R_b.$$

Because of quadriphonic playback requirements, it is clear that two more transmission channels are needed, since, to solve for four unknowns, you must have four equations. The two additional transmission channels are defined as X and U, in which:

$$X = (L_f + R_f) - (L_b + R_b) \text{ and}$$

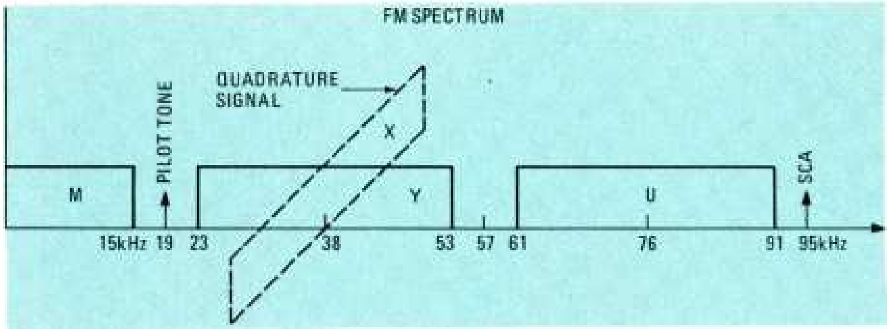


FIG. 2—FREQUENCY SPECTRUM shows how the two additional channels are added to an FM broadcast. This technique is used in the RCA and Quadracast discrete systems.

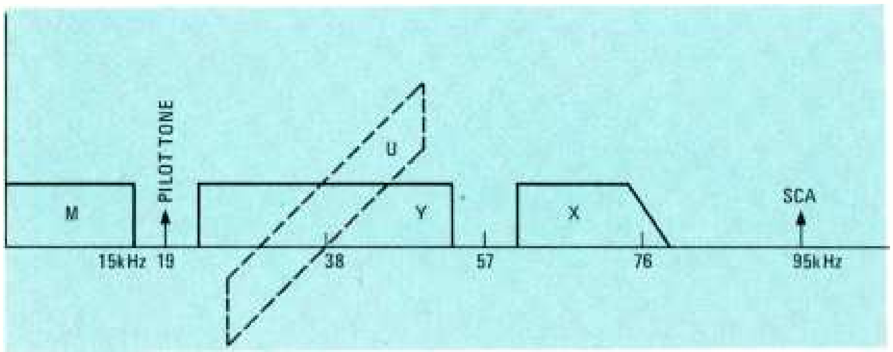


FIG. 3—FREQUENCY SPECTRUM of the GE broadcast system. The X transmission channel is added as a vestigial sideband.

$$U = (L_f + R_b) - (R_f + L_b).$$

We will show how all four signals can be accommodated in a single FM transmission. But, first, let's examine what the 4-channel decoder must do after it has recovered signals M, Y, X and U to solve for the four original, discrete signals:

$$L_f = \frac{M + Y + X + U}{4}$$

$$R_f = \frac{M - Y + X - U}{4}$$

$$L_b = \frac{M + Y - X - U}{4}$$

$$R_b = \frac{M - Y - X + U}{4}$$

Figure 1 shows the principle of discrete 4-channel FM broadcasting. The question is where to assign the extra transmission channels X and U, and how to allow for continued SCA transmission. Figure 2 shows the scheme used by two of the five proponents, Quadracast System, Inc., and RCA. The newly required X channel is centered at a frequency of 38 kHz (similar to the older Y channel required for stereo), but it is in quadrature with the Y channel. This means that the X channel will not be detected by a stereophonic receiver but by a properly designed 4-channel receiver having a synchronous detector designed for that quadrature signal. The U channel is transmitted via a new subcarrier signal centered at 76 kHz (four times the 19-kHz pilot-carrier frequency). The QSI format further proposes that the SCA channel be moved from its present frequency of 67 kHz to 95 kHz and that it be band-limited in order not to interfere with adjacent broadcast channels.

RCA proposes an additional scheme that allows the SCA to remain where it presently is. This is the so-called 4-3-4 or semidiscrete system mentioned earlier in this article. This system uses only three transmission channels (the U channel is dropped from its 76-kHz position in the spectrum), leaving room for the SCA channel at a frequency of 67 kHz. In this system, the recovered four channels include the following original signal components:

$$L_f = L_f + \tfrac{1}{3} L_b + \tfrac{1}{3} R_f - \tfrac{1}{3} R_b$$
$$R_f = R_f + \tfrac{1}{3} L_f + \tfrac{1}{3} R_b - \tfrac{1}{3} L_b$$
$$L_b = L_b + \tfrac{1}{3} L_f + \tfrac{1}{3} R_b - \tfrac{1}{3} R_f$$
$$R_b = R_b + \tfrac{1}{3} L_b + \tfrac{1}{3} R_f - \tfrac{1}{3} L_f$$

The last three components in each equation are crosstalk terms, but overall separation from one channel to any other channel is still just a bit less than 10 dB. This RCA option would be strictly up to the station owner (who wants to have an SCA subcarrier signal at 67 kHz), and receivers designed for regular 4-4-4 operation would require no modifications for the 4-3-4 system.

Another system, using the same baseband signals as those shown in Fig. 2, is the Cooper-UMX system. This scheme differs from the foregoing explanation in that it uses phasor encoding of the four input signals to create three different playback modes: A 4-2-4 matrix (similar to the QS- or SQ-matrix encoding), a 4-

3-4 playback scheme similar to the RCA optional system, and, finally, a full 4-4-4 discrete mode.

Frequency assignments for the General Electric system are shown in Fig. 3. The fourth X channel is transmitted as a set of vestigial lower sideband signals at a frequency of 76 kHz. This allows an SCA channel at a 95-kHz frequency with a greater guard band between it and the adjacent X channel subcarrier as compared with the RCA option.

Finally, Fig. 4 shows the Zenith proposal. The fourth transmission channel, the X channel, is placed at a 95-kHz frequency and uses lower sideband signals only, allowing for SCA transmission to take place at its currently assigned 67-kHz frequency. The Zenith system also uses an encode/decode noise-reduction system, similar to the Dolby system, in order to maintain a lower overall noise level; this helps to counter in part the signal-to-noise degradation that occurs whenever the spectrum width of a transmission system is increased.

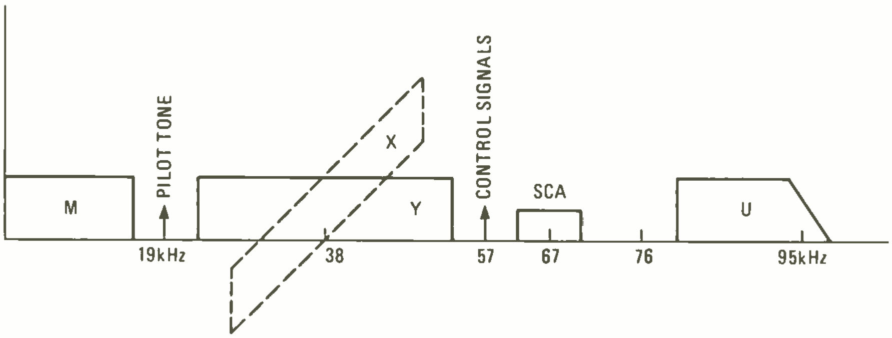


FIG. 4—ZENITH PROPOSAL places the SCA subcarrier at 67 kHz. This system also incorporates a noise reduction scheme.

Argument against a matrix standard

Proponents of the matrix system that was favored by the FCC's panel of listeners believe that this format should be approved as a standard at this time and that no discrete systems should be approved. What would this mean to the listening public? Admittedly, if a listener equipped his or her system with a sophisticated (and expensive) logic decoder such as that used in the FCC tests, results would approximate (but still not equal) those obtained with discrete 4-channel program material. However, if a simple matrix decoder were used, results would be far poorer than those obtainable from discrete program sources. In fact, some stations have been broadcasting matrix-encoded program material (in both QS- and SQ-formats) for some time and public reaction has been anything but enthusiastic. Locking into a matrix system as an FM standard at this time would halt further attempts to improve the matrix idea or to develop other (and perhaps better) matrix formats.

However, suppose the FCC selects one of the five discrete systems as a standard and suppose, further, that matrix programming improves substantially. In that event, there would be nothing to prevent a station from purchasing one (and only one) super-matrix-decoder—even a very expensive one—and *first* decoding the matrix-encoded source material into four discrete channels *before* it is transmitted. The home listener would *not* have reproduction quality determined by his or her financial limitations, since optimum decoding would take place at the station before transmission. This approach would keep the doors open for further improvements in matrix technology and would have many other advantages as well. FM stations could then transmit any and all formats of quadriphonic program material (instead of being limited to one specific matrix approach). Four-channel taped productions could be freely interchanged from one station to another, since no encoders or decoders would be required. Discrete broadcasts have proved to be fully compatible with all existing monophonic or stereophonic receivers. Furthermore, the matrix system still imposes certain artistic limitations upon record producers. A vocalist, for example, cannot be positioned at center-rear in the SQ system if full stereophonic and monophonic compatibility is to be maintained. Such limitations, although of relatively minor significance, are *not* imposed with any discrete system.

By the time you read this, the dates for filing comments and reply comments with the FCC will have passed. Nevertheless, we suspect that the FCC is not going to make any hasty decisions regarding 4-channel broadcasting. It does seem that by choosing a discrete broadcast standard, the FCC would let the final decision as to which kinds of quadriphonic records sound better remain where it belongs—with the public. A decision in favor of any matrix system as a standard would, we believe, be tantamount to taking away that freedom of choice from the music listeners of this country. **R-E**

Mobile radio market to double during 1980-1986

The Mobile Radio Market, a study conducted by the market research firm of Frost & Sullivan, Inc., predicts that the mobile radio equipment market will continue to expand and even double over the next 10 years, with a projected annual compounded growth rate during the period 1980-1986.

Among the factors involved in this projected growth rate are such innovations as 1) the use of digital instead of voice-generated messages in police mobile radios; 2) the increased use of voice scramblers; 3) a new consumer market in FM scanners monitoring police, fire and other public service departments; 4) the cellular approach to using the 800-900-MHz frequency band on mobile radios; and 5) the use of microprocessors and other LSI circuits in CB radios.

Despite the fact that land mobile radio equipment will be affected by declining unit prices, CB radio is expected to make a strong comeback in the vehicle market. Detroit car manufacturers plan to incorporate many more CB/AM-FM/tape deck combinations into a single passenger car unit.

The cellular concept to using the 800-900-MHz frequency band on mobile radios is "likely to be incorporated in leading U.S. cities," according to the study. Companies presently developing the cellular approach are the Bell System, American Radio-Telephone Service, and NTT in Japan.

More information can be obtained from Frost & Sullivan, Inc., Customer Service, 106 Fulton Street, New York, NY 10038.

Motorola's microwave system is an alternative to land lines

Motorola, Inc., has developed a microwave communications system called the Point-to-Point Wireless Visual Communications System that is used with CCTV cameras, lenses and other equipment to transmit a closed-circuit video image wherever installation of land lines is difficult or impossible.

Motorola indicates that the VCS would enable video transmissions to be made up to 10 miles in line of sight just using a single transmitter and receiver. Another advantage cited for the VCS is that users can change the location of transmission or reception sites. Further information can be obtained from Motorola Literature Distribution Center, 2122 North Palmer Dr., Schaumburg, IL 60195.

IHF to set technical standards for turntable/cassette/speaker criteria

In answer to a growing need among high-fidelity manufacturers for acceptable industry measurement standards in differentiating between high- and low-fidelity products, the Institute of High Fidelity (IHF) Board of Directors has organized standards committees to evaluate and discuss criteria for turntables, cassette recorders and speakers.

The first meeting of the IHF Turntable Standards Committee, chaired by Martin Fine of B.I.C./Avnet, set its goals for achieving its industry standard: It would attempt to 1) develop a glossary of technical terms; 2) separate these terms into primary and secondary groups; 3) develop measurement standards for both groups; and 4) devise a set of standard test conditions. **R-E**

Radio-Electronics Tests Tandberg TDA-20A Open-Reel Tape Deck

1

CIRCLE 112 ON FREE INFORMATION CARD

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

TANDBERG OF AMERICA, INC. (LABRIOLA COURT, Armonk, NY 10505) has developed an open-reel tape deck, the *model TD-20A*, that incorporates several electronic and mechanical innovations. The tape deck incorporates a new actilinear recording system that offers up to 20-dB improvement in headroom over most conventional systems. In addition, the tape-transport system uses four separate motors, including a motor for the pinch roller and tape guides.

Figure 1 shows that the *model TD-20A* can handle 10½-inch tape reels. On the front panel, three rectangular pushbuttons to the left below the feed reel handle power, select low or high speed and select the correct tape tension for large or small reels. Below these pushbuttons are rotary left- and right-channel output-level controls, while below them are four toggle switches. The left pair of toggle switches selects playback mode (left channel only stereo or right channel only), and source or tape monitoring. The right-hand pair of toggle switches activates the select-synchronization feature (in multitrack recordings the record head acts as a monitoring playback head when a second track is added in sync with the first recorded track). These same switches also handle the edit-cue function that enables you to hear recorded results as you fast-wind the tape for cueing and editing.

A pair of brightly illuminated VU meters, centered below the tape head assembly, are calibrated from −24 dB to +3 dB. However, it must be emphasized that the 0-dB level on these meters corresponds to a +9-dB level referenced to the standard NAB level of 185 nanowebers. These meters read peak signals, and are positioned in the signal path *beyond* the record-equalization circuits so that readings (regardless of the signal frequency being recorded) are directly related to the levels of magnetization applied to the tape.

Below the meters are a headphone output jack and two microphone input jacks. Below the takeup reel is a four-digit counter, while lower down, in the light-colored section of the panel, are five rectangular tape-transport pushbuttons: RECORD, REWIND, STOP, WIND (fast-forward) and PLAY. For the tape deck to be in the record mode, you must turn on separate left- and right-channel selector switches located on the bottom right of the panel. When either of these switches is engaged, a standby light above the RECORD switch illuminates, and touching the RECORD pushbutton starts the tape and places the tape deck in the record mode. This arrangement permits so-called "flying start" recording—inserting newly recorded signals on cue, as the machine plays back previously recorded program material.

When the STOP/WIND (fast-forward) pushbuttons are pressed simultaneously, the logic-control transport system completely frees both reels, permitting you to hand-cue the reels to a precise syllable or note in a recording. All transport modes are indicated by LED's above each transport pushbutton.

Below the transport-control pushbuttons are two pairs of input-level controls; the first pair of controls handles Line 2 or microphone input signals, and the second pair adjusts the level of Line 1 inputs. This provides full mixing capability for up to four line inputs, or two line inputs plus two microphone inputs. Once these four controls are properly adjusted, a master level control to the right of the Line 1 controls takes care of the overall level. A socket for connecting an optional remote-control attachment is located above this master level control. A two-position toggle switch at the lower right of the front panel provides selectable 25-dB attenuation for the microphone inputs, in case high-output microphones are used that might necessitate inconvenient and inaccurate settings of the separate microphone record level controls.

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Tape Speeds: 7½ ips and 3¾ ips. **Wow and Flutter:** 0.06% at 7½ ips; 0.10% at 3¾ ips, WRMS. **Frequency Response (Maxell UD-XL Tape or Equivalent):** 20 Hz to 22,000 Hz, ±2.0 dB at 7½ ips; 20 Hz to 18,000 Hz, ±2.0 dB at 3¾ ips. **S/N Ratio (A-Weighted):** 66 dB at 7½ ips. **Crosstalk:** 60 dB, mono; 50 dB, stereo. **Harmonic Distortion:** for 0 dB at 7½ ips, 2.0%. **Input Sensitivity:** mike, 0.2 mV; line, 50 mV. **Output Level:** line, 1.5 volts; headphone, 5 mW into 8-ohm loads. **Erase Coefficient:** better than 70 dB. **Suggested Retail Price:** $1300; optional wireless PCM infrared remote-control unit, approximately $200.

Other features

The *model TD-20A* uses no solenoids or mechanical relays, which results in an unusually quiet and noise-free performance. The drive motor is a phase-locked brushless synchronous motor with a belt-drive flywheel and capstan. A separate motor for the pinch roller and tape guides provides smooth and click-free tape positioning that Tandberg claims provides more precision and gentler tape handling.

PROM electronic speed regulation combined with triac-controlled direct-drive supply-reel and takeup-reel motors facilitate efficient fast-forward and rewind-tape tension. Separate power supplies take care of operational and audio-signal functions. This reduces the possibility of thermal stress in the electronic components and insures that external electrical disturbances do not affect sound quality. Complete logic control allows rapid transition from mode to mode, and assures gentle tape handling with controlled tension.

There are special phase-linearity correction circuits in the signal-handling electronic amplifiers of the *model TD-20A*. In addition, "echo" and sound-on-sound recording can be performed through external coupling from line outputs to line inputs on the rear panel.

Laboratory measurements

In previous tests on Tandberg audio products, we have noted that this company is extremely conservative when it comes to published specifications. Their tendency to understatement applies no less to the *model TD-20A*. In actuality, the open-reel deck measured much better than the company's published specifications indicate.

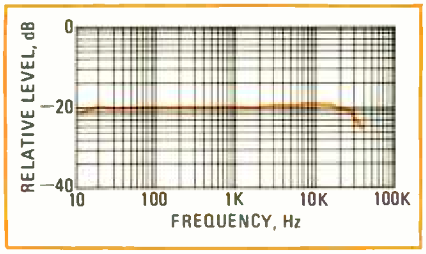


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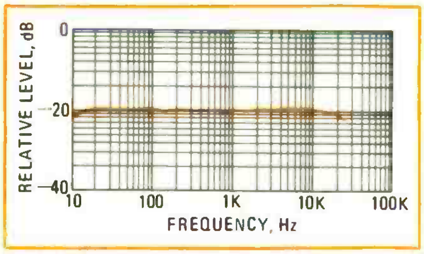
Figure 2 shows the frequency response for Maxell UD tape operating at the higher 7½-ips speed; it was measured at a −20-dB level (referenced to the standard NAB 0 VU level). This level is actually 29 dB below the 0-dB readings on the VU meters. Response was flat to within ±2 dB from 15 Hz to 32 kHz, and variations within the audio spectrum never exceeded 1.0 dB above or below the 1-kHz reference level.

Perhaps even more amazing was the frequency response measured for the slower 3¾-ips speed, also using the same grade of tape. (See Fig. 3.) In this case, the −2-dB points were observed at 10 Hz and a superaudible 24 kHz. In separate tests, we determined just how "hard" we could record a high-frequency signal onto this tape sample. Increasing the mid-frequency record level for maximum output (the point where further increases in input level do not produce additional linear increases in recorded playback level), we noted that at the higher 7½-ips speed we could record a 10-kHz signal to a level only around 6.5-dB lower than that recorded at mid-frequencies before obtaining maximum output level.



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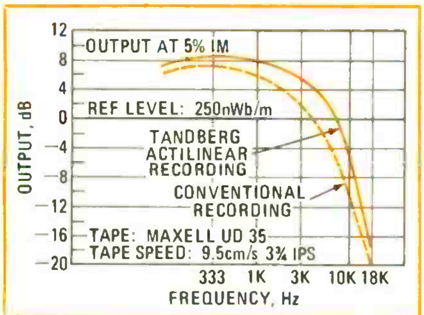
For the slower 3¾ ips speed, the maximum recording-output level obtainable at 10 kHz was approximately 14.0 dB below the mid-frequency maximum output level. These values are considerably better than those usually obtained when this tape is used on other decks, and underline the advantages of Tandberg's new recording electronics.

The Fig. 4 chart (supplied by the manufacturer) shows the practical reel-to-reel record-



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ing benefits provided by Tandberg's actilinear recording system, and also indicates the added dynamic range available at the slow 3¾-ips speed at all frequencies from 333 Hz up. In Fig. 4, the 0-dB reference level is taken as 250 nanowebers per millimaxwell, or approximately 2.6 dB above the standard NAB reference record level. Results of our lab measurements are shown in Table 1.

Summary

Table 2 summarizes our overall product evaluation together with comments.

We spent a great deal of time with the *model TD-20A* on the lab test bench and used it to record a variety of program material. Playback reproduction is excellent, and it is hard to imagine that any features have been left out.

With so many companies concentrating solely on improved stereo cassette decks these days, it is refreshing to find a manufacturer paying attention to the needs of those who still prefer and need a top quality open-reel tape deck. **R-E**

TABLE 1

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Tandberg of America, Inc.** Model: **TD-20A**

OPEN-REEL TAPE DECK MEASUREMENTS

FREQUENCY RESPONSE MEASUREMENTS	R-E Measurements	R-E Evaluation
STANDARD TAPE		
Frequency response at 15 ips (Hz-kHz ± dB)	N/A	
Frequency response at 7½ ips (Hz-kHz ± dB)	15 -32, −2.0	Superb
Frequency response at 3¾ ips (Hz-kHz ± dB)	10 -24, −2.0	Superb
CRO_2 TAPE		
Frequency response at 15 ips (Hz-kHz, ± dB)	N/A	
Frequency response at 7½ ips (Hz-kHz, ± dB)	N/A	
Frequency response at 3¾ ips (Hz-kHz ± dB)	N/A	
	(See Figs. 2, 3)	
DISTORTION MEASUREMENTS (RECORD/PLAY)		
Harmonic distortion at −10 VU (highest speed) (%)	N/A	
Harmonic distortion at −3 VU (highest speed) (%)	N/A	
Harmonic distortion at 0 VU (highest speed) (%)	1.5	Good (See text)
Harmonic distortion at +3 VU (highest speed) (%)	3.0	Good (See text)
SIGNAL-TO-NOISE RATIO MEASUREMENTS		
Best S/N ratio, standard tape (dB)	66	Excellent
Best S/N ratio, CRO_2 tape (dB)	N/A	
MECHANICAL PERFORMANCE MEASUREMENTS		
Wow and flutter at 15 ips (% WRMS)	N/A	
Wow and flutter at 7½ ips (% WRMS)	0.012	Superb
Wow and flutter at 3¾ ips (% WRMS)	0.04	Superb
Rewind time, 2500-foot tape (seconds)	70	Excellent
COMPONENT MATCHING CHARACTERISTICS		
Microphone input sensitivity (mV)	0.2	
Line input sensitivity (mV)	42	
Line output level (mV)	1400	
Phone output level (mV or mW)	5.0 mW/8 ohms	
Bias frequency (kHz)	125 kHz	
TRANSPORT MECHANISM EVALUATION		
Action of transport controls		Superb
Tape guidance system		Excellent
Absence of mechanical noise		Superb
Tape head accessibility		Good
Construction and internal layout		Excellent
Evaluation of extra features, if any		Superb
OVERALL TAPE DECK PERFORMANCE RATING		Superb

OVERALL PRODUCT ANALYSIS

Retail price	**$1300**
Price category	**High**
Price/performance ratio	**Excellent**
Styling and appearance	**Superb**
Sound quality	**Superb**
Mechanical performance	**Excellent**

Comments: There are so many new features in this Tandberg open-reel machine that a brief summary can hardly cover all points. Perhaps the most important feature is its capability of accepting new tapes (such as metal-particle tape) that may soon be available for open-reel decks. The bias adjustments on the front panel have sufficient range to handle the higher bias requirements of such future high-coercivity tapes. Additionally, the system's record electronics (called actilinear recording) provides more than enough recording headroom to handle those future tapes.

One of the most welcome new features is the freewheeling tape mode which, with the aid of the EDIT-CUE switch, permits about the easiest and quickest tape editing we have ever had the pleasure of using. When the STOP and fast-forward pushbuttons are touched simultaneously, both feed and takeup reels become completely freewheeling.

Tape is handled about as gently as on any machine (home or professional) we have ever tested. The four-motor drive system produces precise and unwavering tape transport, as evidenced by the excellent wow-and-flutter values shown in Table 1 for both its higher and lower tape speeds.

We have always appreciated Tandberg's post-equalization metering system that informs the user what signal intensities are actually reaching the tape. High frequencies, which are subjected to more boost by the equalization constants, show up as higher meter indications on this well-calibrated metering system, which is readable with pinpoint accuracy to better than one-half of 1 dB.

Sound reproduction via tape, even at the lower speed, is virtually indistinguishable from the original program source and that is the ultimate test for any cassette or open-reel tape deck. Although the Tandberg *model TD-20A* is fairly expensive, it is worth every penny of its price.

Pioneer Model TVX-9500

TV Audio Tuner

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

CONSUMER ELECTRONICS EXPERTS HAVE LONG been predicting the imminent marriage between audio and video. The introduction of the *model TVX-9500* TV Audio Tuner by U.S. Pioneer Electronics (750 Oxford Drive, Moonachie, NJ 07074) may well signal the beginning of that union. This tuner's appearance on the market is particularly timely, in view of some behind-the-scenes technology that has been taking place recently in TV broadcasting.

After many years of relaying the audio portions of a TV program from studio to transmitter via standard telephone lines (rented from A.T.& T. or other phone companies), a method of diplexing audio signals along with the video signals on the wideband coaxial cables is now being used. This new method permits TV broadcasters to transmit a full-fidelity audio signal whose response is identical to that of FM radio broadcasts. Thus, the audio portion of TV programs (long considered an industry "stepchild") is beginning to take a turn for the better.

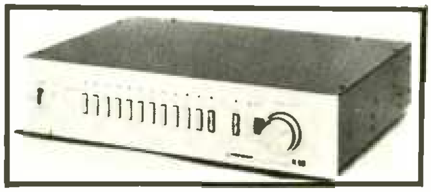
For some time, Public Broadcasting Service (which is noncommercial educational television) has been using satellite communications so that in this area, too, high-quality audio transmission has been possible. Still, as we all know too well, the 3-inch-diameter speakers in most TV sets, driven by minimal-quality one-stage mini-wattage amplifiers, severely limit audio quality. Attempting to bypass the poor-quality TV audio is loaded with problems (and dangerous, since most sets have no transformer isolation between power line and chassis).

Figure 1 shows the *model TVX-9500*, which is really just a good-quality FM tuner, whose range covers TV audio Channels 2 through 13 and UHF Channels 14 through 83.

The slim gold-anodized front panel contains a power on/off switch on the left. The remainder of the panel contains 12 slim pushbuttons labeled with channel numbers 2 to 13, above which are tiny indicator lights. To receive the audio frequencies from UHF TV channels, the UHF pushbutton is depressed, and a continuously variable tuning knob indicates approximate channel numbers in an adjacent window. A green LED indicator lights up when optimum tuning has been achieved.

Although automatic frequency control (AFC) locks desired sound-carrier frequencies for each channel, there are individual screwdriver VHF channel controls on the underside of the unit, along with an AFC defeat switch, for additional tuning adjustment, if necessary. Defeating the AFC also defeats the built-in muting circuit that normally delays sound activation for about two seconds after a given channel button is depressed.

Figure 2 shows the rear-panel layout, as well as how to connect the *model TVX-9500* to a typical high-fidelity component system. Although two output jacks are provided, the TV audio signals recovered are, of course, not stereophonic. But connecting the unit to both the left- and right-channel auxiliary or tuner input jacks on your amplifier or receiver enables sound to be heard from both stereo speakers. If a single output connection is made, the same results are obtained by switching the amplifier or receiver mode selector to monophonic. Separate antenna screw-terminals are provided for connecting an outdoor VHF antenna and an outdoor UHF antenna, and are intended for a 300-ohm twin-lead transmission line. A 75-ohm unbalanced line terminal is provided for the VHF antenna only, if you wish to use a coaxial line input from that antenna.



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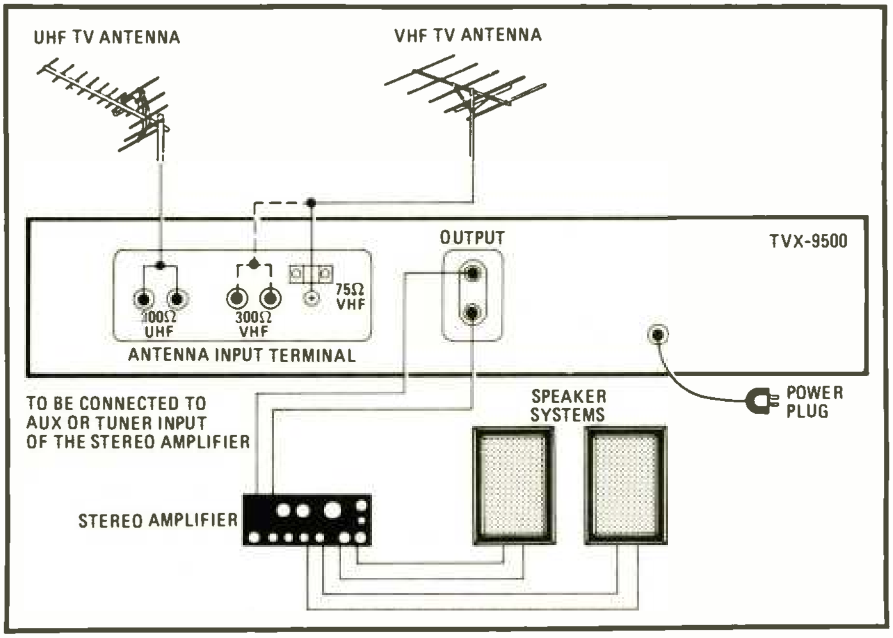

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MANUFACTURER'S PUBLISHED SPECIFICATIONS:

50-dB Quieting: 22 μV (32 dBf). **S/N Ratio at 85 dBf:** 65 dB. **THD at 65 dBf:** 0.07% at 100 Hz and 1 kHz; 0.2% at 6 kHz. **Capture Ratio:** 1.0 dB. **Alternate Channel Selectivity:** 25 dB. **Frequency Response:** 50 Hz to 10 kHz, +0.5, −1.0 dB. **Spurious Response:** VHF, 50 dB; UHF, 40 dB. **Image Rejection:** VHF, 50 dB; UHF, 40 dB. **IF Rejection:** VHF, 50 dB; UHF, 55 dB. **AM Suppression:** 50 dB. **Muting Threshold:** 28 μV (34.1 dBf). **Output Level:** 400 mV (for a 25-kHz deviation). **Power Requirements:** 120 volts, 60 Hz, 12 watts. **Dimensions:** 16⁹⁄₁₆ W × 3⅞ H × 13¾ inches D. **Weight:** 13 lbs, 7 oz. **Suggested Retail Value:** $250.

