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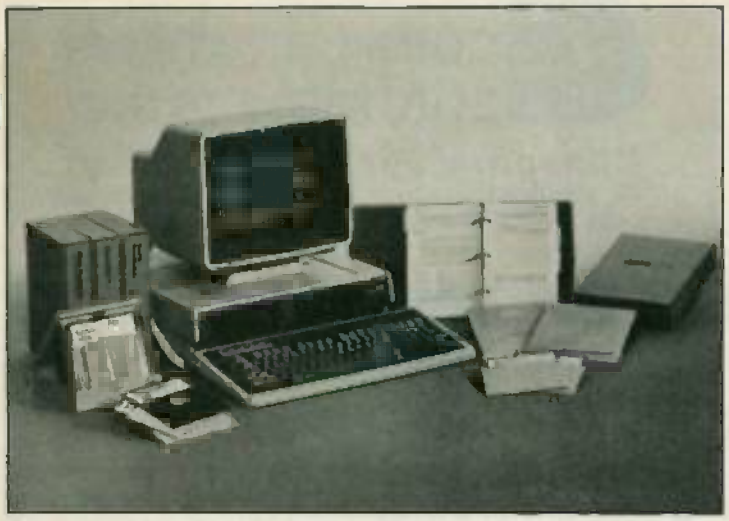

COMPUTER BARGAIN

You won't believe what you can now get for $499. How about a $2,500 computer system?

The $499 professional-quality personal computer has two disk drives, 128K memory and a high-resolution green monitor. The photo also shows the optional software.

I realize that what you are about to read may seem incredible. I can understand. But occasionally there are indeed bargains and opportunities that only come once in a lifetime. I'm convinced that this is one of them.

By Joseph Sugarman, President

The computers we are offering are not outdated rebuilt models from a company that no longer exists but brand new computers from an existing substantial company that provides service and support.

The unit's monitor is a 12" green phosphor, 80 characters x 25 lines bit-mapped graphics display with 640 x 300 points. If you know anything about computers this one piece of hardware is worth $500 itself. The display is so beautiful when it displays either text or graphics that it will probably far surpass anything you've seen to date.

There are two 5¼" 400Kb disk drives, a full 93 key ASCII keyboard including 17 function keys and numeric pad, a 128K memory, standard printer and communications ports (two parallel and one serial), a realtime clock with battery back-up, and it is a Z80A-based system in a dual 8-bit format that actually operates faster than the IBM PC. The unit also reads Kaypro and DEC Rainbow and all CP/M floppy disk formats.

ADVANCED SOFTWARE

The unit also comes with advanced communications software which provides automatic dial-up access to outside computer services or direct connection to a near by host.

The operating system that comes with the unit is the powerful CP/M Plus—an improved release of CP/M which lets you use more available software than even the IBM. You have access to hundreds of popular software packages including word processing, spreadsheet, data base management, accounts receivable, billing, general ledger, client accounting, engineering, statistics, project management and dozens of other programs.

The entire system, complete with monitor, two disk drives, 128K memory, operating system and keyboard sells for only $499. That's right, only $499.

We realize that the thought of buying a professional-quality computer for only $499 may raise serious questions. Why so cheap? What about service, warranty and repair? Let me address these concerns.

The manufacturer makes and sells high-resolution computer terminals to other computer makers for their expensive high-quality systems. Their terminals were so popular and were so well accepted that they thought they'd get into the rotten, dog-eat-dog consumer personal computer business which, as you might have heard, has claimed dozens of casualties. But this manufacturer decided not to become one of those casualties and sold us all his inventory.

MAY HURT OTHERS

The only thing the manufacturer won't let us do is mention his name in this advertisement nor mention the name of the unit as it may hurt many of the other retailers who have sold this unit for thousands of dollars.

The limited warranty is a full 90 days and if anything goes wrong with the unit after that time, warranty repairs are as easy as sending your computer to the closest participating service organization or exchanging the unit's circuit boards with an overnight delivery service. The manufacturer is a substantial company and committed to servicing this product. In fact, if service is a concern, why not get two units and use the second for a backup?

There is also one big plus. With each unit, we'll give you a 2-week trial period. If, during that time, you are not completely satisfied with the operation, performance, value or even the looks of the unit, you may return it in its original carton, for a full $499 refund.

So that's our offer—a brand-new, professional-grade computer system with the hardware and optional accessories that you'd expect from other systems costing more than $2,500—all for only $499. There are no strings attached, nothing else that you must buy or promise to buy in the future. It's just that simple.

SOFTWARE AVAILABLE

JS&A also sells a complete line of software and can supply you with the famous word processing Wordstar program complete with Mail Merge which lets you merge your list of names and addresses onto standard form letters and which converts your unit into a professional word processor when you add a letter-quality printer—all for only $299 which is far below the $500 manufacturer's list price for this program.

If you also order the Wordstar word processing program, we'll also throw in, free of charge, "DR Graph" from Digital Research at no extra charge. This handy software program is a powerful graphics package that lets you convert your data into line, bar, and pie charts as well as step and scatter plots. And it's so simple to do with our computer.

EXTRA BONUS

And as an extra software bonus we'll even add, free of charge, the Multiplan spreadsheet program which, in my judgment, is one of the easiest to use and most powerful of all the spreadsheets. In fact, *Infoworld Magazine* once gave it the Software Product of the Year Award.

Simply by purchasing the Wordstar program at the low price of $299, I'll throw in, free of charge, the DR Graph and Multiplan software which all together give you the capability to use your computer as a full-blown word processor and a spreadsheet analyzer along with its graphics and strong communications capabilities. But there's more. Order the Wordstar program and I'll also include absolutely free, CBASIC—a program that helps you easily create your own programs.

There is a good chance that the 500 computers we have will sell out quickly. So JS&A reserves the right to return any order and the right to fill the orders for the computer and software first.

But please act now. Because of the low cost of this offer, I cannot accept credit cards or C.O.D.'s. Simply send your check or money order for either the computer hardware or the hardware and software using the order numbers shown in parentheses (IL residents add 7% sales tax) plus $25 for postage and handling. Send your order to: JS&A Special Computer Offer at the address below.

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COUPON COUPON COUPON

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Regency® HX-650P-H


with 4 AAA batteries, carrying case and 6 crystal certificates

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Regency® MX7000-H
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7-Band, 45 Channel, AC/DC scanner

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AUGUST '85

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COVER 1

Did you ever wish that you could see in the dark? You can't, of course, because your eyes are sensitive only to visible light. But with the see-in-the-dark viewer that we'll show you how to build, you'll be able to change that.

The viewer uses a special image-converter tube that is sensitive to infrared light and translates infrared wavelengths to visible wavelengths. In that way, it can be used to widen the visible portion of the electromagnetic spectrum. In other words, you'll be able to see objects illuminated with infrared light. The story begins on page 49.

NEXT MONTH

THE SEPTEMBER ISSUE IS ON SALE AUGUST 6

AUTOMOTIVE ELECTRONICS
Both under the hood and in the passenger compartment, your next car will contain a lot of electronic wizardry.

BUILD AN IC TESTER/ANALYZER
This handy device will let you test IC's and digital circuits for proper operation. It makes a great teacher, too.

HOW TO DESIGN PC BOARDS
Making a PC board can sometimes be difficult. But it's not as hard as doing the board design! We'll help make it easier.

BUILD A 64K PRINTER BUFFER
We continue with construction details for the buffer and the EPROM programmer add-on.

The computer-controlled weather station we promised in this space last month will run in a future issue of Radio-Electronics.

Radio-Electronics

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Advertising Sales Offices listed on page 112.

IEEE-488

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We bet the Fluke 8840A is the right 5½-digit multimeter for you.

It's easy to program and operate, and it's easy to integrate into your system. The 8840A is versatile; if your system changes, your DMM doesn't have to.

You get the functions you need. With the best accuracy and fastest reading rates in its class.

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All starting at **$695.** IEEE-488 interface and true rms ac options are available for just **$150** each.

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CIRCLE 253 ON FREE INFORMATION CARD

WHAT'S NEWS

New D-cell charges itself

A new D-size battery offered by MJR Co. of Phoenix, AZ, carries its own built-in solar panel and will charge in bright sunlight at half the rate recommended for charging conventionally from a wall plug. Since each cell charges individually, the cells will charge whether they are connected in parallel or in series.

The new cell is claimed to have an exceptionally long service life—up to 1,000 full cycles. (Average use is said to be about 500 cycles in five years.) Voltage rating is 1.2 at 1.2 ampere hours, and the cell can be stored for years—regardless of charge state—with no appreciable loss of service life. It is priced at $20.

THE MJR Ni-Cad SN2000 SOLAR RECHARGEABLE D-CELL, which in bright sunlight will charge at half the rate recommended for charging it from a wall plug.

Author of Rider Manuals dies at age 85

John F. Rider, radio pioneer, inventor, author, and publisher, died Feb. 6, 1985, at age 85.

John Rider began as an author in the 1920's, writing feature articles and columns on radio, for several New York papers. He was associate editor of *Radio Engineering* and managing editor of *Radio Listener Guide and Call Book*. In 1932 he joined Hugo Gernsback's *Radio-Craft* as Service Editor, and was with that magazine for some years.

He then started the firm of John F. Rider Publisher, and began putting out the famous Rider Manuals—anthologies of broadcast-receiver schematics that became the bibles of the service technician for many years. He also wrote and published numerous books on radio-service subjects and instruments.

He developed a vacuum-tube voltmeter, the Rider VoltOhmyst, and invented an intermittent indicator, the Chanalyst. In World War II, John Rider served as Director of the Signal Corps Publication Agency, responsible for publishing the myriad instruction and service manuals covering all Signal Corps equipment. Retiring as a Lieutenant Colonel, after the war, he resumed operations at John F. Rider Publisher until his retirement, at which time he sold his company to Hayden Book Co.

Rider was an ardent stamp collector, specializing in 19th century stamps and covers, and wrote on philatelic subjects. He was internationally known as an expert in identifying counterfeit stamps.

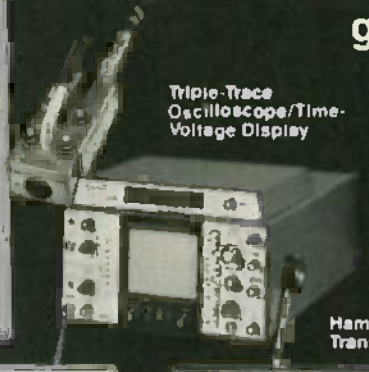
RCA and Sharp to join in VLSI manufacture

RCA Corporation and the Sharp Corp. have agreed to establish a joint venture to design, develop, and manufacture complementary metal oxide silicon (CMOS) very large scale integrated (VLSI) circuits in the United States.

The new concern will be called RCA/Sharp Microelectronics Inc. It will establish a CMOS integrated circuit design center to develop advanced memories, microprocessor gate arrays, standard cells, etc., for sale in the United States, Europe, and the Far East. The next step will be to build a facility in the United States for fabricating six-inch CMOS VLSI wafers. Construction is expected to start late in 1985. R-E

FREE high tech catalog


Metal Detector


Triple-Trace Oscilloscope/Time-Voltage Display


Ham Radio Transceiver


Computerized Weather Station


Microprocessor Trainer & Course


Real Time Spectrum Analyzer


Most Accurate Clock

HERO® 1 Robot


IBM-PC Compatible Computers


40-Channel Scanner

More than just a catalog, a trustworthy guide to what's new in computers and electronics.

Ever since radio grew into electronics, the illustrated Heathkit catalog has been a guide to new and exciting kit products for people like you to build. To enjoy and learn from, while saving money in the process.

What sets the Heathkit catalog apart is its range of high quality products and accurate information on every product offered. And that's a lot of products – over 450 separate items, including: Computer hardware and software • Robots • Precision test instruments • Computerized weather instruments • Solar hot water systems • Automotive and home energy products • Security devices • Color TVs and video accessories • Quality stereo components • Amateur radio gear • Educational courses that lead from the basics of electronics all the way to high tech.

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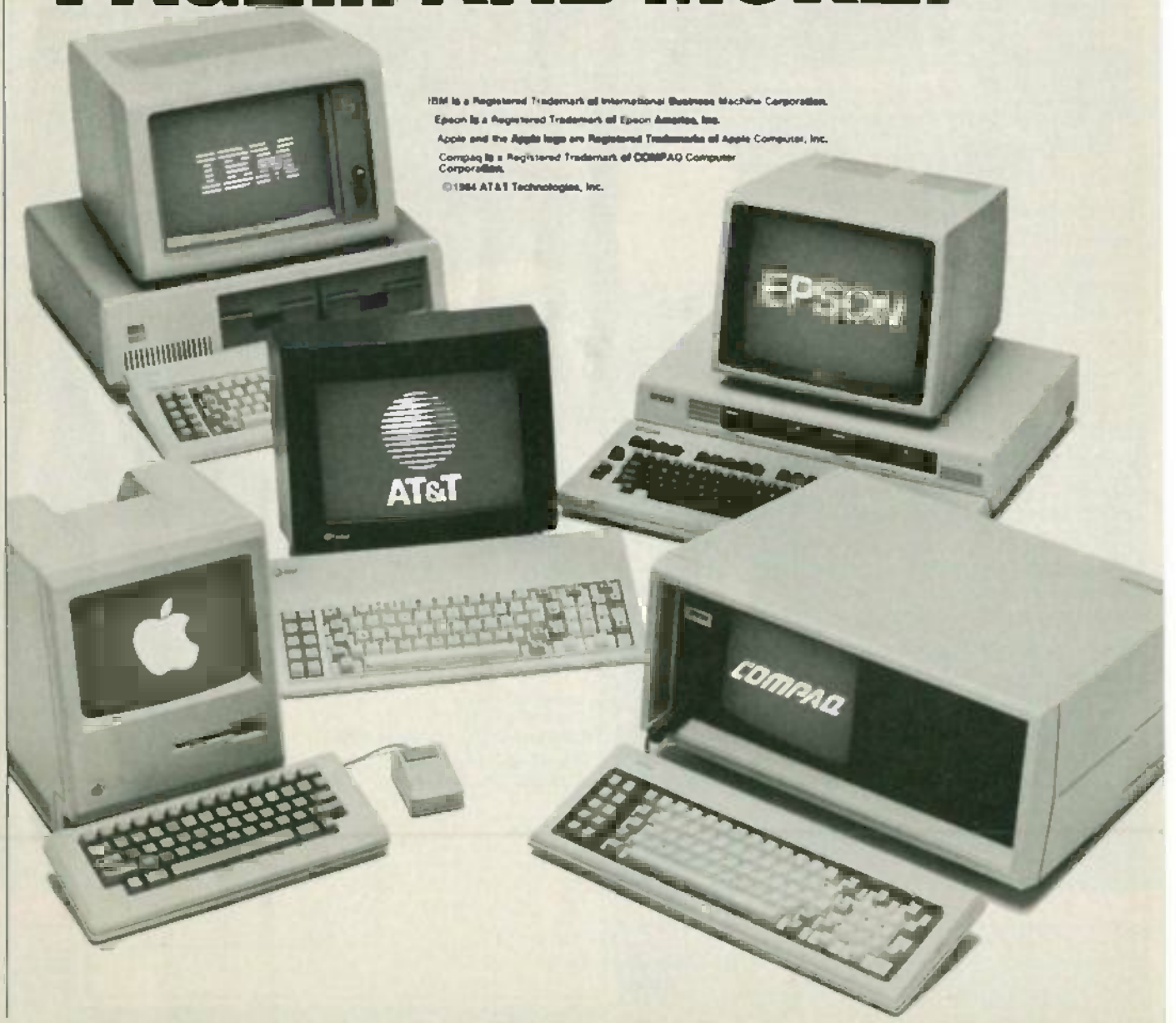
CIRCLE 68 ON FREE INFORMATION CARD

NRI Trains You At Home—As You Build

GET THE KNOW-HOW TO REPAIR EVERY COMPUTER ON THIS PAGE... AND MORE.



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Your Own IBM-Compatible Computer

Learn the Basics the NRI Way—and Earn Good Money Troubleshooting Any Brand of Computer

The biggest growth in jobs between now and 1995, according to Department of Labor estimates, will occur in the computer service and repair business, where demand for trained technicians will actually *double*.

You can cash in on this opportunity—either as a full-time corporate technician or an independent service-person—once you've learned all the basics of computers the NRI way. NRI's practical combination of "reason-why" theory and "hands-on" building skills starts you with the fundamentals of electronics, then guides you through advanced electronic circuitry and on into computer electronics. You also learn to program in BASIC and machine language, the essential languages for troubleshooting and repair.

You Build—and Keep—a Sanyo MBC-550-2

The vital core of your training is the step-by-step building of the 16-bit Sanyo MBC-550-2 computer. Once you've mastered the details of this state-of-the-art machine, you'll be qualified to service and repair virtually every major brand of computer, plus many popular peripheral and accessory devices.

With NRI training, you learn at your own convenience, in your own home. You set the pace—without classroom pressures, rigid night-school schedules, or wasted time. You build the Sanyo MBC-550-2 from the keyboard up, with your own personal NRI instructor and the complete NRI technical staff ready to answer your questions or give you guidance and special help whenever you need it.

Your NRI course includes the Sanyo MBC-550-2 Computer with 128K RAM, monitor, disk drive, and "Intelligent" keyboard; the NRI Discovery Lab®, teaching circuit design and operations; a Digital Multimeter; Bundled Spread Sheet and Word Processing Software worth $1500 at retail—and more.

Learn MS/DOS Operating System

Praised by critics as the "most intriguing" of all the IBM-PC compatible computers, the new Sanyo uses the same 8088 microprocessor as the IBM-PC and features the MS/DOS operating system. As a result, you'll have a choice of thousands of off-the-shelf software programs to run on your completed Sanyo.

Your NRI course includes installation and troubleshooting of the "intelligent" keyboard, power supply, and disk drive, plus you'll check out the 8088 microprocessor functions, using machine language. You'll also prepare the interfaces for future peripherals such as printers and joysticks.

100-Page Free Catalog Tells More

Send the postage-paid reply card today for NRI's big 100-page color catalog on NRI's electronics training, which gives you all the facts about NRI courses in Microcomputers, Robotics, Data Communications, TV/Video/Audio Servicing, and other growing high-tech career fields. If the reply card is missing, write to the address below.

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VIDEO NEWS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

• **More videodisc players.** Laservision videodisc systems quietly gain more adherents. Ever since Pioneer's introduction of the combination videodisc and CD digital audio-disc system, hi-fi companies have been taking notice, and at least two are joining up and offering players (built by Pioneer). Those are Sansui and Luxman. Others, including such names as Proton, are expected to come along soon.

• **The format wars.** What we foreshadowed as a battle of formats (**Radio-Electronics**, July 1985) has now come to pass in the United States as well as in Europe and Japan. Toshiba, once a stalwart of the Beta group, introduced a line of three VHS recorders here; and although it still has Beta machines, the company made it clear at its sales meeting that it believes its future is in VHS.

At the same time, Sony brought its 8mm camcorder to the United States, and promised to follow up with home decks designed for the 8mm format. The camcorder, similar to the one it introduced in Japan, has single-speed recording and playback, accommodating the small cassettes that currently come in 30-, 60- and 90-minute lengths, but soon will be joined by a two-hour version. It has a solid-state CCD pickup with 250,000 picture elements and weights 4.5 pounds without cassette and battery, about five pounds with. Sony's Chairman, Akio Morita, predicts that 8mm will become the most popular format in about three years.

Except for traditional film-camera manufacturers, such as Kodak, Polaroid, Canon, and Fuji, no companies have made as strong a commitment to 8mm as Sony. However, Sony isn't neglecting Beta. It introduced a new Beta line, heavily laced with SuperBeta machines capable of high-resolution pictures.

• **Hi-fi video tuners.** The first of the hi-fi receivers and tuners designed to pick up multichannel TV sound (MTS)—stereo and the separate audio program, or SAP—are now coming on the market. Panasonic's Technics brand is offering one complete audio-video receiver with built-in MTS at about $550, and it also has two lower-priced audio receivers (at $270 and $320), which can accommodate the same adaptor used to convert some of Panasonic's TV sets to MTS. Sansui also is introducing an audio-video switching center for home-stereo systems containing MTS circuitry, and others are expected to follow shortly. The introduction of MTS TV stereo as an audio component means that high-quality stereo audio can be added to existing (non-stereo) TV sets via the home-audio system. Of course, it's necessary to have a hi-fi stereo system that is located in the same room as the television set.

• **Enter the 27-inch tube.** It's not exactly a surprise, since RCA signaled it more than a year ago, but the first 27-inch tube is now on the way in a deluxe stereo console. This RCA product is the first American-made flat-faced tube. The screen was computer-designed and has a completely flat appearance, although its contours more closely resemble a plateau than a flat plane. Other flat-faced tubes, all with square corners like the RCA tube, have been introduced in 14-, 20-, and 26-inch sizes by some Japanese manufacturers, although similar square-cornered tubes in those sizes by both Japanese and American manufacturers are also available with the traditional spherical faceplates that are easier to manufacture. **R-E**

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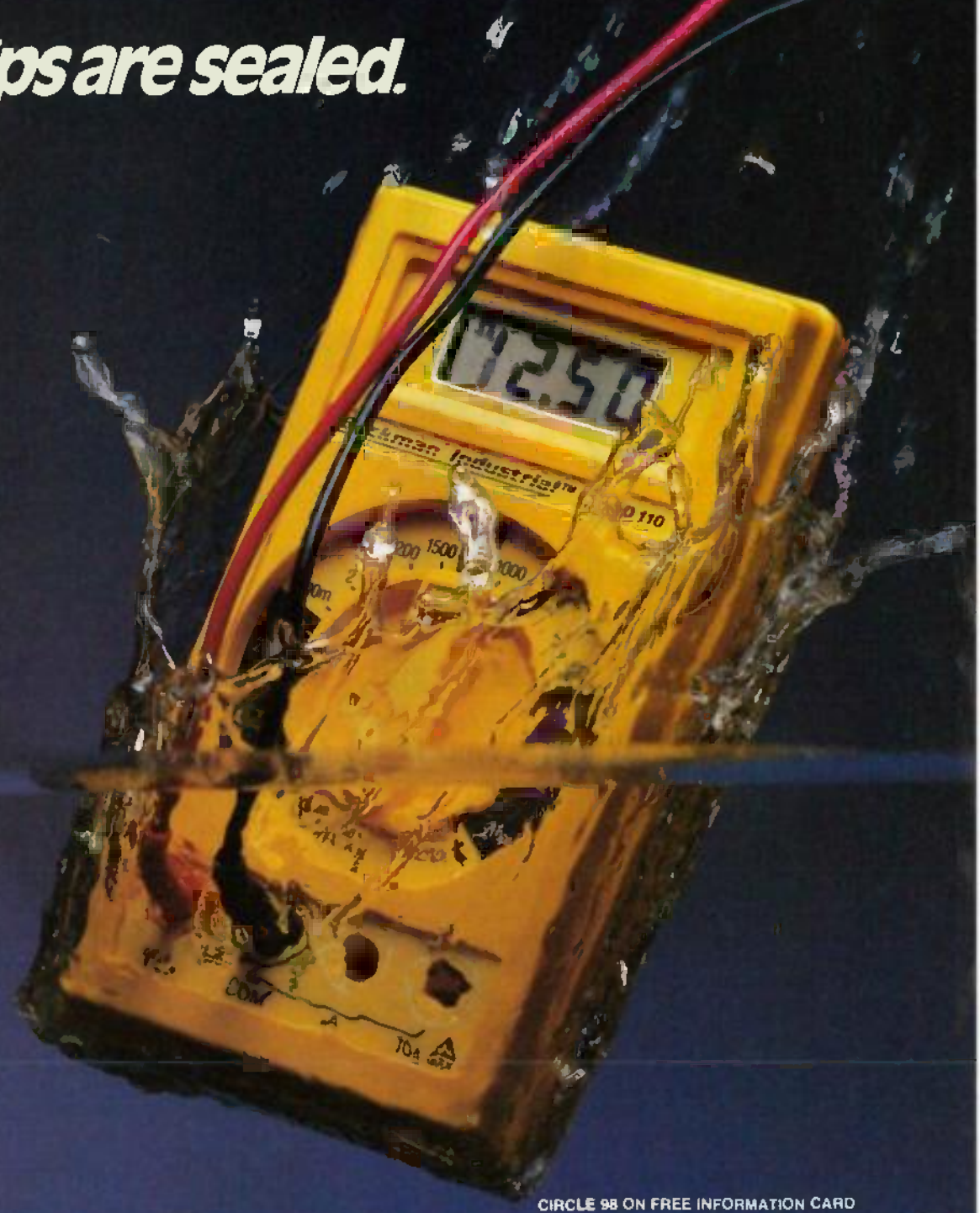

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8" SSSD Shugart Compatible, 32 Hard Sector	———	———	F31A-Z	1.79	———	———	3016-Z	1.94
8" SSDD IBM Compatible(128 B/S, 26 Sectors)	———	———	F131-Z	1.89	———	———	3090-Z	2.19
8" DSDD Soft Sector (Unformated)	———	———	F14A-Z	2.09	———	———	3102-Z	2.59
8" DSDD Soft Sector (256 B/S, 26 Sectors)	———	———	F144-Z	2.09	———	———	———	———
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5¼" SSSD Soft Sector w/Hub Ring	6431-Z	0.74	M11A-Z	0.89	———	———	———	———
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The scrambling snafu

IT ALL BEGAN INNOCENTLY ENOUGH—major premium programmer HBO elected to encrypt or "scramble" its transmissions to protect itself against the unauthorized use of those transmissions. To the unauthorized user, the video would be unwatchable (see Fig. 1). HBO had certain criteria in selecting a "scrambling system;" the system had to be "transparent" to the end user (ie. no visible degradation caused by the scrambling mechanism), it had to be cost effective, and it had to be unbeatable. Not many engineers felt you could have all three in one box, not in this decade at any rate.

But the Linkabit division of M/A-Com delivered and, to the surprise of most, the system did everything HBO requested, and more. There was no degradation; in fact, the Linkabit system actually could improve the signal quality under certain circumstances. (Linkabit claims that their system can increase the carrier-to-noise ratio by as much as 2 dB over traditional satellite transmission systems, primarily because the audio subcarriers are eliminated in favor of digital-audio signals transmitted within the video-information bandwidths. The designers claim that by eliminating the audio subcarriers, that portion of the transmission power normally used for audio is retained for use by the video carrier (scrambled). The system came out of the box at $495 per cable-system descrambler and prices in the $325 range (down to $150) were forecast for a slightly simpler home version. And with

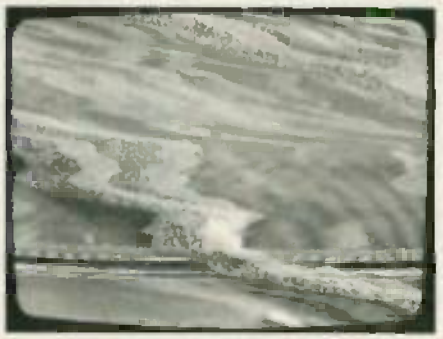

FIG. 1

"70,000,000,000"codes, well, no garage or basement tinkerer was apt to "break" the DES code system. Everything looked rosey, but then something nasty hit the fan.