Test procedures and results

As noted, in the *model TVX-9500*, TV audio is broadcast in FM. While standard 75-μs pre-emphasis and de-emphasis are used, the maximum allowable modulation is only one-third as great as that used in FM radio broadcasting, or ±25 kHz. Compared with an FM tuner, therefore, there is a built-in penalty of 10-dB insofar as signal-to-noise ratio is concerned. On the other hand, the bandwidth requirements of the IF stages and FM detector stages are not as strict, and you could expect very low audio distortion.

In all other respects, the measurements shown in Table 1 were similar to those of any high-quality FM tuner, although, of course, stereophonic performance measurements were not applicable. We did however measure signal-to-noise ratio at 85 dBf instead of the usual 65 dBf. An 85-dBf value corresponds to approximately 10,000 μV of signal strength, while 65 dBf (generally used when measuring ultimate FM tuner and receiver sensitivity) is more nearly 1000 μV across a 300-ohm input. In addition to correlating our results with those in the manufacturer's specifications, we justified the higher signal strength because TV transmitter power is ordinarily much greater than the power which FM station broadcasters are permitted to use; therefore, we can assume that if a good outdoor TV antenna is hooked up to the *model TVX-9500*, signal reception will also be stronger than that for FM tuners and receivers.

The Pioneer "alternate channel selectivity" specification was puzzling since this could not refer to an "alternate channel" 12 MHz away from the desired signal (or the spread between the audio carrier of Channel 7 and Channel 9, for example)! We concluded that selectivity was cited as it would be for an FM tuner, and our measurements confirmed this.

Considering the stronger TV audio transmission signals, the Pioneer *model TVX-9500* performed remarkably well in sensitivity, 50-dB quieting and, most particularly, in S/N ratio and distortion values. To obtain these low distortion figures, it was necessary to trim the channel tuning slightly. Our measurements were conducted with the tuner set for Channel 6. The audio carrier for this channel is at 87.75 MHz—close enough to the edge of the standard FM band for us to be able to tune our FM signal generator "on frequency." Listening tests, however, were conducted for all available TV channels in our viewing area and we could not audibly detect any audio distortion for any channel (aside from the obvious deficiencies in the fidelity of the program sources broadcast at that time).

Summary

Our overall product analysis of the *model TVX-9500* TV Audio Tuner is given in Table 2, along with our summary comments.

Frequency response was fairly flat out to 10 kHz, but was down about 5 dB at 15 kHz, the theoretical limit of TV audio broadcast capability. Still, it is amazing what TV sound can be like when it is flat even out to 10,000 Hz and is free of the distortion normally heard when such sound is reproduced by standard TV circuitry. If all TV broadcasters would pay some attention to the quality of audio they transmit, products such as the *model TVX-9500* should do very well. And, who knows, perhaps the FCC may now reconsider the possibility of stereo-audio transmission on TV as well. **R-E**

TABLE 1

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: U.S. Pioneer Electronics — Model: TVX-9500

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
IHF sensitivity, mono: (μV) (dBf)	2.5 (13.2)	Good
Sensitivity, stereo (μV)	N/A	
50-dB quieting signal, mono (μV)	8.0 (23.3)	Fair
50-dB quieting signal, stereo (μV)	N/A	
Maximum S/N ratio, mono (dB)	75	Excellent
Maximum S/N ratio, stereo (dB)	N/A	
Capture ratio (dB)	1.2	Excellent
AM suppression (dB)	50	Fair
Image rejection (dB)	52 (VHF)	Good
IF rejection (dB)	50 (VHF)	Fair
Spurious rejection (dB)	55 (VHF)	Fair
Alternate channel selectivity (dB)	25	See text
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz (± dB)	50 − 10, ± 2.0	Fair
Harmonic distortion, 1 kHz, mono (%)	0.065	Superb
Harmonic distortion, 1 kHz, stereo (%)	N/A	
Harmonic distortion, 100 Hz, mono (%)	0.17	Good
Harmonic distortion, 100 Hz, stereo (%)	N/A	
Harmonic distortion, 6 kHz, mono (%)	0.21	Excellent
Harmonic distortion, 6 kHz, stereo (%)	N/A	
Distortion at 50-dB quieting, mono (%)	0.25	Excellent
Distortion at 50-dB quieting, stereo (%)	N/A	
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV)	N/A	
Separation, 1 kHz (dB)	N/A	
Separation, 100 Hz (dB)	N/A	
Separation, 10 kHz (dB)	N/A	
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	30 (34.7)	Good
Dial calibration accuracy (± kHz at MHz)	See text	Excellent
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		Excellent
Ease of tuning		Excellent
Accuracy of meters or other tuning aids		Excellent
Usefulness of other controls		N/A
Construction and internal layout		Excellent
Ease of servicing		Excellent
Evaluation of extra features, if any		Good
OVERALL FM PERFORMANCE RATING		Good

TABLE 2

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: U.S. Pioneer Electronics — Model: TVX-9500

OVERALL PRODUCT ANALYSIS

Retail price	$250
Price category	Medium
Price/performance ratio	Good
Styling and appearance	Excellent
Sound quality	Excellent
Mechanical performance	Very good

Comments: For the audiophile who has almost given up trying to find a TV receiver that contains a "high-fidelity" audio section, U.S. Pioneer's innovative *model TVX-9500* TV audio tuner will be welcome. However, two points must be kept in mind: First, when you hook up this unit to your hi-fi system, don't expect every TV channel to deliver the high-quality audio delivered by your other hi-fi program sources. Much audio programming we listened to with the *model TVX-9500* is still of poor "telephone line" quality, even though the potential for full 15-kHz frequency response exists. We particularly noted that the audio quality of many TV commercials is poor and voices are reproduced no better than from a low-cost AM table radio. Obviously, even the *model TVX-9500* cannot add to fidelity that was never there originally.

Second, a *good* outdoor antenna should be used with this tuner. Although lower TV audio modulation levels are partly offset by the higher TV signal strengths (compared with those of FM radio stations), multipath distortion is a problem unless a correctly oriented antenna is used with the tuner. A totally separate antenna is preferable, but if you must use a "splitter" on your regular TV antenna even that will be better than using the indoor dipole supplied with the *model TVX-9500*. This is especially important since the unit's AM rejection ratio is not nearly as high as on hi-fi FM tuners. The best results were obtained from our commercial-free Public Broadcasting Service station whose audio quality was exceptional.

NOM Card For The 1802

Part 2—Add-on math board for an 1802-based microcomputer. Based on a number-crunching IC, this board speeds execution time, reduces software overhead and saves memory

L. STEVEN CHEAIRS

LAST MONTH WE LOOKED AT HOW THE NOM card reduces computer memory requirements and increases processing speed by eliminating number-crunching software routines. This month, we present final construction details.

Construction

The components used in this project are all readily available; assembly is straightforward; and the circuit can be wire-wrapped or built on a PC card.

Use a double-sided glass epoxy circuit board with 2-ounce copper foil (available from Questar). A heavy plate layer covers all runs, and the holes are plated-through. The card has gold-plated fingers and a solder mask. For those who wish to etch the circuit board themselves, the foil patterns are shown in Figs. 8 and 9.

In assembling the board, pay special attention to component orientation. Figure 10 shows the correct placement and orientation of all the components and Fig. 11 shows the PC board pinout and switch placement. First, install and solder all resistors, capacitors and diodes. Connect the +5-volt and −15-volt leads, (the −4 volts is derived from the −15-volt source) and methodically test all power-supply pads for the proper voltages. If the power levels are OK, disconnect the power and install the IC's; if not, check for possible shorts or faulty components. No calibration is required.

Check-out and operation

Check-out and operation is theoretically very simple. First, enter the first number into the X-register. Follow this with the next number; all numbers enter the X-register. Execute a math operation, such as an ADD. Enter and execute an OUT instruction. If the correct answer is obtained, then 90% of the test is complete, and the only remaining functions to test are error and branch. If you did not receive the correct answer, check to see if

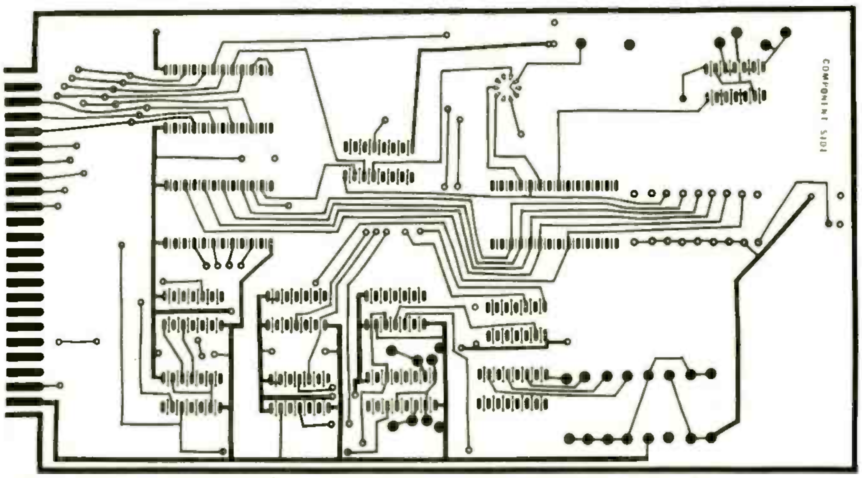


FIG. 8—PRINTED CIRCUIT PATTERN for the component-side of the NOM card.

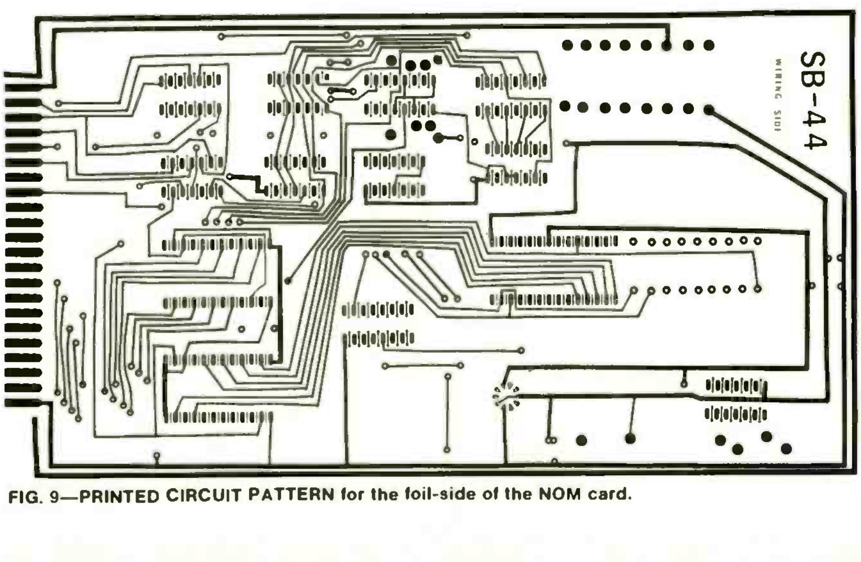
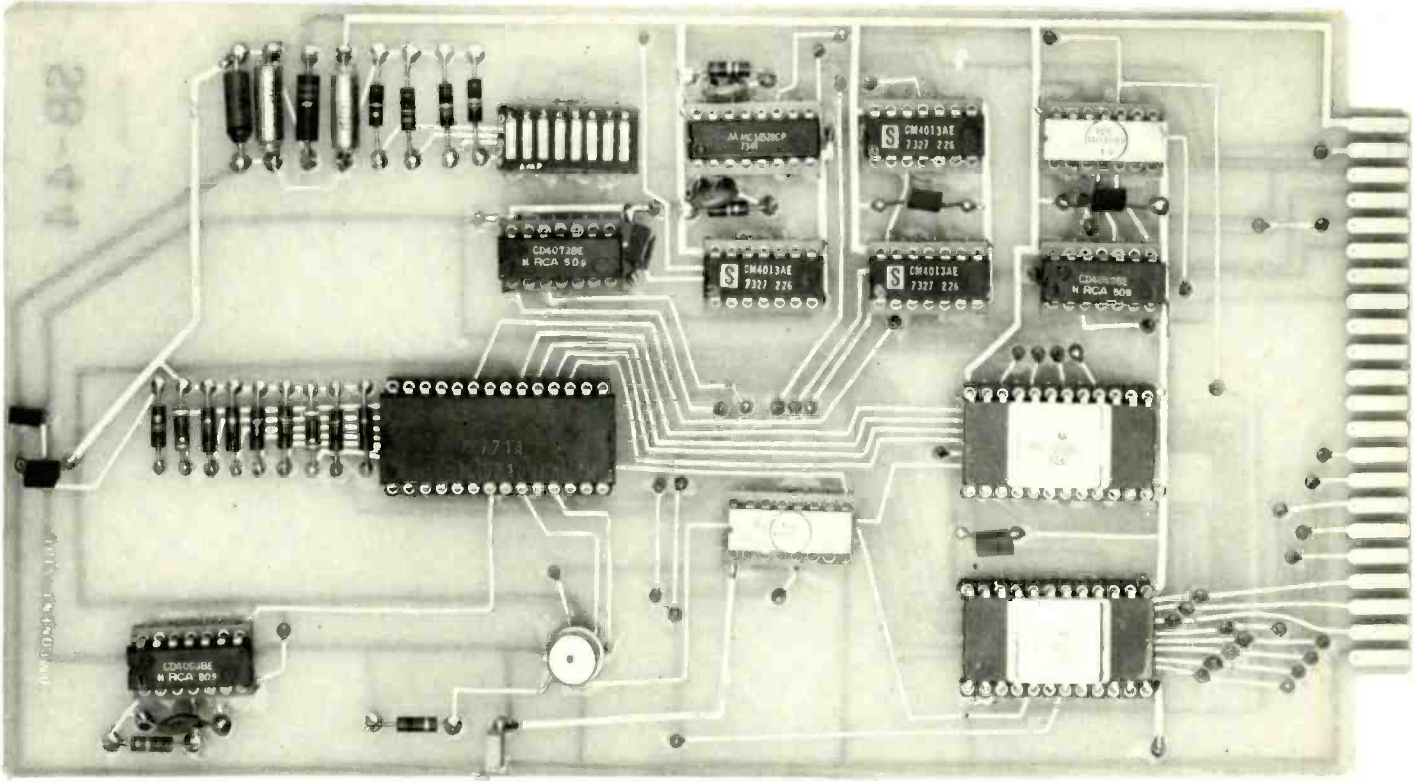


FIG. 9—PRINTED CIRCUIT PATTERN for the foil-side of the NOM card.



all the DIP switches were closed; if so, then recheck component placement and orientation. If no mistake was made (and you have programmed the 1802 correctly), then a component failure has occurred. Use normal digital troubleshooting techniques to isolate and solve the problem.

Now, enter a branch instruction to see if the branch outline interrupts the 1802. If this works, proceed to the final test. Enter a zero into the X-register, then execute the 1/x instruction. If an error occurs, you have completed the NOM interface; if not, check the error flip-flop.

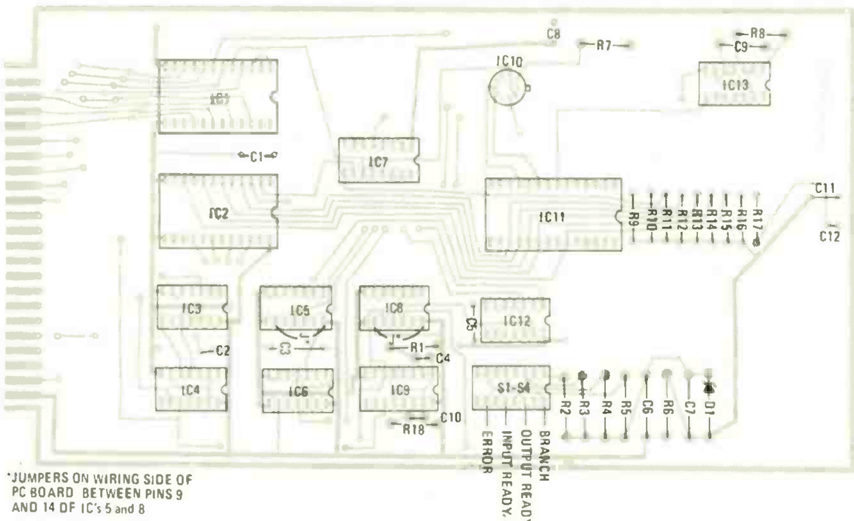


FIG. 10—COMPONENT PLACEMENT DIAGRAM shows where the parts go on the circuit board.

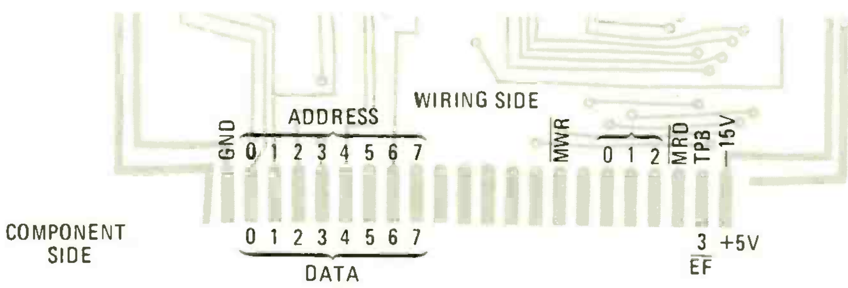


FIG. 11—PINOUT DIAGRAM shows where connections on the circuit board go.

The basic operation is outlined in the flowchart shown in Fig. 12. The user program first places the numbers in a FIFO table along with the required mathematical operations. Enter the first number into the X-register, then exchange the X- and Y-registers. Now, enter the next number into the X-register, then perform the desired operations. Enter the next number (if any) and perform the desired operations. Continue until all numbers and operations are completed. Execute an OUT instruction, store the digits into the user's FIFO table and return to the user program. The above description implies that the 1802 is tied up 100% of the time with the NOM, but actually a very small percentage of the 1802's time is spent with the NOM during these operations. The 1802 only moves data/instruction into (and out) of the NOM; most of the time it is used to perform mathematical calculations or to manipulate data inside the NOM. During this time the 1802 is free to perform other tasks.

Programming the NOM

The NOM has 70 instructions that can be classified into seven groups: Digit entry, move, math, clear, branch, input/output, and mode control. Table 3 lists the mnemonics for these instructions and the associated binary code. (A detailed description of what each instruction does; including the mnemonic, octal op-code and execution time; can be obtained by sending a SASE with 28¢ postage to NOM Instructions, **Radio-Electronics,** 200 Park Ave. South, New York, NY 10003.—Editor)

The first class of instruction—digit entry—has 17 members. The stack is pushed and the X-register is cleared when a digit, a decimal point, or a π is entered with an AIN, 0-9, DP, or PI instructions. After "initiation of number entry," the digit and future digits are entered into the X-mantissa. Any digits following the eighth mantissa digit are ignored, and any subsequent entry of digits or DP, EE, or CS instructions do not cause initiation of number entry. Termination of the number-entry mode occurs when any instruction is executed (except 0–9, DP, EE, CS, PI, AIN, or HALT). When termination occurs, two things happen. First, the number is normalized by adjusting the exponent and decimal point position. The decimal point is placed to the right of the first digit. Second, the next digit, π, or decimal point entered causes initiation of number entry. As you might expect, there is an exception to the number-entry initiation rule. The stack will not be pushed if the ENTER instruction occurred prior to the entered digit; the X-register, however, is still cleared and the new digit is entered into the X-register.

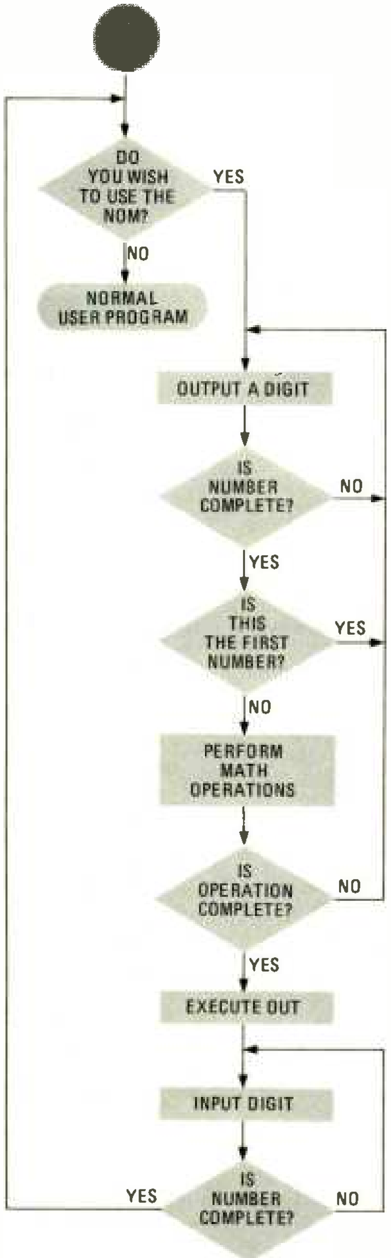


FIG. 12—TYPICAL OPERATION PROCEDURE for the 1802's interface program.

TABLE 3—Instruction Summary Table

I_{4-1} $I_6I_5 \rightarrow$	00	01	10	11
0000	0	TJC	INV	XEY
0001	1	TX=0	EN	EX
0010	2	TXLTO	TOGM	10X
0011	3	TXF	ROLL	SQ
0100	4	TERR	SIN(SIN^{-1})	SQRT
0101	5	JMP	COS(COS^{-1})	LN
0110	6	OUT	TAN(TAN^{-1})	LOG
0111	7	IN	SF1	1/X
1000	8	SMDC	PF1	YX
1001	9	IBNZ	SF2	+(M+)
1010	DP	DBNZ	PF2	−(M−)
1011	EE	XEM	ECLR	x(Mx)
1100	CS	MS	RTD	/(M/)
1101	PI	MR	DTR	PRW1
1110	AIN	LSH	POP	PRW2
1111	HALT	RSH	MCLR	NOP

(Note: All 00 instructions do not terminate number entry)

The IN instruction is used to enter all digits of a number; it does not cause number-entry initiation. However, it does terminate this mode if the NOM is in that mode prior to the IN instruction being executed. Thus, 0–9, AIN and IN instructions can be mixed without performing an ENTER instruction before the IN instruction. The IN instruction always pushes the stack except if the previous instruction was an ENTER, thus allowing multiple IN instructions to be executed without performing an ENTER between them.

Second, the move instruction group has eight parts: ROLL, POP, XEY, XEM, MS, MR, LSH, and RSH. The ROLL instruction simply rolls the stack (X→T, T→Z, Z→Y, Y→X). The POP instruction causes the following sequence: Y→X, Z→Y, T→Z, O→T. The XEY instruction exchanges the X- and Y-registers; while XEM exchanges the X- and M-registers; the MS instruction is memory-store (X↔M); MR is memory-recall (M↔X); and LSH and RSH are shift mantissa instructions.

Third, the math group is composed of 24 instructions. As mentioned earlier, this instruction set is available from **Radio-Electronics** Editorial Offices upon receipt of a SASE with 28¢ postage.

Fourth, the clear group has only two instructions: MCLR and ECLR. Instruction MCLR is the master clear instruction for all internal registers and memory. It also initializes the I/O control signals—MDC = 8 and MODE = floating point. Instruction ECLR is the error flag clear; it loads the error flip-flop with a zero.

Fifth, the branch instruction has eight instructions divided into two subgroups—test and count. The test group is formed by the JMP, TJC, TERR, TX = 0, TXF, and TXLTO. The count subgroup contains instructions IBNZ and DBNZ.

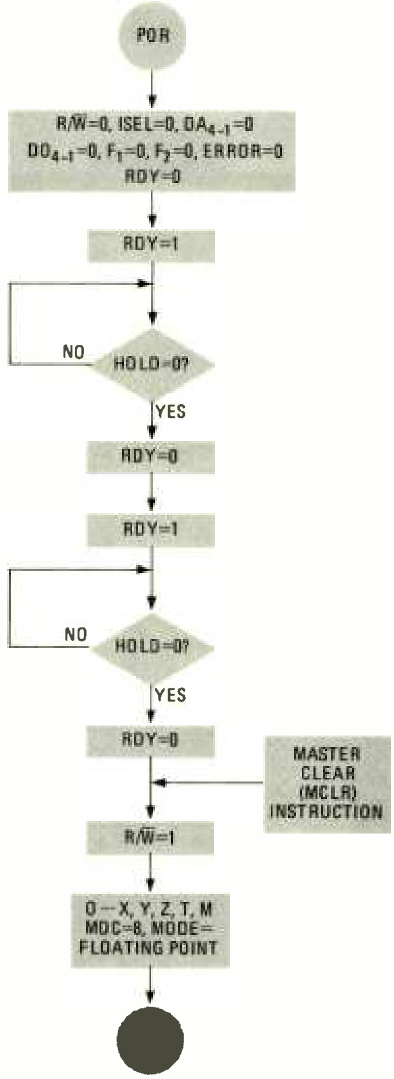


FIG. 13—INSTRUCTION fetch and execution flowchart defining the initialization routine.

Sixth, the input/output group is composed of nine instructions that can be divided into three subgroups: multidigit instructions (IN, OUT), single-digit instructions (AIN), and flags (SF1, PF1, SF2, PRW1, PRW2). In the design described here the event flags were not used: therefore, the SF1, PF1, SF2 and PF2 instructions are of no use with this interface.

The last group of instructions is mode control: It contains TOGM. SMDC and INV.

On power-up the mantissa digit count is set at 8, and the mode is set to floating point. Figure 13 shows the initialization routine. After initialization (POR) or the completion of an instruction, the input-ready signal goes to a logic high, which tells the external hardware to supply a new instruction.

Sixteen of the 70 instructions are two

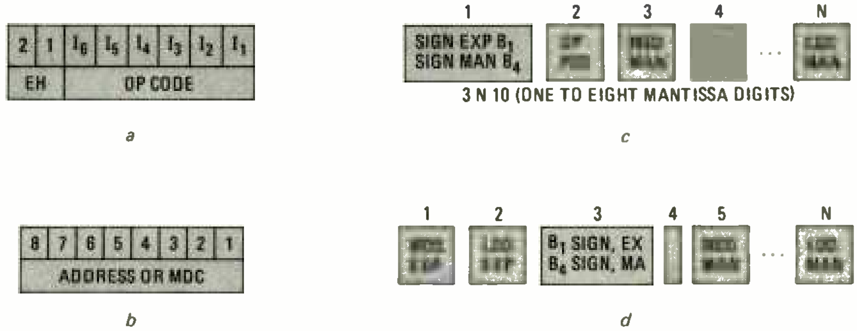


FIG. 14—FIRST WORD of 2-word instruction (a), second word (b). Floating-point notation formats and scientific-notation formats are illustrated at c and d, respectively.

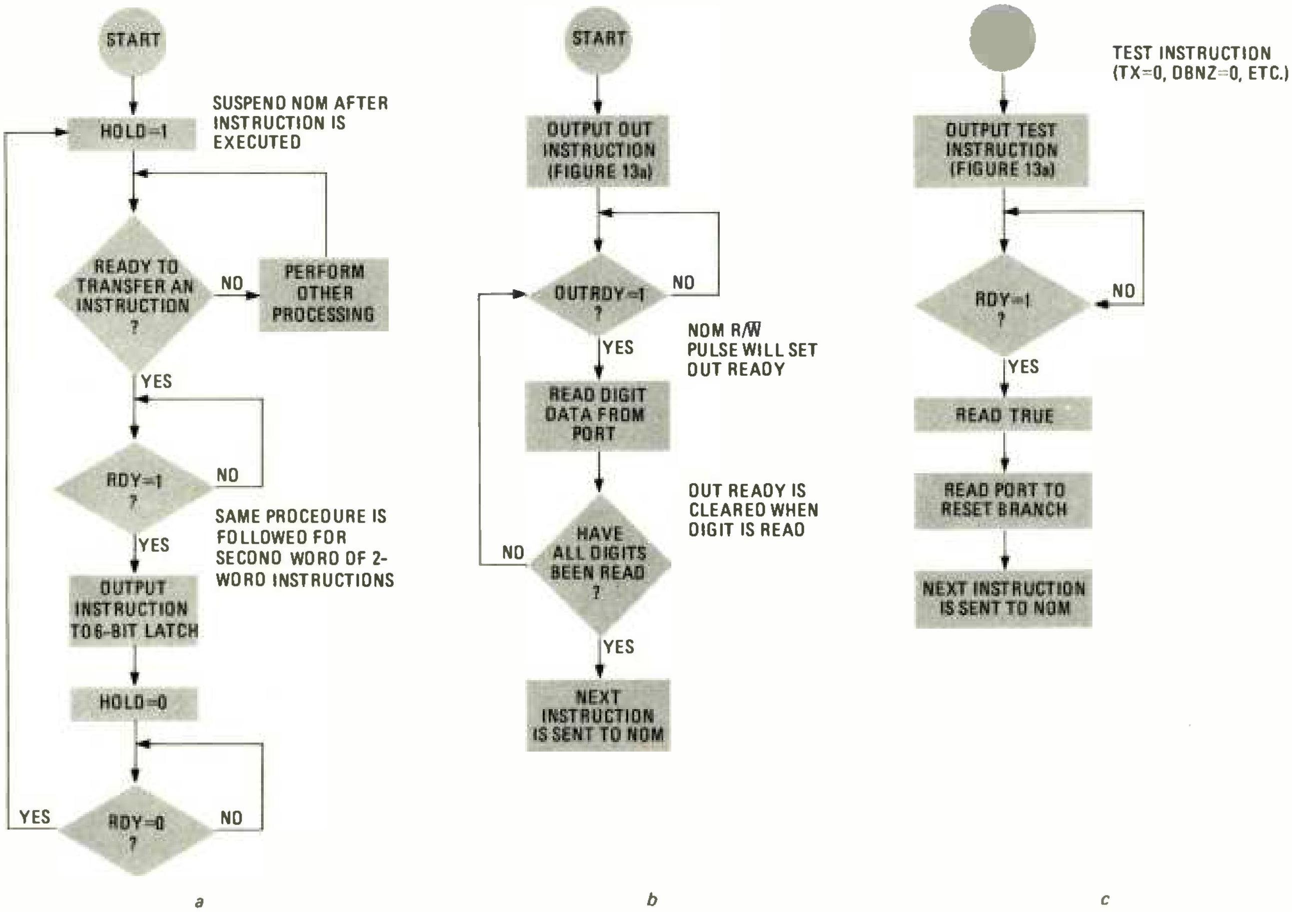


FIG. 15—SOFTWARE FLOWCHARTS. a) TRANSFER of data to NOM; b) TRANSFER of data from NOM; c) USE OF branch-type instructions.

words long (See Fig. 14.) These instructions are: INV+, INV−, INVX, INV/, INV SIN, INV COS. INV TAN. JMP. TJC, TERR. TX = 0, TXF. TXLTO. IN, OUT. and SMDC. The first word of a two-word instruction is the same format as the one-word instruction. The second word contains the branch address that is to be loaded into the PC (*P*rogram *C*ounter) during the branch; or it contains the MDC (*M*antissa *D*igit *C*ount) for SMDC instructions; or it may have the high-order address bits for external RAM on the IN/OUT instructions. The low-order address is placed on the DA lines. This interface does not use an external RAM. Generally, the second word is ignored except for the SMDC instruction. The I_{1-4} lines must contain digit data during the AIN and IN instructions. Each two-word instruction generates an input ready twice—one for each word. The first type are the inverse instructions. These require the INV instruction to be executed first (followed by the desired instruction). The second type is the SMDC instruction. The second word of this instruction is the mantissa digit count—a BCD number from 1 to 8. The other types of two-word instructions have adequately been discussed previously.

Since there are software differences between the many 1802 systems involved (primarily in the I/O and memory addresses), the software I used in my system is not included here. As an alternative, the flowcharts in Figs. 12 and 13 can serve as a guide in developing your own software. R-E

"While I was waiting, I adjusted your roof antenna, aligned your set and cleaned the tuner."

HOBBY CORNER

Learn solid-state circuitry as you build a monophonic music maker.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

THIS MONTH WE'RE GOING TO LEARN HOW to build a music maker or song player. You can set this device up for almost any simple tune and then program it to play automatically. In the process, you'll learn more about solid-state circuits, and end up with a unit that can be used as your doorbell, clock alarm and so on. This versatile circuit has endless possibilities.

Audio oscillator

First, you'll need a tone generator or audio oscillator. Figure 1 shows a very simple instrument. Although it has a minimum of parts, it is difficult to keep it from oscillating. (On the other hand, while the tone probably sounds all right to an untrained ear, it may insult a musician!)

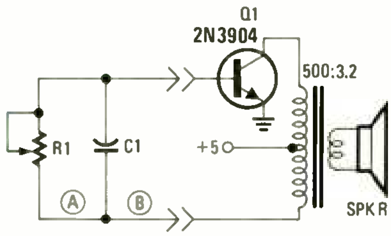


FIG. 1—BASIC TONE GENERATOR

Although in Fig. 1 the transistor is listed as a 2N3904, almost any NPN audio transistor works in this circuit. Any voltage from 1.5 up to the limit imposed by the transistor you select can be used. Figure 1 shows 5 volts because this value represents the power needed to run the IC's. No values are given for R1 and C1, but you can wire in a 100K potentiometer and any 0.01-μF component for testing purposes. As resistor R1 varies, the frequency (tone) changes.

This tone generator is used because it's simple. You can, however, use your own favorite circuit if you can separate out the frequency-determining components, as shown in Fig. 1. You can even add fuzz, attack, or delay if you like.

All you have to do is switch the R–C network or just R1 in and out of the circuit. Other components could be added for additional tones. Of course, you could add a manual switch at point A or point B. For our example, let's choose point A and build an electronic organ, as shown in Fig. 2.

Although manual switches are OK, the tone should really be controlled with electrical pulses. You could use relay switches, but they are expensive, bulky and usually noisy. So, why not use transistor switches?

Figure 3 shows *two* transistor switches that turn the tone either ON or OFF. Switches Q2 and Q3 can be 2N3904, RS2009, 2N2222 or almost any NPN transistors you have on hand. When the base of the switching transistor is connected to the positive voltage, the switch is on. When the base is grounded, the switch is off.

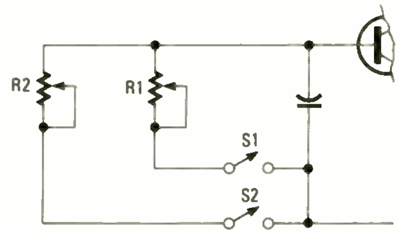


FIG. 2—MANUAL TWO-TONE ORGAN

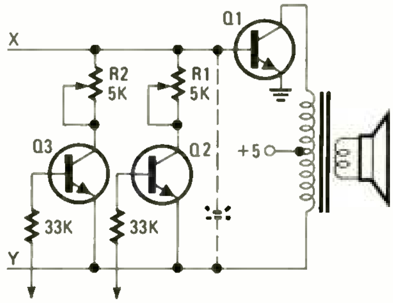


FIG. 3—TUNE MAKER CIRCUIT showing transistor on-off switches.

Now a strange thing happens to the circuit when Q2 and Q3 are added. First, the potentiometer values decrease. With most types of transistors at Q1, the circuit oscillates even when C1 is removed. Therefore, we draw C1 with dashed lines. (You may not need it.) Try your oscillator without using C1. You may have to put it back in (or add one across each pot). This little oscillator is both versatile and fun to experiment with.

You can add as many pots and transistor switches as you want. You need one for each note in the tune to be played. Just add these components out from points X and Y and adjust the pots for the proper tones. Choose a tune with no more than 15 notes (for reasons that are explained later).

Now you need some way to put a positive voltage on the transistor bases, one at a time. Manual switches work, but, again, adding transistor switches activates them automatically. For this task we'll use the 74154 1-of-16 data distributor described in the Hobby Corner article on an IC game roller circuit (**Radio-Electronics,** March, 1978). And if you use less than 10 notes, a 7442 can be used.

The only problem in using the 74154 is that the outputs are of opposite polarity from what you need. The selected output goes low instead of high as required by the switching transistors. This is why the inverters are used (six with each 7404 IC) shown in Fig. 4. Note that outputs 4, 6 and 8 all play the same tone through a

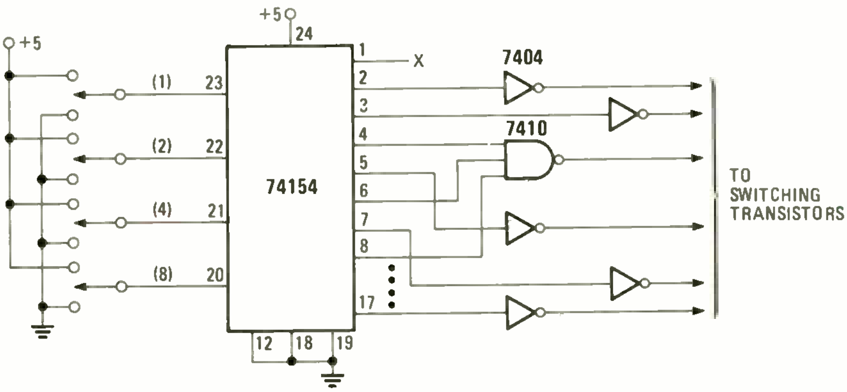


FIG. 4—TONE SELECTOR

gate of a 7410 triple 3-input NAND gate. One gate in a 7400 repeats the same tone on two outputs, while one 7420 gate combines four outputs. Any extra gates you may have can be used for other things, as shown in Fig. 5.

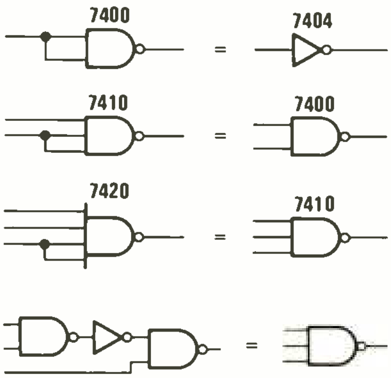


FIG. 5—BASIC GATE EQUIVALENCES

There are several things that you should note about the circuit in Fig. 4. First, four switches were added to the 74154 input (this, however, is only a temporary arrangement). These four switches control the 16 output lines; by using momentary switches, you can "play any of the 15 notes with only four fingers. If you build two such setups, you can play 30 notes with eight fingers! Of course, these switches count in the binary system.

Second, you only need 7404 gates at the output if you are going to play the device this way. However, automatic play may require a combination of repeat notes depending upon the tune you select.

Third, output line 1 is not used. This means only 15 notes are available, but the output line will be necessary if you add on automatic-play control. If you are not going to add the automatic-play feature, you can put in a 16th note and raise pin 19 from ground to the positive voltage to get an off or no-sound condition.

Here are some programming suggestions: how about using the whole tune for the front door, and just part of the tune for the back door? Or perhaps you could play three notes for the quarter-hour, eight notes for the half-hour, the whole tune for three-quarters of an hour, and the tune twice for the hour?

In a future article, we'll discuss making additions to this circuit that will cause it to play automatically at the touch of a button.

Old radios, TV's, etc.

Sometimes a reader writes for help in finding a schematic and other information about an old radio or TV. Here are a few suggestions that may help when you want to recondition or restore an old piece of gear.

First, you must completely identify the equipment. That means finding the model and serial numbers if they are still on the chassis or cabinet. If there are no identifying numbers, make a complete description of the set including the numbers and locations of the tubes. Armed with this information, you are ready to begin your search.

A local service shop may have the information you want in *Sam's Photofacts*, in Supreme Publications manuals, or even in a Rider manual. If you live in a large city, you can probably find these publications in the public library. You can also write the manufacturer, but this may not help if the set is very old. Many have gone out of business.

Whether the set is very old or nearly new, Supreme Publications has data on almost any equipment, and a typical charge for such information is only about $3. Just send the complete details on your set to Supreme Publications, Att: M. N. Beitman, Box 46, Highland Park, IL 60035. If all else fails write ISCET Technical Library, there is a $10 fee for this service or you might even become a member for an annual $25 fee. The address is 8015 Paseo, Kansas City, Missouri. R-E

computer corner

8085 *A look at Intel's 8085 μP and the MCS-48 μP family.*

WILLIAM BARDEN, JR.

INTEL CORPORATION, DESIGNERS OF THE 8008 and 8080 microprocessors, have developed two new devices. One is the Intel 8085, a microprocessor that is designed to replace the 8080A. It is a larger-scale microprocessor because it is designed to be used in applications that in some cases were only in the realm of minicomputers. The MCS-48 family of microprocessor components, on the other hand, is a minimum-configuration type of microprocessor that will be used to implement low-cost consumer and business computer products.

The 8085

The 8085 is a redesigned 8080A microprocessor. One of the weaknesses of the 8080 microprocessor was that for a basic system it required a dozen or so TTL IC's in addition to the basic CPU. The 8085 requires only a few external components to produce a viable microcomputer. Although the 8085 is not pin-compatible with the 8080, it is software-compatible *downwards;* that is, all software written for the 8080 will run on the 8085, except that which is specifically geared for an existing 8080 microcomputer system, which may differ in I/O addresses, memory cycle times, and the like in a new 8085 system.

Figure 1 shows the pinout of the 8085 microprocessor, which uses only one supply voltage, +5 volts, with the input at V_{CC}; V_{SS} is the ground reference. The −5 VDC and +12 VDC of the 8080 are eliminated. The 8085 uses an on-chip clock generator, with only an external crystal or R–C network, whereas the 8080 uses a two-phase external clock. The basic clock speed is 3 MHz, and the basic instruction cycle is 1.3 μs, which is an improvement over the 8080's 2-μs instruction cycle.

The 8085 *multiplexes* the address and data outputs during the instruction cycle. Lines A15 through A8 are the address lines, as in the 8080, but lines AD7 through AD0 are used both as the lower half of the address lines and the data bus. These lines are used as the address bus during the first clock cycle of a machine cycle and as the data bus during the second and third clock cycles. Signal ALE (*A*ddress *L*atch *E*nable) occurs during the first clock cycle to allow components to latch the address.

In the 8080, status signals needed further decoding to produce read and write signals to memory and I/O. In the 8085, these signals are provided directly by $\overline{RD}$, $\overline{WR}$; and IO/$\overline{M}$; the latter indicates whether the read or write is to memory or I/O. Outputs S0 and S1 provide encoded status of the bus cycle (HALT, WRITE, READ, or FETCH). The READY instruction is used similarly as with the 8080—to interface slow-speed memory or I/O devices by deferring CPU operation. Instructions HOLD and HLDA are also similar to the 8080, allowing external devices to control the CPU buses for direct-memory-access action.

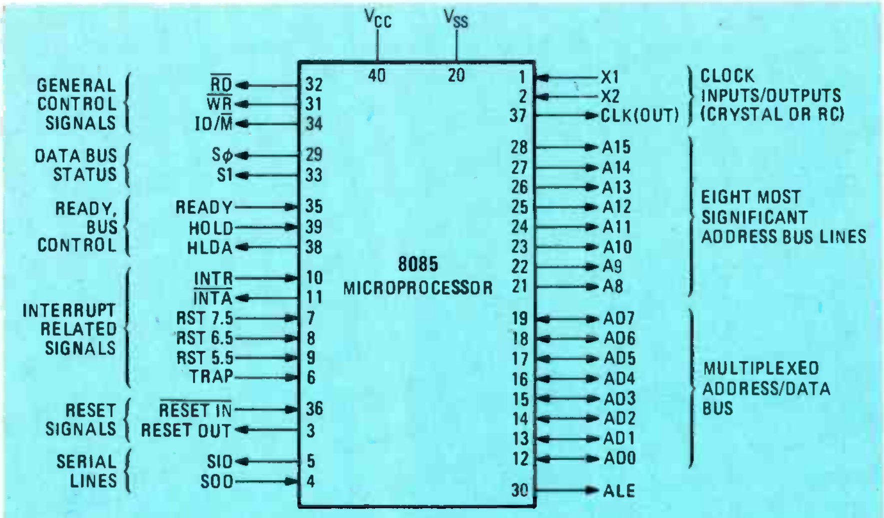


FIG. 1

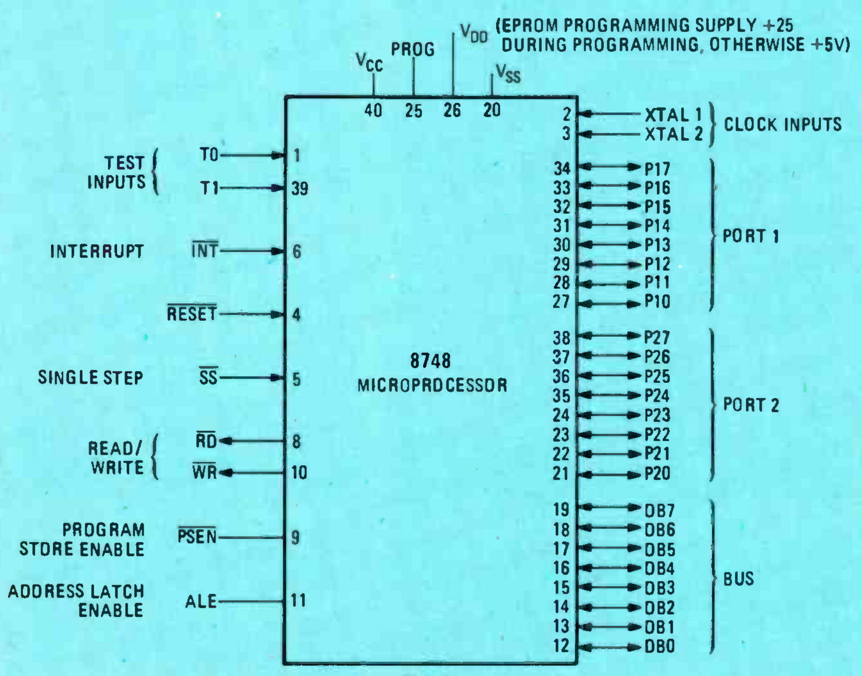


FIG. 2

Interrupt action in the 8085 is more sophisticated than in the 8080. Signals INTR (*INT*errupt *R*equest) and $\overline{\text{INTA}}$ (*INT*errupt *A*cknowledge) are used as before, but three additional interrupt inputs, RST 5.5, RST 6.5 and RST 7.5 cause predefined internal RESTARTS (rather than an *external* RESTART response). In addition, a *nonmaskable* interrupt that cannot be disabled under program control is provided by signal TRAP. A $\overline{\text{RESET IN}}$ input is similar to the 8080's RESET input; the output RESET OUT indicates that the CPU is currently being reset.

One serial-input line and one serial-output line are provided in the 8085; the 8080 had neither. Data on the SID (*S*erial *I*nput *D*ata) line is loaded into accumulator bit 7 whenever a RIM instruction is executed. The serial-output data line can be set or reset by an SIM instruction. These two lines allow serial I/O devices such as *Teletypes* or audio tape cassettes to be directly interfaced to the CPU. Instructions RIM and SIM are the only two new instructions in the 8085. Internal registers within the 8085 central processor unit remain the same as in the 8080.

A dedicated function microcomputer using the 8085, a 2K-byte EPROM chip (8755), a 256-byte RAM (8155) and six discrete components can be assembled on a 4-inch by 3-inch PC board. This is quite a change from the 8080! Such a single board microcomputer can easily handle many control applications and its small size makes it easier to design into household appliances.

MCS-48 family

Speaking of computers on a chip, the microprocessors in the MCS-48 family certainly fit the description. The 8048 microprocessor IC of this family is the most elaborate of them all. The 8048 provides an 8-bit CPU, 1K-byte ROM, 64-byte RAM, 27 I/O lines (which may be programmed for input and output as required) and an 8-bit timer/event counter, all on one IC! The 8748 microprocessor is identical to the 8048 except that it contains a 1K-byte EPROM (*E*rasable *P*rogrammable *R*ead-*O*nly *M*emory). Other versions of these two microprocessors contain additional ROM and data (RAM) memory, or no internal memory. A low-cost version, the 8021, contains an instruction subset of the 8048 and fewer hardware features.

Let's take a brief look at the 8748 (EPROM) version. Figure 2 shows a standard 40-pin 8748 package. In this version, only a single +5-volt power supply is required. A crystal clock input is provided, although this may be an L–C network or an external clock rather than a crystal controlled clock.

Input/output port 1 (P10–P17) and I/O port 2 (P20–P27) are two 8-bit ports than can be used either as input or output ports. Input and output on the same pin and a mixture of input and output lines on the same port is permitted. Lines DB7 through DB0 are also an 8-bit port that serves either as a latched output port or a nonlatching input port. Two additional input pins, T0 and T1, are test inputs that can be tested under program control by specific instructions. One interrupt input, $\overline{\text{INT}}$, is implemented so that an interrupt occurs if an internal interrupt-enable flip-flop is set. Various other control signals are provided.

Figure 3 shows the architecture of the 8748. One 8-bit accumulator serves as the main data register for arithmetic and other operations; both binary and decimal arithmetic are implemented in the CPU. Program memory of 1K bytes is provided on the resident EPROM. Locations 0, 3 and 7 of program memory are dedicated to reset, external interrupt and timer/counter interrupt processing routines, respectively. Data memory consists of 64 bytes of RAM, in which two sets of eight locations are designated bank 0 and bank 1 working registers. Either bank 0 or bank 1 can be selected under program control. When one or the other bank is selected, all registers in the bank are directly addressable by several instructions. An eight-level stack and additional user RAM comprise the remainder of the data memory.

The 8748's instructions include both 1- and 2-byte instructions plus the usual complement of arithmetic, logical, data movement, and conditional and unconditional jumps. Since 70% of the instructions are only 1 byte long, the MCS-48 microprocessors provide efficient programming within the limitations of the relatively small RAM storage and program area. R-E

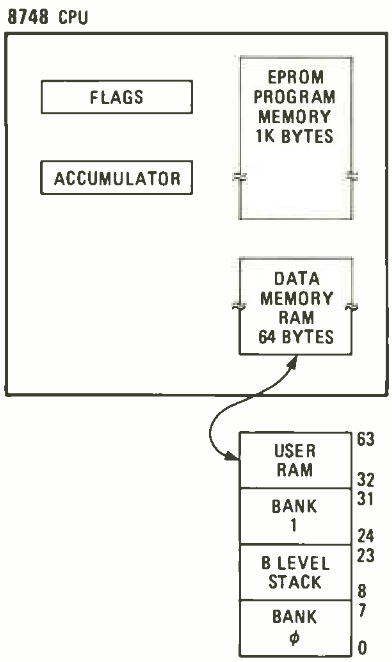


Fig. 3

service clinic

Don't jump to conclusions before obtaining the necessary facts.

JACK DARR, SERVICE EDITOR

A SERVICE CLINIC COLUMN APPEARED A while back containing some fairly elementary material. A reader wrote: "Why? We know all this stuff!" I wrote him back to tell him that it's a good idea to jog your memory once in a while.

This article is another memory jogger. It tells you about the easy way to diagnose troubles in TV sets, and about one of the most "common faults" technicians make in this area. A large amount of Service Clinic mail comes from technicians who know how to do the job, but are simply not using their knowledge in the right way. The common fault in too many cases is jumping to conclusions *before* you make any tests and obtain the facts.

Here's a typical example: The symptoms are a blank screen, plenty of width and height, the brightness is good, and no sound or picture. The calibrated eyeball tells us that quite a few things are OK: there's plenty of B+ voltage, a good picture tube, etc. Correct reasoning tells us that there is a fault somewhere in the *signal path*. This involves a lot of stages, starting at the tuner, the IF, detector, and video amplifier. Anything wrong in these stages can cause problems.

The first thing to do is to break these stages up into smaller sections. A good and fast way to do this is to scope the video detector output. If you see a normal signal here, the tuner, video IF and AGC are not at fault. Proceed through the video amp stages until you find where the signal stops.

If there's no signal at this point, the video stages can be eliminated as a source of problems (for now, anyway). Now, check the IF and/or tuner stages. Hook up a tuner subber to the IF input; if you get a picture, you've just eliminated the IF stage as a cause of your problem. If there's no response, you *do* have an IF problem. As usual, there are multiple causes for the same symptom. It could be caused by a fault in the IF stage, *or* it could be in the IF control voltage; the AGC (*A*utomatic *G*ain *C*ontrol). Here's another simple test. Override the AGC with a bias box. You can *read* the AGC voltage, but overriding it just is one step less to perform and gives you the same result. If you get a picture with the AGC set to approximately normal (check the unit's schematic for the normal voltage, remembering that the AGC shown is a no-signal voltage or the point of maximum IF gain), then you've eliminated the IF amplifier stages, and you can now check the AGC stage.

At this point, you can take some DC voltage readings; all voltages on this AGC stage are critical. Also don't forget to scope the input for the proper video *signal;* it won't work without it. Watch out for *bias* problems in the AGC stages. If one stage is incorrect, it will not chop off the sync pulses to develop an AGC voltage.

If the problem is in the IF stages, here's a good quick check. Don't bother reading the IF signal with a demodulator probe; just read the *emitter* voltages of all IF transistors. Practically all these transistors use a small resistor (bypassed) in the emitter circuit. The DC will run about 1 to 2 volts. Find an IF transistor with zero voltage, and it is probably open. If there's far too much emitter voltage, the transistor is probably shorted. Don't overlook the emitter resistor; check it to make sure. This also works for tube-type IF stages; read the IF tube's cathode voltages.

Another area where reasoning can help is in the sync-separator stage. If you see no vertical sync and the picture slides sideways, go right to the stage that handles both syncs. Do not start checking the vertical oscillator! Scope the composite-sync waveform at the separator output. (Far too many schematics leave out this necessary stage. The typical P-P voltage runs about 50 to 60 for tube stages, and about 20 to 25 for transistor stages; these are just ballpark figures.)

A severe loss of sync amplitude at this point can cause weak *vertical* sync. The vertical sync depends on amplitude; the horizontal sync works mainly on phase, and quite a lot of sync amplitude can be lost before any horizontal instability shows up. Use your scope to check both syncs.

Checking the horizontal sync can be very tricky; you can lock the picture in, but with even the slightest movement of the horizontal hold control, away it goes. The fact that you can stop it momentarily indicates that the horizontal oscillator stage is quite stable. This is often due to a loss of the horizontal sync to the AFC. For a definite test, pull the AFC diodes and scope the point where the sync goes in—usually at the center terminal of the diode unit. The horizontal sync is picked off the composite sync and fed through a small (50-pF) coupling capacitor (which explains why the vertical sync does not go into the horizontal sync). If this coupling capacitor is open, *or* if the PC board conductors between the capacitor and sync separator/AGC circuit are broken, this'll cause problems. Check the conductors with an ohmmeter.

If there's plenty of horizontal sync here, then the AFC diode unit is bad and should be replaced. Look out for *unbalance* in AFC diode units because this can cause some odd problems. You can check this out with an ohmmeter.

The main point is that you must always remember that there's no such thing as a symptom with only *one* possible cause. Make a mental list of all the things that could cause a problem and then patiently check 'em out one by one. You'll pin down the trouble a lot faster. Use time-saving quick-check tests such as the ones mentioned earlier; these tests can clear up or confirm trouble in a great many stages simultaneously, as for example in the IF stage.

The most important thing to remember is—*don't* jump to conclusions without any hard facts. Good luck. **R-E**

service questions

FLYBACK SUBSTITUTE WANTED

This National model TR-317U TV set manufactured by Matsushita has a burned flyback circuit. Since my sources just turn blue when I mention National, where can I get this part?—W. S., Denville, NJ.

Tracking this down calls for some part-number crossing. Matsushita manufactures Panasonic, so I checked out Sams on a TR-315, which is as close as they could get. I found a flyback circuit with a "TLF-xxxx" part number which is very close to the flyback part number you gave me (TLF-3605-1DS) Try ordering a flyback with this number from the nearest Panasonic parts depot. The closest depot to you is: Panasonic, 50 Meadowland Parkway, Secaucus, NJ, 08094. Good luck!

COILS WITH LOOSE CORES

Louis Supek of Brunswick, OH, writes:

"If you have a coil with a loose core that won't stay tuned or falls out, try taking the core out and inserting a thin strip of masking tape inside the coil lengthwise. See if the core fits OK. If it's still too loose, place another thin strip of tape on the other side of the coil. The core will turn freely without binding.

(Thanks, Louis! This helpful hint is much appreciated.)

HIGH VOLTAGE DROPS

Everything else seems to be OK in this model CTC-31A RCA set, but the high voltage drops to where the raster goes out. I've checked the whole output circuit and found zilch.—K. P., Fitchburg, MA.