HBO and the home TVRO

The home-satellite terminal industry stood up, almost to the man, and revolted. Within just days of announcing and showing off the new HBO-paid-for and M/A-Com-created system, it was in serious trouble. And the entire scrambling situation was thrown into a cocked hat. Here's what happened.

HBO repeatedly said that when their scrambling system was in place, they would negotiate some type of deal with home TVRO owners. As the unveiling date came closer and closer, it became increasingly clear that the "some type of deal" would involve the local cable companies. HBO, it turned out, would only sell its home service through their local cable-television affiliates. That immediately placed fear into the hearts of local TVRO dealers who saw themselves in competition with the HBO affiliates; not only for the potentially lucrative "service contracts," but also for the actual sale of the home-terminal systems. Indeed, the cable trade press lately had been running numerous stories on how cable firms had successfully entered the TVRO distribution business. Those reports, telling of sales of 100-plus systems per month and back orders of hundreds of systems didn't make the cable retail operator threat any less palatable.

With the TVRO dealer segment already nervous about the announced way HBO planned to sell home users their service, the HBO-M/A-Com combine proceeded to "get into hot water" with the TVRO receiver manufacturers and importers. Nearly one year ago, M/A-Com had released some preliminary data that was designed to give TVRO receiver designers some assistance in planning future TVRO receivers. They said, in effect, that existing receiver designs must be modified to accommodate the special requirements of the Linkabit scrambling system. That year-old data told the industry that the special receiver requirements were related to the descrambling method or technique. The same preliminary data also suggested that those receiver modifications might add between $2 and $15 at the original equipment manufacturer level to home TVRO receivers.

Then the final design data came down. TVRO receiver designers had two choices—they could modify their existing receivers so that a stand-alone descrambler box could be added by the home

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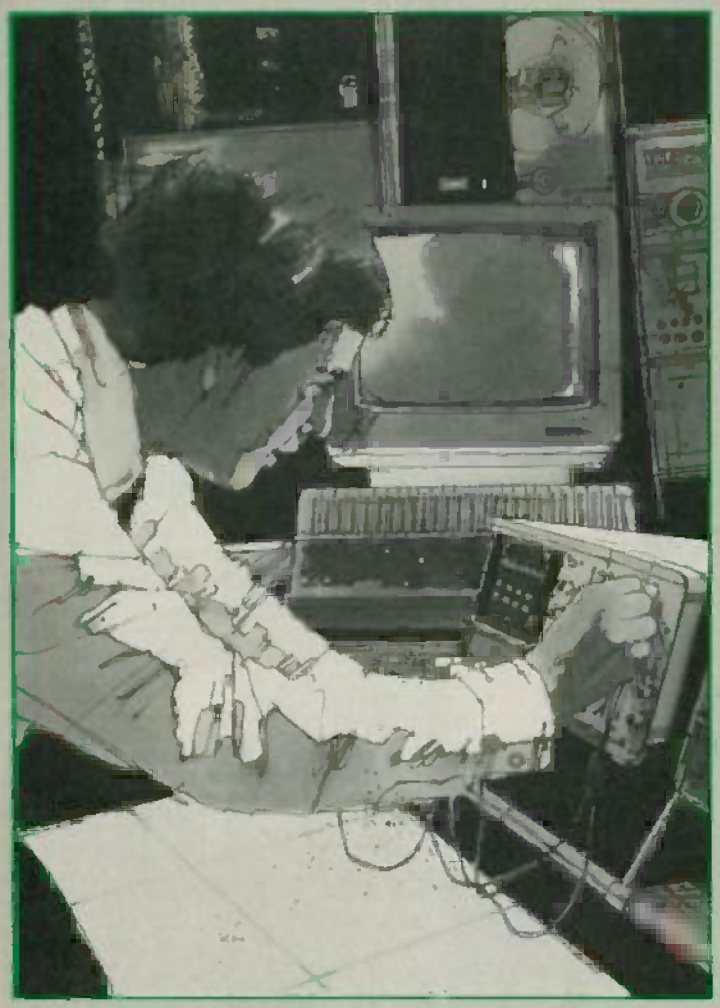

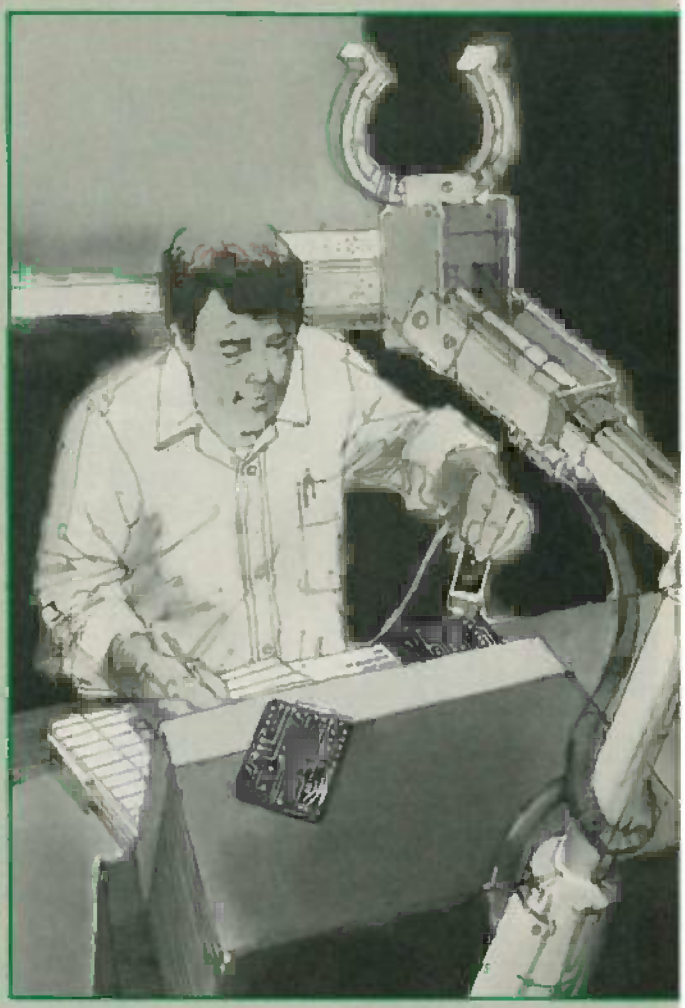

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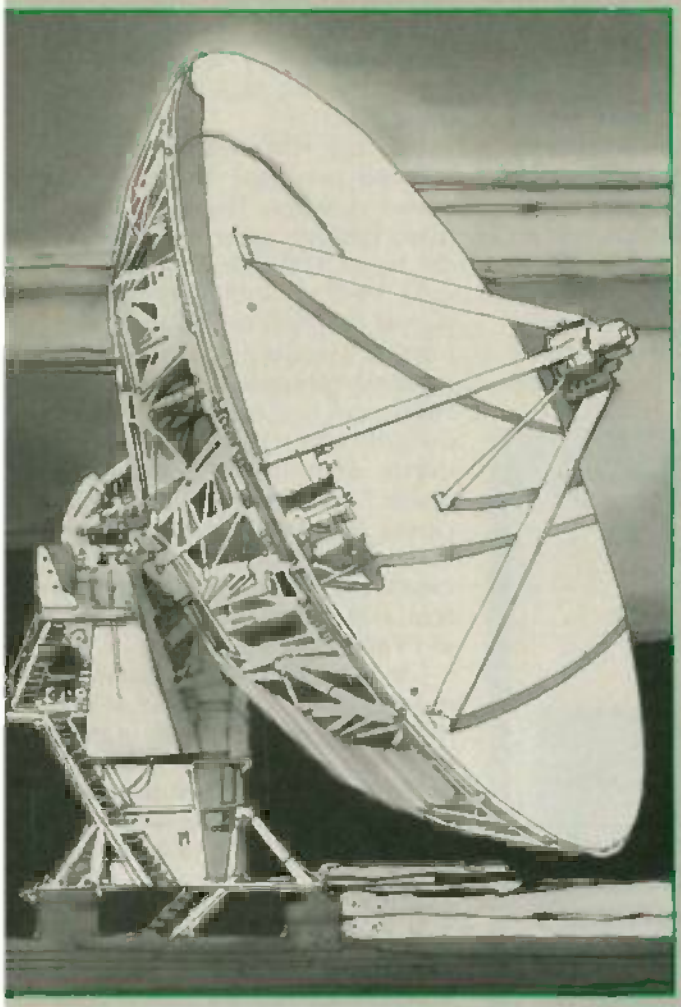

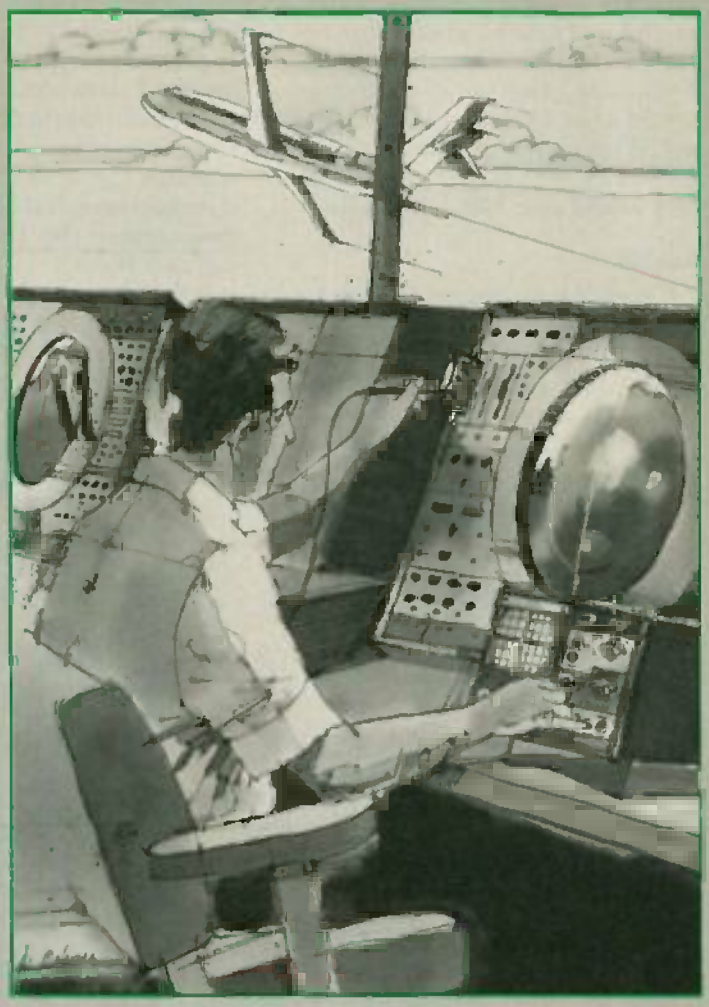

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viewer or a service representative, or the receivers could be redesigned to accommodate a plug-in module. The stand-alone box would cost $325 wholesale, and would have a nationally advertised retail price of $395. The plug-in version would cost $150 wholesale.

Trouble

It wasn't long before somebody noticed that the special engineering requirements for TVRO receivers had little to do with the actual descrambling; it turned out that the special requirements were in place so that the electronic addressing codes built into the system could perform. A series of tests with existing receivers (those without the special engineering changes) revealed that most would descramble the Linkabit signals with no effort.

It was becoming clear that the new receiver designs were merely to accommodate the electronic bookeeping functions of the scrambling package. And so, the receiver OEM's joined the dealers and together they "walked out" on the HBO and M/A-Com scrambling plans.

That left HBO with a very disjointed program to reach the home viewers. Their marketing plan, through cable affiliates, left the home TVRO dealer out in the cold. Their scrambling system, designed to function also as an electronic TV-viewing-bank where the customer prepaid for service and then saw his account balance dwindle after viewing programming, depended upon better-grade TVRO receivers. But the receiver suppliers were not interested in helping the two firms create an electronic-banking-system, at least not if it raised the cost of TVRO's appreciably.

For it also turned out that in the process of outfitting receivers for the newly proposed plug-in modules, for example, that very major receiver changes were required. The module required more current to operate than could be drawn from most receiver power supplies. But bigger power supplies generate more heat and more heat has to be dissipated somehow, or the electronics in the package will fry. Finally, the module was bulky; in fact, at 11.5 × 9 × 1.77 inches, it is larger than many of the complete TVRO receivers now available.

Finally, because the Linkabit scrambling system is based upon a very special security code (DES Algorithms), which is classified by the US government, the technology involved cannot leave the US. A TVRO receiver supplier, in Korea or Japan, for example, would have no way to test the receivers at their plant because the testing equipment is prevented from leaving the US because of its classified status.

And those are but the initial problems presented by the Linkabit system. Manufacturers quickly discovered that they would not be able to solve all of the problems presented by the system and stay in business. Since they naturally want to stay in business, they did the only thing they could do—reject the concept.

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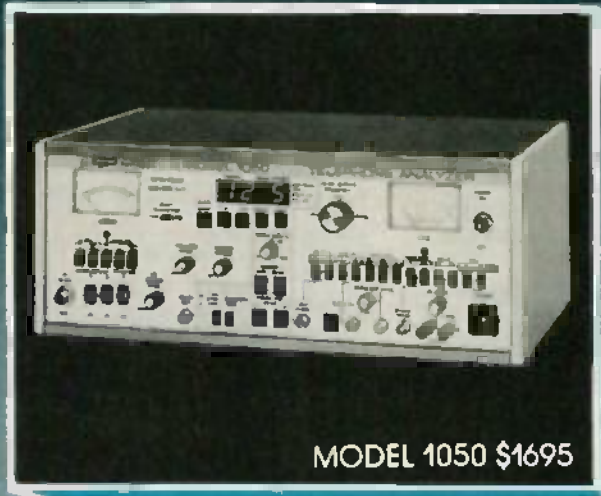

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Model V-212 shown

Model V-1050F shown

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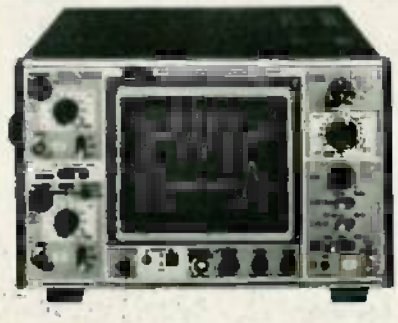

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6 inch rectangular internal graticule CRT.
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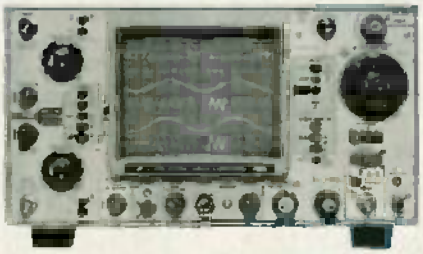

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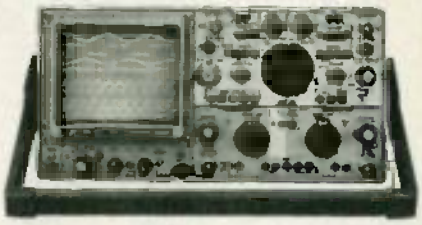

MODEL 5711 **$1695.00**
DC to 100MHz (typically over 120 MHz), 5 mV/div, True 4 channel input, eight trace, Delayed sweep, alternate time base, CRT acceleration voltage 20 KV, (w/saddle bag, front cover, 2 ea. X10 probes).

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(5711 with counter and DMM).

CIRCLE 126 ON FREE INFORMATION CARD

Linkabit scrambling system for its cable affiliates (more than 10,000 cable-system-version Linkabit units are now in the field and tested), HBO was caught between a rock and a hard place. The home TVRO industry was not taking their bait, and yet HBO was so far committed to the Linkabit system that it could not pull back.

Thus, the result was that HBO would scramble, but it was beginning to appear that home TVRO users would not be able to avail themselves of the HBO signals. A task force put together by HBO to create a home-TVRO business back in the fall of 1983, officially disbanded this past spring. HBO might not be ready to throw in the towel with home viewers, but it was not going to continue funding the development of a program for home TVRO's either.

Showtime steps in

Into this mess stepped HBO-competitor Showtime. Showtime has never innovated new services (a matter of corporate philosophy), but the failure at HBO to pull together all of the diverse elements of the home-TVRO business seemed like an ideal marketing opportunity to the management at Showtime.

As a result, they have recently put together a task force of their own to attempt to solve the problems. Unfortunately, Showtime had previously committed itself to also use the same Linkabit scrambling system as HBO. How would Showtime resolve the series of problems that caused HBO to pull back? Tune in next month. R-E

TVRO dealer "Starter Kit" available

Bob Cooper's *CSD Magazine* has arranged with a number of TVRO equipment suppliers to provide a single-package of material that will help introduce you to the world of TVRO dealership. A short booklet written by Bob Cooper describes the start-up pitfalls to be avoided by any would-be TVRO dealer. In addition, product data and pricing sheets from prominent suppliers in the field are included. That package of material is free of charge and is supplied to firms or individuals in the electronics service business as an introduction to the 1984/85 world of selling TVRO systems retail.

You may obtain your *TVRO Dealer Starter Kit* free of charge by writing on company letterhead, or by enclosing a business card with your request. Address your inquiries to: *TVRO STARTER KIT, P.O. Box 100858, Fort Lauderdale, FL 33310*. That kit *not* available to individuals not involved in some form of electronics sales and service.

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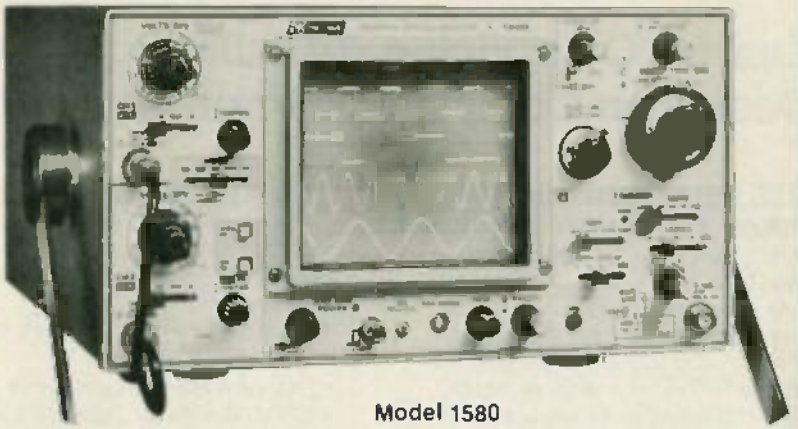

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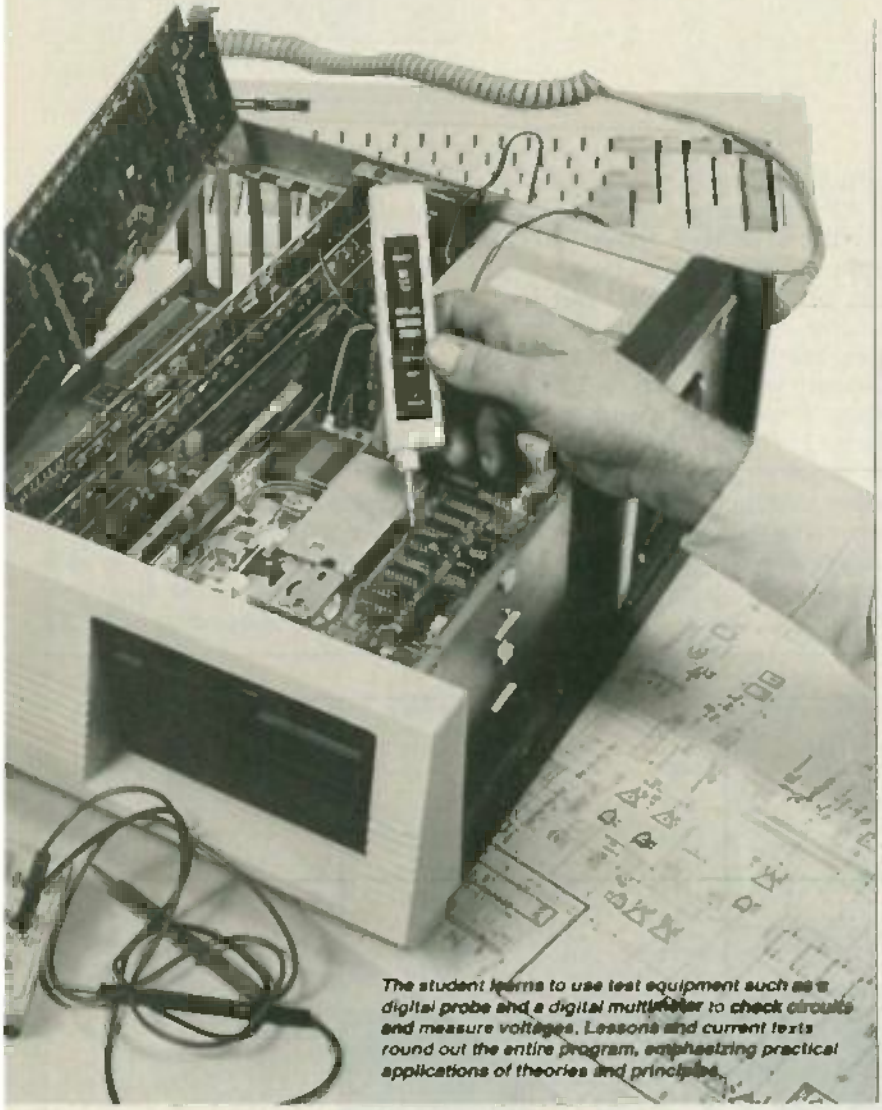

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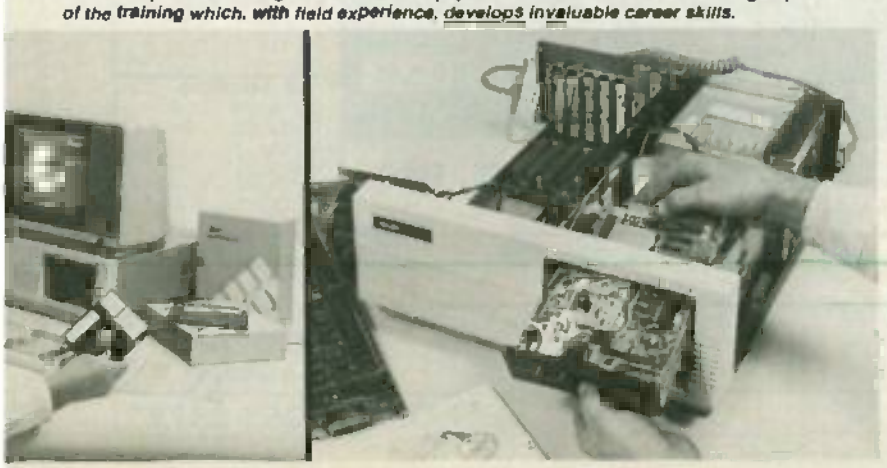

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SOME TROUBLESHOOTING HINTS

I noticed in the January 1984, "Letters" column that four of the letters are requests for schematics needed for servicing. While schematics are a most effective tool, they are not always available. In my work I rebuild old jukeboxes, some of which are over forty years old—and good luck finding a paper manual still hanging around in the bottom of such a unit. Often, the customer does not wish to wait a few more years while I try to find service information.

Fortunately, basic troubleshooting technique can get us out of the majority of those situations. Whether your dead unit be a television or a toaster, start out by checking the power supply, including the cord, switch, and filter capacitors (except maybe in the toaster). Check which end of the capacitor is grounded to determine whether it is a positive or negative supply. Check the circuitry for visible damage: open or lifted printed-circuit traces; burned looking, split-open, or cracked components; cracked solder, and loose or parted connectors or socketed components.

Next consider the nature of the malfunction. You can generally determine which area of the circuit board holds the components in question; amplifier outputs will be on heat sinks or at least they are likely to be larger parts. Follow leads visually from panel controls and connectors to find inputs, etc. In addition to finding what the unit won't do, find out what it *will* do. If one channel of an amplifier still works, then the power supply is

continued on page 82

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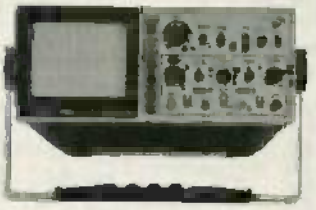

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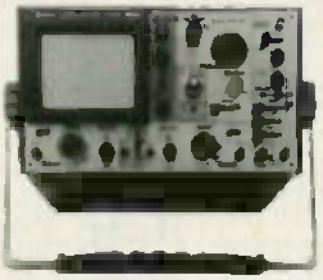

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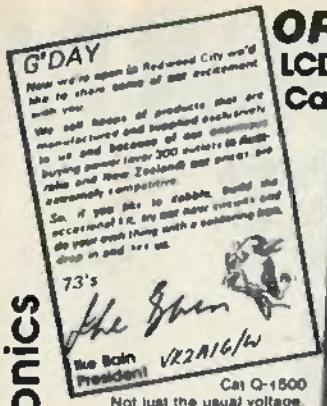

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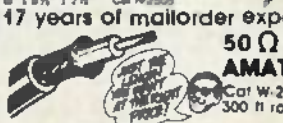

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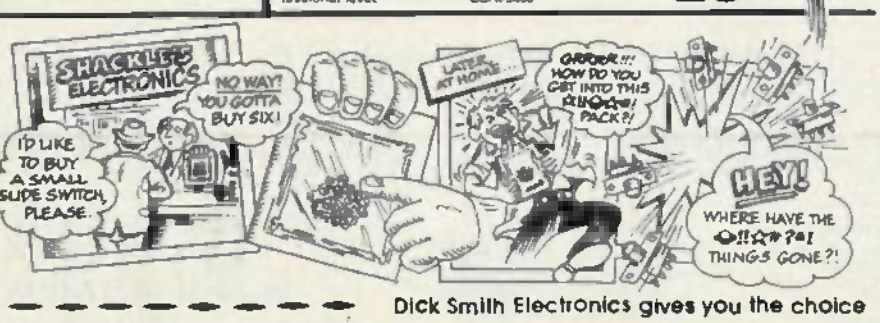

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...one board isn't enough, add more . . as many as you need! Male/female lugs ...e smaller boards as many slots together, too.

...NO EXTRA CHARGE. Each breadboard comes complete with a pad of layout ...sheets so you can transfer that fantastic circuit onto paper for the finished ...

...ally indispensable for the designer, engineer ...... and especially for the hobbyist!

...are educational as well as fun!

Mini Project Board

3" x 2.4" x .3" one-piece board with 88 groups of 5 connected terminals and 4 bus lines of 25 connected terminals.

All terminals are alpha-numerical coded so you can remember what you connect up what. Complete with self-adhesive pad so it won't slide around the table.

Midi Project Board

10 up $16.95 ea

A massive 7" x 2.7" x .3" board which can be split into three parts for convenience. Similar to the Mini Board with alpha-numeric coding and adhesive back, but this one has 128 groups of 5 connected terminals plus 6 bus lines of 25 connected terminals, AND you get the large work sheet pad as well!

Maxi Project Board

10 up $16.95 ea

8" x 6" x .3" one piece board with 266 connected terminals, 3 binding posts and 16 x 14 pin IC capacity - ideal for schools.

Super Project Board

Fantastic 27 x 14 pin IC capacity, makes a great for R & D labs and the serious electronic enthusiast.

Supplied with 4 binding posts and a whopping 2430 tie points to give amazing versatility.

We've seen similar boards selling for 70% more and because we buy direct from the manufacturer we don't think you'll ever be able to beat this value.

Membrane Switch Kits

New! New! We thought you'd like these as they can be used for just about any application from design to finished project. Switching is normally open, momentary contact push button type. Easy to assemble. Even our president can do it!

SPECIFICATIONS

- Circuit resistance less than 150 ohms
- Contact rating: DC 24V max 5mA max
- Open Circuit Resistance 100 MEG minimum
- Contact material carbon in sides

Life time: tested to one 3 million operations at 24V DC 5mA

4 key Cat K-3605 – $4.95
12 key Cat K-3607 – $6.95
16 key Cat K-3609 – $8.95
80 key Cat K-3611 – $39.95

LATEST BUY

COMPARE OUR PRICES

We've bought these direct from the manufacturers & passed the savings on to you. Schools, Universities, Colleges ring for bulk buying prices.

At DSE you don't pay for fancy packaging on components

Digital Trainer

For breadboarding. Digital circuits. Flip-flops, multivibrators, counters, encoders, decoders, multiplexers, demultiplexers, sequencers, registers, LED and 7 segment LED displays, memory devices, etc. Specs: (1) AC power lock - DC +12V800mA; (2) Power switch AC adaptor/battery 1.5V x 4; (3) Pulse Sw: two bounce free push buttons; (4) Logic SW: eight logic level switches in DIP switches; (5) DC O/P: DC +5V 750mA for user; (6) B-023 breadboard: 1580 interconnected tie points; (7) LED display: eight LED buffered logic level indicators; (8) clock range selection 10-40kHz, 1K-20kHz. Power supply to suit (not included). M-9530 12V 1amp $14.95. Comes complete with training manual.

Cat P-4625
10 up $119.95 ea **$129.95**

See our new stores in Redwood City and Berkeley

Logic Probe $18.95

A superb time-saving tool for the hobbyist, technician, engineer etc. This outstanding logic probe hooks onto the circuit under test for it's power (5V DC), and you can tell at a glance what the logic level is by which of the three LED's is glowing. It is easily held in one hand – so your other hand is left free! Cat D-1272

Features:
- Adjustable threshold for DTL/TTL or CMOS ckts
- Two modes of operation: pulse (with time stretching so you don't miss quick pulses!) and mem (holds display until cancelled)
- Low circuit loading (approx 30uA input)
- Tested to 12.5MHz

DICK SMITH'S – WHERE THE ELECTRONICS ENTHUSIAST IS #1

Fun Way 1

See Vol 1 for full instructions and explanations.

Fun Way One Project Kit 1-10

Enables you to build any of the first ten projects in Fun Way One. And because the components are not soldered, they are all re-usable so you can build any other of the first ten projects too. **$7.25** Cat K-2800

- Continuity Indicator
- Transistor Tester
- Water Indicator
- Light/Dark Indicator
- The Flasher
- An electronic Siren
- Dog and cat communicator
- A decision maker
- Morse code communicator
- Music Maker

Fun Way One Project Kit 11-20

Contains the more sophisticated components required to complete the last ten projects (11-20) in Fun Way One. Note: you will also need the 1-10 kit to build the projects. **$7.90** Cat K-2810

- Sound Effects Generator
- A Crystal Set
- One Transistor Amplifier
- Beer Powered Radio
- Two Transistor Amplifier
- World's Simplest Transmitter
- Voice Transmitter
- CB Radio Receiver
- Amateur Radio Receiver
- Radio Booster Amplifier

Each kit requires the book for instructions

20 more fun projects to build in Fun Way Volume 2

$6.95

Cat K-2820 **$17.50**

Fun Way Volume 3

OVER 500,000 FUN WAY KITS SOLD!

ONLY **$6.95**

When you've worked your way through Volumes 1 & 2 you're ready for the more complex projects described in full detail in this book. Then you could be ready for a job in electronics.

Cat K-2610

Each kit requires the book for instructions

READ ON... MORE GREAT BARGAINS AND NEW PRODUCTS OVERPAGE

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MASSIVE POWER

NEW

FANTASTIC TEST BENCH POWER SUPPLY

$129.95

This beauty will supply up to 20 Amps all day to your test bench or amateur radio station. Ideal for 50 and 75 watt, 2 metre base and linear amplifiers. It is a precision regulated DC supply with the added features of

- Electronic overload protection with instant automatic reset
- Fuse protected
- Neon lighted on/off rocker switch

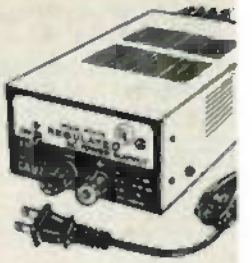
Size: 11.8" x 7.75 x 4.375" Weight: 16lb

Cat M-9547

Be served by an enthusiast like you at DSE

HEAVY DUTY SOLID-STATE 13.8V/ 4A Peak

- Housed in high-impact plastic case with massive ventilation for long service
- Rubber feet to keep stable, eliminate scratching



Regulated D.C. Power Supply. 13.8 VDC, 3/5 Amp. For home, lab, service bench, CB, stereo and auto radios, this is an extremely versatile unit. You'll wonder how you managed without it!

Input is 117VAC 50Hz 100W, and the output is fully regulated low ripple 13.8VDC to supply 3 Amps continuous and up to 5 amps surge. The unit is fuse and double-short circuit protected with on/off switch and pilot light.

Cat M-9545

$19.95

Dick Smith Electronics – your one stop electronics shop

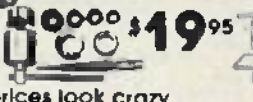
Ni-Cad charging Cabinet

$11.95

10 up $10.50 ea

Can't charge Ni-Cads inside the device? No problems, this incredibly versatile charging cabinet suits virtually all sizes and types of Ni-Cad cell. Has a test meter to indicate charge and 5 LED indicators to show batteries are connected. Fully approved, complete with plug-pack. Cat M-9519

Hole Punch Set



Ideal chassis leather tool, at last a necessary tool for anyone who needs a large hole cut through metal. It's easy to use, needs no filing and it will cut a hole without distortion. The complete set includes a 12mm tapered reamer, tommy bar, 6 punches - 18mm, 19mm, 20mm, 25mm, and 30mm. Individual chassis punches bought separately would cost a lot more than the price being charged for the whole set! Will handle steel to 22 gauge and aluminium to 16 gauge.

Cat T-4800

$19.95

Our worldwide bulk buying power makes our prices look crazy.

1.2 & 2.2GHz Frequency Counters

EXCLUSIVE

We have been fortunate enough to make this exclusive direct buy. Compare the price of this state-of-the-art unit with older models

There are now 2 models to choose from:

MODEL 21 – 10Hz to 1GHz

MODEL 22 – 10Hz to 2.2GHz

MODEL 21 ONLY Cat Q-1315 $249.00

MODEL 22 ONLY Cat Q-1318 $499.00

Compare with much more expensive models

LATEST TECHNOLOGY $149

Cat Z-4845

HUGE 1 AMP OUTPUT

High output Solar Panel

These solar panels utilize high technology solar cells designed for satellites that generate on average 20% more than the normal 4/5 watt cell. High density packaging gives really high output. Exclusive pulsed aluminium support system makes the panel temperature stable, shock proof and weather proof.

Ideal for all sorts of uses to boat owners, amateur operators, technicians or anyone else that has no access to a 12V battery charged in an out of the way place.

1 Amp Output (10 watts) or 20V @ 500 MA Cat Z-4845 10 up $140.00 — $149

600 MA Output (10 watts) or 30V @ 350 MA Cat Z-4844 10 up $99.00 — $109

Both panels supplied with specification sheet, wiring harness, 5 amp in-line fuse, lugs and bolt with nuts ready to suspend your solar panel.

MADE IN U.S.A

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17 years reliable mail order service – as close as your mailbox

FREE Battery Charging with the Solar Battery Chargers

Charge batteries with free Solar Power through Space Age Technology available from Dick Smith Electronics

Here is a convenient and safe way to revitalize worn down batteries. Pocket chargers start saving money the first time they are used. These pack of chargers are completely self contained, compact and easy to use.

Button Cell Charger
Brings new life to your button cells
M-9504 $19.95

4 x AA Charger
Can charge from 2 to 4 "AA" ni-cads complete with suction cup and hook for easy suspension
M-9502 $24.95

NEW

2 x AA, C, or D Charger
This unit comes complete with C and AA adapter as well as suction cup and hook for easy suspension
M-9500 $29.95

Solder Stand with magnifier!

The helping hand when you need it most when you have a hot stick in your hand. Heavy die-cast base, solder stand, clips for holding PCB, etc. – plus 5 prong magnifying lens for those close assembly jobs.

BEAT THIS PRICE $6.95

Cat T-0710

We carry a huge range of electrol, polyester, tantalums, ceramics and styros. Please ask when ordering and we will probably be able to supply your needs.

Dick Smith Electronics – as close as your mailbox

Magazine File

A magazine binder, ideal for any magazines that cover 12 issues in one year. Hard spine with metal rods for placement of the magazines. Cat B-6045

VALUE $4.95

ILLUMINATED PUSH BUTTON

Lamp 12V @ 55mA

4½ sized 4P car bumper alarm, panel punch, etc. Alternate action push with yellow 12V globe. Square finish body, round mounting hole.

Features:
12V AC 2A
Body size: 1/2" x 1/2"
Mounting hole: 1/2"
Clearance: 1/8"
Cat S-1520
10 or more $4.50 each

$4.90

DSE 2840

Primary: 117V, 60Hz
Secondary Voltage: 4.5-6.5V
Secondary Current: 150mA
Terminations: Flying Leads
Cat M-2840

$2.5

10 up $2.25

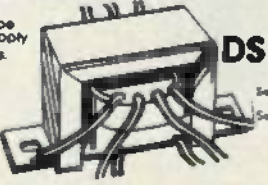
DSE 2851

Primary: 117V, 60Hz
Secondary Voltage: 4.5-6.5V
Secondary Current: 150mA
Terminations: Flying Leads
Cat M-2851

$2.5

NEW

DSE 2155

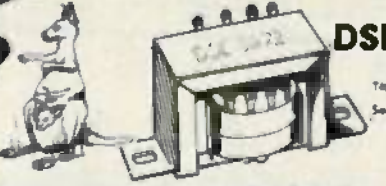


Primary: 117V, 60Hz
Secondary Voltage: 6.3, 7.5, 9, 9.6, 12 & 15V
Secondary Current: 1 Amp
Terminations: Flying Leads
Cat M-2155

10 up $5.50 ea

$5.9

DSE 6672



Primary: 117V, AC
Tapped Secondary Voltages: 18, 17.5, 20, 24, 27.5, 30 volts
Secondary Current: 1 Amp
Termination: Solder Lugs
Cat M-6672

$7.9

10 up $6.95 ea

IRRADIATED HEAT Shrinkable Electrical Tape

$3.75 Cat N-1365

For RF connectors, computer connectors or any connector or cable splice that has to be water proofed or insulated. When heated (a heat gun will serve excellently) there will be a 30% tightening around the object. Secondly the inner lines soften and flow into the tape wrappings. Tensile strength 1200 PSI. Dielectric strength 9kV min. Colour Black. 10' length.

Giant Handbook of Electrical Circuits

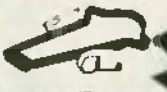
Raymond A Collins-880 pages

Giant isn't the word, its a whopping 880 pages! With 60 chapters covering everything from crystal sets to computer circuitry, you're sure to find what you want here!

Cat B-1780 $19.95

IC EXTRACTION TOOL

$2.95



Cat T-4850

The perfect way to remove IC's without damage. Works with all DIL packs, no bent pins and no static damage! Operates like a pair of tweezers - with hooks!

Satisfaction Guaranteed or your money back.

Signal Injector

$9.95

One of the handiest devices to have in your tool box. Check out both audio and RF circuits. (Harmonics extend to many MHz) simply and easily. Often the quickest method of fault finding (and one of the cheapest!) Self contained with probe and earth clip. Cat Q-1270

Batt Oper

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ATIC RAMS

DEVICE	Cat No	Description	PINS	Speed	Price	10 up ea
2102	Z-9302	1024 x 1	16	350ns	99¢	89¢
2114	Z-9306	1024 x 4	18	450ns	1.05	95¢
6116P-4	Z-9308	2048 x 8/16K CMOS	24	200ns	3.45	2.95

YNAMIC RAMS

4116	Z-9310	16,384 x 1/MM5290N-3	16	200ns	1.00	90¢
6464	Z-9312	65,536 x 1	16	150ns	3.95	3.50
41256	Z-9314	262,144 x 1	16	150ns	10.95	9.95

ROMS

2516	Z-9207	2048 x 8 16K/2716	24	450ns	4.95	4.75
2532	Z-9208	4096 x 8 32K/2732	24	450ns	4.95	4.50
2732A	Z-9209	4096 x 8 32K (21V) Intel	24	150ns	4.95	4.50

00 SERIES

085-AH	Z-9385	CPU 8 bit N-Channel	40	5MHz	6.50	5.95
8086	Z-9386	CPU 16 bit	40	5MHz	19.95	17.95
-8088	Z-9388	CPU 16 bit/8 bit Data bus	40		14.95	12.95
-8235-5	Z-9453	Prog Interval Timer			7.50	6.50
8255A	Z-9455	Prog Peripheral	24		4.95	4.50
8284A	Z-9484	Clock Generator and Driver	40		5.49	4.50
D8288	Z-9488	Bus Controller 8086/88	18		13.95	12.95
			20			

00/6800 SERIES

P6502	Z-9502	MPU with clock	40	1MHz	5.95	5.50
6845	Z-9545	CRT controller			13.95	11.95
6850	Z-9550	Asynchronous Comm Adaptor			3.75	3.50

3½ digit LCD driver Cat Z-6300 $9.95 ea 10 up $9.00 ea

74HC

Type No.	Cat No.	Price Ea	Price 10 up
74HC00	Z-5800	55¢	50¢
74HC02	Z-5802	55¢	50¢
74HC04	Z-5804	55¢	50¢
74HC08	Z-5808	55¢	50¢
74HC11N	Z-5811	55¢	50¢
74HC14	Z-5814	55¢	50¢
74HC27	Z-5827	55¢	50¢
74HC30	Z-5830	55¢	50¢
74HC32	Z-5832	55¢	50¢
74HC74	Z-5874	70¢	65¢
74HC76	Z-5876	70¢	65¢
74HC85	Z-5885	$1.30	$1.20
74HC86	Z-5886	55¢	50¢
74HC123	Z-5910	$2.20	$2.00
74HC138	Z-5915	99¢	90¢
74HC139	Z-5920	99¢	90¢
74HC157	Z-5975	99¢	90¢
74HC165	Z-5930	$1.95	$1.70
74HC174	Z-5935	99¢	95¢
74HC221	Z-5940	$2.80	$2.40
74HC240	Z-6045	$1.95	$1.85
74HC244	Z-6050	$1.75	$1.65
74HC245	Z-6055	$1.85	$1.75
74HC367	Z-6060	99¢	89¢
74HC373	Z-6066	$2.25	$2.00

IC SOCKETS

Why endanger valuable IC's by soldering them directly into circuit? Take the safe approach: use an IC socket! It makes service and repair of your project much easier too. There's an IC socket to suit all common IC's.

THOUSANDS SOLD

VERY SENSIBLE!

8 pin mini DIL socket 16¢ Cat P-4080 10 up 13¢ ea

14 pin DIL socket 16¢ Cat P-4140 10 up 14¢ ea

14 pin DIL socket 18¢ Cat P-4160 10 up 16¢ ea

The semi's listed here are only a tiny fraction of our huge range – please enquire about types and prices.

SCR'S

Economy Plastic Pack Type	Vdrm	IT(AV) rms	Use	Cat No	Price Ea	Price 10 up
C103B	200	0.8	Small Current Sensitive Gate	Z-4310	44¢	40¢
C106Y1	30	4	Sensitive Gate	Z-4315	29¢	25¢
C106D	400	4	Sensitive Gate	Z-4320	99¢	75¢
C122E (BT151, TIC126E)	500	8	AC Switch	Z-4332		

RECTIFIER DIODES

Type No	Cat No	Price Ea	Price 10 up	PIV	IF Amp	Use
		04	03	100	1	General Purpose
IN4002	Z-3202	06	05	400	1	General Purpose
IN4004	Z-3204	10	08	1000	1	General Purpose
IN4007	Z-3207	12	10	400	3	General Purpose
IN5404	Z-3222	30	25	1000	3	General Purpose
IN5408	Z-3228	30	25			

SILICON SMALL SIGNAL DIODE

		Price Ea	Price 10 up
IN914	Z-3120	08¢	06¢

LIQUID CRYSTAL DISPLAY

			Price Ea	Price 10 up
LCD4.6	0.6"	4½ digit liquid crystal	Z-4175	$9.95	$9.00

LINEAR IC's

Type No.	Cat No.	Description	Price Ea	Price 10up ea
TL555CP	Z-6144	CMOS timer	69¢	65¢
NE/DS555	Z-6145	Universal timer	35¢	30¢
NE558	Z-6146	Dual timer	79¢	75¢

Sorry about no data on some products – any can run out of stock. This is only a small sample of our IC range – our range carrying will be the full range – with no exceptions.

Light Emitting Diodes

Type No	Colour	Size	Cat No.	Price EA	Price 10 up	If @ 20 mA	Intensity @ 20mA	Notes
LT2462-52	Red/Grn	0.2" diam	Z-4070	1.89	99¢	60	3.0mCd	Dual
ESBR5501	Red	0.2" diam	Z-4075	99¢	89¢	50	200mCd	High Intensity
TL4211	Red	0.2" diam	Z-4077	39¢	35¢	40	3.5mCd	Premium Quality
TL4231	Green	0.12" diam	Z-4079	39¢	35¢	40	6.0mCd	Premium Quality
TL4251	Yellow	0.12" diam	Z-4081	39¢	35¢	40	7.0mCd	Premium Quality
TL4291	Orange	0.12" diam	Z-4083	39¢	35¢	40	4.0mCd	Premium Quality
TL4213	Red	0.2" diam	Z-4085	29¢	25¢	40	8.0mCd	Premium Quality
TL4233	Green	0.2" diam	Z-4087	29¢	25¢	40	6.0mCd	Premium Quality
TL4253	Yellow	0.2" diam	Z-4089	29¢	25¢	40	9.0mCd	Premium Quality
TL4293	Orange	0.2" diam	Z-4091	29¢	25¢	40	1.2mCd	Rect. Prem. Qual.
TL32155	Red	0.08 x 0.2"	Z-4093	39¢	35¢	40	2.1	1.2mCd Rect. Prem. Qual.
TL32355	Green	0.08 x 0.2"	Z-4095	39¢	35¢	40	2.1	1.2mCd Rect. Prem. Qual.
TL32555	Yellow	0.08 x 0.2"	Z-4097	39¢	35¢	40	2.1	1.2mCd Rect. Prem. Qual.

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Huge 132 Page Enthusiasts's Catalog

Data • High Tech Kits • Books • Components • and much more – Rush 2.00 plus $1.00 shipping for your copy today – or come into one of our stores and pick one up – We want to meet you!

Out of the Inner Circle

$9.95

Cat B-2370

Compact Disc Library System

These very attractive modules are made of high-impact tinted plastic that stack vertically or horizontally with a very positive interlocking system so that they will not slip about or fall over. Your discs stack neatly all in one dual shelves. Two modules in each system hold up to 24 discs!

Cat C-3830

$12.95

Flashing Strobe

$14.95

10 up $13.95 ea

SUPER VALUE

A new idea ... and a beauty! A bright blue flashing "strobe" lamp (like on the top of your-know-what cars!) which demands absolute attention. Placed outside the property (say under the eaves of the house) it will instantly show neighbours, Police, etc where the alarm is occurring (it's not always easy to tell from which direction a siren or bell is coming!) Operates from 12 Volts: use in conjunction with virtually any alarm controller via "relay" output. Cat L-4000

JUST WHISTLE!

Lost your keys again? JUST WHISTLE! That's right with one of these little beauties rigid time you misplace your keys just whistle and it will beep right back at you. A great conversation starter too!

Cat P-4085

$12.95

10 up $11.95 ea

Connector Packs

Here's the list at last minute bargain! Connector packs in either 2, 3, 4, 5, or 6 way. All come with nylon connector housing and 2.36mm tin plated brass pin terminals for long life and reliability with no loose ends.

As used in most cars – ideal replacements.

	Price	10 up Ea
Cat P-5102	$1.20	$1.10 2-way
Cat P-5103	$1.30	$1.20 3-way
Cat P-5105	$1.40	$1.20 5-way
Cat P-5106	$1.40	$1.40 6-way
Cat P-5112	$2.20	$2.00 12-way

IT'S AMAZING... YET TRUE! WOW!

ONLY $1.00 ea

9V DC MOTORS

10 up 80¢ ea

Cat L-5010

Grab 'em while they last! These little beauties are ideal in car cassette players as they are robust and spin quietly. They have plenty of torque so you can use them for all sorts of projects. The 3 flanges on most of the motors makes it extremely easy for mounting.

VALUE

SOUNDBENDER

Easy to build. More fun to play with. This great little kit plugs into a sound box 1 Darth Vader, a Dalek, or any one of a dozen robotic synthetic effects. Used for special effects on electric guitars and other musical instruments.

Cat K-2909

$19.95

Resistance Substitution Wheel

Cat Q-1410

$5.95

Convenient size with large, easy to read value selection that enables you to select values from 5 ohms to 1 M ohm in 36 steps by using most common divisions. Complete with leads and insulated crocodile clips.

Opening soon in San Jose

TOP QUALITY

QUALITY NI-CAD Rechargeable Batteries

From $1.49 ea (10 up price of AA)

Amazing VALUE!

Ni-Cads work out much cheaper in the long run, especially if you buy them from Dick Smith Electronics

Type	Cat No.	Price each
AA	S-3300	1.99
AAA	S-3305	1.95
C	S-3301	2.95
D	S-3303	2.95

CAN'T READ OUR AD?

$6.00

$3 off for any customer who has difficulty reading this ad.

2½" double glass lens 40/60 coin viewer – excellent for inspecting solder cracks in PCB's

Cat T-0500

PASSING BY OUR STORE? DROP IN PICK UP A CATALOG WE'D LOVE TO MEET YOU!

Here's how to find us

DICK SMITH ELECTRONICS 60 STORES IN 3 COUNTRIES

EVERYTHING FOR THE ELECTRONICS ENTHUSIAST

DICK SMITH ELECTRONICS

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OVER 60 STORES IN 3 COUNTRIES

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SHIPPING CHARGES

U.S.A. 5% of merchandise total minimum $2.50. We generally ship UPS ground if you require a faster service please contact us.

OUTSIDE U.S.A. 10% of merchandise total minimum $5.00

Tax, 6½% Californian residents

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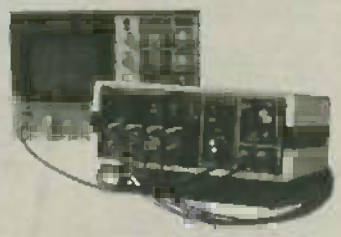
EQUIPMENT REPORTS

Global Specialties Corporation Model 8001 Scope Multiplexer

Display up to eight analog or digital signals at one time



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THE OSCILLOSCOPE IS AMONG THE most versatile troubleshooting tools an electronics technician or hobbyist can own. Even more versatile, however, is an oscilloscope that is capable of displaying two or even more channels of data. But oscilloscopes that are capable of displaying four or more channels can get very expensive.

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The *8001*

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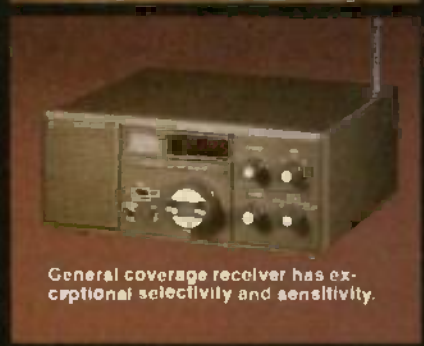

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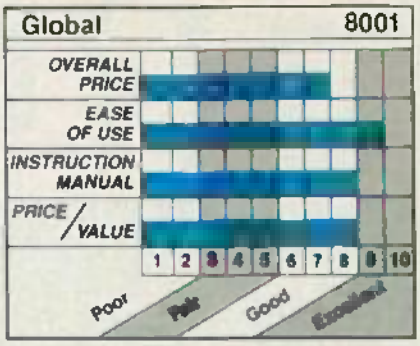
Up to eight input signals can be fed to the unit via a grouping of eight front-panel mounted BNC connectors. Input frequencies of up to 20 MHz (−3 dB) and voltage levels of up to ±5 (10-volts P-P centered about zero volts) can be accommodated. The unit can withstand input voltages of up to ±50-volts.

For input signals of greater than ±5 volts, some degree of attenuation is needed. For signals of up to ±50 volts, a 10:1 attenuator probe can be used. For greater signal levels, or a different level of attenuation, a simple voltage-divider can be used. The excellent instruction manual (more on that in a moment) provides information on several different voltage divider circuits, including variable and calibrated types.

The unit provides two outputs for connection to a scope. To generate the vertical-output signal, the input signals are scanned sequentially and summed with the output of a staircase generator. The amplitude of the input-signal portion of the output signal can be varied from 0 to 75 mV by using the front-panel MULTIPLEXER GAIN control. That control affects the amplitude of all input signals equally. The scanning rate can be varied from 40 kHz to 1 MHz using the RATE control. That control is adjusted for minimum trace flicker.