Here are a couple of hints: Pull the picture tube *socket* and see if the high voltage comes back. If so, check the cathode and grid voltages on the picture tube. If there is very low voltage on the picture tube cathodes, for example, this will make the grids positive, and the picture tube will pull the high voltage way down. The common cause for this: an open winding in the video peaking transformer between the video output and picture tube cathodes causes this voltage to go to 0.

(Feedback: "Thanks! Your crystal ball is working fine; the video peaking transformer *was* open.")

RASTER BRIGHTENS

I've got a funny problem with a Sony model KV-1910. The sound and picture are good, but the raster becomes gradually brighter from left to right; at the far right-hand edge of the screen the video wipes out completely to a brilliant white. The brightness control works, but as you turn it down, the raster is gradually wiped out from left to right. What is this?—D. L., Battle Creek, MI.

I suspect that you've got a blanking problem (along with a lot of other people!).

The schematic shows the horizontal blanking is fed to the three grids of the picture tube, tied together, through a pair of neon lights plus another light over by the flyback. These lights are not shown on the parts list, but they're probably ordinary NE-2's. Check if any of these bulbs are blackened; if so, they're probably bad. In this application, if one of these lights is aired it acts as a short and upsets the horizontal blanking. I suggest you replace them all just for luck. R-E

EQUIPMENT REPORTS

continued from page 33

the location of the white king and queen and black king and queen using the EP key. Then, force *CompuChess* to make the first move by depressing PLAY.

The well-thought-out keyboard provides a tremendous amount of versatility. You can play handicap chess by initially deleting a piece; in fact, you can delete or add any piece you want at any point during the game. You can perform a castle move by using the MD key and *CompuChess* will also handle en-passant moves.

During play, you can cancel a move after entering it, provided the PLAY key has not been depressed, by simply re-entering the move. Also during normal play, on levels 3 or 4, when *CompuChess* sees a threat to any of its more valuable pieces, it will display a flashing hyphen to indicate that it needs more time to calculate its reponse. If you should lose the game, *CompuChess* will notify you by displaying its final move and then flashing the display. *CompuChess* indicates a stalemate by a king move to its own position. If *CompuChess* should lose the game, it displays LOSE.

CompuChess also has a randomizing feature. If after evaluating its move, *CompuChess* determines that there are several moves of equal strategic value, it will randomly choose its move from one of these several moves. Because of this, it is almost impossible to duplicate an attack or repeat a game.

Playing a game

The best way to evaluate a device such as this is to actually play a game with it. I started a game on level 6 to see just how long the response time for this level would be.

I opened with the traditional opening of P—K4. *CompuChess* responded within 18 hours. This turned out to be the shortest response time. From here the response times varied between 2 and 4 days. The response time to the 6th move was an absolute surprise—it took between 11 and 13 days to respond.

I don't feel, however, that the long response time is a big disadvantage. As the owner's manual states, it's perhaps better to start play at level 4 and then switch to level 6 between 6 and 12 moves into the game. This should reduce the response time. And then again, not everyone would be comfortable playing a level 6 game.

I have also received a call from Data Cash Systems that they have just introduced an improved version of *CompuChess*. the newer unit is called *CompuChess, The Second Edition*. In addition to much quicker response times (level 6 now responds within 2 hours), three new game variations have been introduced along with the standard chess game. The game of Knights is similar to a standard chess game except all the pieces on the first rank are converted to knights. The pawns on the second rank remain pawns. The second new game is called the Amazon Queen. Here all the pieces remain identical as in standard chess, except the two queen pieces are given the additional capability to move like knights. The third and final new game is called Survival. This game sets up a randomized mid-game board position. The object is to play a standard chess game from this random board position and mate *CompuChess*.

CompuChess retails for $169.95, and *The Second Edition* retails for $209.95. **R-E**

VIDEO MOTORCYCLE GAME
continued from page 46

the start. Every time a successful jump is made the two right-hand digits are increased by 1 and another bus is added to the area between the two ramps; also, a good-jump sound is generated. The motorcycle reappears at the starting position after each jump. The cycle, score and buses are white; the ramps and track are black. For black-and-white operation, the background is gray, and in color the background is blue.

If the PRO/AM switch is in the easy mode and the MOTORCROSS select switch depressed, then the picture will be like that shown in Fig. 1-c. The cycle moves across the screen, at a rate proportional to the setting of the throttle, as the throttle is advanced from its low-speed setting. No speed shifting exists in this game. As in the Drag Race game, the object of the game is to transverse the three track segments in the minimum amount of time. On each track segment though, there is a blockade. The operator must do a "wheelie" in order to cross over this obstacle.

In the PRO mode, two obstacles per track are displayed; see Fig. 1-d for a typical screen image. The game otherwise functions as the amateur mode did. Again, the cycle, rider, score and block-
continued on page 76

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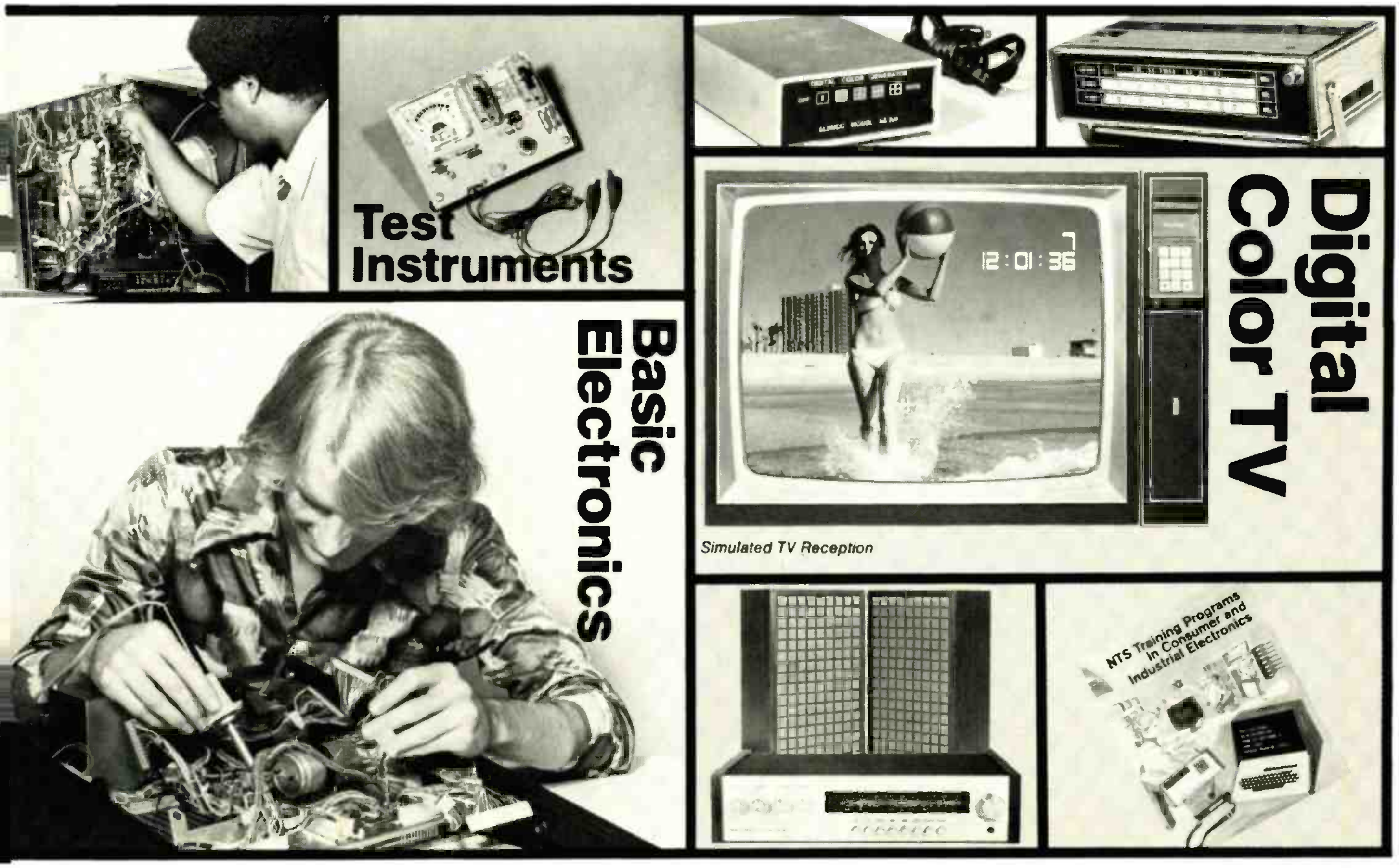

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stereo products

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PEAK POWER INDICATOR, *model PPI-400*, can be used to monitor peak audio power across power-amp and receiver loudspeakers, and to verify loudspeaker phasing and channel balance as well as monitor any musical amplifier. The device provides an accuracy of ±0.5 dB with a

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frequency response of 20 Hz to 20 kHz and a minimum 10,000-ohm input impedance. Unit's 6-position selector switch permits 18 different combinations of power levels and speaker impedances. Instantaneous peak-responding green, yellow and red LED's are calibrated from 0 dB to −30 dB in 8 steps for each stereo channel. Optional walnut cabinet is available. Price: $129.95.—**Lectrotech, Inc.**, 5810 N. Western Ave., Chicago, IL 60009.

POWER AMPLIFIER, *model 300DC*, features low TIM (*T*ransient *I*ntermodulation *D*istortion), a fast slew rate, wide bandwidth and low distortion. It is rated at a minimum RMS of 150 watts-per-channel into 8 ohms, 20-Hz–20 kHz at no more than 0.03% THD. The power transformer has two

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secondaries providing independent power for the two channels, and meter range switching provides accurate VU meter readings. Suggested retail price: $629.95.—**Marantz Co., Inc.**, 20525 Nordhoff St., Chatsworth, CA 91311.

DIRECT-DRIVE TURNTABLE, *model 621*, is an automatic start-stop turntable with an electronic DC motor regulated by digital circuitry. The wow and flutter is rated at less than ±0.03% and rumble better than 70 dB. The tone arm is mounted in a 4-point gimbal, with the counterbalance containing two anti-resonance filters. Other features include 10% pitch control, illuminated strobe, continuous repeat, damped cueing; anti-skate feature is calibrated for all stylus types. Including base and cover, the *model 621* sells for $299.95. A manual start/automatic shutoff *model 604* is also available for $259.95.—**United Audio Products,** 120 S. Columbus Ave., Mt. Vernon, NY 10553.

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ERROR-NULLING POWER AMPLIFIER, *model Stasis I*, is a single-channel audio amplifier that uses feed-forward error-nulling. The amplifier has a rated power output of 175 watts into 8 ohms, 20 Hz–20 kHz; 300 watts into 4 ohms, 20 Hz–2 kHz with less than .002% THD; a maximum slew rate

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of 100 volts-per-μs; a frequency bandwidth of +0 dB, −3 dB, 0.01 Hz–250 kHz. Other features include peak-vs.-average output display from +2 dB to −24 dB; on-off switch; and panel displays such as logic-on, amplifier-on, differential waveforms, etc. The *model Stasis I* measures 19.5 D × 5.25 H × 17-inches W. Suggested retail price: $2500.—**Threshold Corp.**, 1832 Tribute Rd., Sacramento, CA 95815.

MOVING-COIL CARTRIDGE & TONE ARM, *model 10X* and *model DV-505*. The *model 10X* is the latest in the *Dynavector* line of cartridges (manufactured in Japan) and provides a 2-mV output

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level, eliminating the need for a preamp or step-up transformer. The unit contains 2 separate 200-turn copper-alloy coils, 11.5 microns in diameter. The *model DV-505* tone arm is a bi-axis inertia-controlled balanced tone arm with a vertical subarm useful for tracking warped records. Prices: the *model 10X* cartridge, $120; the *model DV-505* tone arm, approximately $600.—**ESS Special Products,** Box 15889, Sacramento, CA 95813. **R-E**

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VIDEO MOTORCYCLE GAME
continued from page 69

ades are white; the track is black. The background is gray for black-and-white operation and green on a color set.

The fourth game, Enduro, in the amateur mode appears like the image seen in Fig. 1-e. As with Motorcross the first two segments contain obstacles; the third segment resembles the Stunt Cycle game in that it contains buses and ramps. For the first two tracks "wheelies" are required to pass the blockades. Before entering the third track the throttle must be adjusted to perform the required jump across the buses. In the professional mode, two additional obstacles are added (see Fig. 1-f).

How it works

The main section is the AY-3-8760 LSI integrated circuit. Section two is a 3.58-MHz crystal clock source. The next section is a set of controls; four game select pushbuttons, one SPST mode select switch, and a 50- to 250-kHz oscillator used as the throttle control. Section four is the power supply—12 volts AC is converted to about 6 volts DC. The next section is the video output summing network. The last block is the audio amplifier.

The throttle oscillator is formed by using an LM555 timer. The frequency is set by the control potentiometer; the output is applied to pin 18 of the AY-3-8760 via a CMOS inverter.

The ¼-watt audio amplifier is formed from a MC1306P monolithic complementary power preamplifier/amplifier. An 8–16-ohm speaker is driven at the output of this section. A volume control trimmer pot can be adjusted for the desired volume level.

The black video (ramps, track and composite blanking) is summed to the white video (motorcycle, rider, buses, score and obstacles) along with the sync pulses. The color A and B outputs (pins 24 and 25, respectively) are pulled-up to V_{cc} +5 volts, then summed together using 20-pF capacitors and fed into the resistor network. The intensity of the white video is reduced when no motion exists on the screen (the game has not been initiated). This will reduce the possibility of the TV screen being burned if the game is left on for extended periods of time. This feature is provided by R11, C11, D1 and CMOS inverter IC2-a. The output of the summing network should be fed directly to a video monitor or to a TV set through an RF modulator.

The power supply takes 12 volts AC from the power transformer secondary and develops the 6-volt DC V_{cc} supply. Four 1-ampere rectifiers are used in a full-wave bridge. A raised-ground 5-volt linear three-terminal IC voltage regulator is used. One volt is developed across ground resistor R2. Capacitor filtering is used at the input and output of the regulator.

Construction

Before beginning construction you must decide on a method of assembly and wiring—either wire-wrap or a printed circuit. If you select the latter, you can use the foil pattern in Fig. 3.

After etching and drilling your board (or purchasing the board listed in the parts list) begin wiring by installing the five jumpers shown on Fig. 4.

The next step is to install the resistors and capacitors. Also the IC sockets if you elect to use them. Install and solder in the five diodes and the regulator IC. Be sure diode polarity is correct before soldering.

You are now ready to wire the PC board to the switches, control pot and power transformers. After making these connections, apply power to the board and check the voltage at the supply pins of IC1–IC4. If it is lower than 6 or higher than 7 volts, readjust the values of R1 and R2 to obtain the desired voltage.

Now install the IC's and the circuit should be ready for use. If problems arise, use regular troubleshooting techniques to find and correct them. I'm sure you'll have a great deal of fun and excitement with this advanced single-player video game. **R-E**

new products

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside back cover.

DUAL-TRACE OSCILLOSCOPE, *model PM3262,* is a 100-MHz, 5-mV (2 mV at 35 MHz) general-purpose instrument designed for many sophisticated lab, computer, telecommunications, and bench and field applications. The unit features an alternate timebase capability that shows both main and delayed timebase displays together across entire screen width; a third channel allows simultaneous viewing of trigger signals. Other features include composite triggering to permit stable display of asynchronous signals; 250-MHz triggering capability; extended X-Y display; cold switching that allows electrical (not mechanical) connections between front-panel controls and internal circuitry. Triggering mode and input controls are pushbutton-selectable. Power consumption is 45 watts. The *model PM3262* measures 12.5 × 6.1 × 16.2 inches and weighs 21.1 lb. Price: $2345.—**Philips Test & Measuring Instruments, Inc.**, 85 McKee Dr., Mahwah, NJ 07430.

CIRCLE 114 ON FREE INFORMATION CARD

COMPUTER PHONE DIALER, *Keymemco,* fully assembled or in kit form, is a solid-state plug-in device that can be connected to any type phone without couplers. The unit holds 15 preset phone numbers (each up to 15 digits) and can hold the last manually dialed number in memory for recall. Touch-tone pad allows manual dialing of unprogrammed numbers. Unit can be installed via direct-wire coupling; piggyback jack permits plugging both dialer and phone in one outlet. Power is supplied either by 4 NiCad batteries or 11-volt AC/DC adapter from 110 volts, 60 Hz. Optional speaker and volume control are available. Prices: Kit, $129; assembled, $220.—**Chung Long Electronics Corp.**, P.O. Box 18732, Seattle, WA 98118.

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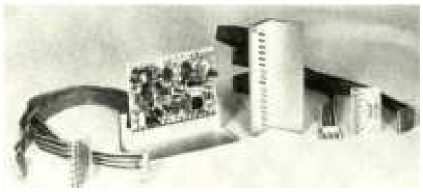
EXTENSION CABLE KITS, Sylvania *Check-A-Board model KZ-2* and *model KRX-5*, are designed to troubleshoot Zenith and RCA solid-state TV sets without removing chassis from set. Kits consist of cables made of stranded multicolored wire (color-differentiated for proper orientation) with female connectors (for TV modules) and mating chassis connectors, plus plated-alloy conductors on glass-fiber PC boards. Suggested retail prices: *model KZ-2* (Zenith) $49.50; *model KRX-5* (RCA) $54.50.—**General Telephone & Electronics Corp.**, 1 Stamford Forum, Stamford, CT 06904.



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3-HOLE LIGHTER OUTLET BOX, *model 1140,* mounts under-dash and plugs into vehicle's lighter outlet. Unit accepts three 12-volt devices, such as a CB transceiver, scanner, radar detector, tape deck, etc.; all three devices can be used simultaneously (maximum current draw, 10 amp). Comes with mounting bracket, and sells for a suggested retail price of $13.95.—**Gold Line**, 992 Danbury Rd., Georgetown, CT 06829.

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PHONE PLUGS AND JACKS. A broad line of phone jacks, enclosed phone jacks and matching plugs is available. The line ranges from microminiature to thick-panel size, either two- or three-conductor and open- or closed-circuit format.—**National Tel-Tronics**, State Road Hill, Meadville, PA 16335. **R-E**

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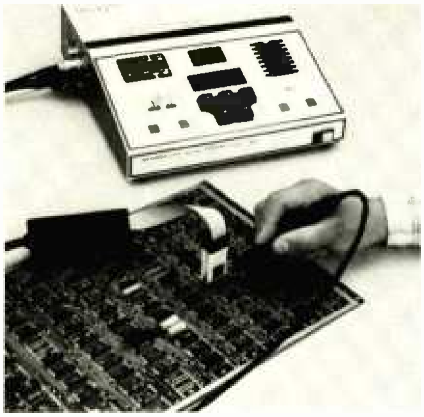
computer products

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside back cover.

HIGH-SPEED LOGIC TROUBLESHOOTER, *model 5700B Scanmaster,* is designed for in-circuit testing of digital IC's; front-panel pushbuttons let you probe pins, and a switch selects five logic families. Other features include a built-in dual-threshold logic state analyzer; 3½-digit display; a DVM (useful also for measuring DC voltages in analog circuits); and a universal logic pulser. The



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unit can be interfaced with an oscilloscope, frequency counter, or other test instruments. Price: $1295.—**Information Scan Technology,** 1725 Rogers Ave., San Jose, CA 95112.

COMPUTER PRINTER INTERFACES, *Sol Hytype I* and *Hytype II,* are designed to increase card-copy capability of the Sol computer. *Hytype I* mounts inside Sol *Diablo Series 1200* printer;

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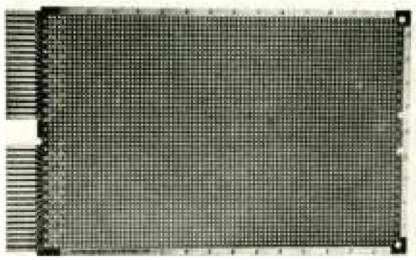
Hytype II interface works with *Diablo Series 1300* printer. Both include fully assembled, tested and etched PC board, software, cables and mounting hardware. Driver software on CUTS cassette is included together with a source listing. Suggested retail price for *Hytype I* and *Hytype II,* $150.—**Processor Technology Corp.,** 7100 Johnson Industrial Drive, Pleasanton, CA 94566.

GENERAL-PURPOSE BREADBOARD, *model 4607 Plugbord,* permits convenient assembly of custom circuits for Heath H-11 and DEC LSI-11, PDP-8 and PDP-11 computers. The *model 4607* (measuring 8.430 × 5.187 × 0.062 inches) has etched contacts spaced to fit dual 36 pin connectors and contact terminations labeled to fit DEC nomenclature. The 0.042-inch-diameter holes on



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0.1-inch centers allows unrestricted placement of discrete components or DIP sockets.

The boards are made of copper-clad blue epoxy glass with solder-plated pads and gold/nickel-plated edge connectors. The *model 4607 Plugbord* sells for $15.95 each in quantities of 1 to 4; from 5 to 9 quantities, $14.36; quantities over 10, $12.76.—**Vector Electronic Co., Inc.,** 12460 Gladstone Ave., Sylmar, CA 91342.

FLOPPY DISC SYSTEM, *Disk II,* is designed for the Apple II personal computer. System provides rapid access to programs and data, and the DOS software uses standard BASIC. The *Disk II* con-

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sists of an interface card and one or two mini-floppy drives and offers full 116K-bytes-per-diskette in soft-sectored format. Complete bootstrap in ROM and operating system in RAM provide full disc capability for systems with as little as 16K bytes; can load and store files, and allow random and sequential data access. System can be driven solely from Apple II power supply. Price: $495 (includes card and *Disc II* drive).—**Apple Computer, Inc.,** 10260 Bandley Drive, Cupertino, CA 95014.

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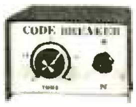

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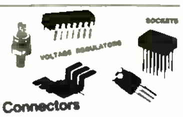

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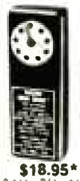

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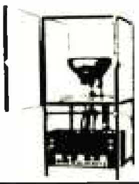

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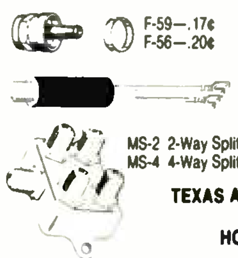

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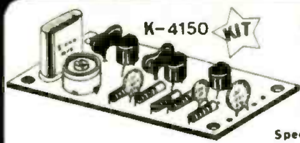

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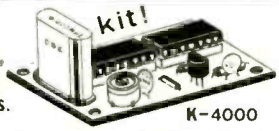

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2SC2021	.55	.60	.65
2SC2028	.50	.60	.65
2SC2029	1.45	1.75	1.95

	25-UP	10-24	1-9
2SC2072	3.55	3.75	3.95
2SC2076	.45	.60	.65
2SC2091	.85	1.05	1.15
2SC2092	1.75	1.95	2.20
2SC2098	3.00	3.20	3.45
2SD72	.50	.60	.65
2SD91	1.30	1.40	1.55
2SD92	1.40	1.55	1.75
2SD180	1.55	1.75	1.95
2SD187	.35	.40	.45
2SD218	2.95	3.20	3.45
2SD234	.60	.70	.80
2SD235	.60	.70	.80
2SD261	.30	.35	.40
2SD287	2.50	2.65	2.85
2SD291	2.05	2.45	2.75
2SD313	.60	.65	.70
2SD315	.60	.70	.80
2SD325	.60	.65	.75
2SD330	.69	.79	.89
2SD356	.70	.75	.80
2SD358	.70	.80	.90
2SD359	.75	.85	.95
2SD427	1.75	1.95	2.20
2SD525	.70	1.05	1.15
2SD526	.60	.70	.80
2SK19	.45	.50	.55
2SK23	.80	.95	1.05
2SK30	.40	.45	.50
2SK33	.60	.65	.75
2SK34	.50	.55	.60
2SK41	.50	.55	.60
2SK55	.60	.65	.75
3SK22Y	1.60	1.70	1.80
3SK35	1.20	1.35	1.50
3SK37	1.70	2.00	2.30
3SK40	1.25	1.40	1.55
3SK41	1.25	1.40	1.55
3SK45	1.25	1.40	1.55
3SK48	3.30	3.40	3.70
3SK49	1.25	1.40	1.55
AN115	2.00	2.15	2.25
AN214Q	1.55	1.65	1.85
AN228	4.10	4.30	4.50
AN239	4.10	4.30	4.80

	25-UP	10-24	1-9
AN247P	2.40	2.60	2.90
AN274	1.50	1.70	1.90
AN313	4.20	4.40	4.60
AN315	1.75	1.95	2.20
BA511A	1.70	1.90	2.15
BA521	1.85	2.05	2.35
HA1151	1.45	1.70	1.85
HA1156	1.60	1.75	1.95
HA1306W	1.90	2.10	2.40
HA1322	2.40	2.60	2.90
HA1339	2.45	2.65	2.95
HA1339A	2.45	2.65	2.95
LA1222	2.10	2.30	2.50
LA3101	3.45	3.60	3.75
LA4031P	1.75	1.95	2.20
LA4032P	1.75	1.95	2.20
LA4220	2.25	2.40	2.55
LA4400	1.85	2.05	2.35
LD3141	1.70	1.80	1.90
M5115P	4.85	4.90	4.95
M51513L	1.95	2.15	2.45
MN3001	13.20	14.85	16.50
MN3002	9.25	10.40	11.55
MN3003	5.64	6.34	7.04
PLL01A	4.00	4.15	4.55
PLL02A	4.95	5.20	5.80
PLL03A	7.50	7.90	8.70
SG264A	7.00	7.40	7.80
SG609	4.10	4.30	4.50
SG613	5.05	5.45	5.85
SM5104	7.90	8.40	8.90
STK011	3.55	3.95	4.35
STK013	8.90	10.00	11.10
STK015	4.10	4.30	4.80
STK050	23.10	25.98	28.86
STK415	7.10	7.60	8.10
STK435	4.45	4.95	5.55
STK439	8.00	9.00	10.00
TA7045M	1.95	2.15	2.45
TA7055P	1.95	2.15	2.45
TA7060P	.85	1.05	1.15
TA7061P	.85	1.05	1.15
TA7062P	1.05	1.20	1.35
TA7063P	1.25	1.35	1.50
TA7074P	3.70	3.85	4.00

	25-UP	10-24	1-9
TA7089P	1.95	2.15	2.45
TA7092	4.40	4.90	5.40
TA7120P	1.45	1.65	1.85
TA7139P	1.55	1.75	1.95
TA7153P	5.70	5.90	6.10
TA7203P	2.45	2.60	2.85
TA7204P	1.95	2.10	2.45
TA7205P	1.55	1.75	1.95
TA7214P	3.90	4.20	4.50
TA7310P	1.25	1.40	1.55
TA7607P	5.80	6.00	6.20
TA7609P	4.40	4.60	4.80
TBA8105H	1.85	2.05	2.35
TC5080P	4.80	5.00	5.60
TC5081P	2.90	3.10	3.30
TC5082P	3.30	3.45	3.80
UHIC001	4.90	5.10	5.60
UHIC002	4.90	5.10	5.60
UHIC003	4.90	5.10	5.60
UHIC004	4.90	5.10	5.60
UHIC005	4.90	5.10	5.60
UHIC006	4.90	5.10	5.60
UPC20C	2.00	2.40	2.70
UPC141C	2.30	2.40	2.50
UPC157A	3.25	3.45	3.65
UPC554C	1.60	1.70	1.80
UPC555H	1.60	1.70	1.80
UPC572C	3.70	4.10	3.69
UPC574C	.90	1.08	1.20
UPC575C2	1.25	1.40	1.55
UPC576	1.85	2.05	2.35
UPC592H2	.75	.85	.95
UPC1001H2	1.85	2.05	2.35
UPC1008C	4.85	5.15	5.75
UPC1020H	1.85	2.05	2.35
UPC1025	1.85	2.05	2.35
UPC1028	1.40	1.62	1.80
UPC1031H	2.52	2.74	2.98
UPC1032H	1.70	1.85	2.10
UPC1152H	2.90	3.10	3.30
UPC1156	1.85	2.05	2.35
UPD277C	8.70	8.90	9.10
UPD857C	7.90	8.30	9.40
UPD858C	7.00	7.10	7.20
UPD861C	8.70	8.90	9.10

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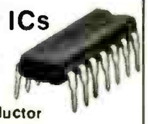
TTL and CMOS Logic ICs