The trigger output is used to supply a trigger signal to the scope. The unit uses the signal present on channel 1 to generate the scope trigger pulse. As such, all signals to be displayed should be time-related to the channel 1 signal; otherwise an asynchronous display will result. In addition, the lowest frequency signal should be connected to channel 1.

The trigger circuitry in the *8001* is limited to 10 MHz. At that point, the trigger signal becomes a positive DC voltage. For applications where the lowest signal of interest is greater than 10 MHz, the scope trigger must be connected directly to the signal source rather than the multiplexer.

The pulse width of the trigger signal is switch (internally located) selectable between 0.1 and 1.0 µs. The trigger threshold level is variable between −5 and +5 volts. A POLARITY switch selects whether triggering will take place on the positive-or negative-going edge of the trigger signal.

The unit offers several options in terms of the trace display. Possible multiple-channel displays include all eight channels, the first four channels, or the last four channels. The multiplexer is also capable of a single-channel display. In that mode, only one trace is displayed at a time. Successive channels can be viewed by pressing the front-panel INCREMENT switch. A PUSH-TO-CALIBRATE switch

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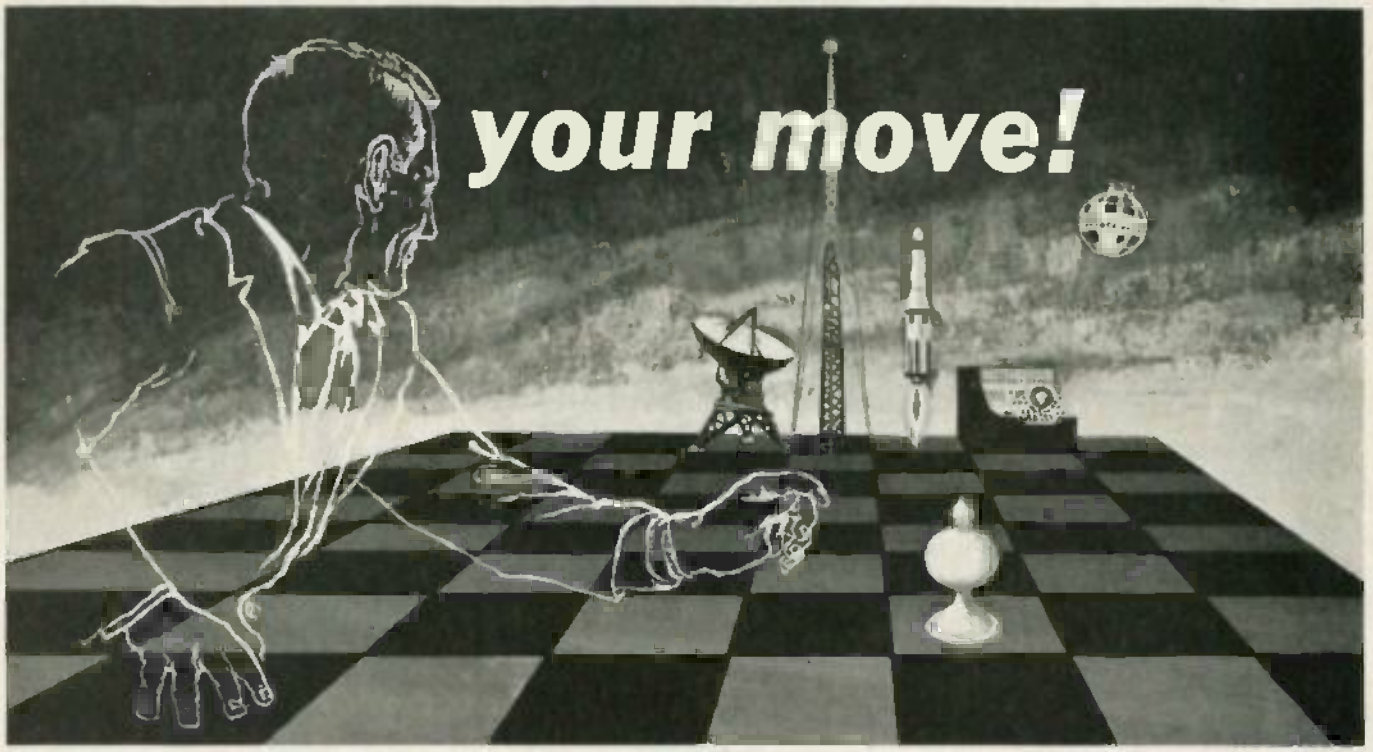

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zeros all traces to allow proper positioning on the scope.

The instruction manual that accompanies the unit is nothing fancy, but it performs its intended function very well. As the unit is extremely easy to use, a great deal of space is devoted to the theory of operation of the unit, and maintenance and calibration details. Interestingly, while a complete schematic diagram is provided, there is only a partial parts-placement diagram; only adjustments and test points for calibration are shown.

The model *8001* is covered by a 1-year warranty. It sells for $450. R-E

ONCE UPON A TIME THERE WAS ONLY one kind of modem—a 110-baud accoustically coupled type. Well, time marches on. The rubber cups went the way of whale bone corsets and common baud rates increased as inevitably as taxes. What started at 110 baud became 300, 300 became 1200, and now we've arrived at 2400-baud modems for home computers.

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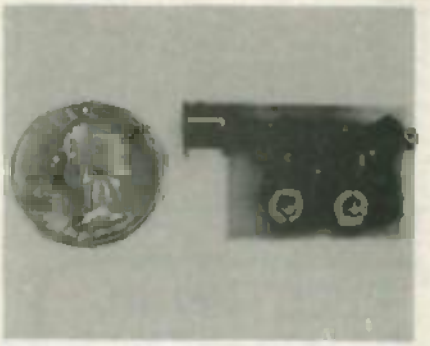

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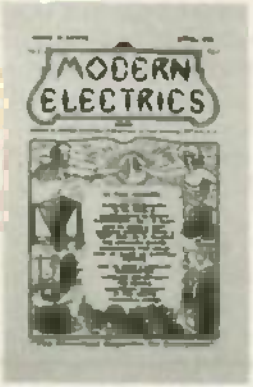

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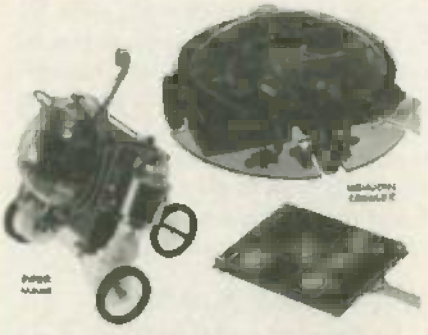

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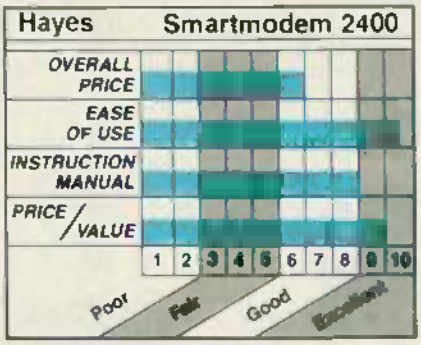


the keyboard or inside running programs. The command syntax itself is a curious carryover from the early days of telecommunications. All the commands have to be prefixed with the letters "AT" - just like the old Attention Codes from the era of teletypes and paper tape.

Everything from the baud rate to the speaker volume can be set by using the AT commands and the settings you select will be written into the Smartmodem's RAM. If the command is issued correctly, the modem will let you know by printing "OK" on the screen. And if you fumble on the keyboard, the modem will let you know by responding with the word "ERROR". In all, there are ten result codes that the modem can put on the screen. They range from letting you know if a dial tone is present on your line to whether or not the number you're calling is busy.

Hayes has also included a series of commands for testing both the modem and your terminal. You can tell the modem to do a local loopback to test your equipment, or loop the TELCO lines to test the equipment on the other end. As always, you'll get an indication on the screen to let you know exactly what's going on. All those messages not only make it easier to keep track of things; if you write your own modem software you'll find that they'll go a long way toward cutting down your programming time.

Where's the DIP switch?

Configuring the modem for a particular set of communication settings is easy. All the parameters—baud rate, bit settings, how many rings to wait, etc. are stored in memory. How they're stored depends on whether you want them for just one session or decide to keep them permanently. As with most modems, temporary storage is done by keeping the configuration in RAM. Unlike other modems, permanent storage does *not* involve setting any DIP switches!

Hayes has replaced the dreaded DIP switches with non-volatile memory. Permanently configuring the modem involves nothing more than telling it what settings you want and then issuing a "write" command. That's all there is to it! As an added bonus, since the factory default settings are in the modem's firmware, resetting it is only a matter of issuing another command. The idea of storing-system defaults in non-volatile memory is a great idea and we'd be surprised if it didn't start to show up in other peripheral devices. Printers, for example, could for that approach.

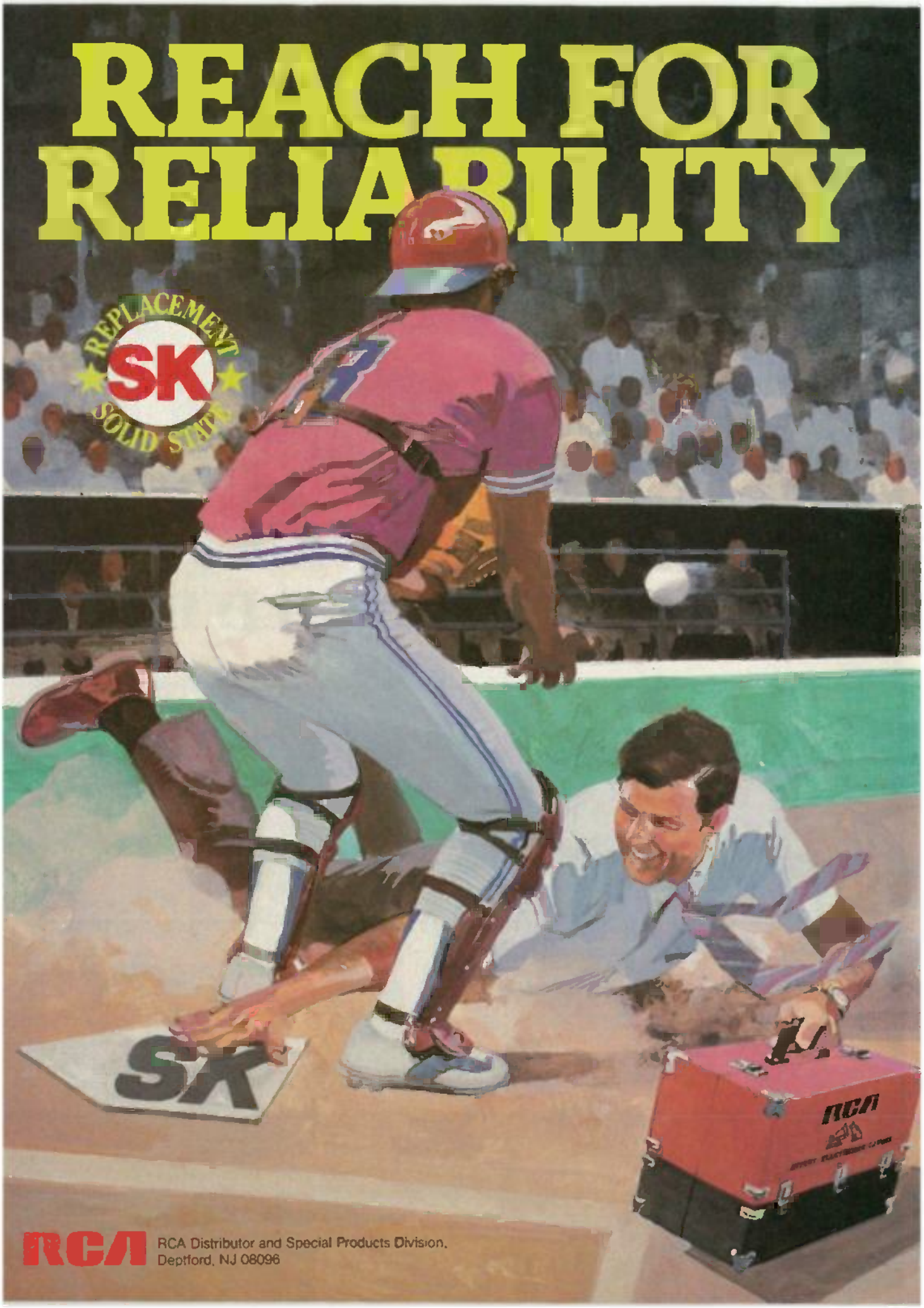
The Smartmodem 2400 is a stand-alone unit that's set up to accept a standard RS-232 connector, and a group of LED's on the front let you keep track of the modem's status.

At the moment there aren't a lot of dial-up services that can support 2400 baud, but that's the way it used to be when 1200 baud started to become popular. It's only a matter of time. And while you're waiting for your favorite bulletin boards to upgrade to 2400 baud, there are still a lot of advantages to the Smartmodem 2400. It has every possible feature you could want in a modem and it's incredibly easy to use.

The manual is well written, comprehensive, and goes over every aspect of the modem in an easy-to-understand, step-by-step fashion. The Smartmodem 2400 has a 2 year warrantee that can be extended to 4 years for a $75 charge.

The modem has a retail price of $899. That may seem a bit steep, but don't forget that every time you communicate at 2400 baud, you're cutting your connect time charges in half (at least)!

Hayes products have always been regarded as top-of-the-line modems, and one look at the Smartmodem 2400 will tell you why. In everything from the packaging to the product, this modem will set industry standards for years to come. **R-E**



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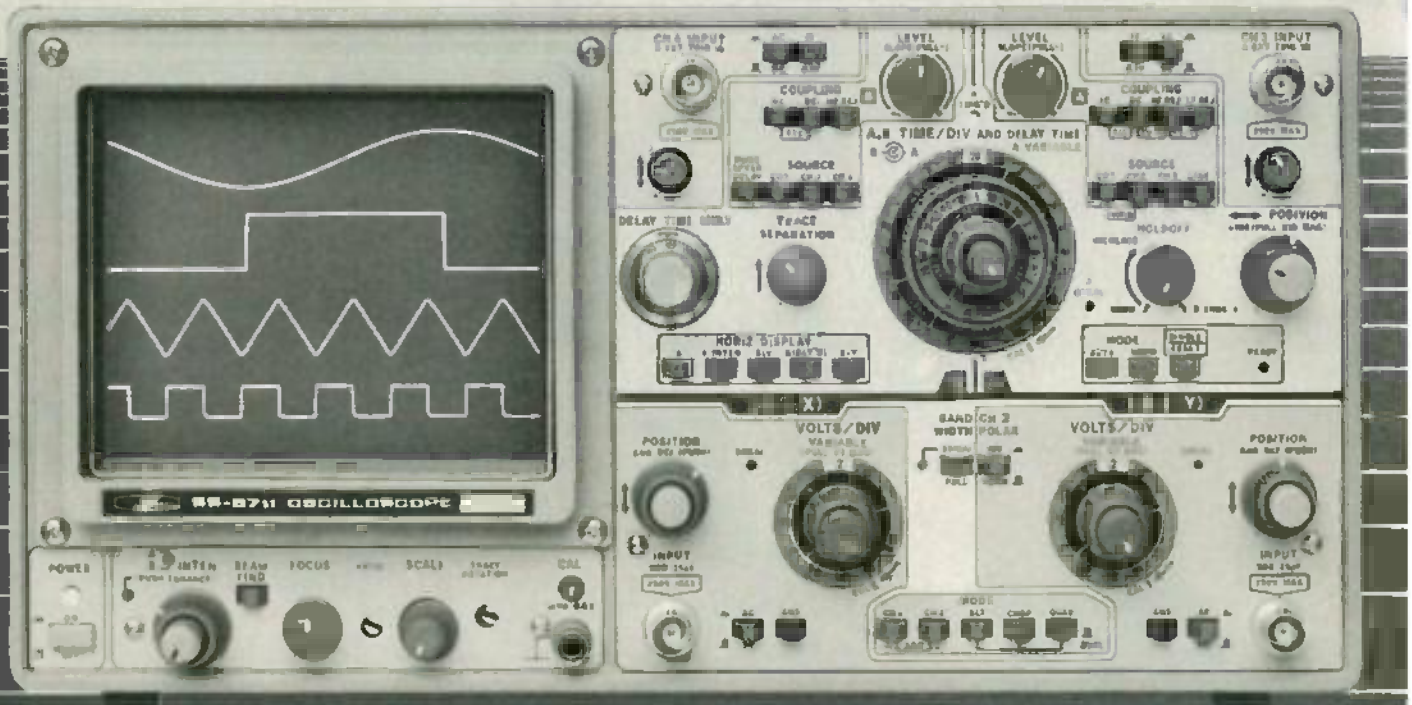

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BUILD THIS

SEE-IN-THE-DARK VIEWER

ROBERT GROSSBLATT

"See in the dark" with this easy-to-build infrared viewer!

THE PHRASE "SEEING IN THE DARK" is a misleading one. With the possible exception of mystics and mutants, when the lights go out, we all walk into walls. Being able to see in the dark all depends on what you mean by "dark." The human eye is only sensitive to a very narrow band of the electromagnetic spectrum, as shown in Fig. 1. Figure 2 shows the eye's relative sensitivity to wavelengths in that narrow band.

The infrared portion of the electromagnetic spectrum is just below visible light and extends from about 700 to well past 10,000 millimicrons. The human eye is normally insensitive to electromagnetic radiation in that region. In order to produce a visible image using infrared light, then, we need a device that's both sensitive to infrared and able to translate an infrared image into one that the human eye can see. One such device is the RCA 6032 image converter tube, and that tube is the heart of the infrared viewer that we'll show you how to build.

The 6032 can be thought of as being divided into two parts. The front end is a photosensitive cathode that responds to infrared radiation in the range of 500 to 1200 millimicrons. Whatever image is focused on the cathode is reversed left-to-right and passed on to the second part of the tube. That is a small fluorescent screen on which the visible image is formed. Focusing the image on the screen is done electrostatically—a voltage is applied to the focus ring at the tube's center and controls the convergence and divergence of the electrons being aimed at the screen's phosphor. That is similar to the way the electron gun is focused in a television set.

Building the viewer

The schematic of our viewer is shown in Fig. 3. As you can see, the circuit's only job is to produce the voltages that the image converter tube needs to operate. Before we start talking about how the circuit works and what's needed to actually build it, there are two things that have to be said.

CAUTION! The tube needs about 12,000 volts to operate, and 12,000 volts is a very serious amount of voltage! Because of that, the utmost care must be observed when working with this circuit. Any carelessness is dangerous, and could very possibly be fatal. BE VERY, VERY CAREFUL!

That caution should be taken seriously, even though the circuit is powered by a 9-volt battery. That's because our power supply is capable of producing as much as 15,000 volts from a fresh battery. Also, although the tube only needs a handful of microamps to operate, the supply can produce over 200 microamps. There's a world of difference between 200 microamps at 10 volts and 200 microamps at 15,000 volts! Once again, 15,000 volts can be lethal, even if the current is negligible. Be careful!

Secondly, the tube itself is made of glass and, just as any other type of electronic tube, it contains a vacuum. Although the glass is thick and the tube is strong, the tube will implode if punctured. Now, flying glass from such an occurrence is bad enough, but the phosphor on the screen can do you a lot of damage if it gets into a cut. To avoid any problems, handle the tube carefully and when you solder the high-voltage leads on the tube, make sure the iron is in contact with the tube for as short a time as possible. Tin the wire ahead of time and *never—repeat, never*—solder near the tube's glass seals.

Keeping those warnings in mind, let's take a look at the circuit.

The first stage of the power supply is an oscillator formed basically by Q1, Q2, and part of the primary of T1. Resistor R1 keeps the circuit unbalanced so that oscillation will start when power is first applied. The base current for the transistors is produced by induction in T1 and is limited by R2. The switching action of the transistors causes the induced voltage in T1 to switch polarity and that alternatively turns on Q1 and Q2 in turn. The two diodes, D1 and D2, are steering diodes for the base current.

When S1 is closed, current flows through R1 and T1. The base drive for the transistors comes from T1's stand-alone winding. Because the two transistors are being driven out of phase, the circuit begins to oscillate. That causes an induced voltage to appear across T1's secondary. How great that voltage will be depends on how much voltage is available from the battery. Assuming that the battery is between 7 and 9 volts, the induced voltage on T1's secondary will be between 200 and 300 volts.

That voltage is rectified by the full-wave bridge made from diodes D3 to D6. Capacitor C2 is charged through D7 and R3, setting the stage for the next part of the circuit's operation. Transistor Q3 is the center of a timing circuit with an R-C constant determined by the values of R6, R7, and C3. The 15-microsecond pulse produced by that part of the circuit fires SCR1, and causes C2 to discharge, inducing a high-voltage pulse in the secondary of T2. That voltage is rectified by D9.

The voltage produced by the discharge of C2 is boosted by the inductance of T2's primary and that negative overshoot causes the SCR to turn off. As soon as the SCR turns off, the whole process starts all over again.

The image-converter tube requires a high voltage in order to focus the image on the fluorescent screen. That voltage is applied via a voltage-divider circuit made up of R8 and R9. Don't forget that by the time power gets up to the tube, we're talking about some 12,000 volts at fairly high peak-current values. The values for those two resistors are extremely high because only flea power is needed at the focus ring of the tube. Excessive current can destroy the tube, so the resistor values are probably higher than you've ever seen before.

Getting the tube to produce a sharp image is a matter of providing the right voltage at the focusing ring. The value of 2000 megohms for R9 can be considered a final value, but the voltage will have to be adjusted by daisy-chaining resistors together to form R8. A value of 200 megohms is a good starting point; the optimum value, which varies from tube to tube, will be within 15% of that.

If the operation of the power supply seems familiar to you, it's probably because the same basic principles are used in the design of most automobile capacitive discharge systems. The same sort of

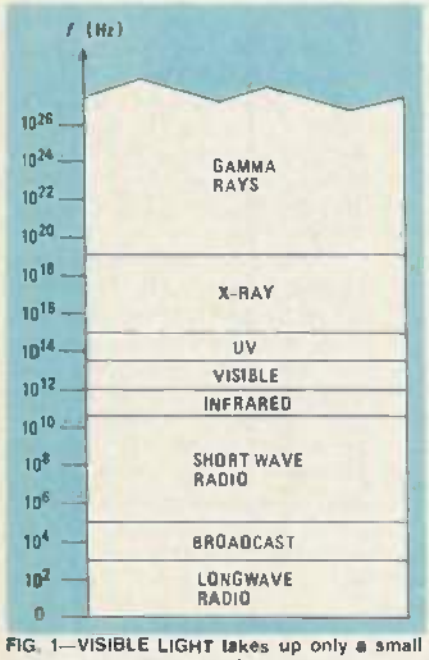


FIG. 1—VISIBLE LIGHT takes up only a small slice of the electromagnetic spectrum.

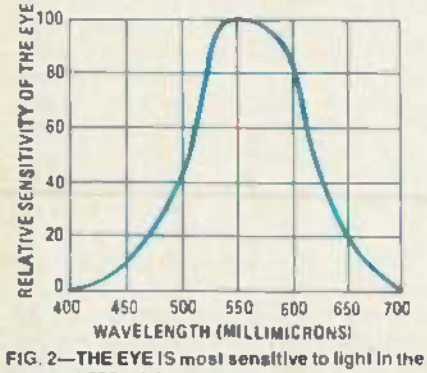


FIG. 2—THE EYE IS most sensitive to light in the range of 550 millimicrons.

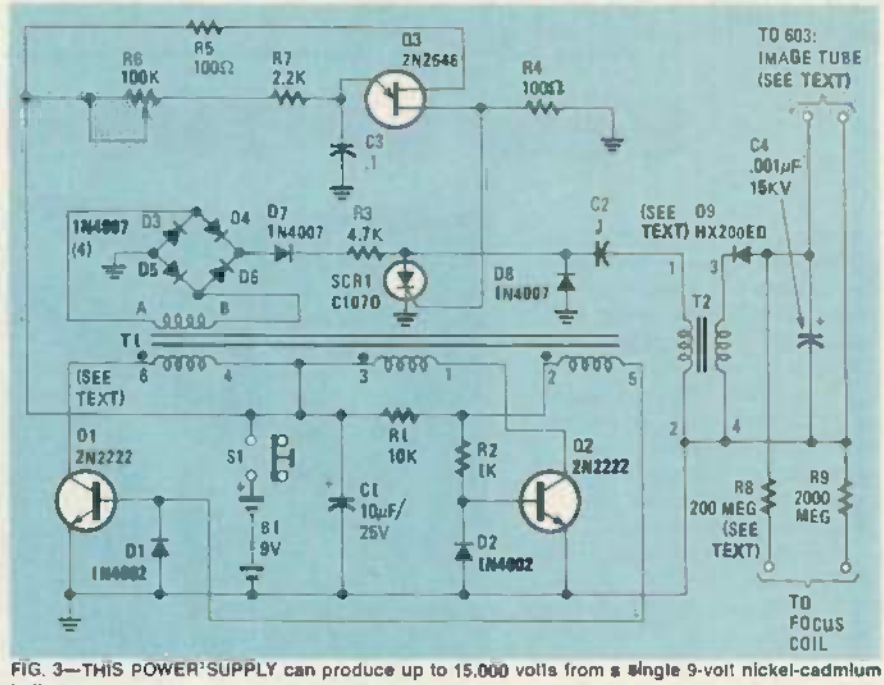


FIG. 3—THIS POWER SUPPLY can produce up to 15,000 volts from a single 9-volt nickel-cadmium battery.

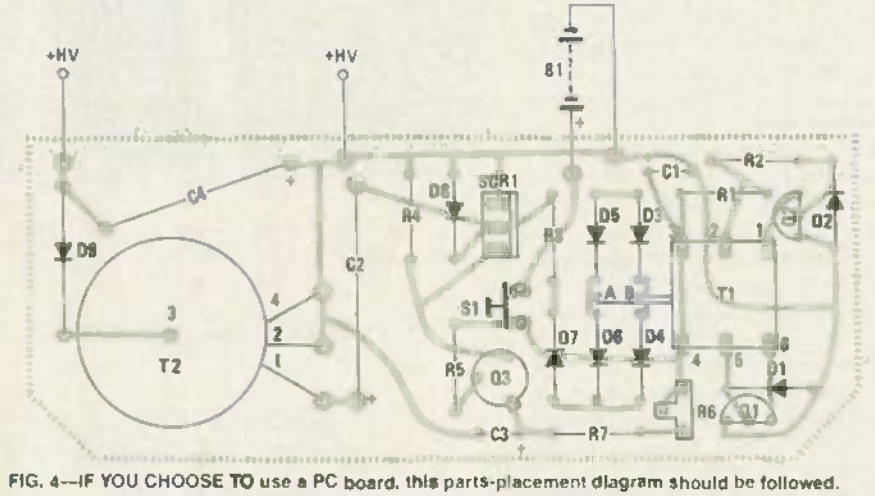


FIG. 4—IF YOU CHOOSE TO use a PC board, this parts-placement diagram should be followed.

pulsed high voltage is needed to make the spark plugs fire. And if you've ever fooled around under the hood of a car, you know that you can be knocked over backward by the juice at the plugs. Once again: **BE CAREFUL WHEN YOU ARE WORKING WITH THE HIGH VOLTAGES INVOLVED IN THIS PROJECT.**

Construction

Building the circuit for the infrared viewer is relatively straightforward and can be done on either a perfboard or PC board. We recommend using a PC board; an appropriate pattern is provided in our "PC Service" section, on page 78, and the corresponding parts-placement diagram in Fig. 4.

Whatever method you choose, because we're dealing with high voltages, there are several considerations that are different from a low-voltage circuit:

- All solder joints must be clean and shiny. Because of the voltages involved, anything less than a perfect joint will cause arcing.
- Leads must be absolutely cut as short as possible.
- All the components on the board, and especially those that follow T1, should be locked in position with paraffin, varnish, or high-voltage putty.

The first step is to mount and solder the components onto the board. Do not, however, mount the high-voltage portion of the circuit (T2 and the circuitry on the secondary side of that transformer). Before building that part of the circuit, you need to verify that the balance of the project is operating correctly. When you mount the components on the board, pay attention to the polarities of the diodes and capacitors. Make sure that the transistors are correctly oriented and the transformer

leads are properly identified. Do your soldering only when you're sure that everything is correct.

The next step is to verify that everything to this point is operating correctly. Connect the leads from an ohmmeter to the battery clips and press S1. That is an easy way to make sure you don't have a short across the power supply. If that checks out fine, connect the power leads to a 6-volt supply and measure D7's anode voltage. You should see about 175 volts there, and the drain on the 6-volt supply should be no more than 75 mA. *Be very cautious* when you're taking those measurements. It may seem that 175 volts is a long way from 15,000 volts, but that voltage can still do a bit of damage.

Once everything checks out, you can mount and wire the rest of the circuit. If you don't get the proper readings, check your connections on the board again. The circuit is simple enough for you to be able to find your mistake without too much irritation.

Take the high-voltage leads and tape them down so that they're about a quarter of an inch apart. Connect the circuit to the 6-volt source again and you should see sparking at the output. You have to adjust R6 for the minimum spark rate. If you watch the current draw, you should see it drop as the sparking rate is reduced.

Once again a word of caution. Anytime you're adjusting a circuit that produces high voltage, you want to be absolutely sure to isolate yourself from the board. That means that a metal-bladed screwdriver, or anything else metal, for that matter, to make adjustments is a definite no-no. And contrary to popular belief, you don't want to use a wooden anything either. High voltages do weird things and that includes traveling through anything that is even the least bit conductive. Wood is porous, can absorb moisture from the air; the result can very well be you lying on the floor!

Once you've finished assembling the high voltage supply and you're sure it works, you're ready to tackle the image converter tube. But just as there was for the power supply, there are some precautions to keep in mind for this part of the assembly as well.

- When you're soldering connections to the various rings on the tube, do it as quickly as possible. Tin the wires before you solder the connections. If you apply too much heat for too long, you'll destroy the glass-to-metal seals on the tube.
- The tube is made of glass and contains a vacuum. The weakest points on the tube are at the small areas where the glass was sealed after the tube was assembled. **Keep your iron and any solder away from the glass in general and those seals in particular.** The glass can implode and the phosphor coating on the screen can cause you a great deal of trouble.

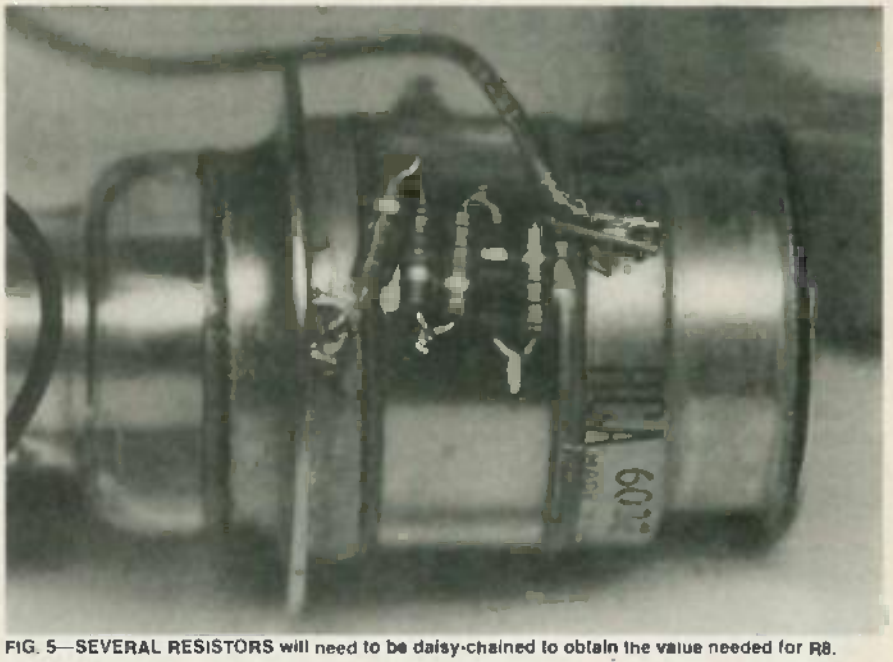


FIG. 5—SEVERAL RESISTORS will need to be daisy-chained to obtain the value needed for R8.

With those precautions in mind, solder R9 between the focus ring and the ring surrounding the fluorescent screen. Once you've done that, solder short pieces of wire to the ring surrounding the objective end of the tube and another point on the focus ring. Temporarily connect R8 across those pieces of wire as well as the high voltage leads from the power supply. Make sure that the lead coming from the D9-C4 junction on the power supply board is connected to the R8/objective end of the imaging tube and the other lead is connected both to ground on the board and the R9/eyepiece end of the tube.

When you've made sure that everything is hooked up properly, apply power to the circuit and you should see the phosphor at the eyepiece end of the tube glow with a green light. Turn off the power and fasten a piece of window screening flush against the objective end of the tube. Re-apply power and you should see an image of the screening on the phosphor screen. Your next step is to adjust the value of R8 to make the image as sharp as possible. Varying the voltage at the focusing ring changes the electrostatic focus of the tube. You'll have to experiment with a number of resistor combinations to find the value that produces the sharpest focus. As we said before, 200 megohms is the nominal value and the correct value for your tube is probably within plus or minus 15 percent of that.

Once you've daisy chained the resistors together and soldered them to the imaging tube (see Fig. 5), you have only one more final test to do before you can call it a wrap. Turn out the lights and apply power to the circuit again. What you're looking for here is evidence of high voltage leaks. Those will show up as small sparks or "corona." Note the places where they show up and turn the power off. Wait a second or so for the circuit to discharge, then insulate those areas with high-voltage putty.

Believe it or not, once you've made sure that the focus is as sharp as you can make it, (or is at least acceptable to you), and there's no evidence of corona, the project is completed.

Now we come to the question of the case. You need a focusing lens in front of the tube and a viewing lens at the rear. In order for the front lens to focus a sharp image on the tube's objective, both the tube and the lens have to be on the same axis. And the same conditions apply to the

MEASURING WAVELENGTH

Whenever you're talking about the electromagnetic spectrum, some confusion can arise over the units used to refer to the wavelength of the radiation.

As you move up the spectrum from DC toward daylight, the frequency of the radiation will increase and the wavelength will decrease. Those two measurements are related by "c," the speed of light through: $\lambda = K(f/c)$

where λ is the wavelength, f is the frequency in Hertz, c is the speed of light, and K is a constant determined by the medium through which the radiation is travelling.

Although you can refer to the wavelength in meters, by the time you get up to the visible part of the spectrum, the wavelengths are pretty small. Green light, for example, has a wavelength of about 550 $\times 10^{-9}$ meters. The two most common units of measurement for the upper reaches of the spectrum are the millimicron (10^{-9} meters) and the Angstrom (10^{-10} meters). The latter is named after the 19th-century Swedish physicist A. J. Angstrom.

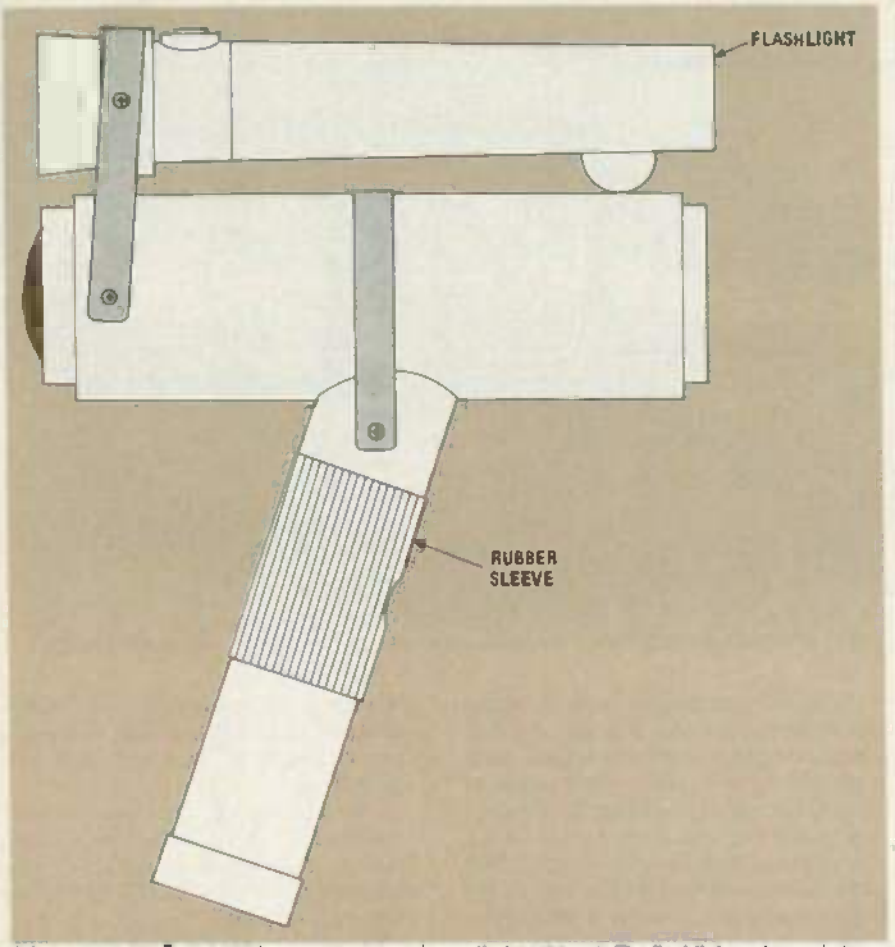


FIG. 6—THOUGH THE CASE is not critical, here is one that works well. The flashlight at the top is fitted with an infrared filter for use as a source of infrared light.

viewing lens at the rear. The easiest solution to the problem is to use a piece of tubing to hold the whole assembly. PVC tubing is perfect for that purpose.

A length of 2½-inch diameter PVC will hold the imaging tube if you shim the ends with 2⅛-inch tubing. The same 2⅛-inch tubing can also be used to mount the front and rear lenses. Use set screws to hold the 2⅛-inch tubes inside the main PVC enclosure.

One appropriate case is shown in Fig. 6. The optics in that unit are encased as just described. The PVC handle contains the power supply board and the battery. Once the board is mounted, cut a hole out over S1 so that it can be conveniently pressed. To prevent accidental contact with the board, slide a flexible rubber sheath (a section from an old bicycle tire inner tube will do) over the handle so that the hole is covered.

Note that there is nothing critical about the case. When designing and building a case for your unit, the only precaution is to make sure that no extraneous light can leak inside the tube, because that will degrade the quality of the image. Black tape or putty can take care of any light leaks.

Once you have the viewer assembled, you're ready to explore the world of infrared light. It's interesting, and somehow reassuring, to watch a television remote control. Yes, they really do put out bright flashes of previously invisible infrared. If you put an infrared filter in front of a flashlight, you'll be able to see in the dark by using the flashlight and peering through the viewer. (You'll note that the unit shown has such a flashlight mounted on it. That flashlight serves as an infrared light source. Also note that once the infrared filter is in place; the light emitted by the flashlight can not be seen by the naked eye.) Deep infrared filters are expensive but a piece of unexposed but developed Kodachrome will do almost as well. Use the ends that come back in the box along with your developed slides.

Infrared energy is also produced by heat. You can prove that by getting a steam iron nice and hot and putting it next to a piece of newspaper. Turn out the lights, look through the viewer, and you'll be able to read by the heat of the iron.

As to the quality of the image you see using the viewer, there are two limiting factors. Those are the "brightness" of the infrared source, and the quality of the optics used.

Turning first to the brightness of the source, the unit shown uses a common flashlight as described. That should be sufficient in most cases. If not, a brighter source of light can be substituted, as long as an infrared filter is used as outlined above.

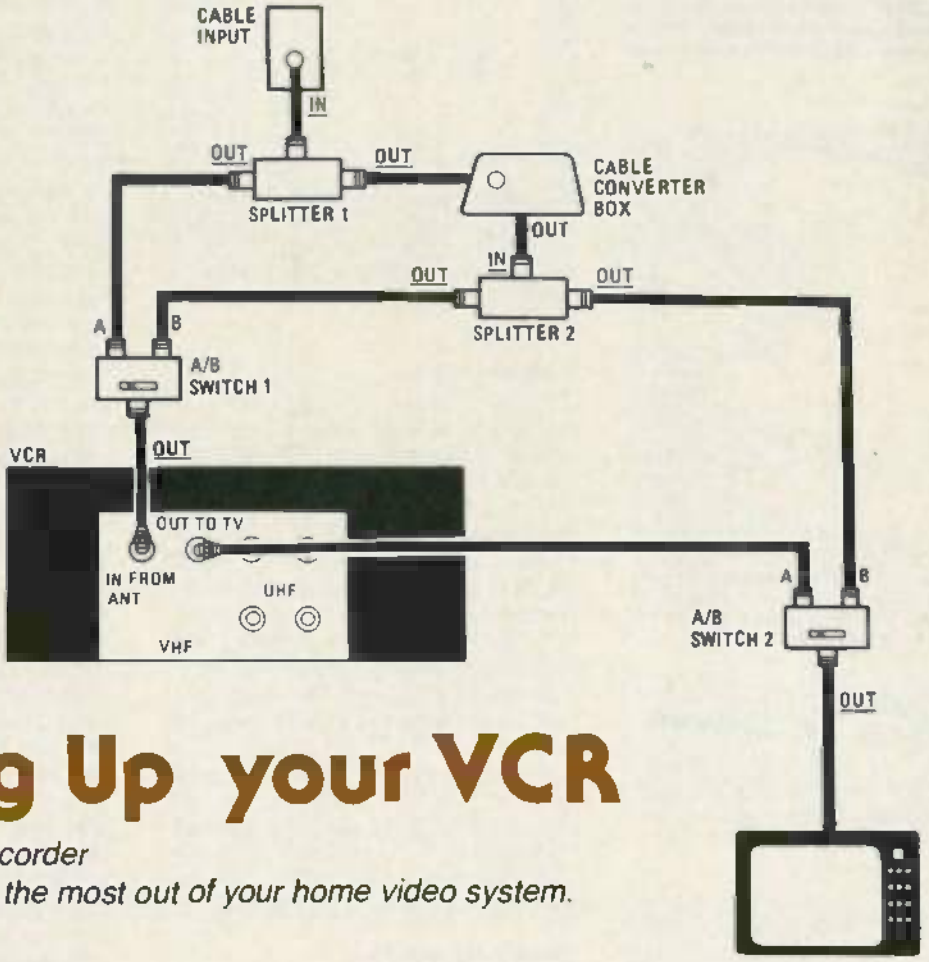
The optics (lenses) are much more critical. The standard optics supplied with the kit offered by the source mentioned in the Parts List are adequate for most hobbyist applications. If you require images with more sharpness and clarity, however, you will need to use higher quality, and more expensive lenses. Such lenses are also available from the source given in the Parts List.

The uses of infrared imaging are endless and eye opening. If you want to find out more about the subject, Kodak publishes a wonderful booklet called "Applied Infra Red Photography." Write to **Kodak**, Consumer Markets Division, Rochester, NY 14650. **R-E**

PARTS LIST

All resistors ¼ watt, 10% unless noted
R1—10,000 ohms
R2—1000 ohms
R3—4700 ohms
R4, R5—100 ohms
R6—100,000 ohms, potentiometer
R7—2200 ohms
R8—200 megohms, see text
R9—2000 megohms, see text
Capacitors
C1—10μF, 25 volts, electrolytic
C2—1μF, 400 volts, electrolytic
C3—1μF, 25 volts, electrolytic
C4—.001μF, 15 kV, ceramic
Semiconductors
Q1, Q2—2N2222 NPN transistor
Q3—2N2646 FET transistor
D1, D2—1N4002
D3–D8—1N4007
D9—MX200EP, 20-kV diode
SCR1—C107D
Other components
B1—9-volt nickel cadmium battery
S1—SPST, momentary pushbutton, normally open
T1—12 to 400 volts, 10kHz switching transformer
T2—11 kV pulse transformer, 400-volt primary
Miscellaneous: 6032 image tube (RCA), PC board, PVC tubing for case, focusing and viewing lenses, battery clip, flashlight, wire, solder, etc.

The following are available from Information Unlimited, PO Box 716, Amherst, NH 03031: Complete kit, including case and basic lenses, but minus the 6032 image tube, $99.50; 6032 image tube, $49.50; assembled and tested unit $199.50; power board kit $34.50; assembled power board, $49.40; T1 alone, $14.50; T2 alone, $15.50; D9 alone, $2.50; C4 alone, $3.00; optional 75mm telephoto focusing lens with iris adjustment and C-mount, $125.00; optional 50mm wide-angle focusing lens with C-mount, $95.00.



Hooking Up your VCR

Hook-up that video recorder the right way, and get the most out of your home video system.

CARL LARON
ASSOCIATE EDITOR

SO, YOU FINALLY BROKE DOWN AND bought yourself a VCR. Now that it's home, uncrated, and set up on a stand, it is time to hook it up to your antenna or cable system, and your TV. Sounds like a simple enough task, and maybe it is.

But then again, maybe it is not. That's especially true when you are dealing with cable-TV setups. Unless a cable-TV setup is wired correctly, you will lose one of the most attractive benefits of VCR ownership—the ability to watch one channel while recording another.

Finally, keep in mind that the VCR has a built in RF modulator. That, in essence, is a miniature TV transmitter. Thus, if the VCR is hooked up incorrectly—that is, its output is connected directly to a TV antenna—the output may very well be broadcast to your neighbors. That, of course, is a violation of FCC rules. And, it might get your neighbors annoyed if they don't care for your choice in programming.

In this article, we are going to show you the ins and outs of VCR hookups, ranging from the most simple to the very complicated. When we deal with cable hookups, both cable-ready and non-cable-ready, TV's and VCR's will be covered.

Tools of the trade

As with any other job, there are certain "tools" you will need to get things done right. In VCR hookups, those tools consist of the various cables, adapters, splitters, and switches that an installation might call for.

Figure 1 shows the two types of cable you might need. In Fig. 1-*a*, a length of 75-ohm coax cable is shown; in Fig. 1-*b*, a length of 300-ohm twin-lead is shown.

The coax is used to connect the VCR's 75-ohm VHF output terminal to the set. While most newer sets are provided with a 75-ohm cable input (F-connector), many still use the familiar 300-ohm, two screw-terminal inputs, for use with twin lead. In such cases, the coax must be terminated with a 75-ohm-to-300-ohm adaptor, such as the one shown in Fig. 2.

Most VCR's use 300-ohm two screw-terminal outputs for the UHF-out connection. As such, it is most convenient to use standard twin lead to route a UHF signal from the VCR to the TV.

For the most part, twin lead is also used as the lead-in wire from the antenna to the set. To adapt the twin lead for connection to a VCR's 75-ohm input, a 300-ohm-

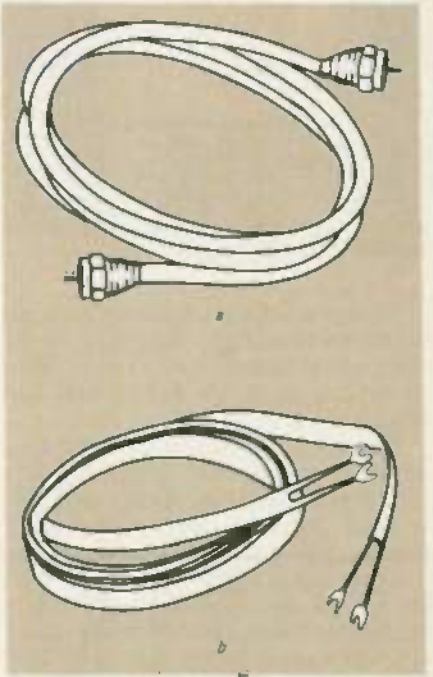


FIG. 1—TWO TYPES OF CABLE might be used in a home video setup. Those are 75-ohm coaxial cable, shown in *a*, or 300-ohm "twin-lead", shown in *b*.

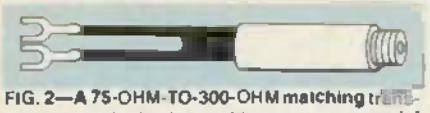


FIG. 2—A 75-OHM-TO-300-OHM matching transformer or adaptor is used to connect a coaxial cable to the antenna input terminals at the back of a TV set.

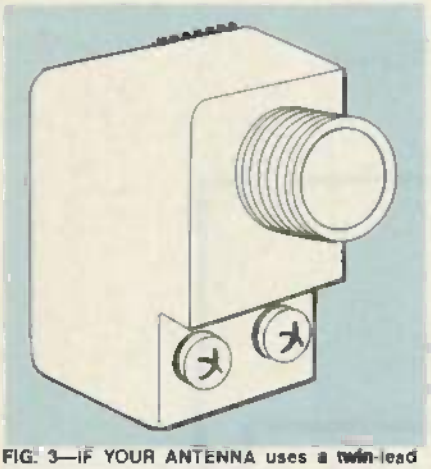


FIG. 3—IF YOUR ANTENNA uses a twin-lead down-lead, a 300-ohm-to-75-ohm adaptor is used to connect the down-lead to the VCR's 75-ohm antenna input terminal.

FIG. 4—AN ANTENNA BLOCK is used to splice two lengths of twin-lead together.

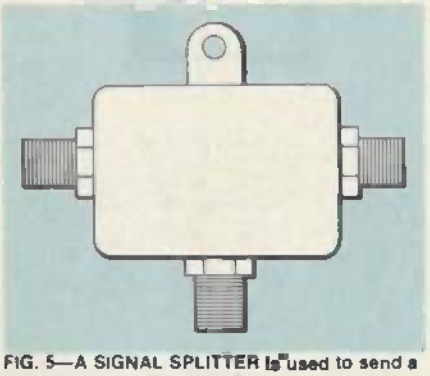


FIG. 5—A SIGNAL SPLITTER is used to send a signal to two different devices.

to-75-ohm matching transformer, such as the one shown in Fig. 3, is needed. Note that some installations use 75-ohm coax for the down-lead. In those set ups, no adaptor is needed.

There are a few other pieces of equipment that, in many cases, will prove valuable. Figure 4 shows an antenna block. It is used to splice two lengths of twin lead together. Figure 5 shows a splitter. That device is used to "split" a signal so that it can be fed to more than one device. And, finally, Fig. 6 shows an A/B switch. That is a two-position switch, used with 75-ohm coax. It is used to select between two signals or two devices.

And now on to the installations!

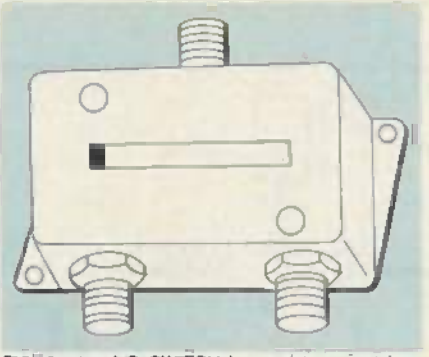


FIG. 6—AN A/B SWITCH is used to select between two different signal sources.

A simple start

Figure 7 shows just about the most basic of our VCR installations. It involves simply an antenna with a 75-ohm coax down-lead, a VCR, and a TV set. The down-lead is connected to the antenna-input terminal on the VCR. A length of 75-ohm coax is run from the VCR's VHF output to the TV's VHF input. If the TV does not have a 75-ohm coax VHF input, a 75-ohm-to 300-ohm transformer must be used between the cable and the set.

If your antenna uses a twin-lead down-lead, the down-lead must be terminated in a 300-ohm-to-75-ohm adaptor before it is connected to the VCR. For UHF reception, the twin-lead down-lead from the antenna is attached to the UHF input terminals on the VCR and a length of twin lead is run between the VCR's UHF output terminals and the TV's UHF input.

Cable Installations

In the balance of this article, we'll turn our attention to the various cable installations that you might run into.

In cable installations, it is important to consider whether or not the set involved is "cable ready," and whether or not there are any premium channels (in cable-TV terminology, premium is another word for scrambled). Keep in mind that cable-ready sets are not capable of descrambling the premium services. For that you need a cable-company supplied descrambler, which is usually integrated with a conversion box. Cable-ready sets are good for viewing unscrambled services, and are handy to have in some of the more complex cable installations; that's because, as we'll soon see, they eliminate the need for a second conversion box.

As you might have gathered from the foregoing, descramblers and converters are not the same thing. Let's see what each is, and how they differ.

Early cable systems were capable of only supplying 12 channels of programming. That's because a standard television tuner is capable of receiving only 12 discrete frequencies in the 54–300 MHz VHF band. Granted, if UHF frequencies were used, an additional 68 channels of programming might be available. But, due to the high line losses at those frequencies (remember, it is *cable* TV we are talking about here), the use of UHF was impractical. In fact, if a cable system wanted to provide a UHF-TV station, it would have to downconvert the signal and send it out over the cable system on a VHF channel.