Full-Spec Devices Direct from Motorola and National Semiconductor

Type	Cat No		ONLY
7400	276-1801		35¢
7402	276-1811		39¢
7404	276-1802		35¢
7406	276-1821		49¢
7410	276-1807		39¢
7413	276-1815		79¢
7420	276-1809		39¢
7427	276-1823		49¢
7432	276-1824		49¢
7441	276-1804		99¢
7447	276-1805		99¢
7448	276-1816		99¢
7451	276-1825		39¢
7473	276-1803		49¢
7474	276-1818		49¢
7475	276-1806		79¢
7476	276-1813		59¢
7485	276-1826		1.19
7486	276-1827		49¢
7490	276-1808		79¢
7492	276-1819		69¢
74123	276-1817		99¢
74145	276-1828		1.19
74150	276-1829		1.39
74154	276-1834		1.29
74192	276-1831		1.19
74193	276-1820		1.19
74194	276-1832		1.19
74196	276-1833		1.29
4001	276-2401	Reg. $ .49	Sale 39¢
4011	276-2411	Reg $ 49	Sale 39¢
4012	276-2412	Reg $ 69	Sale 49¢
4013	276-2413	Reg $ 89	Sale 69¢
4017	276-2417	Reg $1 49	Sale 1.19
4020	276-2420	Reg $1 49	Sale 1.19
4021	276-2421	Reg. $1 49	Sale 99¢
4023	276-2423	Reg. $ 69	Sale 49¢
4027	276-2427	Reg. $ 89	Sale 69¢
4028	276-2428	Reg. $1.29	Sale 89¢
4046	276-2446	Reg. $1 69	Sale 1 29
4049	276-2449	Reg. $ 69	Sale 49¢
4050	276-2450	Reg. $ 69	Sale 49¢
4051	276-2451	Reg. $1 49	Sale 1.19
4066	276-2466	Reg $ 99	Sale 79¢
4070	276-2470	Reg $ 69	Sale 49¢
4511	276-2447	Reg $1 69	Sale 1.19
4518	276-2490	Reg $1 49	Sale 1.19
4543	276-2491	Reg $1 89	Sale 1.49

Linear ICs

Type	Cat No	ONLY
301CN	276-017	49¢
324N	276-1711	1.49
339N	276-1712	1.49
386CN	276-1731	99¢
555CN	276-1723	79¢
556CN	276-1728	1.39
566CN	276-1724	1.69
567CN	276-1721	1.99
723CN	276-1740	69¢
741CN	276-007	49¢
741H	276-010	49¢
3900N	276-1713	99¢
3909N	276-1705	99¢
4558CN	276-038	79¢
75491	276-1701	99¢
75492	276-1702	99¢
7805	276-1770	1.29
7812	276-1771	1.29
7815	276-1772	1.29

8080A Microprocessor

The heart of a low-cost microcomputer. 2 µsec cycle time. Includes 10-page data sheet and full specs.
276-2510 Reg. $12.95 .... Sale 9.95

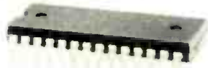
RAM Memory ICs
Under 450 nS Access Time

2102 1024 x 1 Array. Low-cost static memory chip. 16-pin DIP. Buy 8 and save!
276-2501 .... 2.49 Ea. or 8/14.95

2114L 1024 x 4 Array. High-density static RAM. 18-pin DIP. NMOS design. 276-2504 .... 12.95

SN-76477 Sound/Music Synthesizer IC

NEW

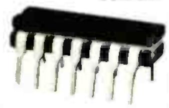


2.99 Featured in Oct. Popular Electronics

Creates almost any type of sound — music to "gunshots!" Built-in audio amp. Includes 2 VCO's, LF osc., noise gen., filter, 2 mixers, envelope modulator, logic circuit. 28-pin DIP. With data/applications circuits. 276-1765 .... 2.99

Analog Audio Delay IC MN 3002

NEW

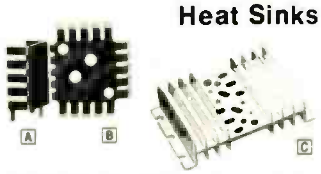


10.95

For Phase-Shifter, Reverb & Delay Circuits

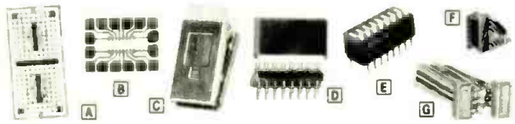
"Bucket Brigade" device uses 512 shift registers to provide a continuously variable electronic delay for complex audio signals. Includes data sheet and applications circuits. 276-1760 .... 10.95

Heat Sinks



A TO-220. For PC board-mounted power semiconductors in TO-220 cases. Anodized aluminum.
276-1363 .... 79¢
B TO-3 Sink. For PC or chassis mtg.
276-1364 .... 1.39
C Universal. Mounts 2 devices, accepts 9 case styles. 276-1361 .... 2.69

Top-Quality IC and PCB Accessories

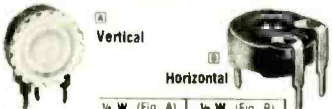


A PC Board. Mounts two 14 or 16-pin ICs or sockets for bread boarding. Copper clad. 2½x5x1¹⁄₁₆" 276-151 Reg. $2.99 .... Sale 1.99
B PC Board. Mounts single 14 or 16-pin IC or socket.
276-024 .... Pkg. of 2/99¢
C 16-Pin IC Test Clip. 276-1951 .... 3.99
D 16-Pin DIP Header. With snap-on cover. 276-1980 .... 1.29
E 8-Rocker 16-Pin DIP Switch. 276-1301 .... 1.99
F Vertical 16-pin Socket. For LED displays. 276-1986 .... 1.49
G 16-Pin DIP Jumper Cable. 18" long. 276-1976 .... 3.99

Wire Wrapping Accessories

Wire Wrapping Tool. Strips and wraps 30-gauge wire.
276-1570 .... 6.95
14-Pin Wire Wrapping Sockets.
276-1993 .... 2/1.29
16-Pin Wire Wrapping Sockets.
276-1994 .... 2/1.39
50' Red 30-ga. Kynar Wire. 278-501 .... 1.99
50' White 30-ga. Kynar Wire. 278-502 .... 1.99
50' Blue 30-ga. Kynar Wire. 278-503 .... 1.99

PC Potentiometers



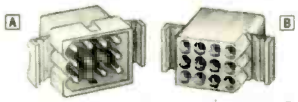
A Vertical
B Horizontal

	¼ W. (Fig. A)		⅛ W. (Fig. B)	
Ohms	Cat No	Ea	Cat No	Ea
500k	271-226	49¢	—	—
1k	271-227	49¢	271-333	39¢
5k	271-217	49¢	—	—
10k	271-218	49¢	271-335	39¢
25k	—	—	271-336	39¢
50k	271-219	49¢	—	—
100k	271-220	49¢	271-338	39¢
500k	271-221	49¢	—	—
1 Meg	271-229	49¢	—	—

Switches

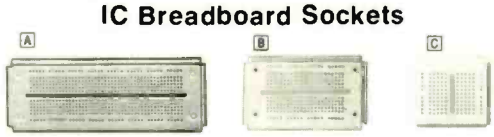
A Miniature Toggle. 6A @ 125VAC.
SPDT. 275-662 .... 2.39
DPDT. 275-663 .... 2.89
DPDT. Center-Off. 275-664 ...... 2.99
B Momentary SPST. 275-609 ... 1.79
C Momentary SPDT. 275-1549 .. 1.99
D SPST Mercury. 275-027 .... 99¢

Molded Connectors



Molded nylon body. Each circuit rated 8A @ 250V. Standard .093" pin diameter.
A 4-Pin Male. 274-224 .... 99¢
6-Pin Male. 274-226 .... 1.19
9-Pin Male. 274-229 .... 1.39
12-Pin Male. 274-232 .... 1.49
B 4-Pin Female. 274-234 .... 99¢
6-Pin Female. 274-236 .... 1.19
9-Pin Female. 274-239 .... 1.39
12-Pin Female. 274-242 .... 1.49
2-Pin Male & Female. (Not Shown.)
274-222 .... Pair 89¢

IC Breadboard Sockets



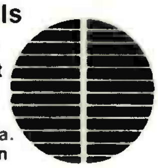
Modular boards snap together and feature standard 0.3" center. Accept 22 through 30-gauge solid hookup wire.
A 550 connections in 2 bus strips of 40 tie points each with 47 rows of 5 connected tie points. 2⅛x6". 276-174 .... 9.95
B 270 connections in 2 bus strips of 40 tie points each with 23 rows of 5 connected tie points. 2⅛x3⅝". 276-175 .... 5.95
C Mini-Socket. 22 rows of 5 tie points each, plus 2 bus strips with 10 connections each. 2⅛x1⅞". 276-176 .... 3.95

SALE Solar Cells

Electricity from Light

4cm x 2cm Silicon Cell

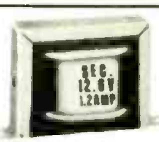
Silicon type cell converts light to electrical power, delivering up to 100 mA at 0.5V. Use several in series-parallel for higher voltage or current.
276-120 Reg. 2.99 ... Sale 2.29



2¼" Dia. Silicon Cell

Highly efficient! Delivers up to 400 mA at 0.5V. Ideal for solar power projects, battery charging and operating electronic equipment.
276-121 .... 5.99

Low-Cost Power Transformers



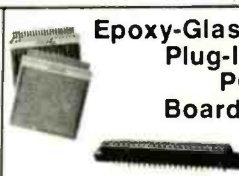
- Primaries Designed to Operate from 120VAC, 60 Hz
- Solder Lugs for Easy Wiring or PC Board Mounting

Volts	Current	Cat. No	Each
6 3	1 2A	273-050	2.49
6 3	300 mA	273-1384	1.99
12	300 mA	273-1385	1.99
24	300 mA	273-1386	2.49
24	1 2A	273-1480	2.99
12.6 CT	1 2A	273-1505	2.89

Volts	Current	Cat. No	Each
6 3 CT	3A	273-1510	3.99
12 6 CT	3A	273-1511	4.69
25 2 CT	2A	273-1512	4.99
12	5A	273-1513	8.95
18 CT*	4A	273-1514	8.95
18 CT*	2A	273-1515	4.99

*Ideal for 5V (using CT) or 12V solid-state regulators

Epoxy-Glass Plug-In PC Boards



For 22-pin connectors. 4½x4¹⁄₁₀" grid. 3 styles available.
Standard. 276-155 .... 4.49
Digital. 276-156 .... 4.49
Op-Amp. 276-157 .... 4.49
22-Pin Dual Connector.
276-1551 .... 2.99

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CT-50

SPECIFICATIONS:
Frequency range: 6 Hz to 65 mHz, 600 mHz with CT-600
Resolution: 10 Hz @ 0.1 sec gate, 1 Hz @ 1 sec gate
Readout: 8 digit, 0.4" high LED, direct readout in mHz
Accuracy: adjustable to 0.5 ppm
Stability: 2.0 ppm over 10° to 40° C, temperature compensated
Input: BNC, 1 megohm/20 pf direct, 50 ohm with CT-600
Overload: 50VAC maximum, all modes
Sensitivity: less than 25 mv to 65 mHz, 50-150 mv to 600 mHz
Power: 110 VAC 5 Watts or 12 VDC @ 400 ma
Size: 6" x 4" x 2", high quality aluminum case, 2 lbs
ICS: 13 units, all socketed

The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 mHz and up to 600 mHz with the CT-600 option. Large Scale Integration, CMOS circuitry and solid state display technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation. Features of the CT-50 include: large 8 digit LED display, RF shielded all metal case, easy pushbutton operation, automatic decimal point, fully socketed IC chips and input protection to 50 volts to insure against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step by step instructions guide you to a finished unit you can rely on.
Order your today!

CT-50, 60 mHz counter kit	$89.95
CT-50WT, 60 mHz counter, wired and tested	159.95
CT-600, 600 mHz scaler option, add	29.95
CB-1, Color TV calibrator-stabilizer	$14.95
DP-1, DC probe, general purpose probe	12.95
HP-1, High impedance probe, non-loadir	15.95

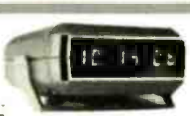
CAR CLOCK

The UN-KIT, only 5 solder connections

Here's a super looking, rugged and accurate auto clock which is a snap to build and install. Clock movement is completely assembled—you only solder 3 wires and 2 switches, takes about 15 minutes! Display is bright green with automatic brightness control photocell—assures you of a highly readable display, day or night. Comes in a satin finish anodized aluminum case which can be attached 5 different ways using 2 sided tape. Choice of silver, black or gold case (specify).

DC-3 kit, 12 hour format	$22.95
DC-3 wired and tested	$29.95
110V AC adapter	$5.95

Under dash car clock



12/24 hour clock in a beautiful plastic case features 6 jumbo RED LEDS, high accuracy (1 min/mo), easy 3 wire hookup, display blanks with ignition, and super instructions. Optional dimmer automatically adjusts display to ambient light level.

DC-11 clock with mtg. bracket	$27.95
DM-1 dimmer adapter	2.50

PRESCALER

Extend the range of your counter to 600 mHz. Works with any counter. Includes 2 transistor pre-amp to give super sens, typically 20 mv at 150 mHz. Specify ÷ 10 or ÷ 100 ratio.

PS-1B, 600 mHz prescaler	$59.95
PS-1BK, 600 mHz prescaler kit	49.95

OP-AMP SPECIAL

741 mini dip	12/$2.00
BI-FET mini dip, 741 type	10/$2.00

VIDEO TERMINAL

A completely self-contained, stand alone video terminal card. Requires only an ASCII keyboard and TV set to become a complete terminal unit. Two units available, common features are, single 5V supply, XTAL controlled sync and baud rates (to 9600), complete computer and keyboard control of cursor. Parity error control and display. Accepts and generates serial ASCII plus parallel keyboard input. The 3216 is 32 char. by 16 lines, 2 pages with memory dump feature. The 6416 is 64 char. by 16 lines, with scrolling, upper and lower case (optional) and has RS-232 and 20ma loop interfaces on board. Kits include sockets and complete documentation.

RE 3216, terminal card	$149.95
RE 6416, terminal card	189.95
Lower Case option, 6416 only	13.95
Power Supply Kit	14.95
Video/RF Modulator, VD-1	6.95
Assembled, tested units, add	60.00

CALENDAR ALARM CLOCK

The clock that's got it all. 6-.5" LEDs, 12/24 hour, snooze, 24 hour alarm, 4 year calendar, battery backup, and lots more. The super 7001 chip is used. Size 5x4x2 inches.
Complete kit, less case (not available)

DC-9	$34.95

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain: 1 W in for 8 out, 2 in for 15 out, 4 W in for 30 out. Max output of 35 W, incredible value, complete with all parts, less case and T-R relay.

PA-1, 30 W pwr amp kit	$22.95
TR-1, RF sensed T-R relay kit	6.95

FM MINI MIKE KIT

A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

FM-3 kit	$12.95
FM-3 wired and tested	16.95

CLOCK KITS

our Best Seller
your Best Deal

Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six .4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors, silver, gold, bronze, black, blue (specify).

Clock kit, 12/24 hour, DC-5	$22.95
Clock with 10 min. ID timer, 12/24 hour, DC-10	27.95
Alarm clock, 12 hour only, DC-8	24.95
12V DC car clock, DC-7	27.95

For wired and tested clocks add $10.00 to kit price.

Hard to find PARTS

LINEAR ICs		REGULATORS	
301	$ .35	78MG	$1.25
324	1.50	723	.50
380	1.25	309K	.85
380-8	.75	7805	.85
555	.45	78L05	.25
556	.85	7905	1.25
566	1.15	7812	.85
567	1.25	7912	1.25
1458	.50	7815	.85
3900	.50	**TTL ICs**	
CMOS ICs		74S00	.35
4011	.20	7447	.65
4013	.35	7475	.50
4046	1.85	7490	.50
4049	.40	74196TI	1.35
4518	1.25	**SPECIAL ICs**	
5369	1.75	11C90	13.50
TRANSISTORS		10116	1.25
2N3904 type	10/1.00	4511	2.00
2N3906 type	10/1.00	5314	2.95
NPN 30W Pwr	3/1.00	5375AB	2.95
PNP 30W Pwr	3/1.00	7001	6.50
2N3055	.60	4059 + N	9.00
UJT 2N2646 type	3/2.00	7208	17.95
FET MPF102 type	3/2.00	**LEDs**	
UHF 2N5179 type	3/2.00	Jumbo red	8/1.00
MRF-238 RF	11.95	Jumbo green	6/1.00
SOCKETS		Jumbo yellow	6/1.00
8 pin	10/2.00	Mini red	8/1.00
14 pin	10/2.00	Micro red	8/1.00
16 pin	10/2.00	BiPolar	.75
24 pin	4/2.00	**FERRITE BEADS**	
28 pin	4/2.00	With info, specs	15/1.00
40 pin	3/2.00	6 hole balun	5/1.00

Ramsey's famous MINI-KITS

FM WIRELESS MIKE KIT

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.
FM-1 kit $2.95 FM-2 kit $4.95

COLOR ORGAN/MUSIC LIGHTS

See music come alive! 3 different lights flicker with music. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300W. Great for parties, band music, nite clubs and more.
Complete kit, ML-1 $7.95

LED BLINKY KIT

A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts.
Complete kit, BL-1 $2.95

VIDEO MODULATOR KIT

Converts any TV to video monitor. Super stable, tunable over ch. 4-6. Runs on 5-15V, accepts std. video signal. Best unit on the market!
Complete kit, VD-1 $6.95

TONE DECODER

A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone decoding, tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts.
Complete kit, TD-1 $5.95

WHISPER LIGHT KIT

An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Completely self-contained, includes mike, runs on 110VAC, controls up to 300 watts.
Complete kit, WL-1 $6.95

SUPER SLEUTH

A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2 W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker.
Complete kit, BN-9 $5.95

POWER SUPPLY KIT

Complete triple regulated power supply provides variable 6 to 18 volts at 200 ma and + 5V at 1 Amp. Excellent load regulation, good filtering and small size. Less transformers, requires 6.3V @ 1 A and 24 VCT.
Complete kit, PS-3LT $6.95

SIREN KIT

Produces upward and downward wail characteristic of a police siren. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker.
Complete kit, SM-3 $2.95

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TERMS: Satisfaction guaranteed or money refunded. COD, add $1.50. Minimum order, $6.00. Orders under $10.00, add $.75. Add 5% for postage, insurance, handling. Overseas, add 15%. NY residents, add 7% tax.

CIRCLE 35 ON FREE INFORMATION CARD

Rockwell AIM 65
The Head-Start in Computers

AIM 65 Technical Overview

THERMAL PRINTER
Most desired feature on low-cost microcomputer systems
- Wide 20-column printout
- Versatile 5 x 7 dot matrix format
- Complete 64-character ASCII alphanumeric format
- Fast 120 lines per minute
- Quiet thermal operation
- Proven reliability

FULL-SIZE ALPHANUMERIC KEYBOARD
Provides compatibility with system terminals
- Standard 54 key terminal-style layout
- 26 alphabetic characters
- 10 numeric characters
- 22 special characters
- 9 control functions
- 3 user-defined functions

TRUE ALPHANUMERIC DISPLAY
Provides legible and lengthy display
- 20 characters wide
- 16-segment characters
- High contrast monolithic characters
- Complete 64-character ASCII alphanumeric format

PROVEN R6500 MICROCOMPUTER SYSTEM DEVICES
Reliable high performance NMOS technology
- R6502 Central Processing Unit (CPU) operating at 1 MHz
Has 65K address capability 13 addressing modes and true index capability Simple but powerful 56 instructions
- Read Write Memory using R2114 Static RAM devices Available in 1K byte and 4K byte versions
- 8K Monitor Program Memory using R2332 Static ROM devices Has sockets to accept additional 2332 ROM or 2532 PROM devices to expand on-board Program Memory up to 20K bytes
- R6532 RAM-Input Output-Timer (RIOT) combination device Multipurpose circuit for AIM 65 Monitor functions
- Two R6522 Versatile Interface Adapter (VIA) devices which support AIM 65 and user functions Each VIA has two parallel and one serial 8-bit bidirectional I O ports two 2-bit peripheral handshake control lines and two fully-programmable 16-bit interval timer event counters

BUILT-IN EXPANSION CAPABILITY
- 44-Pin Application Connector for peripheral add-ons
- 44-Pin Expansion Connector has full system bus
- Both connectors are KIM-1 compatible

TTY AND AUDIO CASSETTE INTERFACES
Standard interface to low-cost peripherals
- 20 ma current loop TTY interface
- Interface for two audio cassette recorders
- Two audio cassette formats ASCII KIM-1 compatible and binary blocked file assembler compatible

ROM-RESIDENT ADVANCED INTERACTIVE MONITOR
Advanced features found only on larger systems
- Monitor-generated prompts
- Single keystroke commands
- Address independent data entry
- Debug aids
- Error messages
- Option and user interface linkage

ADVANCED INTERFACE MONITOR COMMANDS

Major Function Entry
(RESET Button) —Enter and initialize Monitor
ESC—Re-enter Monitor
E —Enter and initialize Text Editor
T — Re-enter Text Editor
N —Enter Assembler
5 —Enter and initialize BASIC Interpreter
6 — Re-enter BASIC Interpreter

Instruction Entry and Disassembly
I — Enter mnemonic instruction entry mode
K — Disassemble memory

Display/Alter Registers and Memory
* Alter Program Counter to (address)
A — Alter Accumulator to (byte)
X — Alter X Register to (byte)
Y —Alter Y Register to (byte)
P — Alter Processor Status to (byte)
S — Alter Stack Pointer to (byte)
R Display all registers
M —Displays four memory locations starting at (address)
(SPACE)—Display next four memory locations
/ —Alter current memory location

Manipulate Breakpoints
\# — Clear all breakpoints
4 — Toggle breakpoint enable on off
B —Set one to four breakpoint addresses
? — Display breakpoint addresses

Control Instruction/Trace
G — Execute user s program
Z — Toggle instruction trace mode on off
V — Toggle register trace mode on off
H —Trace Program Counter history

Control Peripheral Devices
L — Load object code into memory from peripheral I O device
D Dump object code to peripheral I O device
1 — Toggle Tape 1 control on off
2 —Toggle Tape 2 control on off
3 — Verify tape checksum
CTRL PRINT—Toggle Printer on off
LF —Line Feed
PRINT Print Display contents

Call User-Defined Functions
F1 — Call User Function 1
F2 —Call User Function 2
F3 — Call User Function 3

Text Editor Commands
R — Read lines into text buffer from peripheral I O device
I — Insert line into text buffer from Keyboard
K —Delete current line of text
(SPACE)—Display current line of text
L — List lines of text to peripheral I O device
U —Move up one line
D —Move down one line
T —Go to top line of text
B — Go to bottom line of text
F —Find character string
C —Change character string
Q —Quit Text Editor return to Monitor

LOW COST PLUG-IN ROM OPTIONS
- 4K Assembler — symbolic two-pass
- 8K BASIC Interpreter

POWER SUPPLY SPECIFICATIONS
- 5 VDC ± 5% regulated @ 2 0 amps (max)
- +24 VDC ± 15% unregulated @ 2 5 amps (peak) 0 5 amps (average)

AIM 65 (1K) $375 00 (*$15 00)
AIM 65 (4K) $450 00 (*$15 00)
Assembler ROM — Add $85 00
BASIC Interpreter — Add $100 00
Power Supply — Add $45 00
*Shipping and handling charge
Calif residents add 6% sales tax

MONEY BACK GUARANTEE
If you are not convinced that the AIM 65 is the best of its kind on the market, we will refund your money immediately.

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Rockwell's AIM 65 Advanced Interactive Microcomputer can get you into the exciting world of microcomputers a lot easier and at a lower cost than you may have thought possible And you'll be working with the 6500 family the advanced state-of-the-art NMOS system that's an everincreasing favorite for new commercial and hobbyist applications

As a learning aid AIM 65 gives you an assembled versatile microcomputer system with a fullsize keyboard 20-character display and uniquely a thermal printer An on-board Advanced Interactive Monitor program provides extensive control and program development functions And our AIM 65 User's Manual will help you along each step of the way

You ll master fundamentals rapidly Then you ll appreciate the fact that unlike the computer toys on the market AIM 65 offers flexibility and expandability you would expect to find in a sophisticated microcomputer development system

THERMAL PRINTER GIVES YOU HARD COPY — FAST AND QUIET.
AIM 65 s 20 column Thermal Printer prints on low-cost thermal roll paper at a fast 120 lines per minute It produces all of the standard 64 ASCII characters with a crisp-printing five-by-seven dot matrix AIM 65 s on-board printer is a unique feature for a low-cost computer

EXTENDED ALPHANUMERIC DISPLAY IS BUILT FOR UNDERSTANDING, NOT DECIPHERING.
AIM 65 comes with a 20-character true Alphanumeric Display Information is displayed with bright magnified 16-segment font monolithic characters It s both unambiguous and easily readable

FULL-SIZE KEYBOARD IS DESIGNED FOR HUMANS, NOT ELVES.
AIM 65 s terminal-style keyboard frees you from the hassles of fumbling around with a tiny calculator-type keypad And its 54 keys provide 70 different alphabetic numeric control and special functions

ON-BOARD ADVANCED INTERACTIVE MONITOR GETS YOUR PROGRAMS UP AND RUNNING.
The ROM-resident AIM 65 Advanced Interactive Monitor Program provides a comprehensive set of easy-to-use single-keystroke commands for debugging your programs and offers features normally available only in larger expensive microcomputer development systems And with the AIM 65 Monitor there s no guesswork involved the Monitor gives a self-explanatory prompt when it needs information and it will generate a meaningful error message if an error has occurred

The AIM 65 Monitor includes commands to
- Enter and edit programs directly no "opcode" memorization
- List programs on Printer or TTY
- Display alter registers and memory
- Set breakpoints trace and debug program execution
- Control the Thermal Printer
- Transfer information to from attached Cassette Recorders or TTY
- Execute programs in on-board or external RAM ROM or PROM memory
- Interface the optional AIM 65 Assembler and BASIC Interpreter

AIM 65'S ADVANCED R6500 NMOS ARCHITECTURE.
The R6502 Central Processing Unit is the heart of the AIM 65 It provides demonstrated speed and simplicity plus 65K addressability and the power of a 56-command minicomputer-like instruction set

The R6532 RAM-Input Output-Timer (RIOT) combination device is used by the AIM 65 Monitor for scratchpad memory and Keyboard operations

Two R6522 Versatile Interface Adapter (VIA) devices are provided One device supports AIM 65 s Thermal Printer and the TTY and Cassette Interfaces the other supports two user-dedicated 8-line I O ports plus an 8-bit serial I O port and access to two 16-bit interval timer/event counters, on the module s Application Connector

AIM 65 comes with two R2332 4K Read Only Memory (ROM) devices installed These hold the Advanced Interface Monitor program Spare sockets allow the user to expand on-board ROM up to 20K bytes These sockets will accept user programs on R2332 ROMs or compatible PROMs, or can be used to install the optional AIM 65 Assembler and BASIC Interpreter ROM devices

On-Board Read Write RAM memory is available in 1K-byte and 4K-byte configurations

AIM 65 HAS EXPANSION BUILT IN.
And to allow AIM 65 to grow the way you want it to we've provided an Application Connector and an Expansion Connector The Application Connector permits you to plug on a TTY (20 ma current loop) and one or two standard audio cassette recorders It also has the pinouts for the VIA s General-Purpose I/O ports The Expansion Connector extends AIM 65's system bus — address data and control — out to additional memory, or anything else you might attach

And BASIC high-level language programming is a built-in option

CIRCLE 5 ON FREE INFORMATION CARD

600 MHZ FREQUENCY COUNTER

continued from page 43

moved from its socket and a jumper wire used to connect socket pins 8 and 2. The input will now be applied directly to the 7208 counter without being prescaled. You can also go a step farther and use a DPDT miniature toggle switch (S4) to open the supply going to the 74196 and short together pins 8 and 2 (see schematic). You will of course have to make allowances for the decimal point being one place to the right in this mode.

Calibration

Before calibration, check the regulated supply voltage at pin 2 of the voltage regulator IC6. The voltage should be between 5.1 and 5.35 referenced to ground. Resistor R1 can be replaced with a higher value to increase or a lower value to decrease the regulator's output voltage. Allow the counter to warm up for 30 minutes before calibration.

Calibration is performed by allowing the counter to count an accurately known and stable signal (preferably between 3 MHz and 50 MHz) and adjusting trimmer C14 until the known frequency is displayed. A nonmetallic screwdriver or TV alignment tool should be used when adjusting C14. The 1-megohm/60-MHz input and the 1-second gate position should be used for maximum resolution.

If an accurately calibrated frequency counter is available then allow it and the OPTO-7000 to measure a stable oscillator or signal generator output. Adjust the OPTO-7000 until identical readings are obtained. The reference frequency counter should have at least the same number of digits of resolution as the OPTO-7000.

A signal generator or oscillator (15-MHz if available) can be adjusted for a zero beat against the WWV signal received on a general-purpose communications receiver. When a zero beat or meter null is obtained, read the frequency on the OPTO-7000 and adjust C14 for the correct display. A color TV set that is tuned to a network (CBS, NBC, ABC) color signal is phase-locked to a secondary frequency standard of 3.579545 MHz. The color-burst frequency standard should be used only by those who have experience working with powered-up TV set chassis.

It may be possible to locate a local two-way radio service shop that has suitable frequency calibration equipment and would be willing to calibrate a counter for a reasonable charge.