To add more channels of programming, cable operators resorted to the use of a converter box. A converter box is essentially an external tuner. It allows the selection of the frequencies "between" the channels. The selected frequency is then converted to a single VHF channel (usu-

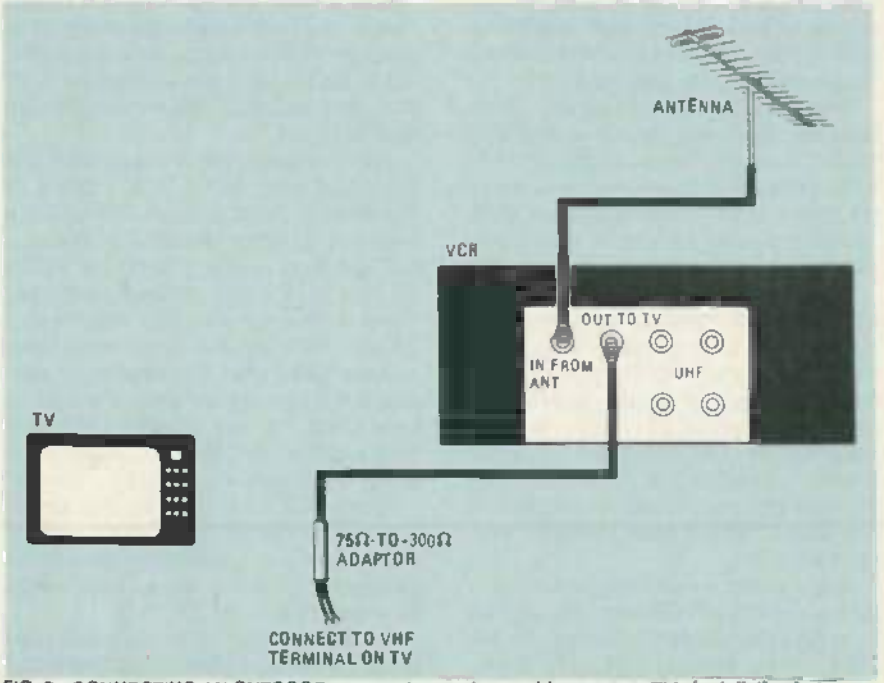


FIG. 7—CONNECTING AN OUTOOOR antenna to your home video system. This installation is among the most basic.

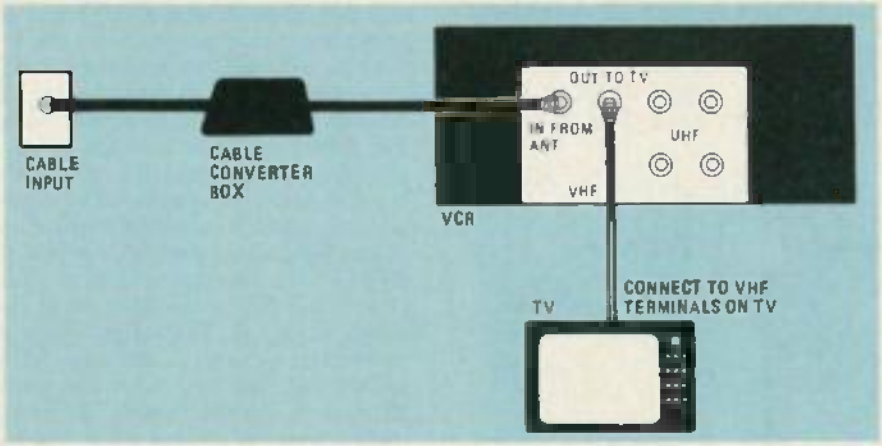


FIG. 8—CONNECTING A CABLE-TV FEED to your home video system. With this setup, you can only record and view the same scrambled or unscrambled signal.

ally either Channel 3 or 4) and fed by the converter to the set. Cable-ready sets are made "cable-ready" by using a tuner of the type found in cable converter-boxes.

Thus, essentially, a converter is a tuner that allows you to receive frequencies that are not available using a standard TV tuner. If the signal on a particular frequency is scrambled, the output of the converter will also be scrambled. That is, unless it is first fed to a descrambler.

Cable companies use many different scrambling/descrambling schemes, and for more information on them, you might want to refer to "Cable-TV Descrambling" in the February 1984 issue of **Radio-Electronics**. For our purposes, the descrambling scheme used is not important, just its result—the delivery of a normal, unscrambled TV signal to your set. For the installations discussed below, we will assume that the converter box in your cable-TV setup incorporates an appropriate descrambler.

Figure 8 shows the simplest cable installation; it allows an owner of a non-cable-ready set to view and record the same scrambled or unscrambled cable channel. (Note that 75-ohm coax is used throughout the installation. The cable signal is delivered from the cable output via that type of feed also. If your TV set does not have a 75-ohm input, you will need a 75-ohm-to-300-ohm adaptor. In all of the following installations, it will be assumed that coax is used, and that the lead to the TV is terminated properly.)

That installation robs you of one of the best features of a VCR—the ability to view one channel and record another. To do that, you need a more complex installation.

Owners of non-cable-ready sets may want to consider the installation shown in Fig. 9. That installation allows you to record one scrambled or unscrambled channel while watching another.

Let's trace that installation out. The signal from the cable system is fed into a two-way splitter. Each output of the splitter is fed into a separate converter box. The output from one box, labeled CONVERTER BOX 1 in Fig. 9, is fed into the VHF input on the VCR. From the VCR, the signal is fed to the TV through the A side of an A/B switch. The output of the second box, labeled CONVERTER BOX 2, is fed, via the B side of the A/B switch, to the set.

To record a scrambled or unscrambled channel, first set the output of the converter boxes to different channels (usually a choice of either Channel 3 or Channel 4 output is provided). Then set the channel selector on the VCR to the output channel selected for CONVERTER BOX 1. Next, select the channel to be recorded on that box. Finally, set the A/B switch to A and turn the TV selector to the output channel of the VCR (once again, that's most likely to be either Channel 3 or 4).

After you are sure that the desired channel is recording, you can switch the VCR output away from the set and view another channel via CONVERTER BOX 2. To do that, set the A/B switch to B. Then set the TV's channel selector to the output channel of CONVERTER BOX 2, and select the channel to be viewed on that converter.

Owners of cable-ready sets can eliminate one of the converter boxes used in the previous installation. That's possible because the cable-ready feature of the set allows you to view an unscrambled signal without the need for additional electronics. The required setup differs from the one in Fig. 9 only in that the converter box located between the splitter and the TV (via the A/B switch) has been removed.

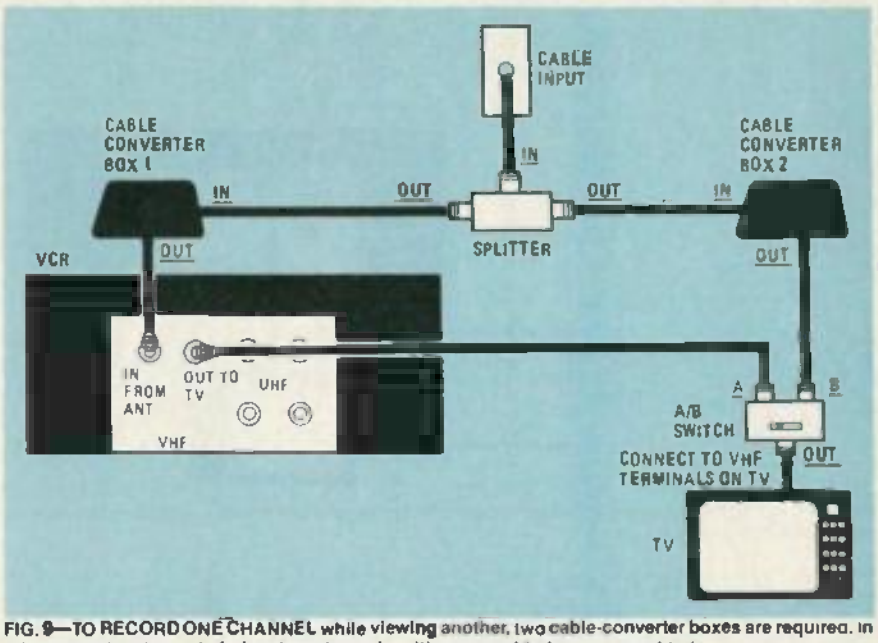


FIG. 9—TO RECORD ONE CHANNEL while viewing another, two cable-converter boxes are required. In this setup, the channels to be viewed may be either scrambled or unscrambled.

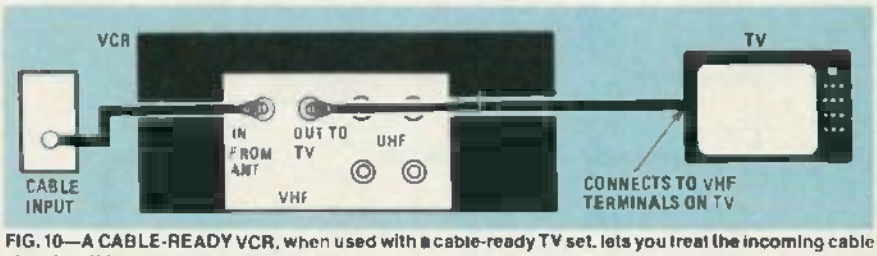


FIG. 10—A CABLE-READY VCR, when used with a cable-ready TV set, lets you treat the incoming cable signal as if it were an over-the-air one.

Cable-ready VCR's

In addition to cable-ready sets, many of the VCR's now on the market also feature cable-ready tuners. The following examples show some typical installations using that type of VCR.

If you do not wish to receive or record scrambled channels, a cable-ready VCR,

when used in tandem with a cable-ready TV set, can eliminate the need for a converter box altogether. Such an installation is shown in Fig. 10. If the TV set is not cable-ready, a converter box must also be installed between the VCR and the set.

That setup allows you to treat the cable signal just as you would an over-the-air one. In other words, all of the VCR's features, such as programability (the feature that allows a VCR to be preset to record one or more programs at some future time and date) and the ability to watch one channel while recording another, are retained. In fact, that setup is the only one that allows the VCR to retain its programability when used with a cable feed.

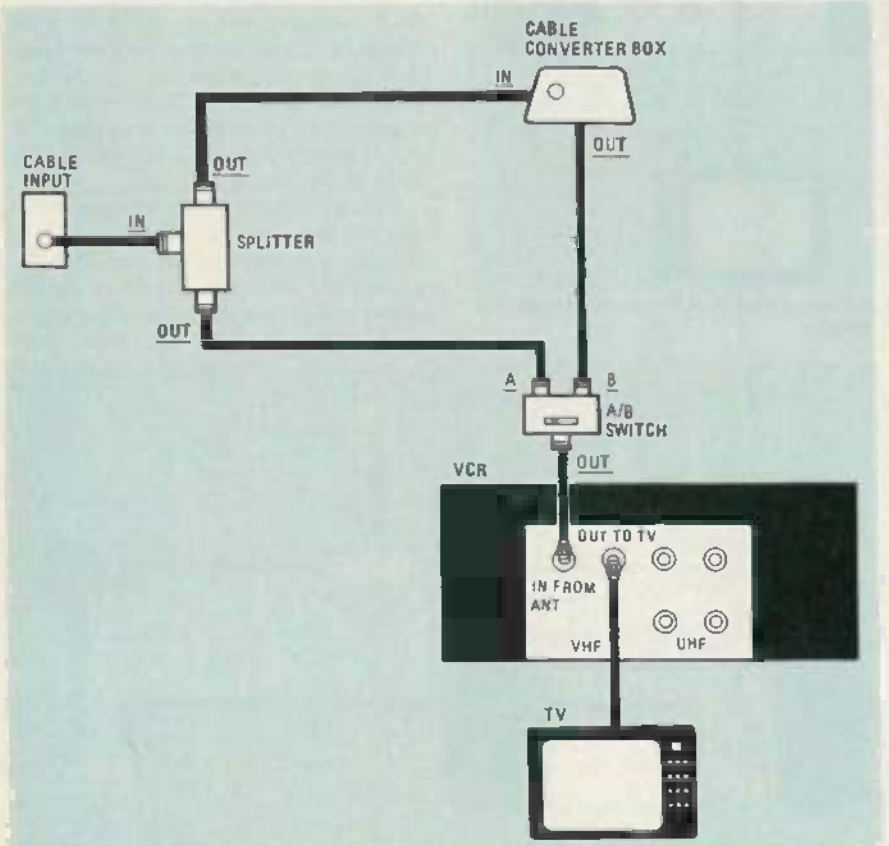


FIG. 11—THIS SETUP lets you record an unscrambled channel while viewing another scrambled or unscrambled channel.

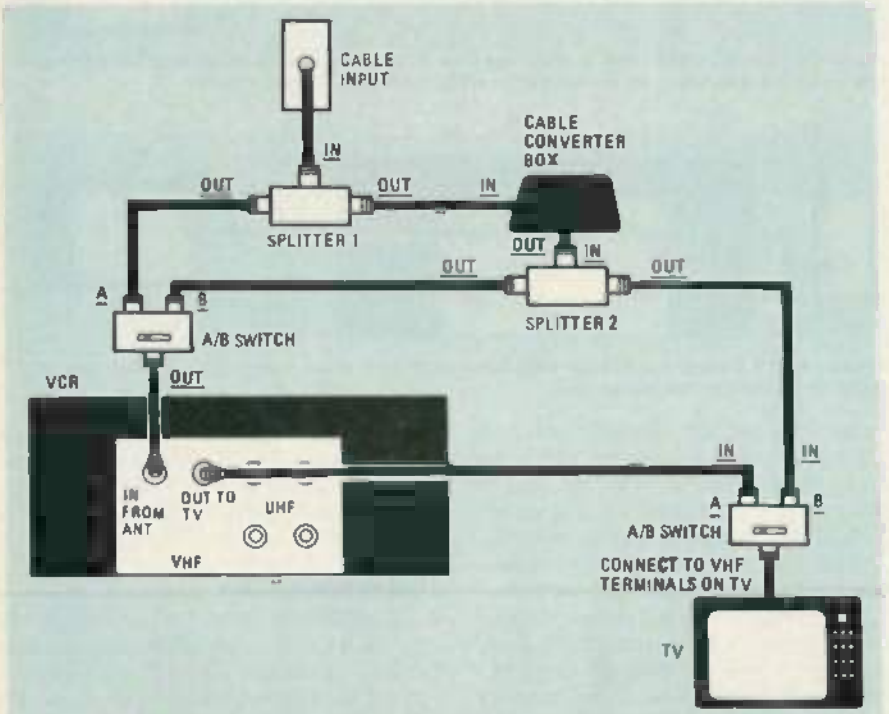


FIG. 12—THIS SETUP allows an owner of a cable-ready VCR and a non-cable-ready set to record and view the same scrambled channel, or to record an unscrambled channel while viewing a different scrambled or unscrambled channel.

As should be obvious by now, if you wish to record a scrambled channel, a descrambled signal must be provided to the VCR. That means placing the converter box just before the VCR input, as shown in Fig. 11. That setup, which is intended for use with a cable-ready VCR and set, will allow you to record and view the same scrambled channel, or record one unscrambled channel while viewing another.

Our last example deals with a cable-ready VCR and a non-cable-ready TV set. That installation, shown in Fig. 12, allows you to record and view the same scrambled channel, or to record an unscrambled channel while viewing a different channel that is either scrambled or unscrambled.

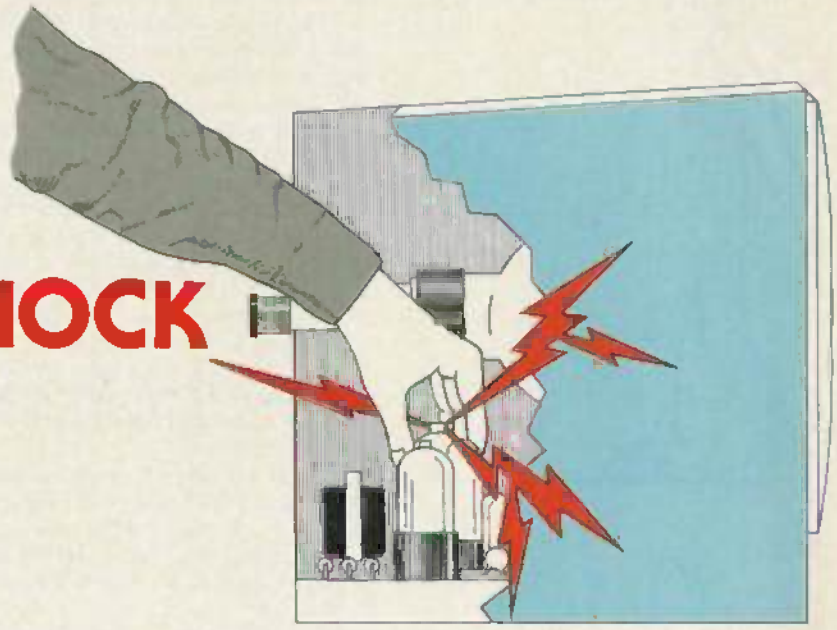
Let's trace that installation through. The cable input is first fed to SPLITTER 1. One output of that splitter is fed to the VCR via A/B SWITCH 1. The other output of the splitter is fed to a converter box. The output of the converter box is fed to SPLITTER 2. One output of that splitter is fed to the VCR via A/B SWITCH 1, while the other output is fed to the TV set via A/B SWITCH 2. The output of the VCR also is fed to the set via A/B SWITCH 2.

To record and view the same scrambled channel, first set A/B SWITCH 1 to B and A/B SWITCH 2 to A. Then, select the channel to be recorded and watched on the converter box, set the VCR to receive the output channel of the converter box, and set the TV to receive the VCR's output channel.

To record an unscrambled channel while watching another channel that is either scrambled or unscrambled, set both A/B switches to A. Select the channel to be recorded using the VCR's tuner. Once you've verified that the proper channel has been selected by monitoring it on the TV, set the VCR to record and set A/B SWITCH 2 to B. Set the TV to the output channel of the converter box and use that box to select the channel to be viewed.

There are, of course, many other ways to hook up a VCR system. But the ones we've shown here are among the simplest. Remember that it is best to use as few switches, splitters, and other devices as possible in an installation. That's because each device will cause some, albeit minimal, picture degradation due to their insertion losses. Also, the fewer the switches, splitters, or other devices in a circuit, the fewer the sites for potential problems. Finally, use good-quality components. For instance, a switch with poor isolation is good for little aside from producing headaches. R-E

All About ELECTRIC SHOCK



All about electrical shock, and how it can affect your body.

RAY FISH, Ph.D., M.D.

MOST OF US ARE FAMILIAR WITH THE effects of a mild electric shock—the sharp sting, the tingling sensation. The effects of a severe electric shock, however, can be much more devastating, even fatal. In this article, we are going to take a look at electric shock, and how it does its damage.

All about shock

Put quite simply, electric shock is the passage of a current through the body. The human body, as shown in Fig. 1, can be modeled as a network of resistances. Simply touching a voltage source is not sufficient to cause a shock (see Fig. 2-*a*). That's because, no circuit is completed. For current to flow, another part of the resistance network that is the body must be in contact with a ground or a different voltage level (see Fig. 2-*b*).

To understand more about the effects of shock, it is sometimes more useful to construct more detailed models of the body. Consider the model of an arm shown in Fig. 3. An electric shock that is applied between the hand (R_{SKIN-1}) and the elbow (R_{SKIN-2}) must pass through three separate resistances. That's because, in addition to the resistance presented by the forearm, R_{FA}, the skin surface at the hand and the elbow also resist current flow. And even more complex electrical models of the body are often made. In those models, the body is broken down into more separate parts. The parallel resistances of bone, blood vessels, nerves, and other tissues are modeled by additional resistors. The different ways that high-frequency currents are passed through various tissues can be modeled by using capacitors and inductors. For our purposes, however, the simple models we've shown you thus far are sufficient.

The resistance to current flow at the skin surface depends on a number of factors. The area of contact is important. A flat piece of metal held against the skin will affect the resistance; pushing harder lowers the resistance. You can prove that to yourself by holding onto the leads from an ohmmeter. Holding them loosely will yield a reading of about 50,000 ohms; holding them more tightly will yield a reading of 10,000 ohms.

The surface of the skin is dry compared to lower layers, which causes it to offer a higher resistance. In order to reduce skin resistance, the top dry layer can be partially rubbed off with little discomfort.

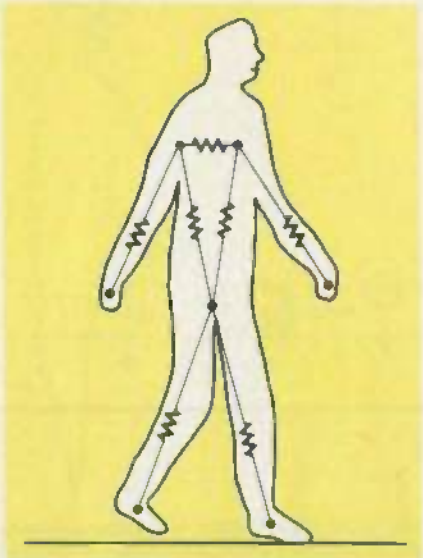


FIG. 1—A PERSON CAN be modeled as a network of resistances.

The skin surface can also be made more conductive by moistening it with water. Electrolyte solutions (such as sweat) are more effective than water in lowering skin resistance.

Those facts are taken into account when designing and using cardiac monitors and defibrillators. Some pre-packaged electrodes have an abrasive area that can be rubbed on the skin before the electrode is applied. The electrode has a relatively large (one square centimeter) surface area, which is covered by an electrolyte-containing electrode jelly.

Defibrillator paddles (a defibrillator is shown in Fig. 4) are used to deliver strong shocks that change the heart rhythm (For more about defibrillators and what they do, see the August 1984 issue of **Radio-Electronics**). The paddle surface area is roughly 50 square centimeters. Medical personnel are taught to apply about 20 pounds of force on each paddle when defibrillating (trying to apply more pressure than that causes some people to lose their balance).

Electrolyte-containing electrode jelly or saline-soaked pads are used to a make uniform electrical connection between each paddle and the skin. Saline pads have the advantage of not leaving a slippery surface that makes chest compressions (CPR) difficult. The jelly may also coat the chest between the electrodes, giving an unwanted current path. Alcohol-soaked pads are not used because they might ignite. If no conductive medium is placed between the paddles and the chest wall, a spark and burns may occur. Even so, chest-wall burns sometimes occur even when proper defibrillation techniques and equipment are used.

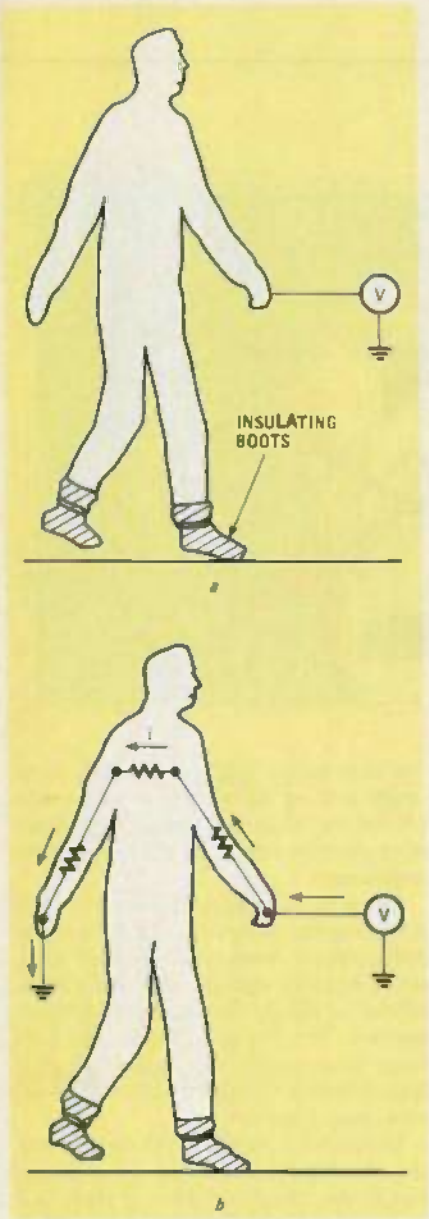


FIG. 2—MERELY TOUCHING a voltage source is not sufficient to cause shock. But when a person comes in contact with two voltage sources of different levels (such as 120 volts and ground), a circuit is completed and current flows.

The effects of electrical shock

As you might expect with current flowing through a resistance, electrical shock causes the heating of tissues. Electrical shock heats body tissues in several ways. A high voltage can give flash burns due to arcing of current through the air to the body. The arcing may even cause your clothing to catch on fire. In either case you end up with a burn.

More commonly, heat is caused by the flow of current through the resistance of bodily tissues. Burns of tissues by electrical current itself often give painless round or oval gray areas with surrounding redness.

The heat delivered to each area of tissue depends on the current flowing in that area and the resistance at that point. In some applications, such as defibrillation, a certain amount of current must be delivered. A large paddle area spreads the current over a surface area sufficiently large that skin burns are usually avoided (though, as noted above, not always).

With uncontrolled shock, burns can be significant. Temperatures up to 3000 degrees Centigrade may be generated. Much of the tissue damage with electrical burns is often under the skin. As such, many major electrical burns look deceptively minor at first. Deep injury to muscle and blood vessels is much more common than with other types of burns (such as those due to hot water and fires).

In addition to burns, electrical shock can have many other effects. Let's look at some of them next.

Contact with alternating (but not direct) current can cause a sustained contraction of muscles. That can prevent the victim from releasing the source of voltage, causing the damage to the body to be much more severe.

Electrical shock can cause death within minutes by stopping breathing or the beating of the heart. Breathing can be stopped by current passing through the respiratory centers of the brain. Electrical current passing through the heart itself can disrupt the heart's normal beating pattern. With severe shocks, such as those caused by lightning, the heart's electrical activity may cease altogether.

In cases where heart activity has been disrupted by an electrical shock, CPR should be performed to keep the brain from dying. When CPR has been performed, there have been reports of victims recovering after even hours of no spontaneous heart or respiratory activity.

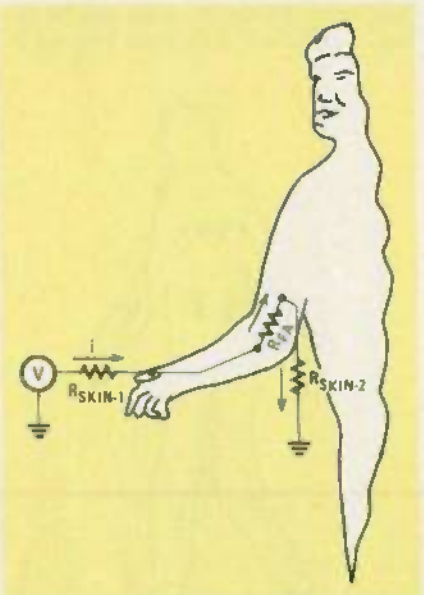


FIG. 3—WHEN A SHOCK is received between the hand and the elbow, resistance is offered by the skin at both the hand and the elbow, as well as by the arm itself.

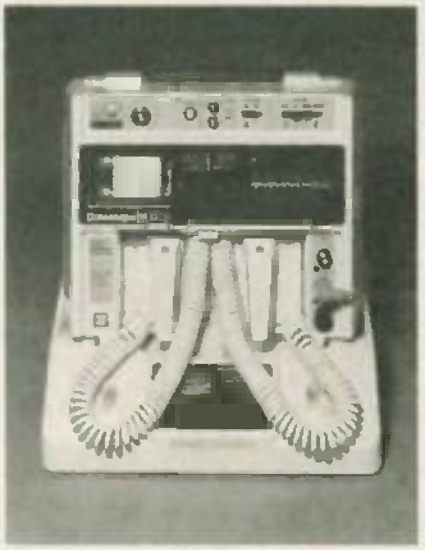


FIG. 4—A DEFIBRILLATOR uses electrical shock to restore a heartbeat to normal.

The nervous system can be directly affected by electrical shock. Paralysis, amnesia, and other conditions all can result from nerve damage.

Kidney damage can occur if an electric current passes through that organ. Kidney damage can also occur if that organ is blocked by large amounts of a chemical (called mycoglobin) that is released from muscle cells that are damaged by the passage of an electrical current.

Finally, large and small blood vessels may bleed or develop clots after electrical shock. That can lead to deeper and more extensive tissue damage than is apparent on initial inspection.

Lightning

Lightning produces all of the above effects, and more. A person hit directly by lightning will, in all likelihood, be killed immediately. People who have been "hit by lightning" and have survived, are those who were fortunate enough to be victims only of a near miss. They were merely close enough to the lightning to receive severe electrical shocks.

If lightning hits a tree (or other object in the ground), a voltage gradient leading from the tree will exist along the ground. A cow standing facing the tree will receive more voltage between its legs than a cow standing with its side to the tree. People lying on the ground may develop burns on areas of the skin that were in contact with the ground. If the burns are not severe, they may resemble light red, fine paintings—small burns may resemble stick figures, while larger ones may look like evergreen bushes with thousands of needles on their branches. In addition to the burns, there may also be transient paralysis or transient loss of vision or hearing.

Serious effects of a lightning "strike" can include severe burns and cardiac arrest.

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Buffer/Converter for your Printer

This buffer is more than just a 64K printer buffer—it's also a parallel-to-serial and serial-to-parallel converter. And you can expand it to program EPROM's, too!

BY BILL GREEN

COMPUTERS CAN CERTAINLY GET THINGS done in a hurry. But when you hook one up to a printer, it can run at an amazingly *slow* speed. There is a way to speed things up, though. By using a printer buffer, you'll be able put your computer back to work even as a 20-page document is being printed.

The buffer we'll describe does a great job of freeing your speedy computer from your comparatively slow printer. But it does a great deal more, too! It's more versatile than standard buffers because it accepts either parallel or serial data from your computer(s), and it outputs that data in either parallel or serial form. So you can interconnect mismatched equipment and avoid the cost of separate adapters and the hassel of swapping cables.

The buffer has some other features not normally found in printer buffers. You can download Z80 machine code to customize its operation if you want special buffer features. You can even use it as a Z80 hardware development system. Plus, with the EPROM programmer option that we'll discuss, you can read, program, and duplicate 2716, 2732, and 2764 EPROM's.

This buffer is truly a universal printer buffer. It is designed to work with all popular computers and printers equipped with Centronics parallel and/or RS-232 serial ports. In addition, it will work directly with the user I/O port of the Commodore *64* and it will convert Commodore's non-standard code so that it can be used with a regular ASCII printer.

The buffer hardware

The schematic of the printer buffer is shown in Fig. 1. As you can see, it is a dedicated application of the Z80 microprocessor (IC1). The Z80 was chosen for its low cost and because it interfaces easily with dynamic RAM (which is mandatory when large amounts of memory are required). The 64K RAM is made up of eight 1×64K dynamic RAM IC's, IC3–IC10.

The Z80 refreshes only 128-cycle RAM IC's. However, because 256-cycle 4164's are generally available for a better price, we added IC17 and IC18 to provide the eighth refresh line (RA7). If 128-cycle RAM's are used, those two IC's can be omitted. If you're not sure what type you have, play it safe and use the two IC's.

The Z80, of course, cannot do anything unless it has instructions to follow. The software instructions for the buffer are stored in IC2, a 2K×8 EPROM. (See the parts list for information on how to order that EPROM.) The EPROM occupies 2K bytes in address area (0000H-07FFH), thus reducing the usable RAM from 64K to 62K. In addition, the area from 0800H-08FFH is reserved for the stack pointer and temporary scratchpad storage. Thus, the total usable RAM is 63,232 bytes.

The 16 address lines are multiplexed onto the RAM address bus (MA0–MA7) by two 2- to 1-line data multiplexers, IC11 and IC12. The timing for the multiplexers, and the generation of the RAS (*Row Address Strobe*) and CAS (*Column Address Strobe*) signals for the RAM are handled by IC13, IC14, IC16, and one half of IC24 as is the generation of the chip-enable signal for the EPROM.

Three of the inverters in IC26, along with the 8-MHz crystal provide the buffered clock for refresh timing. That clock is divided by IC23 to give the 2-MHz clock required by the Z80.

Octal D-type latches, IC19 through IC22, are used for the I/O and status ports. The port-enable strobes are sent from IC25, a 3- to 8-line decoder that is used here as the I/O port decoder. One half of IC24 is wired as an R-S flip-flop. It provides the BUSY signal for the PARALLEL INPUT port when it is strobed by the parallel sending device. The BUSY line is cleared under software control by pin 11 of IC25 (ENABLE 04). Turning to the serial port, we see that IC27 is used as a line driver/receiver for serial I/O.

Switches S1–S4 are read by IC20. The FUNCTION SELECT switches (S1, S2 and S3) are three-position toggle switches that give us 27 possible unique combinations of inputs, outputs, and other functions. We'll explain how to use them shortly. One terminal of each SELECT switch is fed by pin 19 of IC19, which is switched high

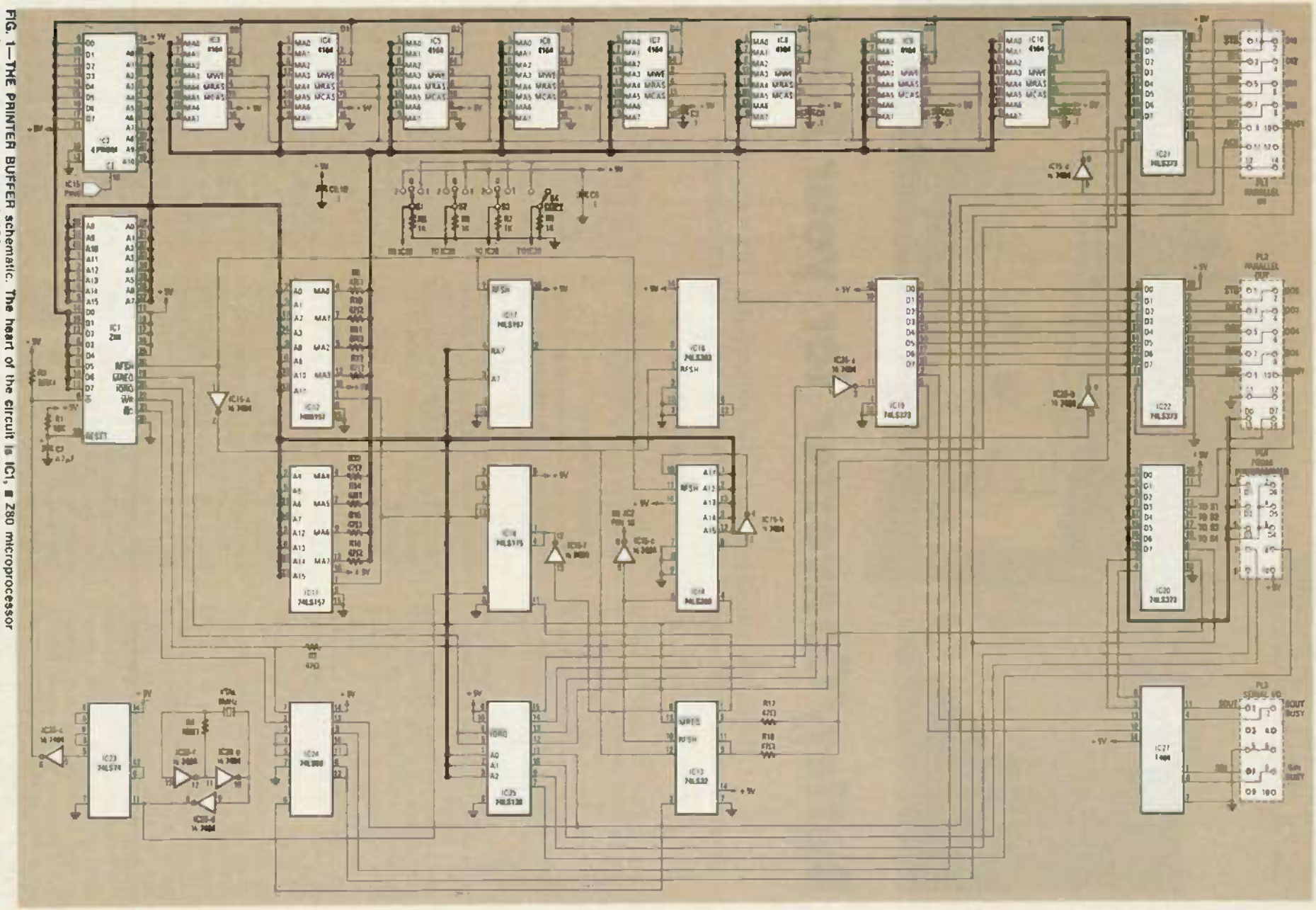


FIG. 1—THE PRINTER BUFFER schematic. The heart of the circuit is IC1, a Z80 microprocessor running the program contained in IC2.

or low by the operating program at the appropriate time.

A power-on reset is provided by R1 and C7. Decoupling of the +5-volt supply is handled by eight .1-μF capacitors, C2–C6 and C8–C10.

Power for the buffer is provided by a simple half-wave rectified supply using a three-terminal IC regulator. The schematic is shown separately in Fig. 2. The AC input is obtained from a wall-mounted 9-volt AC transformer, which is switched by S5 and fused for 1 amp.

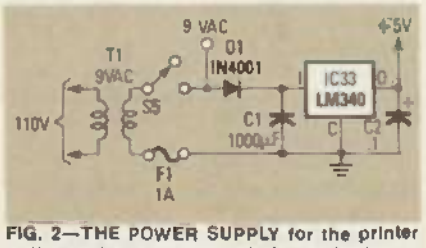


FIG. 2—THE POWER SUPPLY for the printer buffer. Although the supply is on the buffer board, it is shown separately due to space restrictions.

The EPROM programmer

As an addition to the printer buffer, you can build the EPROM programmer/copier shown in Fig. 3. It connects to the buffer board through S01 (and PL2 and PL4 on the buffer board). An octal D-type latch, IC28, latches the high address lines and the program-control lines to the EPROM. Another octal latch, IC22 (on the buffer board), latches the low address lines. The data sent to the EPROM is latched by IC29 and the data read from the EPROM is latched by IC30.

Part of IC31 and Q1, Q2 and Q3 switch the programming voltage V_{PP} on and off at the appropriate times. The seven switches in DIP switch S8 (the eighth switch is not used) are used to configure the programmer for the different types of EPROMS. The 5-to-25 volt converter provides the programming voltage. Since different EPROM's require different programming voltages, S8-g is used to select either 21 or 25 volts.

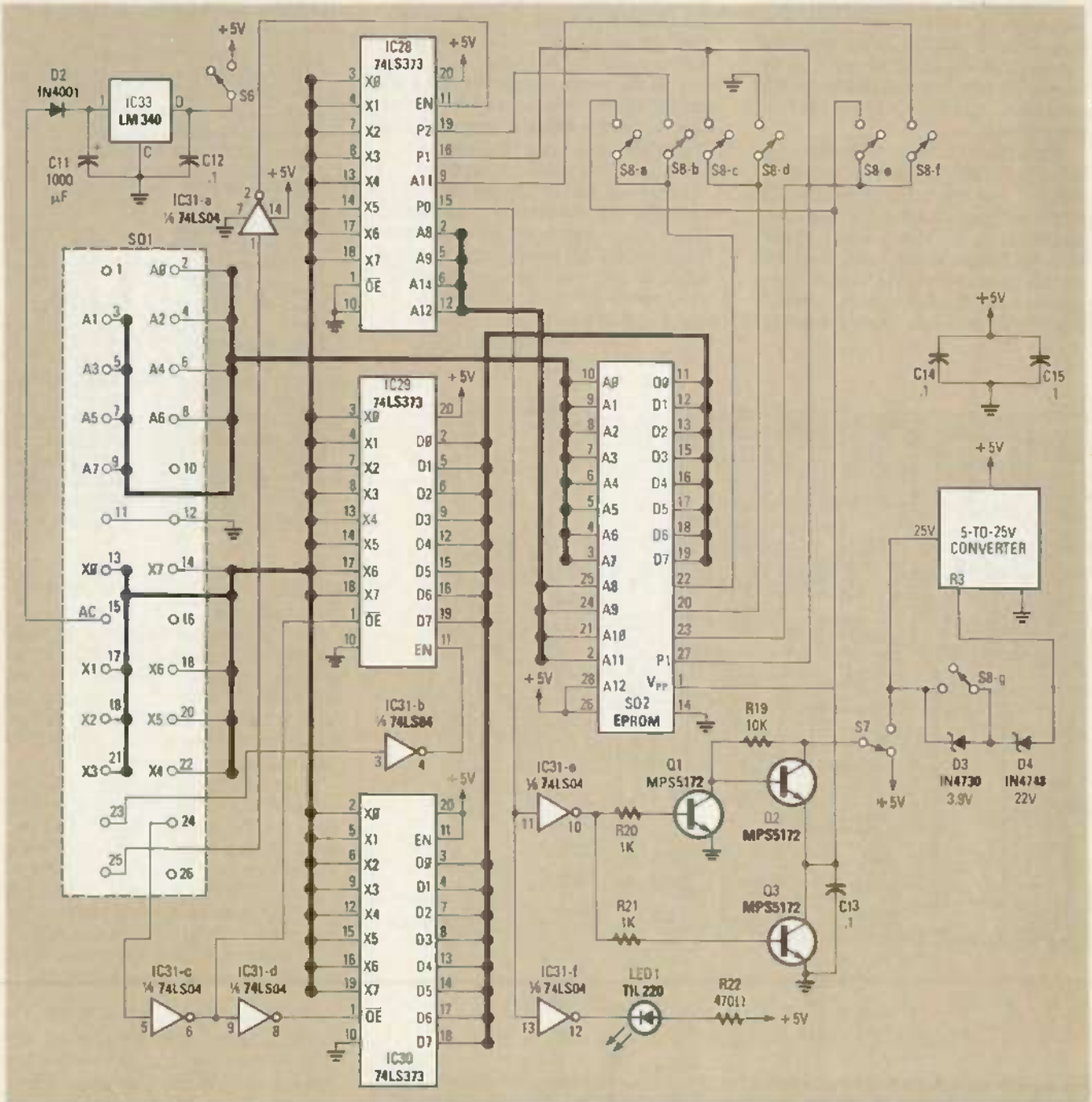


FIG. 3—THE EPROM PROGRAMMER is meant to be used as an extension to the printer buffer. Socket S01 plugs into PL2 and PL4 on the buffer board.

The firmware

As we mentioned earlier, the operating instructions for the Z80 microprocessor are stored as machine code in IC2. While that code is too lengthy to list here, we can describe what it does.

When power is first applied, the stack pointer and the I/O ports are initialized. The FUNCTION SELECT switches (S1–S3) are then read and the selected function is jumped to. In the case of parallel input and output, the data is handled and stored with no modification. The BUSY lines are used for synchronization of data flow. It should be noted that incoming data will be sent to the output device any time the device is ready.

Since internal data is handled in parallel, and serial I/O data must be converted from serial to parallel at the input and converted from parallel to serial at the output. The conversion is done by the Z80 using delay routines based on the baud rate selected.

When the SERIAL INPUT function is selected (we'll tell you just how to select it shortly), the processor raises the $\overline{\text{SIN}}$ BUSY line (ready), reads the SIN line until a start bit (high) is detected. It then sets $\overline{\text{SIN}}$ BUSY low (busy), delays, and so on until 8 bits are stored in the buffer location that is pointed to by the data-in pointer and the stop bits are received. That process is repeated until all of the data has been received. The routine requires one start bit, 8 data bits, and one or two stop bits with no parity bit allowed. As is the case with parallel I/O, data will be sent out as soon as the output device is ready for it.

Serial output is similar to serial input except that the $\overline{\text{SOUT}}$ BUSY line is read until it goes high, indicating that the device is ready to accept data. Then, data are loaded from the buffer location pointed to by the data-out pointer and are sent out one bit at a time on the SOUT line. One start bit, eight data bits, and one stop bit are sent. No parity bit is sent.

While this printer buffer is universal in the sense that it can be used with both serial and parallel equipment, be aware that all serial ports are *not* created equal. That's because the RS-232 standard is not really a standard. For a better explanation of what that means, see Herb Friedman's articles in the October and November 1984 issues of **Radio-Electronics**. Those articles are a good general guide to interfacing serial and parallel equipment.

The DOWNLOAD function allows you to customize the operation of the buffer. When it is selected, the program reads both the serial and parallel input ports for data. (The only baud rate supported on the serial port in this mode is 1200 baud). As data are received, they are loaded into memory. When the COPY switch (S4) is pressed, control is passed to the downloaded program.

If the PROM READ function is selected, address data are sent to the latches on the programmer board. Data are read from the EPROM address selected by the latched address data and sent into the buffer. It may then be read into a computer or used to program a blank EPROM.

Programming an EPROM is similar, except that data is sent to the buffer (1200 baud serial or parallel) and latched onto the EPROM's data bus after the address information. The programming voltage, V_{PP}, is switched on, and 50-millisecond pulses program each datum into the location addressed by the latched address lines. After each location is programmed, the datum at that location is verified.

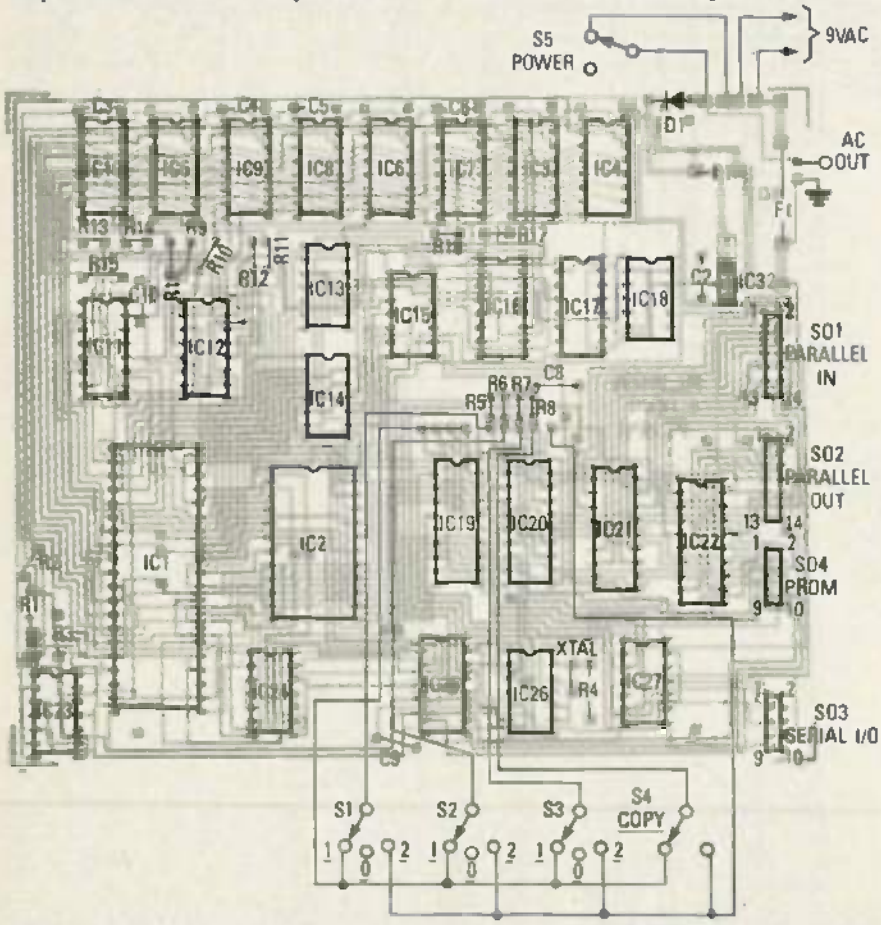


FIG. 4—PRINTER BUFFER PARTS PLACEMENT. Except for the five switches, all parts mount on the board. Most of the resistors are installed "standing up." See the text for information on how to mount the bypass capacitors near the RAM IC's.

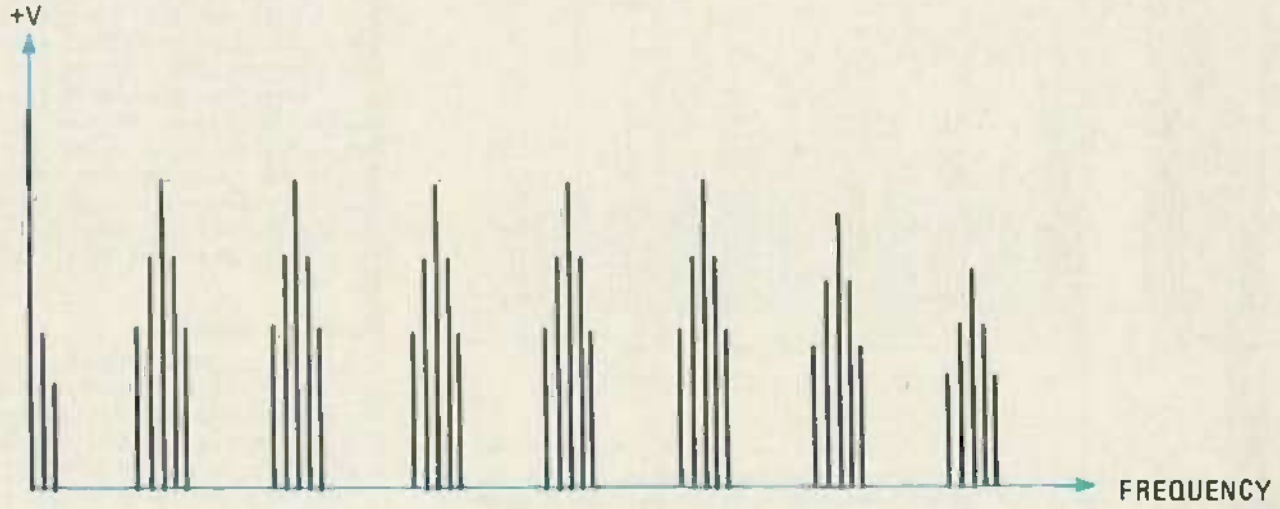
PARTS LIST—PRINTER BUFFER

All resistors 1/4 watt, 5%
R1—10,000 ohms
R2, R9–R18—47 ohms
R3—330 ohms
R4—180 ohms
R5-8—1000 ohms
Capacitors
C1—1000 µF, 25 volts, electrolytic
C2–C6, C8-1C0—0.1 µF ceramic disc
C7—4.7 µF, 12 volts, electrolytic
Semiconductors
IC1—Z80 microprocessor
IC2—EPROM with control software (Alpha 9134t)
IC3–IC10—4164 64K x 1 dynamic RAM
IC11, IC12, IC17—74LS157 quad 2- to 1-line multiplexer
IC13—74LS32 quad NAND gate
IC14—74LS260 dual 5-input NOR gate
IC15, IC26—7404 hex inverter
IC16—74LS175 octal D-type flip-flop
IC18—74LS393 dual 4-bit binary counter
IC19–IC22—74LS373 octal D-type latch
IC23—74LS74 dual D-type flip-flop
IC24—74LS00 quad NAND gate
IC25—74LS138 3- to 8-line decoder
IC27—MC1489 line receiver
IC32—LM340 5-volt regulator
D1—1N4001
Other components
S1–S3—SP3T toggle
S4—normally open pushbutton
S5—SPST toggle
PL1, PL2—14-pin right-angle male header
PL3—10-pin right angle male header
F1—1 amp fuse
T1—10 volts, 1 amp, wall mounted transformer
XTAL—8-MHz crystal
Miscellaneous:—Case (CM6-225, PacTec) heatsink for IC32, fuse clips, wire, mounting hardware, PC board, IC sockets, connectors for your computer and printer, etc.

Assembling the universal buffer

The assembly of the buffer is not very difficult. Just keep in mind the following. When we say "install," we mean that the

(Continued on page 85)



COMB FILTERS for your TV

Learn all about comb filters, how they work, and how they can be used to improve the performance of your video system.

NEIL W. HECKT

COMB FILTERS ARE FREQUENTLY BEING used these days in video systems to separate the chrominance and luminance information from a composite video signal. In this article, we are going to learn more about comb filters and how they operate. We'll also look at an experimental NTSC decoder that you can build. It is used to derive RGB signals from a composite NTSC video input.

In order to understand how comb filters can separate the chrominance and luminance portions of an NTSC composite signal, we first need to understand more about the frequency spectrum of an NTSC composite signal. The NTSC signal is a "sampled data system" with sampling rates at 15734 Hz, 60 Hz, and 30 Hz; that is, the horizontal, field, and frame rates. As a result, the frequency spectrum of the luminance channel consists of a series of carriers spaced 15734 Hz apart, each having sidebands spaced 60 and 30 Hz about them (see Fig. 1). There are, of course, many more sidebands spaced about each carrier at multiples of 60 and 30 Hz than shown in Fig. 1, but for this discussion, the spectrum is simplified.

The frequency spectrum shown in Fig. 1 is for a monochrome signal and consists of the luminance information. For a color signal, in order to keep that signal compatible with the millions of black and white sets on the market, the chrominance information is cleverly "stuffed" into the empty frequencies between each of the luminance carrier and sideband sets (see Fig. 2).

The chrominance information, like the luminance information has a spectrum that consists of a series of carriers spaced 15734 Hz apart, each having sidebands spaced about them. The chrominance carriers, however, are located at frequencies that are precisely midway between two adjacent luminance carriers. (It was not by accident that the color-burst frequency was chosen to be exactly 455 times the horizontal sweep frequency, divided by 2: (455 × 15734)/2 = 3,579,485 Hz. That frequency is exactly 227.5 15734-Hz carriers away from 0 Hz.) Because of that arrangement, the total spectrum of the NTSC signal appears as a neatly interlaced set of luminance and chrominance carrier/sideband sets. There are, of course, many more of those carrier/sideband sets than shown here.