The Optoelectronics TCXO-70 can be used as a precision .1-ppm timebase for the OPTO-7000 and comes from the factory precalibrated. **R-E**

INTEGRATED ELECTRONICS

540 Weddell Drive, #4, Sunnyvale, CA 94086 (408)734-8470

SN6477 Complex Sound Generator $3.50
This is a programmable sound effect generator capable of producing a wide variety of sounds from high to low frequency. Using this chip & a small number of inexpensive parts, a variety of projects may be built. Spec shs & application notes $1.00

TL500 Analog Processor $8.50
The TL500 contains all the active analog elements for an automatic zeroing and automatic polarity. It is a 13-bit dual-slope A/D converter that has true differential inputs. It requires 3 caps. & 2 resistors with no special matching or tolerances. It is designed for use with the TL502. Spec sheet $ .25

TL502 Digital Panel Meter L.D. $5.50
This is a 4½-digit Digital Panel Meter L.D. that is designed to interface with the TL500 analog processor. It provides base drive for external PNP digit & segment drivers providing direct interface with 7-segment display. Spec sheet $ .25

LD130 A/D Converter $5.50
Single-reference voltage, auto zero and auto polarity. It is designed for Digital Voltmeters, Panel Meters, Digital Thermometers, Microprocessor Interfaces to Analog Signals, & General Instrumentation. 34-pg. Spec & Application notes $2.50

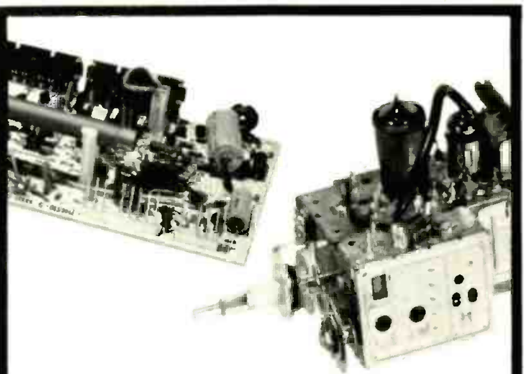
MM5865 Programmable Stopwatch $7.50
7-function Universal Timer and Stopwatch. Start/stop with elapse time, start/stop accumulative event time, split, sequential total elapse time, rally total elapse time, program up and down count. It uses 32.8 KHz crystal or external clock.
Spec sheet & 10-page Application notes $1.50

32.8 KHz Crystal $4.00

Minimum order $5.00 US currency. Check or money order only. Add 5% to cover shipping and handling charges. Calif. residents add 6% sales tax. Santa Clara County residents add 6.5% sales tax.

CIRCLE 45 ON FREE INFORMATION CARD

TUNERS • MODULES



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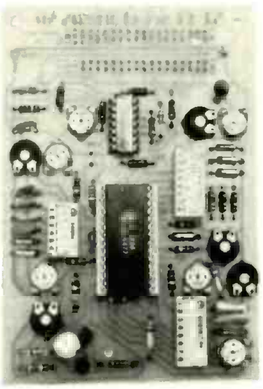
CIRCLE 62 ON FREE INFORMATION CARD

BULLET ELECTRONICS

The SE-01 is a kit that contains all the parts needed to build a programmable sound effects generator. Designed around the new **Texas Instruments 76447 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. Another IC is used to implement an Adjustable Pulse Generator. Level Comparator and Multiplex Oscillator for even more versatility. The 3¼" by 5" plated PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains**, or an almost infinite number of **other sounds**, the unit has a multitude of applications. The **$16.95** price includes Assembly Manual, Programming Charts, and 76477 Chip specifications (speaker not included). Available from stock.



MC1469R POSITIVE VOLTAGE REGULATOR
¼ AMP. COMPLETE SPECS AND APPLICATIONS SHOW HOW TO BUILD FIXED OR VARIABLE POWER SUPPLIES FROM 3 TO 30VDC. DRIVE EXTERNAL SERIES PASS FOR CURRENT TO 20 AMPS!
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HOUSE #

IL-1 OPTO ISOLATORS
BY LITRONIX 6 PIN DIP STANDARD PINOUT LED TRANSISTOR COMBINATION
50¢
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HOUSE # PNP POWER
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KYNAR® Insulat.
500 FT
4.50

NEW ITEMS:
MV1624 Varicap Diode 10pfd Nom. 2:1 Tuning Range 49¢
2N5583 High Freq. Amp 1 Watt @ 1.5 GHZ! TO-5 Case style, House # 50¢
MFC4000B ¼ Watt Audio Amp 4 pin plastic pack 50¢
HI10103 100V 3A SCR Ultra sensitive gate drives from TTL TO-220 55¢
HI03SS 50V 3A Triac Sensitive Gate TO-5 40¢

MPF131 N-CHANNEL DUAL GATE MOSFET
50¢
DESIGNED FOR AMPLIFIER AND MIXER APPLICATIONS TO 200 MHZ. PLASTIC CASE. UNITS ARE HOUSE NUMBERED WITH SPECS

CAPACITORS
SMALL SIZE!
2200 MFD @ 16 VDC RADIAL 3/1.00
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220 MFD @ 25VDC 7/1.00 AXIAL
1 MFD @ 20VDC DISC CERAMIC 15/1.00

.022	100VDC Mylar	8/1.00
.22	50VDC Mylar	6/1.00
1.5mfd	400VDC Mylar	4/1.00
.1mfd	35V Tant Axial	6/1.00
.47mfd	35V Tant Axial	6/1.00
2.2mfd	35V Tant Axial	5/1.00
22mfd	20V Dip Tant	4/1.00
33mfd	10V Dip Tant	4/1.00

YOU'VE SEEN IT ON QUALITY STEREO GEAR
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BLACK INSERT
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DPDT Toggle
ALCO CST-022
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FANTASTIC SOUND EFFECTS CHIP
THIS 28 PIN MARVEL CONTAINS A LOW FREQUENCY OSCILLATOR, VCO, NOISE OSCILLATOR, ONE SHOT, MIXER AND ENVELOPE CONTROL WITH 8 PAGE MANUAL 5 to 9VDC 3.95

HOUSE #
LM3900 QUAD NORTON AMP
WE BOUGHT A LARGE QUANTITY OF THESE HOUSE NUMBERED PARTS AT A BARGAIN PRICE THAT ALLOWS US TO SELL THEM AT A LOW LOW 39¢

FND510 69¢
COMMON ANODE READOUT ½" CHARACTER
LIMIT 24 PER CUSTOMER
LED'S JUMBO RED 5/.89 GREEN 4/.89
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MC1351P FM-IF AMP AND DISCRIMINATOR
USED IN FM & TV SOUND CIRCUITS. REQUIRES MINIMUM EXTERNAL COMPONENTS. 14 PIN DIP. DIRECT REPLACEMENT FOR HEPC 6060, ECG 746 and MANY OTHERS. HOUSE # WITH SPECS 50¢

739 FAIRCHILD
DUAL LOW NOISE AUDIO PRE-AMPLIFIER
89¢ 2/1.69

EMITTER RESISTORS
HARD TO FIND VALUES!
1 ohm @ 5W
25 ohm @ 5W
YOUR CHOICE 7/1.00

25A 100V SCR 1.95
Perfect for battery chargers, switching supplies, crowbars, etc.

MJ900 - MJ1000
COMPLIMENTARY PNP NPN DARLINGTON POWER TRANSISTORS. 8 AMPS. WE SUPPLY A SCHEMATIC TO BUILD A HIGH POWER (35W) LOW DISTORTION AUDIO AMP WITH ONLY ONE ADDITIONAL TRANSISTOR AND A DOZEN INEXPENSIVE COMPONENTS! TO-3 CASE STYLE. BUY A PAIR FOR
$3.00!

ALL COMPONENTS 100% GUARANTEED

CA3011	WIDEBAND IF AMP w/specs	50¢
2N3569	NPN EPOXY 1W	8/1.00
741	OP AMP 8 PIN DIP	5/1.00
723	VOLTAGE REG 14 PIN DIP	50¢
MPS6530	NPN HOUSE #	8/1.00
725	OP AMP LOW NOISE HOUSE #	99¢
7815	15V 1A REGULATOR HOUSE #	69¢
2N4343	P CHANNEL J FET	4/1.00
2N6111	PNP MED PWR 40W TO-220	3/1.00
2N6028	PROGRAMMABLE UNIJUNCTION w/specs	50¢
TRIAC	200V 8A UNMARKED	3/1.00

Diodes

1N4003	200V 1A	15/1.00
1N4006	800V 1A	12/1.00
1N270	Germanium Diode	8/1.00
1N38A	Germanium Diode	10/100
1N4148	Cut & Bent for PC Board Insertion	100/1.25

UNMARKED POWER DIODES with cathode bands. Guaranteed to be at least 400PIV @ 1A. 100% Good parts. Epoxy case
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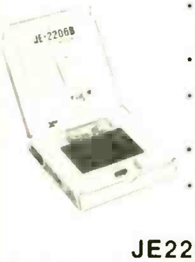
Jameco Electronics — New Kits

Regulated Power Supply

- Uses LM 309K
- Heat sink provided
- P.C. board construction
- Provides a solid 1 amp @ 5V
- Includes components, hardware and instructions
- Sizes: 3-1/2" x 5" x 2" high

JE200 $14.95

Function Generator Kit



- Provides 3 basic waveforms: sine, triangle & square wave
- Frequency range from 1 Hz to 100K Hz
- Output amplitude from 0-volts to over 6 volts (peak to peak)
- Uses a 12V supply or a ± 6V split supply
- Includes chip, P.C. board, components and Instructions.

JE2206B $19.95

Digital Stopwatch Kit

- Use Intersil 7205 Chip
- Plated thru double-sided P.C. Board
- LED display (red)
- Times to 59 min. 59.59 sec. with auto reset
- Quartz crystal controlled
- Three stopwatches in one: single event, split (cummulative) and taylor (sequential timing)
- Uses 3 penlite batteries
- Size: 4.5" x 2.15" x .90"

JE900 $39.95

4-Digit Clock Kit

- Bright .357" ht. red display
- Sequential flashing colon
- 12 or 24 hour operation
- Extruded aluminum case (black)
- Pressure switches for hours, minutes and hold modes
- Includes all components, case and wall transformer
- Size: 3-1/4" x 1-3/4" x 1-1/4"

JE730 $14.95

6-Digit Clock Kit

- Bright .300 ht. common cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 20 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6-3/4" x 3-1/8" x 1-3/4"

JE701 $19.95

Jumbo 6-Digit Clock Kit

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

JE747 $29.95

MICROPROCESSOR COMPONENTS

Part	Description	Price
8080A/8080A SUPPORT DEVICES		
8080A	CPU	$9.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	5.95
8238	System Controller	5.95
8251	Prog. Comm. I/O (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. I/O (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95
6800/6800 SUPPORT DEVICES		
MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810AP1	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024x8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25
MICROPROCESSOR CHIPS—MISCELLANEOUS		
Z80(780C)	CPU	$19.95
Z80A(780-1)	CPU	24.95
CDP1802	CPU	19.95
2650	MPU	19.95
8035	8-Bit MPU w/clock, RAM, I/O lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95
SHIFT REGISTERS		
MM500H	Dual 25 Bit Dynamic	5.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	1.95
UART'S		
A-Y-5-1013	30K BAUD	5.95

Part	Size	Description	Price
MICROPROCESSOR MANUALS			
M-Z80		User Manual	$7.50
M-CDP1802		User Manual	7.50
M-2650		User Manual	5.00
ROM'S			
2513(2140)		Character Generator(upper case)	$9.95
2513(3021)		Character Generator(lower case)	9.95
2516		Character Generator	10.95
MM5230N		2048-Bit Read Only Memory	1.95
RAM'S			
1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	9.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16x4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin	14.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00
PROM'S			
1702A	2048	FAMOS	$5.95
TMS2516 (2716)	16K*	EPROM(Intel 2716) *Requires single +5V power supply	49.95
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I.	16K**	EPROM **Requires 3 voltages: -5V, +5V, +12V	29.95
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	4.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

NEW!! IN STOCK... POWERACE

ALL-CIRCUIT EVALUATORS WITH POWER

POWERACE 101 -General purpose model for prototyping all types of circuit.
#923101 $ 84.95

POWERACE 102 -Complete digit prototyping lab with built-in logic probe
#923102 $114.95

POWERACE 103 -Triple-output power supply for prototyping both linear and digit circuits.
#923103 $124.95

- 1680 solderless, plug-in tie points ...will hold up to 18 14-pin DIP's.
- Breadboard elements accept all DIP sizes ...including RTL, DTL, TTL and CMOS devices. TO-5's and discretes with leads up to .032" dia.
- All connections to/from switches, indicators, power supplies and meters are made via solderless, plug-in, tie-point blocks on control panels.
- Interconnect with any solid 20 to 30 AWG wire.
- Breadboard elements are mounted on ground planes ...ideal for high-frequency and high-speed low-noise circuits.
- Short-circuit-proof fused power supplies
- Operate on 110 to 130 VAC at 60 Hz
- Space-age compact styling and high-grade components permit convenient, organized and quick prototyping
- All models are 7.5" wide 11.5" deep and 4.0" high (rear) 0.75" high (front) and weigh approx. 2.5 lbs

B&K PRECISION 3½-Digit Portable DMM

- Overload Protected
- .3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv, 1Va, 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage 0-1000V
AC Voltage 0-1000V
Freq. Response 50-400 HZ
DC/AC Current 0-100mA
Resistance 0-10 meg ohm
Size 6.4 x 4.4 x 2

Model 2800 $99.95
Comes with test leads, operating manual and spare fuse

Accessories:

AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC 100 MHz 8-Digit Counter

Continental Specialties Corporation

- 20 Hz-100 MHz Range
- .6" LED Display
- Crystal controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces: i.e. batteries, 110 or 220V with charger, 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

ACCESSORIES FOR MAX 100:
Mobile Charger Eliminator use power from car battery — Model 100 — CLA $3.95
Charger/Eliminator use 110 V AC — Model 100 — CA1 $9.95

New! CSC Mini-Max 6 Digit 50MHz Frequency Counter

- Guaranteed frequency range of 100 Hz to 50 MHz
- Full 6 digit display with antiglare window
- Fully automatic-range, polarity, slope, trigger, input level switching not required.
- Lead-zero blanking—All zeros to the left of the first non-zero digit are blanked. Kilo Hertz and Mega Hertz decimal points automatically light up when the unit is turned on.
- Built in input overvoltage protection.
- Use 9V Battery or 110/220V power.
- Complete with mini antenna.
- Lightweight — Only 8oz

MINI-MAX $89.95

Accessories For Mini-Max

Part No.	Description	Price
MM-A4	Antenna	$ 3.95
MM-C5	Carrying case	5.95
MM-IPC	Input cable with clip leads	3.95
MM-AC2	110V adapter	9.95
MM-AC3	220V adapter	9.95

$5.00 Minimum Order – U.S. Funds Only
California Residents – Add 6% Sales Tax

Spec Sheets – 25¢
1979 Catalog Available—Send 41¢ stamp

NEW 1979 Catalog

Jameco ELECTRONICS

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS – WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
Advertised Prices Good Thru January

The Incredible "Pennywhistle 103"

$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half duplex selectable).
Maximum Data Rate	300 Baud
Data Format	Asynchronous Serial (return to mark level required between each character)
Receive Channel Frequencies	2025 Hz for space, 2225 Hz for mark
Transmit Channel Frequencies	Switch selectable: Low (normal) — 1070 space, 1270 mark. High — 025 space, 2225 mark
Receive Sensitivity	-46 dbm accoustically coupled
Transmit Level	-15 dbm nominal. Adjustable from -6 dbm to -20 dbm
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts
Physical	All components mount on a single 5" by 9" printed circuit board. All components included

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

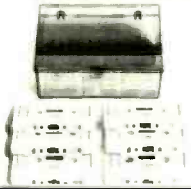
TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:
- 8 each UPD416 (16K Dynamic Rams)
- Documentation for conversion

TRS-16K $115.00

Special Offer - Order both your TRS-16K and the Sup'R' MOD II Interface kit together (retail value $144.95) **for only $139.95**

COMPUTER CASSETTES

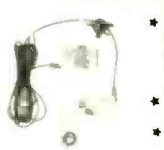


- 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- PLASTIC CASE INCLUDED 12 CASSETTE CAPACITY
- ADDITIONAL CASSETTES AVAILABLE #C-15-$2.50 ea

CAS-6 $14.95
(Case and 6 Cassettes)

SUP 'R' MOD II

UHF Channel 33 TV Interface Unit Kit

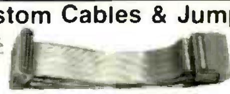


Wide Band B/W or Color System
- ★ Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, TRS-80, Challenger, etc.
- ★ MOD II is pretuned to Channel 33 (UHF).
- ★ Includes coaxial cable and antenna transformer.

MOD II $29.95 Kit

Custom Cables & Jumpers

NEW NEW



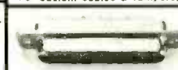
DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft.	2-DP25P	$15.95 ea.
DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea
DB25S-4-S	4 ft	2-DP25S	$17.95 ea
Dip Jumpers			
DJ14-1	1 ft	1-14 Pin	$1.59 ea.
DJ16-1	1 ft	1-16 Pin	1.79 ea
DJ24-1	1 ft	1-24 Pin	2.79 ea
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea
DJ24-1-16	1 ft.	2-24 Pin	4.95 ea.

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

CONNECTORS

25 Pin-D Subminiature



DB25P(as pictured)	PLUG	$2.95
DB25S	SOCKET	3.50
DB51226-1	Cable Cover for DB25 P or S	1.75

63-Key Unencoded Keyboard

This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK **$29.95/each**

Hexadecimal Unencoded Keypad

19-key pad Includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

CIRCLE 20 ON FREE INFORMATION CARD

7400 TTL

SN7400N	16	SN7470N	29	SN74160N	89
SN7401N	18	SN7472N	29	SN74161N	89
SN7402N	18	SN7473N	35	SN74162N	1 95
SN7403N	18	SN7474N	35	SN74163N	89
SN7404N	18	SN7475N	49	SN74164N	89
SN7405N	20	SN7476N	35	SN74165N	89
SN7406N	29	SN7479N	5 00	SN74166N	1 25
SN7407N	29	SN7480N	50	SN74167N	1 95
SN7408N	20	SN7482N	99	SN74170N	1 59
SN7409N	20	SN7483N	59	SN74172N	6 00
SN7410N	18	SN7485N	79	SN74173N	1 25
SN7411N	25	SN7486N	35	SN74174N	89
SN7412N	25	SN7489N	1 75	SN74175N	79
SN7413N	40	SN7490N	45	SN74176N	79
SN7414N	70	SN7491N	59	SN74177N	79
SN7416N	25	SN7492N	43	SN74179N	1 95
SN7417N	25	SN7493N	43	SN74180N	79
SN7420N	20	SN7494N	65	SN74181N	1 95
SN7421N	29	SN7495N	65	SN74182N	79
SN7422N	39	SN7496N	65	SN74184N	1 95
SN7423N	25	SN7497N	3 00	SN74185N	1 95
SN7425N	29	SN74100N	89	SN74186N	9 95
SN7426N	29	SN74107N	35	SN74188N	3 95
SN7427N	25	SN74109N	59	SN74190N	1 25
SN7429N	39	SN74116N	1 95	SN74191N	1 25
SN7430N	20	SN74121N	35	SN74192N	79
SN7432N	25	SN74122N	39	SN74193N	79
SN7437N	25	SN74123N	49	SN74194N	89
SN7438N	25	SN74125N	49	SN74195N	69
SN7439N	25	SN74126N	49	SN74196N	89
SN7440N	20	SN74132N	75	SN74197N	89
SN7441N	89	SN74136N	75	SN74198N	1 49
SN7442N	49	SN74141N	79	SN74199N	1 49
SN7443N	75	SN74142N	2 95	SN74S200	4 95
SN7444N	75	SN74143N	2 95	SN74251N	1 79
SN7445N	75	SN74144N	2 95	SN74279N	79
SN7446N	69	SN74145N	79	SN74283N	2 25
SN7447N	59	SN74147N	1 95	SN74284N	3 95
SN7448N	79	SN74148N	1 29	SN74285N	3 95
SN7450N	20	SN74150N	89	SN74365N	69
SN7451N	20	SN74151N	59	SN74366N	69
SN7453N	20	SN74152N	59	SN74367N	69
SN7454N	20	SN74153N	59	SN74368N	69
SN7459A	25	SN74154N	99	SN74390N	1 95
SN7460N	20	SN74155N	79	SN74393N	1 95
		SN74156N	79		
		SN74157N	65		

20% Discount 100 pcs combined order 25% -1000 pcs combined order

C/MOS

CD4000	23	CD4028	89	CD4070	55
CD4001	23	CD4029	1 19	CD4071	23
CD4002	23	CD4030	49	CD4072	49
CD4006	1 19	CD4035	99	CD4076	1 39
CD4007	25	CD4040	1 19	CD4081	23
CD4009	49	CD4041	1 25	CD4082	23
CD4010	49	CD4042	99	CD4093	99
CD4011	23	CD4043	89	CD4098	2 49
CD4012	25	CD4044	89	MC14409	14 95
CD4013	39	CD4046	1 79	MC14410	14 95
CD4014	1 39	CD4047	2 50	MC14411	14 95
CD4015	1 19	CD4048	1 35	MC14419	4 95
CD4016	49	CD4049	49	MC14433	19 95
CD4017	1 19	CD4050	49	MC14506	75
CD4018	99	CD4051	1 19	MC14507	99
CD4019	49	CD4053	1 19	MC14562	14 50
CD4020	1 19	CD4056	2 95	MC14583	3 50
CD4021	1 39	CD4059	9 95	CD4508	3 95
CD4022	1 19	CD4060	1 49	CD4510	1 39
CD4023	23	CD4066	79	CD4511	1 29
CD4024	79	CD4068	39	CD4515	2 95
CD4025	23	CD4069	45	CD4518	1 29
CD4026	2 25			CD4520	1 29
CD4027	69			CD4566	2 25

74C00

74C00	39	74C85	2 49	74C163	2 49
74C02	39	74C90	1 95	74C164	2 49
74C04	39	74C93	1 95	74C173	2 60
74C08	49	74C95	1 95	74C192	2 49
74C10	39	74C107	1 25	74C193	2 49
74C14	1 95	74C151	2 90	74C195	2 49
74C20	39	74C154	3 00	74C922	5 95
74C30	39	74C157	2 15	74C923	6 25
74C42	1 95	74C160	2 49	74C925	8 95
74C48	2 49	74C161	2 49	74C926	8 95
74C73	89			80C95	1 50
74C74	89			80C97	1 50

LINEAR

78MG	1 75	LM340K-18	1 35	LM710N	79
LM108H	99	LM340K 24	1 35	LM711N	39
LM300H	80	LM340T 5	1 25	LM723N H	55
LM301CN H	35	LM340T 6	1 25	LM733N	1 00
LM302H	75	LM340T-8	1 25	LM739N	1 19
LM304H	1 00	LM340T 12	1 25	LM741CN H	35
LM305H	60	LM340T 15	1 25	LM741-14N	39
LM307CN H	35	LM340T-18	1 25	LM747N H	79
LM308CN H	1 00	LM340T-24	1 25	LM748N H	39
LM309H	1 10	LM358N	1 00	LM1310N	2 95
LM309K	1 25	LM370N	1 95	LM1458CN H	59
LM310CN	1 15	LM373N	3 25	MC1488N	1 95
LM311N/H	90	LM377N	4 00	MC1489N	1 95
LM312H	1 95	LM380N	1 25	LM1496N	95
LM317K	6 50	LM380CN	99	LM1556V	1 75
LM318CN H	1 50	LM381N	1 79	MC1741SCP	3 00
LM319N	1 30	LM382N	1 79	LM2111N	1 95
LM320K 5	1 35	NE501N	8 00	LM2901N	2 95
LM320K-5 2	1 35	NE510A	6 00	LM3053N	1 50
LM320K 12	1 35	NE529A	4 95	LM3065N	1 49
LM320K 15	1 35	NE531H V	3 95	LM3900N(3401)	49
LM320K 18	1 35	NE536T	6 00	LM3905N	89
LM320K-24	1 35	NE540L	6 00	LM3909N	1 25
LM320T-5	1 25	NE544N	4 95	MC5558V	59
LM320T-5 2	1 25	NE550N	1 30	8038B	4 95
LM320T 8	1 25	NE555V	39	LM75450N	49
LM320T-12	1 25	NE556N	99	75451CN	39
LM320T-15	1 25	NE560B	5 00	75452CN	39
LM320T 18	1 25	NE561B	5 00	75453CN	39
LM320T 24	1 25	NE562B	5 00	75454CN	39
LM323K-5	5 95	NE565N/H	1 25	75491CN	79
LM324N	1 80	NE566CN	1 75	75492CN	89
LM339N	99	NE567V H	99	75493N	89
LM340K 5	1 35	NE570N	4 95	75494CN	89
LM340K-6	1 35	LM703CN H	69	RC4136	1 25
LM340K-8	1 35	LM709N H	29	RC4151	5 95
LM340K 12	1 35			RC4194	5 95
LM340K 15	1 35			RC4195	4 49

74LS00TTL

74LS00	23	74LS47	69	74LS138	69
74LS01	23	74LS51	23	74LS139	69
74LS02	23	74LS54	23	74LS151	69
74LS03	23	74LS55	23	74LS155	69
74LS04	29	74LS73	35	74LS157	69
74LS05	29	74LS74	35	74LS160	89
74LS08	23	74LS75	49	74LS161	89
74LS09	29	74LS76	35	74LS162	89
74LS10	23	74LS78	39	74LS163	89
74LS11	60	74LS83	75	74LS164	99
74LS13	49	74LS85	99	74LS175	79
74LS14	99	74LS86	35	74LS181	2 49
74LS15	29	74LS90	49	74LS190	89
74LS20	23	74LS92	59	74LS191	89
74LS21	29	74LS93	59	74LS192	89
74LS22	29	74LS95	79	74LS193	89
74LS26	29	74LS96	89	74LS194	89
74LS27	29	74LS107	35	74LS195	89
74LS28	29	74LS109	35	74LS253	79
74LS30	23	74LS112	35	74LS257	69
74LS32	29	74LS123	99	74LS258	1 39
74LS37	35	74LS125	69	74LS260	55
74LS40	29	74LS132	79	74LS279	59
74LS42	69	74LS136	39	74LS367	59
				74LS368	59
				74LS670	1 95

Vigilite

Electronic Home Security Timer

A microprocessor-based pre programmed light control that fits into a home wall socket replacing the standard on off light switch. Discourages intruders and burglars by turning lights on and off in a "real life" pattern while you're away.

Unlike other electromechanical timers Vigilite can simulate the lighting patterns of five different rooms as selected by the user. Vigilite can also control over head lights which other timers cannot. Three Vigilite units simulating kitchen, bathroom and bedroom lighting can give a home ultimate protection because the user chooses a lighting pattern that depicts his real life pattern. He then sets the Vigilite clock and room pattern accordingly. (See bar chart below.) The house actually looks occupied although no one is home.

Easy to install. The Vigilite unit contains an accurate digital LED clock plus pre programmed independent lighting patterns for bedroom, bath room, kitchen, living room and outside porch lights. All solid state components assure the user long product life and reliability.

Technical Specifications

1) Electrical requirement — 120 VAC 60Hz 2 ½ Amps
2) For use with permanently installed incandescent 40 W to 300 W light fixtures—single pole circuits
3) Cannot be used to control television appliances or other motor driven equipment
4) One Vigilite unit required for each room circuit

Part Number **VGL-1** **$39.95 ea.**

DISCRETE LEDS

.200 dia.				.125" dia.			
XC556R	red	5/$1		XC209R	red	5 $1	
XC556G	green	4/$1		XC209G	green	4 $1	
XC556Y	yellow	4/$1		XC209Y	yellow	4 $1	
XC556C	clear	4/$1					
.200" dia.				.185" dia.			
XC22R	red	5/$1		XC526R	red	5/$1	
XC22G	green	4/$1		XC526G	green	4/$1	
XC22Y	yellow	4/$1		XC526Y	yellow	4/$1	
.170" dia.				XC526C	clear	4/$1	
MV10B	red	4 $1		.190 dia.			
.085" dia.				XC111R	red	5/$1	
MV50	red	6/$1		XC111G	green	4/$1	
INFRA-RED LED 1/4"x1/4"x1 16" flat		5/$1		XC111Y	yellow	4/$1	
				XC111C	clear	4/$1	

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LIQUID CRYSTAL DISPLAY
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4 DIGIT – 5 CHARACTERS
THREE ENUNCIATORS
2 00 X 1 20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive	$7.95
T1001A-Reflective	8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode red	270	2 95	MAN 6730	Common Anode red · 1	560	99
MAN 2	5 x 7 Dot Matrix-red	300	4 95	MAN 6740	Common Cathode red-D D	560	99
MAN 3	Common Cathode-red	125	25	MAN 6750	Common Cathode red · 1	560	99
MAN 4	Common Cathode red	187	1 95	MAN 6760	Common Anode red	560	99
MAN 7G	Common Anode-green	300	1 25	MAN 6780	Common Cathode red	560	99
MAN 7Y	Common Anode-yellow	300	99	DL701	Common Anode red · 1	300	99
MAN 72	Common Anode-red	300	99	DL704	Common Cathode-red	300	99
MAN 74	Common Cathode red	300	1 25	DL707	Common Anode red	300	99
MAN 82	Common Anode yellow	300	99	DL728	Common Cathode red	500	1 49
MAN 84	Common Cathode yellow	300	99	DL741	Common Anode-red	600	1 25
MAN 3620	Common Anode-orange	300	99	DL746	Common Anode red · 1	630	1 49
MAN 3630	Common Anode orange · 1	300	99	DL747	Common Anode red	600	1 49
MAN 3640	Common Cathode orange	300	99	DL749	Common Cathode red · 1	630	1 49
MAN 4610	Common Anode-orange	300	99	DL750	Common Cathode red	600	1 49
MAN 4640	Common Cathode-orange	400	99	DL338	Common Cathode-red	110	35
MAN 4710	Common Anode red	400	99	FND70	Common Cathode	250	69
MAN 4730	Common Anode red · 1	400	99	FND358	Common Cathode · 1	357	99
MAN 4740	Common Cathode red	400	99	FND359	Common Cathode	357	75
MAN 4810	Common Anode-yellow	400	99	FND503	Common Cathode(FND500)	500	99
MAN 4840	Common Cathode yellow	400	99	FND507	Common Anode (FND510)	500	99
MAN 6610	Common Anode orange D D	560	99	5082 7730	Common Anode red	300	1 30
MAN 6630	Common Anode orange · 1	560	99	HDSP 3400	Common Anode red	800	2 10
MAN 6640	Common Cathode orange D D	560	99	HDSP 3403	Common Cathode red	800	2 10
MAN 6650	Common Cathode-orange · 1	560	99	5082 7300	4 x 7 sgl Digit-RHDP	600	19 95
MAN 6660	Common Anode orange	560	99	5082 7302	4 x 7 Sgl Digit LHDP	600	19 95
MAN 6680	Common Cathode orange	560	99	5082 7304	Overrange character (· 1)	600	15 00
MAN 6710	Common Anode red-D D	560	99	5082 7340	4 x 7 Sgl Digit Hexadecimal	600	22 50

RCA LINEAR

CA3013T	2 15	CA3082N	2 00
CA2023T	2 56	CA3083N	1 60
CA3035T	2 48	CA3086N	85
CA3039T	1 35	CA3089N	3 75
CA3046N	1 30	CA3130T	1 39
CA3059N	3 25	CA3140T	1 25
CA3060N	3 25	CA3160T	1 25
CA3080T	85	CA3401N	49
CA3081N	2 00	CA3600N	3 50

CALCULATOR CHIPS/DRIVERS

MM5725	$2 95
MM5738	2 95
DM8864	2 00
DM8865	1 00
DM8887	75
DM8889	75
9374 7 seg C A LED driver	1 50

CLOCK CHIPS

MM5309	$4 95
MM5311	4 95
MM5312	4 95
MM5314	4 95
MM5316	6 95
MM5318	9 95
MM5369	2 95
MM5387 1998A	4 95
MM5841	9 95

MOTOROLA

MC1408L7	$4 95
MC1408L8	5 75
MC1439L	2 95
MC3022P	2 95
MC3061P	3 50
MC4016(74416)	7 50
MC4024P	3 95
MC4040P	6 95
MC4044P	4 50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$17	16	15	22 pin LP	$ 37	36	35
14 pin LP	20	19	18	24 pin LP	38	37	36
16 pin LP	22	21	20	28 pin LP	45	44	43
18 pin LP	29	28	27	36 pin LP	60	59	58
20 pin LP	34	32	30	40 pin LP	63	62	61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin ST	$ 27	25	24	28 pin ST	$ 99	90	81
16 pin ST	30	27	25	36 pin ST	1 39	1 26	1 15
18 pin ST	35	32	30	40 pin ST	1 59	1 45	1 30
24 pin ST	49	45	42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin SG	$ 30	27	24	24 pin SG	$ 70	63	57
14 pin SG	35	32	29	28 pin SG	1 10	1 00	90
16 pin SG	38	35	32	36 pin SG	1 65	1 40	1 26
18 pin SG	52	47	43	40 pin SG	1 75	1 59	1 45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin WW	$ 39	35	31	22 pin WW	$ 95	85	75
10 pin WW	45	41	37	24 pin WW	1 05	95	85
14 pin WW	39	38	37	28 pin WW	1 40	1 25	1 10
16 pin WW	43	42	41	36 pin WW	1 59	1 45	1 30
18 pin WW	75	68	62	40 pin WW	1 75	1 55	1 40

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ASST. 4	5 ea	50 PCS	1.75
ASST. 5	5 ea	50 PCS	1.75
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ASST. 7	5 ea	50 PCS	1.75

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HD0165	Keyboard Encoder (16 keys)	7 95
74C922	Keyboard Encoder (16 keys)	9 95

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ICM7045	CMOS Precision Timer	24 95
ICM7205	CMOS LED Stopwatch/Timer	19 95
ICM7207	Oscillator Controller	7 50
ICM7208	Seven Decade Counter	19 95
ICM7209	Clock Generator	6 95

NMOS READ ONLY MEMORIES

MCM6571	128 X 9 X 7 ASCII Shifted with Greek	13 50
MCM6574	128 X 9 X 7 Math Symbol & Pictures	13 50
MCM6575	128 X 9 X 7 Alphanumeric Control Character Generator	13 50

MISCELLANEOUS

TL074CN	Quad Low Noise bi-fet Op Amp	2 49
TL494CN	Switching Regulator	4 49
TL496CP	Single Switching Regulator	1 75
11C90	Divide 10/11 Prescaler	19 95
95H90	Hi-Speed Divide 10/11 Prescaler	11 95
4N33	Photo-Darlington Opto-Isolator	3 95
MK50240	Top Octave Freq Generator	17 50
DS0026CH	5Mhz 2-phase MOS clock driver	3 75
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MM5320	TV Camera Sync Generator	14 95
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XR215	4.40			XR2556	3.20
XR320	1.55	JE2206KA	14.95	XR2567	2.99
XR-L555	1 50	JE2206KB	19 95	XR3403	1.25
XR555	39	XR1800	3.20	XR4136	1 25
XR556	.99	XR2206	4.40	XR4151	2.85
XR567CP	.99	XR2207	3.85	XR4194	1.45
XR567CT	1.25	XR2208	5 20	XR4202	3.60
XR1310P	1 30	XR2209	1 75	XR4212	2 05
XR1468CN	3.85	XR2211	5 25	XR4558	75
XR1488	1.39	XR2212	4.35	XR4739	1.15
XR1489	1 39	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12 1 00
				1N4003	200 PIV	1 AMP	12 1 00
1N746	3 3	400m	4 1 00	1N4004	400 PIV	1 AMP	12 1 00
1N751	5 1	400m	4 1 00	1N4005	600 PIV	1 AMP	10 1 00
1N752	5 6	400m	4 1 00	1N4006	800 PIV	1 AMP	10 1 00
1N753	6 2	400m	4 1 00	1N4007	1000 PIV	1 AMP	10 1 00
1N754	6 8	400m	4 1 00	1N3600	50	200m	6 1 00
1N757	9 0	400m	4 1 00	1N4148	75	10m	15 1 00
1N759	12 0	400m	4 1 00	1N4154	35	10m	12 1 00
1N959	8 2	400m	4 1 00	1N4305	75	25m	15 1 00
1N965	15	400m	4 1 00	1N4734	5 6	1w	28
1N5232	5 6	500m	28	1N4735	6 2	1w	28
1N5234	6 2	500m	28	1N4736	6 8	1w	28
1N5235	6 8	500m	28	1N4738	8 2	1w	28
1N5236	7 5	500m	28	1N4742	12	1w	28
1N5242	12	500m	28	1N4744	15	1w	28
1N5245	15	500m	28	1N1183	50 PIV	35 AMP	1 60
1N456	25	40m	6 1 00	1N1184	100 PIV	35 AMP	1 70
1N458	150	7m	6 1 00	1N1185	150 PIV	35 AMP	1 70
1N485A	180	10m	5 1 00	1N1186	200 PIV	35 AMP	1 80
1N4001	50 PIV	1 AMP	12 1 00	1N1188	400 PIV	35 AMP	3 00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1 95
C38M	35A @ 600V	SCR	1 95
2N2328	1 6A @ 300V	SCR	50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1 95
MDA 980-3	12A @ 200V	FW BRIDGE REC	1 95

TRANSISTORS

C106B1	50			2N3904	4 1 00
MPSA05	30	2N3055	89	2N3905	4 1 00
MPSA06	5 1 00	MJE3055	1 00	2N3906	4 1 00
TIS97	6 1 00	2N3392	5 1 00	2N4013	3 1 00
TIS98	6 1 00	2N3398	5 1 00	2N4123	6 1 00
40409	1 75	PN3567	3 1 00	PN4249	4 1 00
40410	1 75	PN3568	4 1 00	PN4250	4 1 00
40673	1 75	PN3569	4 1 00	2N4400	4 1 00
2N918	4 1 00	MPS3638A	5 1 00	2N4401	4 1 00
2N2219A	2 1 00	MPS3702	5 1 00	2N4402	4 1 00
2N2221A	4 1 00	2N3704	5 1 00	2N4403	4 1 00
2N2222A	5 1 00	MPS3704	5 1 00	2N4409	5 1 00
PN2222 Plastic	7 1 00	2N3705	5 1 00	2N5086	4 1 00
2N2369	5 1 00	MPS3705	5 1 00	2N5087	4 1 00
2N2369A	4 1 00	2N3706	5 1 00	2N5088	4 1 00
MPS2369	5 1 00	MPS3706	5 1 00	2N5089	4 1 00
2N2484	4 1 00	2N3707	5 1 00	2N5129	5 1 00
2N2906	4 1 00	2N3711	5 1 00	PN5134	5 1 00
2N2907	5 1 00	2N3724A	65	PN5138	5 1 00
PN2907 Plastic	7 1 00	2N3725A	1 00	2N5139	5 1 00
2N2925	5 1 00	2N3772	2 25	2N5210	5 1 00
MJE2955	1 25	2N3823	1 00	2N5449	3 1 00
2N3053	2 1 00	2N3903	5 1 00	2N5951	3 1 00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
10 pf	05	04	03	001µF	05	04	035
22 pf	05	04	03	0047µF	05	04	035
47 pf	05	04	03	01µF	05	04	035
100 pf	05	04	03	022µF	06	05	04
220 pf	05	04	03	047µF	06	05	04
470 pf	05	04	035	1µF	12	09	075

100 VOLT MYLAR FILM CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
001mf	12	10	07	022mf	13	11	08
0022	12	10	07	047mf	21	17	13
0047mf	12	10	07	1mf	27	23	17
01mf	12	10	07	22mf	33	27	22

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	1-9	10-99	100-		1-9	10-99	100-
1 35V	28	23	17	1 5 35V	30	26	21
15 35V	28	23	17	2 2 25V	31	27	22
22 35V	28	23	17	3 3 25V	31	27	22
33 35V	28	23	17	4 7 25V	32	28	23
47 35V	28	23	17	6 8 25V	36	31	25
68 35V	28	23	17	10 25V	40	35	29
1 0 35V	28	23	17	15 25V	63	50	40

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1 0 50V	16	14	11	47 50V	16	14	11
3 3 50V	14	12	09	1 0 16V	15	13	10
4 7 25V	15	13	10	1 0 25V	16	14	11
10 25V	15	13	10	1 0 50V	16	14	11
10 50V	16	14	12	4 7 16V	15	13	10
22 25V	17	15	12	4 7 25V	15	13	10
22 50V	24	20	18	4 7 50V	16	14	11
47 25V	19	17	15	10 16V	14	12	09
47 50V	25	21	19	10 25V	15	13	10
100 25V	24	20	18	10 50V	16	14	12
100 50V	35	30	28	47 50V	24	21	19
220 25V	32	28	25	100 16V	19	15	14
220 50V	45	41	38	100 25V	24	20	18
470 25V	33	29	27	100 50V	35	30	28
1000 16V	55	50	45	220 16V	23	17	16
2200 16V	70	62	55	470 25V	31	28	26

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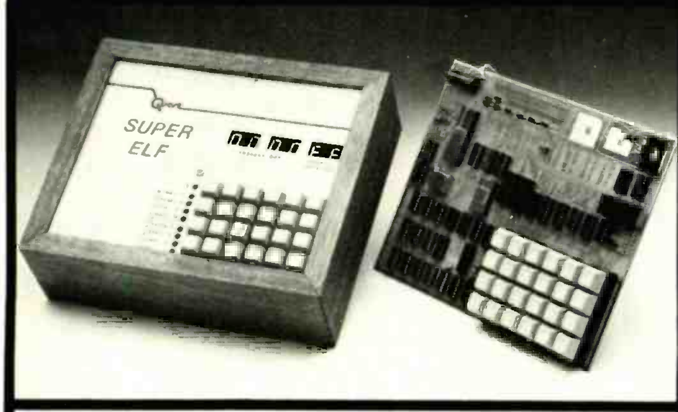

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Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic for ANY 1802 System

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This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed** ($12.00 value). EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, video graphics driver with blinking cursor and block move capability. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports with full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. A Godbout 8K RAM board is available for $127.95. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $12.50 for easy connection between the **Super Elf** and the **Super Expansion Board**.

The **Power Supply** for the Super Expansion Board is a 5 amp supply with + 8v ± 18v + 12v − 5v. Regulated voltages are +5v & +12v $29.95. Deluxe version includes the case at $39.95.

INTEGRATED CIRCUITS

7400TTL	
7400N	.17
7402N	17
7404N	.19
7409N	.23
7410N	.17
7414N	.63
7420N	.17
7422N	1.39
7430N	.20
7442N	.50
7445N	.69
7447N	.60
7448N	.69
7450N	.17
7474N	.29
7475N	.49
7485N	.88
7489N	2.00
7490N	.43
7492N	.43
7493N	.43
7495N	.69
74100N	.90
74107N	.29
74121N	.34
74123N	.59
74125N	.39
74145N	.69
74150N	.95
74151N	.69
74154N	1.00
74157N	.69
74161N	.87
74162N	87
74163N	87
74174N	96
74175N	90
74190N	1.15
74192N	.87
74193N	.85
74221N	1.55
74298N	1.65
74365N	.66
74366N	.66
74367N	.66

74LS00 TTL	
74LS00N	.25
74LS02N	25
74LS04N	.25
74LS05N	.25
74LS08N	.25
74LS10N	.25
74LS13N	.40
74LS14N	.90
74LS20N	.25
74LS22N	.25
74LS28N	.41
74LS30N	.25
74LS33N	.39
74LS38N	.30
74LS74N	.35
74LS75N	.47
74LS90N	.51
74LS93N	.51
74LS95N	1.89
74LS107N	.35
74LS112N	.35
74LS113N	.35
74LS132N	.72
74LS136N	.35
74LS151N	.67
74LS155N	.67
74LS157N	.67
74LS162N	91
74LS163N	.91
74LS174N	.95
74LS190N	1 06
74LS221N	1.95
74LS258N	.67
74LS367N	.89

LINEAR	
CA3045	.90
CA3046	.67
CA3081	1.80
CA3082	1 90
CA3089	2 95
LM301AN/AH	.35
LM305H	.87
LM307N	35
LM308N	.89
LM309H	1.15
LM309K	.95
LM311H/N	.90
LM317T/K	2.92
LM318	1.35
LM320K-5	1.20
LM323K-5	6.95
LM320K-12	1.35
LM320K-15	1.35
LM320T-5	1 60
LM320T-8	1 60
LM320T-12	1 50
LM320T-15	1.60
LM324N	1.15
LM339N	1.55
LM340K-5	1.10
LM340K-8	1.10
LM340K-12	1 10
LM340K-15	1.10
LM340K-24	1.10
LM340T-5	1.10
LM340T-8	1 10
LM340T-12	1 10
LM340T-15	1 10
LM340T-18	1.10
LM340T-24	1 10
LM343H	4 50
LM370	1.15
LM377	4 50
LM379	5.00
LM380N	1 00
LM381	1.60
LM382	1 60
LM703H	40
LM709H	.28
LM723H/N	50
LM733N	67
LM741CH	.35
LM741N	.25
LM747H/N	.62
LM748N	.35
LM1303N	.82
LM1304	1.10
LM1305	1.27
LM1307	2.00
LM1310	2.75
LM1458	.47
LM1800	1.75
LM1812	7.50
LM1889	3.00
LM2111	1.75
LM2902	1.50
LM3900N	60
LM3905	1.75
LM3909N	.61
MC1458V	50
NE540L	2.89
NE550N	.65
NE555V	.43
NE556A	79
NE565A	1 00
NE566V	1.50
NE567V	1 20
NE570B	5 00
NE571B	5 00
78L05	.60
78L08	.60
79L05	70
78M05	85
75108	1.75
75491CN	.50
75492CN	.55
75494CN	.89

A to D CONVERTER	
8038B	4.50
8700CJ	13 95
8701CN	22 00
8750CJ	13.95
LD130	9.95
9400CJV/F	7.40
ICL7103	9.50
ICL7107	14.25

CMOS	
CD34001 Fair.	.50
CD4000	.16
CD4001	.21
CD4002	21
CD4006	1.10
CD4007	.21
CD4008	.21
CD4009	39
CD4010	.39
CD4011	21
CD4012	21
CD4013	.36
CD4014	.86
CD4015	.86
CD4016	.36
CD4017	94
CD4018	94
CD4019	.21
CD4020	1.02
CD4021	1.02
CD4022	.86
CD4023	.21
CD4024	75
CD4025	.21
CD4026	1.51
CD4027	.36
CD4028	79
CD4029	1.02
CD4030	.21
CD4035	1.02
CD4040	1.02
CD4042	71
CD4043	.63
CD4044	63
CD4046	1.67
CD4049	.36
CD4050	36
CD4051	1.13
CD4060	1.42
CD4066	.71
CD4068	40
CD4069	.40
CD4070	.40
CD4071	.21
CD4072	.21
CD4073	.21
CD4075	.21
CD4076	1.75
CD4078	.40
CD4081	.21
CD4082	.21
CD4116	.47
CD4490	5.50
CD4507	1.00
CD4508	4 25
CD4510	1.02
CD4511	.94
CD4515	2 52
CD4516	1.10
CD4518	1.02
CD4520	1.02
CD4527	1.51
CD4528	.79
CD4553	5.75
CD4566	2 25
CD4583	4.50
CD4585	1.10
CD40192	3 00
74C00	.28
74C04	.33
74C10	.28
74C14	2.10
74C20	.28
74C30	.28
74C48	1.95
74C74	.75
74C76	1.40
74C90	1.15
74C93	1.40
74C154	3 00
74C160	1.44
74C175	1.35
74C192	1 65
74C221	2 00
74C905	3 00
74C906	.75
74C914	1.95
74C922	5 50
74C923	5.50
74C925	6.95
74C926	6 95
74C927	6.95

INTERFACE	
8095	.65
8096	.65
8097	.65
8098	.65
8T09	1 25
8T10	4.50
8T13	3.00
8T20	5 50
8T23	3.10
8T24	3.50
8T25	3 20
8T26	1.69
8T28	2.75
8T97	1.69
8T98	1.69

MOS MEMORY RAM	
2101-1	3.95
2102-1	.95
2102AL-4	1.60
21F02	1.25
2104A-4	4.95
2107B	4.95
2111-1	3 75
2112-2	3.95
2114	8 50
4116	17.95
25138	6 30
21L02-1	1.49
MM5262	.40
MM5280	3.00
MM5320	9.95
MM5330	5.94
PD411D-3	4.00
PD411D-4	5 00
P5101L	13 95
4200A	9.95
82S25	2.90
91L02A	1.75
HD0165-5	8.95
MM57100	4.50
GIAY38500-1	9 95
MCM6571A	9.95
9368	3.50
4100	10 00
416	16 00

CLOCKS	
MM5309	3 00
MM5311	3 60
MM5312	4.80
MM5313	3 60
MM5314	3 90
MM5315	4.00
MM5316	5 00
MM5318	3 60
MM5369	2 10
MM5841	14.45
MM5865	7.95
CT7001	5.80
CT7002	8 95
CT7010	8.95
CT7015	7.25
MM5375AA/N	3.90
MM5375AB/N	4.90
7205	16.50
7207	7.50
7208	15.95
7209	4 95
DS0026CN	3 75
DS0056CN	3.75
MM53104	2 50

MICROPROCESSOR	
6800	17 50
6802	24 95
8080A with data	8 95
8085	27 00
Z80	29 95
8212	2.90
8214	8.00
8216	2 90
8224	2.90
8228	5 35
8251	8 50
8253	10 00
8255	9.25
8257	19.50
8259	19 50
CDP1802CD	19.95
CDP1802D	25.00
CDP1861	12 95
6820	9.95
6850	12.95
6502	12 50

IC SOCKETS

Solder Tin Low Profile			
PIN	1 UP	PIN	1UP
8	.15	22	30
14	.18	24	35
18	.20	28	42
18	.27	36	.58
20	.29	40	.57

3 level wire wrap gold
14 pin 25 16 pin 27
7 level 14 pin ww 20

WIRE WRAP LEVEL 3

PIN		PIN	
14	25	24	.86
16	.27	28	1.00
18	57	40	1.23

UART/FIFO	
AY5-1013	5.50
AY5-1014	7 50
3341	6.95

PROM	
1702A	3.95
N82S23	2 95
N82S123	3 50
N82S126	3.75
N82S129	3.75
N82S131	3.75
N82S136	8.75
N82S137	8.75
2708	12.50
DM8577	2 90
8223	2.90
2716T1	22 50
2716 Intel	48 00

CRYSTALS	
1 MHz	4.50
2 MHz	4 50
4 MHz	4.25
5 MHz	4 25
10 MHz	4 25
18 MHz	3.90
20 MHz	3 90
32 MHz	3 90
32768 MHz	4 00
1.8432 MHz	4.50
3.5795 MHz	1.20
2.0100 MHz	1.95
2 097152 MHz	4 50
2 4576 MHz	4.50
3.2768 MHz	4.50
5.0688 MHz	4.50
5.185 MHz	4 50
5.7143 MHz	4.50
6.5536 MHz	4.50
14.31818 MHz	4.25
18.432 MHz	4.50
22.1184 MHz	4 50

CONNECTORS	
44 pin edge	2.00
100 pin edge	4.50
100 pin edge WW	4.50

KEYBOARD ENCODERS	
AY5-2376	$12.50
AY5-3600	13 50
74C922	5 50
74C923	5 50
HD0165-5	8.95

IC Test Clips

	1	10
Red	55	.47
Black	.55	.47

Keyer 8043 14.50
comp. w spec /sock

TRANSISTORS	
2N1893	40
2N2222A	18
2N2369	30
2N2904A	20
2N2907A	25
2N3053	40
2N3638	25
2N3643	.25
2N3904	.18
2N3906	18
2N3055	69
2N4400	25
2N4401	75
2N4402	.20
TIP31	60
TIP33A	1 00

CLOCK MODULES Complete alarm clocks ready to hook up with transformer and switches. Very compact with .50" and .84" digits

MA1002A, C or E .50"	8.95
102P3 Transformer	2.25
MA1010A, C or E .84"	11.95
102P2 Transformer	2.25
Special transformer and six switches when purchased w/module	2.95
MA1003 car module .3" green fluor. display	15.95

RESISTORS ¼ watt 5%
10 per type .03 1000 per type .012
25 per type .025 350 piece pack
100 per type .015 5 per type 6.75

KEYBOARDS	
56 key ASCII keyboard kit	$62.50
Fully assembled	72.50
53 key ASCII keyboard kit	55 00
Fully assembled 65.00 Enclosure	14.95

LEDS	
Red T018	.15
Green, Orange, Yellow T018	.20
Jumbo Red	20
Green, Orange, Yellow Jumbo	.25
Clipite LED Mounting Clips	8/$1.25

(specify red, amber, green, yellow, clear)

CONTINENTAL SPECIALTIES in stock
Complete line of breadboard test equip.
MAX-100 8 digit Freq. Ctr. $128.95

OK WIRE WRAP TOOLS in stock
Portable Multimeter $18.00

DIGITAL THERMOMETER $48.50
Batt. oper. General purpose or medical 32°–230°F. Disposable probe cover ± 2° accuracy. Comp. Assy. in compact case

COMPUTER BOARD KITS	
8K RAM Board Kit	$134 95
4K EPROM Kit	114 95
I/O Board Kit	44 50
Extender Board w connector	12 50
Video Interface board kit	125 00
16K EPROM board kit w/o PROMS	74.50
16K Static RAM board kit	395 00
North Star Floppy Disk Kit	$665.00
Additional Drive Kit	415 00

SPECIAL PRODUCTS	
MM5865 Stopwatch Timer	9 00
PC board	7.50
Switches Mom. Pushbutton	.27
3 pos. slide	.25
Encoder HD0165-5	6.95
3 Digit Universal Counter Board Kit Operates 5–18 Volt DC to 5 MHz typ. .125" LED display	10.50
Voice actuated switch	.50
Paratronics 100A Logic Analyzer Kit	$224.00
Model 10 Trigger Expander Kit	$229 00
Model 150 Bus Grabber Kit	$369 00

TRANSFORMERS	
6V 300 ma	3 25
12 Volt 300 ma transformer	1.25
12.6V CT 600 ma	3.75
12V 250 ma wall plug	2 95
12V CT 250 ma wall plug	3 50
24V CT 400 ma	3.95
10V 1 2 amp wall plug	4 85
18V 6 amp	12 95

DISPLAY LEDS			
MAN1	CA	.270	2.90
MAN3	CC	.125	.39
MAN72/74	CA/CA	.300	1.00
DL704	CC	.300	1 25
DL707/DL707R	CA	.300	1 00
DL727/728	CA/CC	.500	1 90
DL747/750	CA/CC	.600	1 95
DL750	CC	.600	1 95
FND359	CC	.357	.70
FND500/507	CC/CA	.500	1 35
FND503/510	CC/CA	.500	.90
FND800/807	CC/CA	.800	2 20
3 digit Bubble			60
4 digit bubble			80
DG8 Fluorescent			1 75
DG10 Fluorescent			1 75
5 digit 14 pin display			1 00
NSN69 9 digit display			.60
7520 Clairex photocells			.39
TIL311 Hex			9.50

COMPUTER GRADE CAPS			
1600	mfd	200V	4 50
2000	mfd	45V	2.50
3200		50V	2.50
5500		25V	2.50
5800		40V	3 00
6100		40V	3.00
6100		50V	3.00
7700		50V	2 50
8000		55V	2.50
9400		65V	3 00
10000		20V	2 50
12000		30V	3.50
35000		25V	5 00
55000		25V	5 00
82000		15V	6 00
160000		10V	6 00

Auto Clock Kit $15.95
DC clock with 4-.50" displays. Uses National MA-1012 module with alarm option. Includes light dimmer, crystal timebase PC boards. Fully regulated, comp. instructs. Add $3.95 for beautiful dark gray case. Best value anywhere.

RCA Cosmac VIP Kit 229.00
Video computer with games and graphics.

Not a Cheap Clock Kit $14.95
Includes everything except case. 2-PC boards. 6-.50" LED Displays. 5314 clock chip, transformer, all components and full instrucs. Green and orange displays also avail. **Same kit w/.80" displays.** Red only. **$21.95**

60 Hz Crystal Time Base Kit $4.40
Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy. Kit includes: PC board, MM5369, crystal, resistors, capacitors and trimmer.

Digital Temperature Meter Kit
Indoor and outdoor. Switches back and forth. Beautiful. 50" LED readouts. Nothing like it available. Needs no additional parts for complete, full operation. Will measure −100° to +200°F, tenths of a degree, air or liquid. Very accurate. **$39.95**
Beautiful hardwood case w/bezel **$11.75**

NiCad Battery Fixer/Charger Kit
Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/full parts and instructions. **$7.25**

PROM Eraser
Ultraviolet, assembled **$49.95**

Clock Calendar Kit $23.95
CT7015 direct drive chip displays date and time on .6" LEDS with AM-PM indicator. Alarm/doze feature includes buzzer. Complete with all parts, power supply and instructions, less case.

Sinclair 3½ Digit Multimeter
Batt./AC oper. 1mV and .1NA resolution. Resistance to 20 meg. 1% accuracy. Small, portable, completely assem. in case. 1 yr. guarantee. Best value ever! **$59.95**

Video Modulator Kit $8.95
Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

2.5 MHz Frequency Counter Kit
Complete kit less case **$37.50**

30 MHz Frequency Counter Kit
Complete kit less case **$47.75**
Prescaler kit to 350 MHz **$19.95**

1978 IC Update Master Manual
1978 IC Update Master Manual **$24.50.** Complete IC data selector, 2175 pg. Master reference guide. Over 42,000 cross references. Free update service through 1978. Domestic postage $3.50. Foreign $6.00.

Stopwatch Kit $26.95
Full six digit battery operated. 2–5 volts. 3.2768 MHz crystal accuracy. Times to 59 min., 59 sec., 99 1/100 sec. Times std., split and Taylor. 7205 chip, all components minus case. Full instructions.

D Connectors RS232
25 Pin Subminiatures

DB25P	2.95	DE9P	1.50
DB25S	3.95	DE9S	1.95
Cover	1.50	DA15P	2.10
RS232 Complete Set	6.50	DA15S	3.10

S-100 Computer Boards

8K Static RAM Kit	$127.00
16K Static RAM Kit	265.00
24K Static RAM Kit	423.00
32K Dynamic RAM Kit	449.00
64K Dynamic RAM Kit	945 00
8K/16K Eprom Kit (less PROMS)	**$89.00**
Video Interface Kit	**$139.00**
Motherboard **$39.**	Extender Board **$8.99**

**TERMS: $5.00 min. order U.S. Funds. Calif residents add 6% tax.
BankAmericard and Master Charge accepted.
Shipping charges will be added on charge cards.**

FREE: Send for your copy of our NEW 1978 QUEST CATALOG. Include 28¢ stamp.

CIRCLE 22 ON FREE INFORMATION CARD

CIRCLE 54 ON FREE INFORMATION CARD

THE MOST ADVANCED TIMEPIECE OF ITS KIND IN THE WORLD!

LCD Quartz Alarm Chronograph with calendar and dual time zone!! Watch is the same as Seiko but you pay a lot more for the name! Features:

- 24 hour alarm
- Chronograph counts up to 12 hrs., 59 mins. 59.9 sec.
- Precision of chrono up to 1/10 sec indicated by 10 moving arrows!!
- Lap time (with chrono running uninterrupted)
- Time displays by LCD for hour, min, sec, day, date of the week and AM/PM.
- Calendar gives out date-day
- Dual time zone for any two cities of the world at your own choice.
- With light switch to allow you to see the time in the dark!

$65.50

ONE YEAR FULL WARRANTY!

JUMBO 1" LED ALARM CLOCK MODULE

Assembled – not a kit!

Features:
- 1" 4 digits red LED display
- 12 hours real time format
- 24 hours alarm audio output (just add speaker)
- Power failure indicator
- Count down timer 59 mins.
- 12-16V AC 50/60 Hz input
- 10 min. snooze control

$8.50 EACH

#FCM 701

Transformer $1.75

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 red). 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 $17.50

ELECTRONIC DUAL SPEAKER PROTECTOR

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

KIT FORM
$8.75 EA.

It is not a pack of cigarettes. It is a new FM wireless mic kit! New design PC board fits into a plastic cigarette box. (case included) Uses a condensor microphone to allow you to have a better response in sound pick-up. Transmits up to 350 ft! With an LED indicator to signal the unit is on.

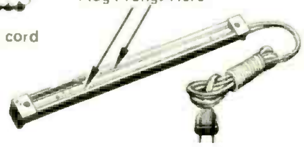
KIT FORM
$7.95

#FMM2

AN AIR HORN!

Good for anything needing sound. This is not electronic, but we bought them with some other deals. They are all brand new in boxes. **$2.50 EA.**

TAP-A-LINE



It is a multi-plug extension cord for 110V AC
Maximum 12 plugs
$3.50 EA.

3-579 MHz Color TV Crystal

ON SALE
$1.25 EA.
10 for $11.00

6V 2AMP Rechargeable Battery

for moped, backup light system, alarm system, CB or other purpose. All brand new, never charged!

SPECIAL PRICE
$4.25 EA

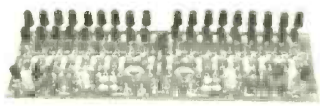
THE MOST POPULAR MM5314 CLOCK KIT

Features:
- 12/24 Hours Display
- 50/60 Hz Input
- 6 Digits Bright Orange Readouts

Kit includes plastic case, MM 5314 I.C. One set transistor drivers, P.C. Board, gas discharge displays, all other electronic parts and transformer. Catalog no. DC-8SP

SPECIAL PRICE
$17.95 PER KIT

9 STEPS LED LEVEL INDICATOR KIT



for most stereo amplifiers

This new project works as a pair of VU meter to indicate the output level of your amplifier from -20dB to +3dB. Kit includes all LED, transistors, electronic components, P.C. Board and Instructions.

Easy to build and fun to see.

ONLY $12.50 EA.

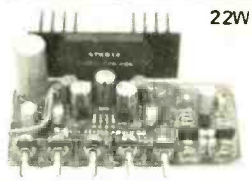
60W + 60W STEREO AMPLIFIER

COMPLETED UNIT—NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8Ω. Power supply is 24 - 36V AC or DC. Complete unit

*Kit form $37.50 — Assembled $49.50 ea.
Power transformer — $ 8.50 ea.

22W + 22W STEREO HYBRID AMPLIFIER KIT

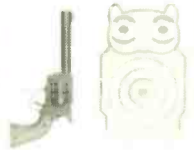


It Works in 12V D.C. As Well! Kit includes 1 PC SANYO STK-024 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 44 watts (22 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100Mz and 10KHz. **$32.50 PER KIT**

POWER TRANSFORMER $6.50 EACH

WHAT A SAFE WAY TO SHOOT!

Electronic shooting game for all ages. Target uses photo electric cell and pistol shoots light beams.



Range approx. 10 ft. and target makes sound. Not a kit! Battery not included.

$13.50 per set

SANYO HYBRID

Audio power amplifiers I.C. Max. hi-fi output power, minimum ext. components needed.

15 Watts	STK-028	$ 8.50
23 Watts	STK-054	$13.50
30 Watts	STK-056	$17.50
50 Watts	STK-050	$26.50
10W + 10W (stereo)	STK-040	$14.50
15W + 15W (stereo)	STK-041	$25.50
20W + 20W (stereo)	STK-043	$31.50

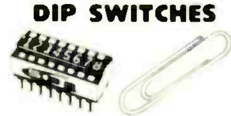
*data sheet comes with purchase

COMPUTER GRADE CAPACITORS

All capacitors are Brand New U.S. made in standard size

6000MFD	50V	$2.60 EA.
9000MFD	50V	$3.25 EA.
11000MFD	35V	$3.20 EA.
14500MFD	40V	$3.40 EA.
23000MFD	20V	$3.00 EA.
58000MFD	20V	$3.20 EA.
100,000MFD	6V	$2.50 EA.

DIP SWITCHES

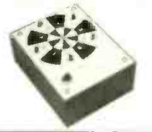


(On-Off Contacts)

4 positions	$1.50
5 positons	$1.60
6 positions	$1.70
7 positions	$1.70
8 positions	$1.80
10 positions	$2.00

ELECTRONIC WHEEL OF FORTUNE KIT!

With 10 numbers split into black and white on dial. The LED turns when you hit the play switch, then it slows down and stops on one number. It sounds like a motor inside, but there is none. Lots of fun and easy to build. Kit comes with nice looking case, all electronic parts, P.C. Board and LEDs. Battery not included.



$12.50

CIRCLE 7 ON FREE INFORMATION CARD

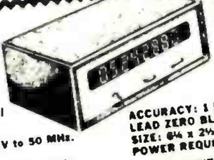
CIRCLE 30 ON FREE INFORMATION CARD

POLY PAKS®
DISCOUNT ALLEY
WE'RE PUTTING "GREENBACKS" IN YOUR POCKET!

10% OFF

That's right! Take 10% discount off any item in this ad! Or, for any $50 shipment, take 25% discount! POLY PAKS DISCOUNT ALLEY continues with the biggest discounts available anywhere!

4" GIANT SOLAR DISCS $9.95
High efficiency energy cells produce 0.5VDC @ rated amperage. Gang in series for higher voltages, or in parallel for high amperages! Perfect for science projects, experiments, industrial & commercial applications 1.5 Amp
Cat. No. U5075

8 DIGIT FREQUENCY COUNTER $77


Easy to read .35" led digits, dependable MOS/LSI circuitry. Quartz crystal controlled for high accuracy! Displays internal frequency standard at the touch of a button. Built in power supply! Flip-top black vinyl covered wooden cabinet for easy access.

- More features for the money!
- Easy to assemble and callibrate!

SPECIFICATIONS:
SENSITIVITY: 25mV to 35 MHz, 50 mV to 50 MHz.
FREQ. RANGE: 10Hz to 50MHz. optional prescaler to 500 MHz.
RESOLUTION: 1 Hz @ 1 sec, 10 Hz @ 10 sec.
GATE TIMES: 1 and 0.1 sec.
INTERNAL FREQUENCY STANDARD: 5.24288 MHz
INPUT IMPEDANCE: 1 megohm
ACCURACY: 1 PPM @ 4 MHz
LEAD ZERO BLANKING
SIZE: 6¼ x 2½ x 5½" deep. WT: 2 lbs.
POWER REQUIREMENTS: 110VAC, 60 Hz.

Cat. No. 4049 COUNTER KIT ... $77
Cat. No. 4050 COUNTER WIRED & CALIBRATED ... $112
Cat. No. 5433 COUNTER WITH PRESCALER WIRED & CALIBRATED ... $150

3 AMP "TEFLON" RECTIFIERS
Order by Cat. No. 5278 and PIV

PIV	Sale
☐ 25	10 for .89
☐ 50	10 for 1.09
☐ 100	10 for 1.29
☐ 200	10 for 1.89
☐ 400	10 for 2.39
☐ 600	10 for 2.89

GIANT SALE! MINI TOGGLE SWITCHES
- 3A 125VAC contacts

*center off

	Contacts	Sale
U4036	SPDT*	$1.29
U5085	SPDT	1.39
U4037	DPDT*	1.45
U5422	DPDT	1.65
U5434	3PDT	1.85
U5458	4PDT*	1.95
U5087	4PDT	1.95

MOTOR SPEED CONTROL "BASIC"* KIT $2.95
Controls up to 10 AMps, 1000 watts! Works with noninductive type motors and incandescent lights. Varies from 5% to 95%. Wt. 10 oz. Cat. No. 5327
*Basic kits include all necessary electronic components, less PC board, case, line cord, transformer, or battery. Easy to breadboard, with instructions

NEW! DIGITAL CAPACITANCE METER KIT $69.95
- 5 Ranges!
- Four .5" digits!
- You've seen it at twice the price!

Measure any capacitor value from 100 pF to 10,000 uF! Five ranges: 0.1uF, 10uF, 100uF, 1000uF, 10,000uF. Also tests leakage! Directly reads all types of capacitors at the touch of a button. Easy to assemble! Complete kit, nothing else required. With step-by-step instructions. Size 6¼ x 2½ x 5½" deep, vinyl covered wooden cabinet. Wt. 2 lbs.

Cat. No. 5238 Capacitance Meter Kit $69.95
Cat. No. 5239 Capacitance Meter Wired $98

DIP SWITCHES
Order by Cat. No.

Cat. No.	Switches	Sale
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1N4000 EPOXY RECTIFIERS
Order by Cat. No.

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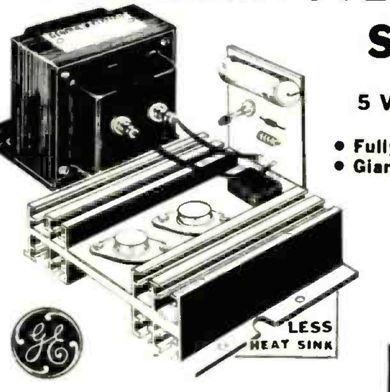
☐ 2380	1N4004	400	10 for .89
☐ 2381	1N4005	600	10 for 1.09
☐ 2362	1N4006	800	10 for 1.49

BASIC COMPUTER POWER SUPPLY


5 VOLT 10 AMP
- Fully Regulated!
- Giant 12 Amp Transformer!

Imagine . . . 5 volts at 10 full amps! Provides the high power required by most minicomputers! Kit includes transformer, and all electronic parts necessary to make it complete, less PC board, case, and line cord. Because of new design technology, effective capacitance is 1,000,000 uF!

$19.95

SPECIFICATIONS:
Input: 105 to 125 VAC, 50-60 Hz.
Ouput: 4.8 to 5.2 VDC @ 0-10 Amps, fixed.
Ripple: 1 mV RMS maximum under all conditions within Operating range of unit.
Transients: No turn on or turn off transients.
Overload Protection: Fuse protected.
Wt. 10 lbs.
Cat. No. U5335

COMMUNICATIONS MIKE $4.95


- Ham-CB-Audio
- Dynamic cartridge
- Top US maker
- Push to talk

Perfect replacement for all HAM and CB rigs. 500 ohm impedance dynamic element. Wide range frequency response 300-5000 Hz, high sensitivity, 6 ft. coiled cord. Case made of unbreakable black plastic. Cat. No. U4074

BLOCK FANS $11
For cooling, flushing, heating and ventilliating! Quiet & dependable. Lightweight, flame retardant. 3 blades or better (sorry, no choosing!). Removed from new equipment. Ship wt. 1½ lbs. Cat. No. U3108
- Famous USA Makers!
- 4-11/16" sq. 1½" deep.

30 WATT STEREO AMPLIFIER KIT $24.95
Easy to build, assembles in minutes. Uses two 15 watt Hybrid Amplifier Modules with heat sinks included! Power output 2 x 15W RMS, both channels into 8 ohms from 40-22,000 Hz. Total distortion less than 1%. Size: 5¼ x 2-3/4". Wt. 1 lb. Cat. No. 5408 *Made For Fisher!*
- Use with any preamp!

MICROPROCESSORS! MEMORIES! SUPPORT!
Order by Cat. No. 3459 and type

Type	Price	Type	Price
☐ 8008	$7.95	☐ 8259	19.95
☐ 8080A	9.95	☐ 2102-L1	$1.59
☐ 8212	3.50	☐ 1103	.79
☐ 8214	7.95	☐ MM5260	.99
☐ 8216	3.50	☐ MM5262	.39
☐ 8224	3.50	☐ MM5280	3.95
☐ 8228	6.95	☐ MK4200P-11	3.95
☐ 8238	7.95	☐ MK4096	3.95
☐ 8251	9.95	☐ MK4116	19.95
☐ 8253	19.95	☐ 1702A	4.95
☐ 8255	10.50	☐ MM5202	2.95
☐ 8257	19.95	☐ 2708	10.95

FREQUENCY COUNTER PRESCALER KIT
Fits inside our Frequency Counter Cabinet. Requires +5VDC, 100mA. With instructions.
Cat. No. 5215 PRESCALER KIT $24.95
Cat. No. 5225 PRESCALER WIRED $34.95
- Works with all frequency counters!

$24.95 kit
- Extends range to 500 MHz!

SANYO AUDIO AMPLIFIER MODULES
Easy to build a complete audio amplifier for hi-fi, tape, AM, FM, PA, and more! Response 20-20,000 Hz, less than .5% distortion at full power. Efficient heat radiating construction. Output 8 ohms. Size 3½ x 2 x ¼" thick approx. Wt. 8 oz. With instructions.

Cat. No.	Type	Watts-RMS	Sale
☐ 5350	STK-009	13	$8.88
☐ 5351	STK-013	15	11.50
☐ 5352	STK-028	20	14.88
☐ 6411	STK-056	30	18.88
☐ 5228	STK-050	50	26.88

"MINI-MITE" SELF POWERED LIQUID CRYSTAL DIGITAL ALARM CLOCK $26.88


- Built-in nite lite!
- Fits into shirt pocket.
- Built in beeper alarm!
- Perfect for any room, office, car, van boat, plane, travel!

From "Star Wars" to "Time Wars" . . Poly Paks' newest LCD digital clock declares "WAR ON TIME". Uses the latest in Space Age Liquid Crystal Technology, featuring low current drain, dependable quartz crystal accuracy. *Operates for a full year on a single AA penlite battery. Compact, only 3 x 1¾ x 1" deep. Charcoal grey hi-impact plastic case. Pushbutton controls for Slow Set, Fast Set, Nite Lite, Snooze, Alarm display. Easy to read .3" digits with AM-PM indicator. NOT A KIT! Completely wired and ready to go! (battery included). With leatherette carry case. Cat. No. 92CU5268

FLAT MAGNIFYING LENSES $3.95


- Build a 2000° Solar Furnace!
- Replaces most overhead projector lenses!

It's different! It's unusual! Magnifies like a lens, yet it's flat! A series of small concentric grooves extend from the center to the edge of the lens, acting like a giant prism! Each groove bends the light waves that hit it, acting like a conventional convex lens. Lightweight, inexpensive, and extremely short focal length of 12". Harness the sun's energy with the fresnel lens and a simple wooden frame! Focus the sun on any flammable object and watch it burst into flames within seconds! Size 11" square, 3/32" thick. Optically perfect. Wt. 1 lb. Cat. No. U5339

RIBBON CABLE AT THIN PRICES
- Ultra flat!
- 28 AWG

Cond.	Length	Sale	Cond.	Length	Sale
☐ 10	10 ft	$1.98	☐ 34	3 ft	1.98
☐ 14*	8 ft	1.98	☐ 36	3 ft	1.98
☐ 20	5 ft	1.98	☐ 40	2 ft	1.98
☐ 25	4 ft	1.98	☐ 50	2 ft	1.98
☐ 26	4 ft	1.98	☐ 60	1 ft	1.98

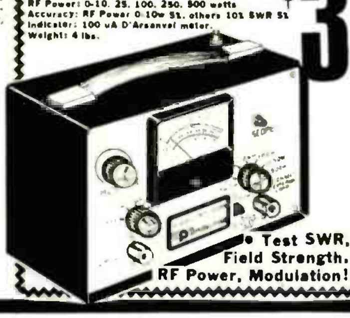
* color coded.

Order by Cat. No. 3938 and conductors.

"BEEM-O-LITE" LASER DIODES 8.88
NEVER BEFORE OFFERED (as far as we know)! Type LASD-69. With power rating of 5 to 9 watts, transmitting a powerful ray of infra red light. Designed in hetero-junction coaxial type structure. N-Type. For "PULSE" mode operation. Wavelength approx. 904nm., 3 volts reverse voltage, threshold current 10, emitting area .9x.08mm. Max. peak fwd current 40. YOU MUST FOLLOW THE LASER SAFETY RULE accompanying laser diode. Gold encased. Size: .25" diameter, ⅛" high, 4/40".

ULTRASONIC TRANSDUCER $1.98
Originally designed for ultrasonic "radar" type alarms. Perfect for dozens of projects, including remote control, alarms, etc. Sends and receives! 1" diameter, 3/4" deep, with standard RCA type phono jack. Wt. 2 oz. Cat. No. U5375

$33.88 PACE CB-HAM TWO-WAY RADIO TESTER
Catalog No. U5393



SPECIFICATIONS:
Frequency Range: 25-30 MHz
Line Impedance: 50 ohms
SWR: 1:1 to 1:3
RF Power: 0-10, 25, 100, 250, 500 watts
Accuracy: RF Power 0-10w 5%, others 10% SWR 5%
Indicator: 100 uA D'Arsanval meter.
Weight: 4 lbs.

- Test SWR, Field Strength, RF Power, Modulation!

Adjust your transmitter for maximum output! Essential for "tuning up" your rig, and eliminating power losses from your system. Easy and simple to use! Runs directly from unit, no external connections required. Built-in 25 watt dummy load, with provisions for 500 watt external load. Power measurements to 500 watts can be made in 5 separate steps to achieve more accurate readings! Oscilloscope jack on front panel permits monitoring the signal when measuring power and percent modulation. Black ripple finish metal cabinet, 8½ x 7 x 3½", with carrying handle. 3" easy to read two color meter. Brushed metal front panel. Controls for METER ADJUST, SELECT RANGE, DUMMY LOAD SELECT, TRANSMITTER JACK (PL-259), EXTERNAL LOAD JACK (PL-259), OSCILLOSCOPE (RCA type). Requires 9V transistor radio battery (not included).

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CIRCLE 57 ON FREE INFORMATION CARD

ADVERTISING INDEX

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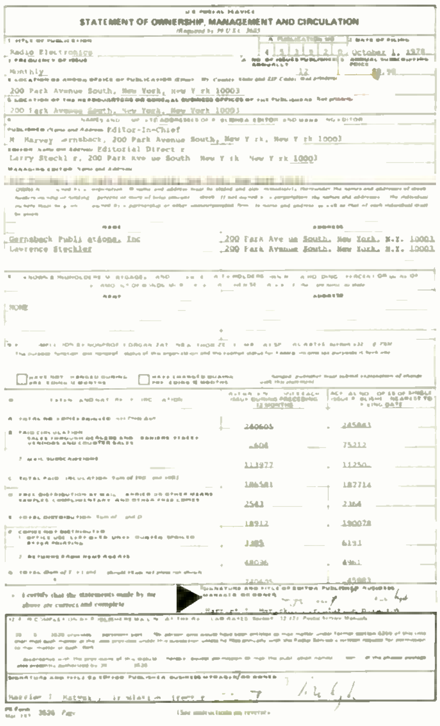
Free Information Number — **Page**


STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

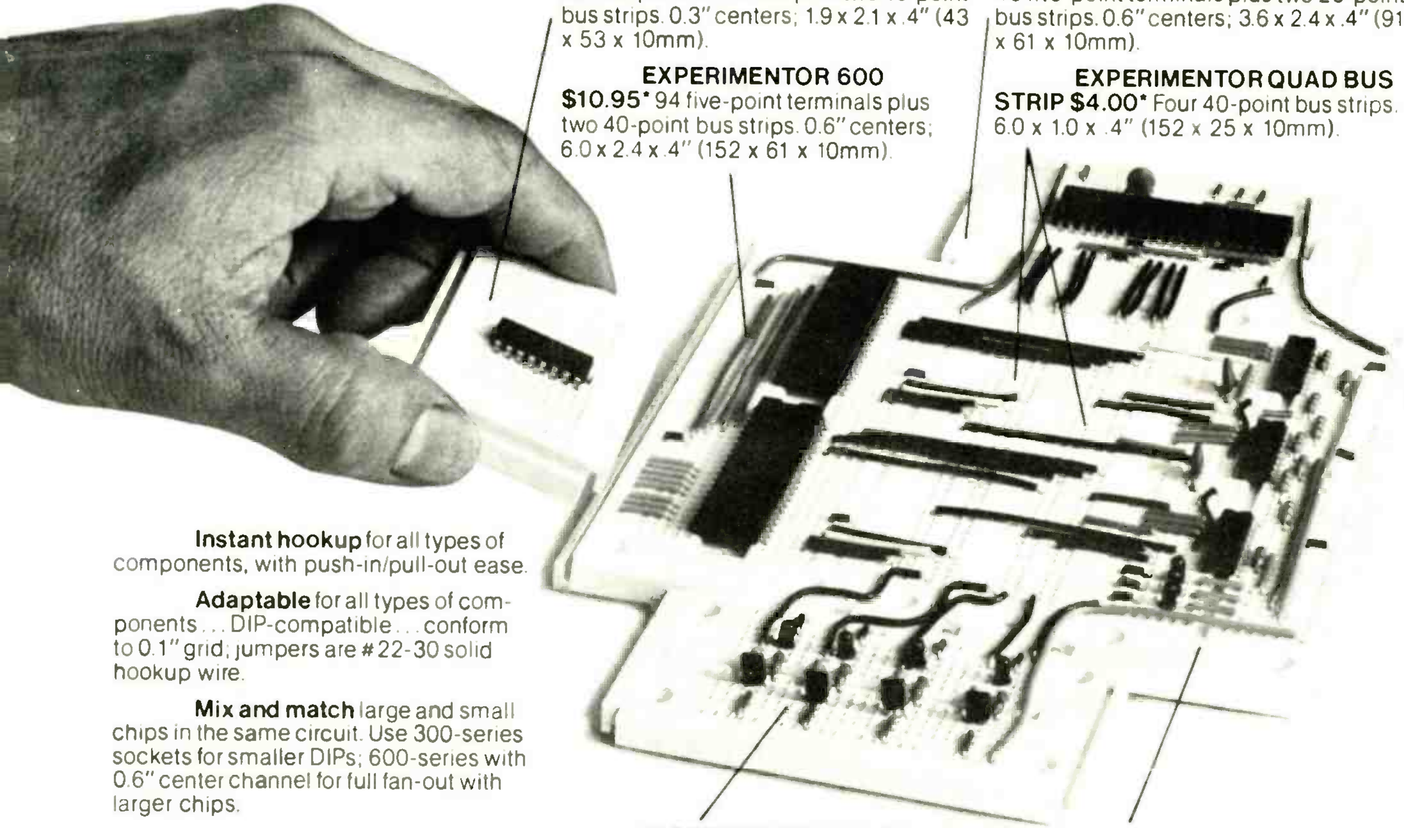
A breadboard as big as your ideas.

EXPERIMENTOR 325 $2.75*
22 five-point terminals plus two 10-point bus strips. 0.3" centers; 1.9 x 2.1 x .4" (43 x 53 x 10mm).

EXPERIMENTOR 650 $6.25*
46 five-point terminals plus two 20-point bus strips. 0.6" centers; 3.6 x 2.4 x .4" (91 x 61 x 10mm).

EXPERIMENTOR 600 $10.95* 94 five-point terminals plus two 40-point bus strips. 0.6" centers; 6.0 x 2.4 x .4" (152 x 61 x 10mm).

EXPERIMENTOR QUAD BUS STRIP $4.00* Four 40-point bus strips. 6.0 x 1.0 x .4" (152 x 25 x 10mm).



Instant hookup for all types of components, with push-in/pull-out ease.

Adaptable for all types of components . . . DIP-compatible . . . conform to 0.1" grid; jumpers are #22-30 solid hookup wire.

Mix and match large and small chips in the same circuit. Use 300-series sockets for smaller DIPs; 600-series with 0.6" center channel for full fan-out with larger chips.

Infinite flexibility lets you expand and modify circuits vertically and horizontally, simply by snapping sockets together.

Easy mounting using 4-40 screws from front or 6-32F self-tapping screws from rear. Vinyl-insulated backing lets you fasten to any surface.

EXPERIMENTOR 350 $5.50*
46 five-point terminals plus two 20-point bus strips. 0.3" centers; 3.6 x 2.1 x .4" (91 x 53 x 10mm).

Marked tie-points simplify translation from breadboards to PC boards or wiring tables.

Ruggedly built of abrasion-resistant materials that withstand 100°C.

EXPERIMENTOR 300 $9.95*
94 five-point terminals plus two 40-point bus strips. 0.3" centers; 6.0 x 2.1 x .4" (152 x 53 x 10mm).

Quick construction of microprocessors and other circuits—each EXP-4B gives you four bus lines, with 8-, 12-, and 16-line address and data buses easily created by combining Bus Strips.

It's hard to believe how much faster and easier building circuits can be . . . until you try CSC Experimentor™ solderless breadboarding sockets. From the largest DIP to the smallest resistor, components plug in and out instantly, without special hardware or jumper cables. So you save time and money by eliminating soldering and component damage. Start small and expand in any direction your thinking takes you, by snapping sockets together vertically or horizontally. With no limit to your ideas. Get started today, for as little as $2.75*!

NEED MORE INFORMATION? CALL 203-624-3103 to order, or for the name of, your local distributor. Prices slightly higher outside U.S.A.

 Prices, specifications subject to change without notice.

*Manufacturer's suggested list.

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New, K40 Magnamount: Grips like a grapple, actually improves transmission.

We double guarantee it.*

Exclusive Octopole Construction.

That's eight magnets set in eight different directions to give you a magnetic seal so complete and powerful, your antenna would stay up there if you could squeeze between two semis passing each other at 180 miles an hour. That's magnetic octopower.

> * GUARANTEE I
>
> Placed on the roof of a vehicle; properly tuned, the K40 Magnamount is guaranteed to transmit a further distance than a standard K40 without the Magnamount or you will receive a prompt and full refund from your K40 dealer who installed and tuned the Magnamount K40 for you.
>
> * GUARANTEE II
>
> Materials and workmanship are guaranteed for a full 12 months. Any part that fails to perform satisfactorily will be replaced absolutely free.

Exclusive K40 Flux Harmonics for Greater Transmission.

The magnetic radiation pattern was designed to match the K40 antenna radiation for greater distance than the standard K40. See our guarantee.

The facts: Physics and Physical.

1. Magnamount is a bigger, stronger magnet—in fact it's 8 bigger, stronger, magnets.
2. It doesn't just hold the K40 antenna, it helps it transmit further.
3. Remember the law of reciprocity. The antenna that transmits better, receives better.
4. It provides a flatter, lower SWR because the Magnamount is capacitance grounded.
5. It puts your 5/8 wave K40 antenna securely in place in the most advantageous place to work against a ground plane—high and free from obstruction. That's square in the middle, right up on top.

$15.95 buys it.

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K40 Magnamount.

American Antenna 1945 South Street Elgin, Illinois 60120

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