In a typical color-TV set, the chrominance information is separated from the luminance information by passing the composite spectrum through a chroma bandpass filter. That effectively removes all luminance information outside the passband; however, the luminance information that is within the passband remains (see Fig. 3).

Similarly, the chrominance informa-

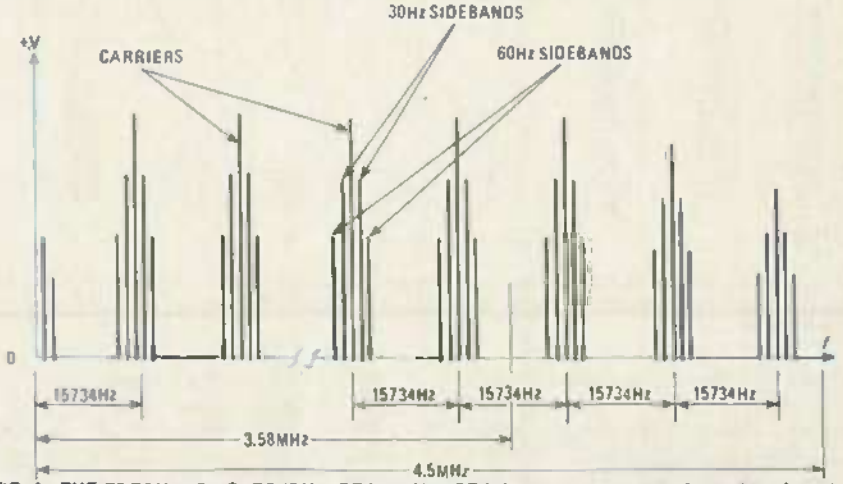


FIG. 1—THE FREQUENCY SPECTRUM OF LUMINANCE information consists of a series of carriers spaced 15.374 Hz apart, each having sidebands at 60 and 30 Hz on either side.

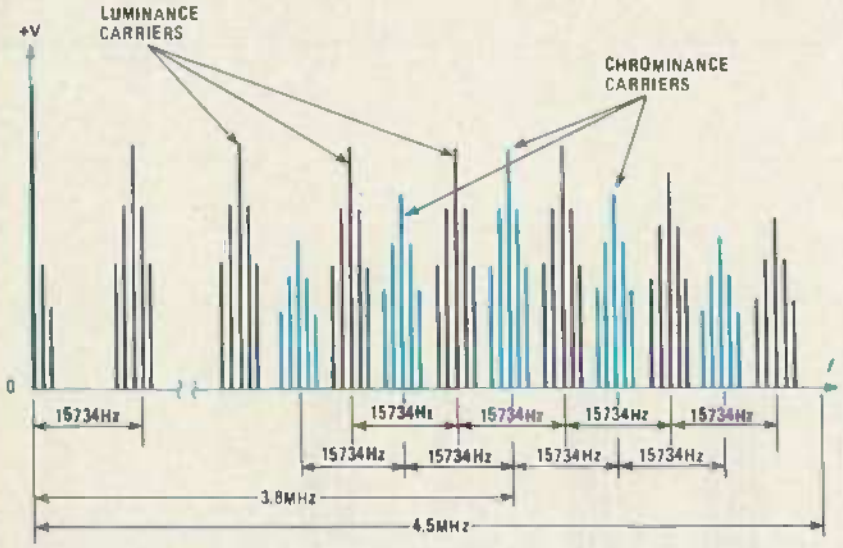


FIG. 2—IN ORDER TO ENSURE COMPATIBILITY with black-and-white TV sets, the chrominance information is located in the empty frequencies between each of the luminance carrier and sideband sets.

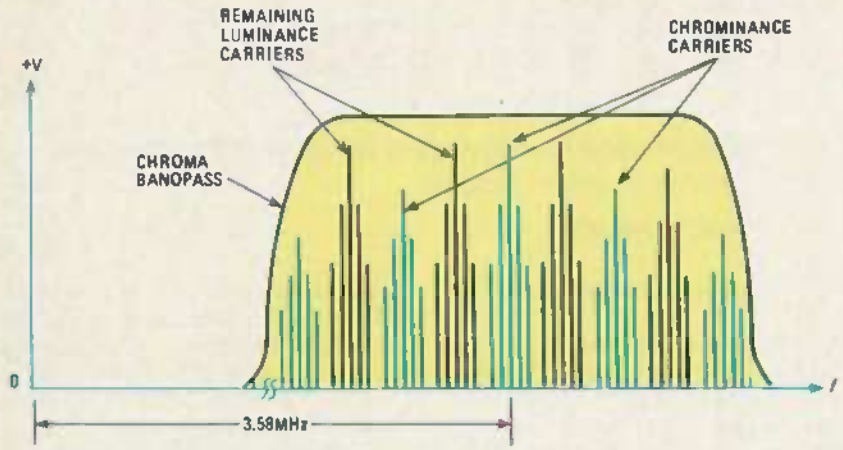


FIG. 3—USING A BANDPASS FILTER removes the luminance information that falls outside of the passband, but the luminance information that falls within the passband is not affected.

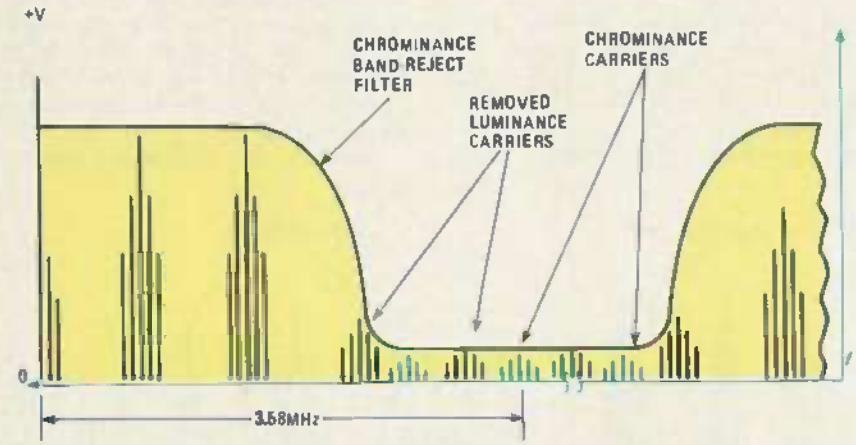


FIG. 4—USING A NOTCH FILTER to remove chrominance information also results in the removal of some of the luminance information. The lost luminance information consists of much of the fine detail of the picture.

tion is removed from the luminance information by passing the composite spectrum through a band-reject (notch) filter. That effectively removes the chrominance, but also removes some of the luminance information (see Fig. 4). That removed luminance information contains much of the fine detail of the picture.

As should be obvious, then, an ideal luminance filter would be one that passes all of the luminance information and rejects the chrominance (see Fig. 5). An ideal chroma filter would be one that passes all of the chrominance information while rejecting the luminance (see Fig. 6). Such a filter would have a characteristic that would look somewhat like a comb; hence they are called *comb filters*.

The comb-filter characteristics shown in Figs. 5 and 6 are greatly simplified. In fact, each of our luminance and chrominance filters would have about 280 teeth (nulls) in each comb. In addition, the chroma comb nulls would be offset 7867 Hz (15734/2) away from the luminance filter nulls.

Building a comb filter

Such a filter can be designed around a delay line. The delay time of the line must be equal to the period of the spacing between the teeth of the comb. For NTSC television, the period must be 1/15734 Hz = 63.5566 µs, and that delay time must be very precise.

A simplified block diagram of a comb filter is shown in Fig. 7; let's see how that filter works.

Since the delay of the line is exactly 1/15734, it will store exactly one cycle of a 15734 Hz sinewave. At 15374 Hz, the output of the delay line will be in phase and equal in amplitude to the input signal. Since both the input signal and the output of the delay line are fed to the Y (luminance) channel "adder," the amplitude of the output of that adder at 15374 Hz will be twice that of the input signal. That constitutes a peak in the filter response at 15734 Hz. Similarly, the C (chrominance) channel "subtractor" also sees two equal-amplitude in-phase signals at 15374 Hz. The C channel subtractor will thus produce zero output. That constitutes a null in the filter response at 15734 Hz.

At 7867 Hz (15734/2), the delay line will have one half cycle stored in it. The output from the delay line is, at that time, 180 degrees out-of-phase with the input signal. That will cause the Y-channel adder produce a zero output (null), while the C-channel subtractor will generate a signal that has twice the amplitude of the input signal (peak).

At 31468 Hz (15734 × 2), the delay line stores two cycles, causing an identical effect as one cycle—a peak in the Y-channel filter characteristic and a null in the C-channel filter characteristic. At 1-½ times 15734 Hz (23601 Hz), an effect identical to the half cycle effect causes a null in the Y channel and a peak in the C channel.

Thus, for every integer multiple of 15734 Hz, a peak is produced in the Y channel, and a null is produced in the C channel. At every integer multiple of 23601 Hz, there is a null in the Y channel and a peak in the C channel.

The filter we've just described is actually a little too good since it "combs" all the way from 0 to 4.5 MHz, and our desir-

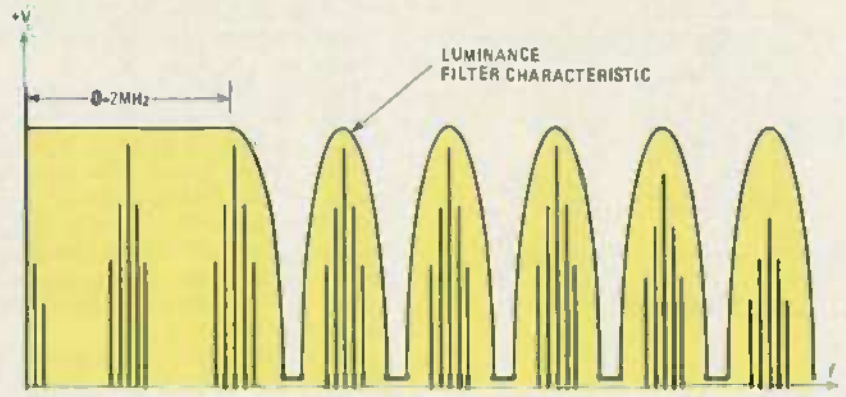


FIG. 5—AN IDEAL LUMINANCE FILTER would be flat to about 2 MHz, then comb every 15,734 Hz to 4.5 MHz.

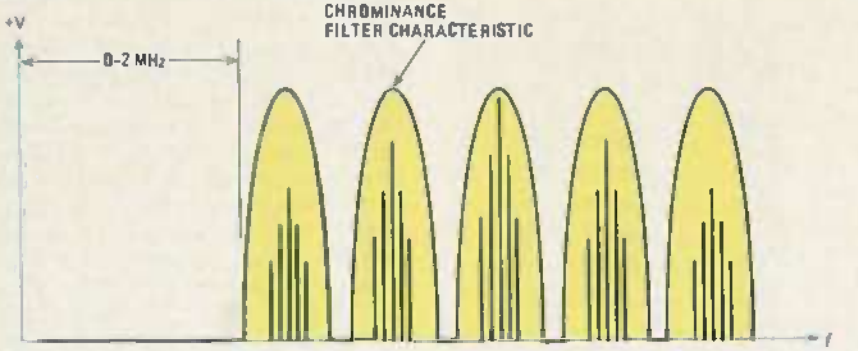


FIG. 6—AN IDEAL CHROMA FILTER would have zero response to about 2 MHz, then comb every 15,734 Hz to 4.5 MHz.

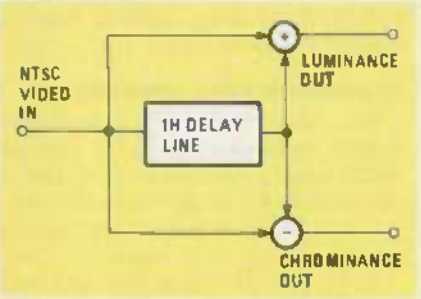


FIG. 7—A BASIC COMB FILTER can be built around a 1H-delay line. One drawback to the filter shown here is that it combs from 0 Hz.

ed response is to be flat in the first 2 MHz of the Y channel, and to have zero response in the first 2 MHz of the C channel. The reason we want flat response to 2 MHz in the luminance channel is because much of the low-frequency information (which represents horizontal line-to-line luminance differences) will otherwise be removed by the comb filter.

Figure 8 shows a more practical configuration for our filter. As is shown in that block diagram, the Y channel can be made essentially flat for the first 2 MHz by adding the first 2 MHz of the C channel to the Y channel. Since there is a peak in C for every null in Y, they tend to cancel out when added.

A 2 MHz lowpass filter in the C channel passes the first 2 MHz of the chrominance signal, which is then added back to the Y channel. That creates a Y-filter characteristic that is essentially flat from 0 to 2 MHz, with combing from 2 to 4.5 MHz. The 4.5-MHz lowpass filter sets the Y-channel's upper passband edge at 4.5 MHz, which is just below the audio channel. Meanwhile, a 1-MHz bandpass filter in the C channel, centered at 3.58 MHz, restricts combing to just the chrominance frequency band.

The RCA PW600 module

The delay line used in the experimental comb filter NTSC decoder about to be described is part of an RCA PW600 module (see Fig. 9), which is used in some recent RCA color TV models. (For a schematic diagram of that module, see Howard W. Sam's Photofact Set 1945, folder 2, RCA chassis CTC101A, 1981 production.) The PW600 also contains some vertical detail enhancements.

The difficult part of any comb filter is the 1H delay line which, as mentioned earlier, must be very precise. The one onboard the PW600 is a sophisticated device; it is a charge-coupled analog shift register of 683 ½-stages. The delay introduced by the shift register is purely a function of the frequency of the applied shift clock and number of stages. When a shift frequency of three times the color burst frequency (10.74 MHz) is used, the total delay is exactly 1H.

A charge-coupled shift register consists of a series of switches and storage capacitors. On each shift (or clock) signal, the charge of any particular capacitor is transferred to the next capacitor in line. The first capacitor in the device, of course, gets its charge from the applied input voltage. The process is very similar to the old "bucket brigade" used for fire fighting. Each person holds a bucket. The bucket of the first person in line is filled to some level. That person then empties his bucket into the bucket of the next person in line. The next person then empties his bucket into the bucket of the third person in line. Meanwhile, the first person has refilled his bucket and is ready to empty it into the bucket of the second person. That process is carried on continuously with the last person emptying his bucket on the fire.

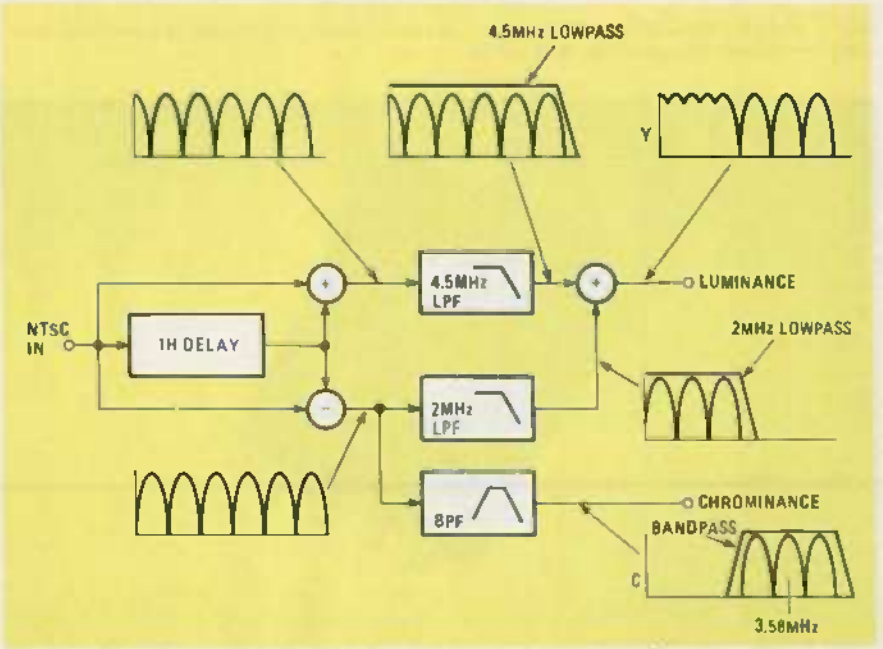


FIG. 8—A PRACTICAL COMB FILTER. In the luminance channel, this filter will have nearly flat response to 2 MHz; in the chrominance channel, this filter will have zero response to 2 MHz.

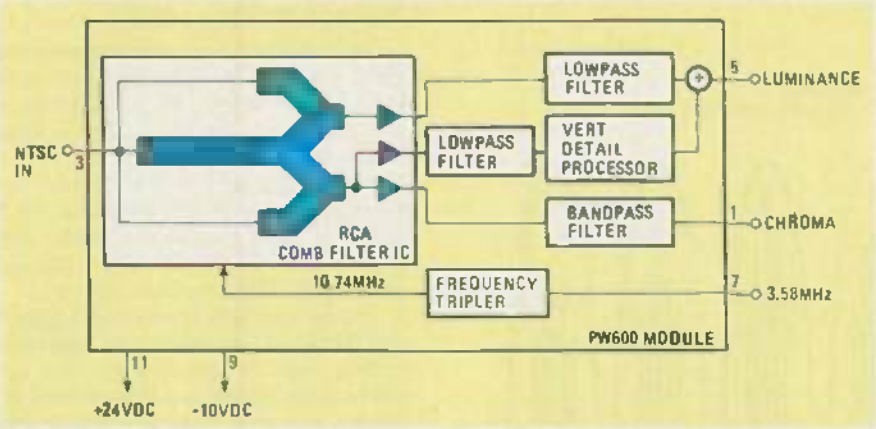
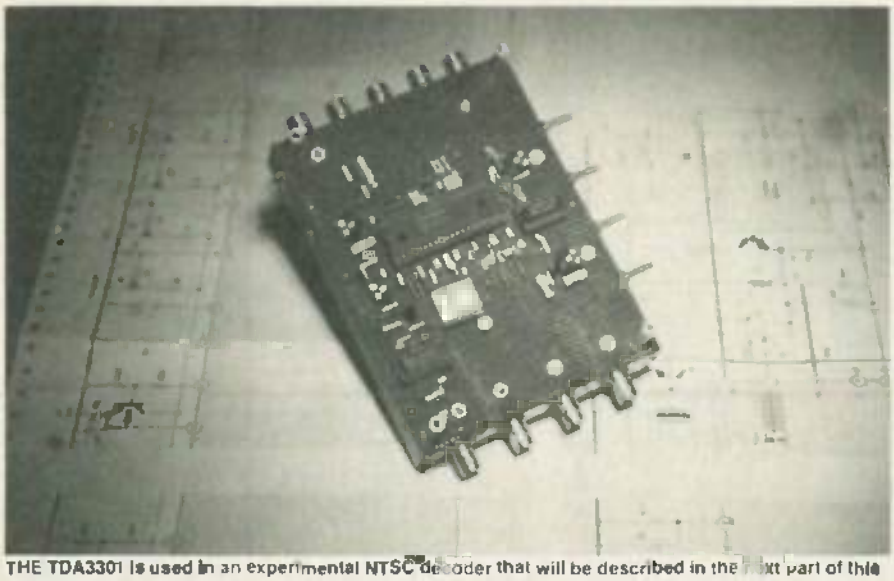


FIG. 9—THE PW600. This RCA module contains all of the components of our basic comb filter.

FIG. 10—PINOUT OF THE TDA3301. This Motorola IC contains everything needed to convert luminance and chrominance information into RGB signals.



THE TDA3301 is used in an experimental NTSC decoder that will be described in the next part of this article.

That similarity of charge-coupled devices to the old bucket-brigade has caused them to be called "bucket-brigade" devices as often as not.

The delay-line IC used in the PW600, also contains the adder and subtractor. Thus, it is essentially the basic comb filter we spoke about earlier. The remaining circuitry of the PW600 is the 4.5 MHz and 2 MHz lowpass filters, the 3.58 MHz bandpass filter, the vertical detail processor, and the frequency tripler for converting the 3.58-MHz color burst to the 10.74 MHz shift clock.

The PW600 inputs one volt peak-to-peak composite NTSC video and 3.58 MHz color burst reference, and outputs separated luminance and chrominance. It requires +24- and −10-volts DC.

Just a word about the vertical-detail processor. That is peculiar to the PW600 module, and is not used with all comb-filter applications. The combing action in the Y channel, at frequencies below 2 MHz, removed much of the vertical detail of the picture. Adding back the lower 2 MHz of the C channel restored the lost detail. It follows that if the vertical detail is added back at a greater level than originally received, then the vertical detail may be enhanced. The vertical-detail processor circuit is an amplifier having nonlinear gain vs. frequency. The process can be compared to the use of high-frequency peaking in the video amplifier stages to improve horizontal detail.

An advanced color demodulator

Thus far we have only separated chrominance and luminance by the most advanced process available. Next we have to convert those signals into ones that can be used to drive a color picture tube, namely RED, GREEN, and BLUE video.

A 40-pin IC demodulator, the TDA3301, has recently been introduced by Motorola (see Fig. 10). It contains everything needed to process the luminance and chrominance signals into RGB signals, and when used with the PW600, does it all without any inductors, tuned circuits, or luminance delay lines. The device is of European design, and is useable for either PAL or NTSC demodulator applications.

In addition to doing the color demodulation, it has RGB and blanking inputs that allow external mixing of computer information with the video picture.

The TDA3301 provides automatic black-level setup and beam-current limiting. It normally requires no oscillator adjustment, has three on-screen display inputs (RGB), a high-speed blanking input, and it operates from a single 12-volt DC supply.

That's all we have room for now. Next time, we'll show you how the PW600 and the TDA3301 can be used to build an NTSC decoder. R-E

PC Compatible Computer

Part 2

Now that we've introduced you to the HiTech PC-compatible computer, let's see how it's put together.

ELLIOTT S. KANTER

WHEN WE LEFT OFF last time, we were just getting ready to configure the motherboard. The first step is to set the configuration switch SW1, which is a DIP switch that is made up of eight separate switches that we'll call SW1-1–SW1-8.

As we showed you last month, for our configuration the switches should be set as follows:

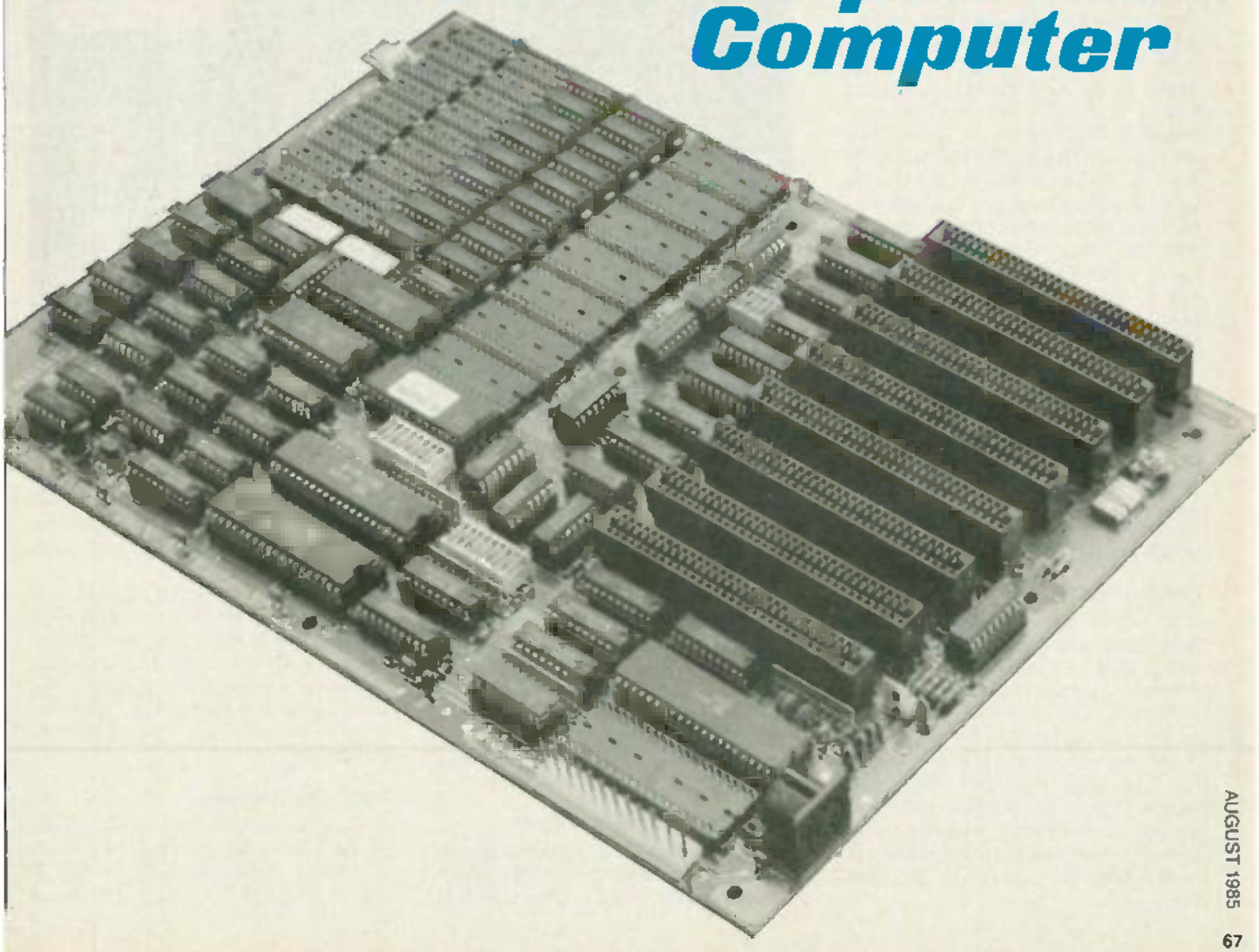
- SW1-1: OFF.
- SW1-2: ON.
- SW1-3: OFF.
- SW1-4: ON.
- SW1-5: OFF.
- SW1-6: OFF.
- SW1-7: OFF.
- SW1-8: ON.

Switch SW1-1 is always off for normal operation, while SW1-2 is on unless an 8087 co-processor is being used.

Switches SW1-3 and SW1-4 are set depending on how much memory is installed. For 128K, they should be set off and on respectively. For 192K, they should be set on and off, respectively. For 256K, they should both be off.

Switches SW1-5 and SW1-6 are set depending on the display adapter used. They should both be on if no display adapter is used. If a color/graphics adapter (with 40×20 resolution) is used, SW1-5 should be off, but SW1-6 on. For a resolution of 80×25, those settings should be reversed. If both adapters are used, or if a monochrome adapter is used, both SW1-5 and SW1-6 should be off.

Switches SW1-7 and SW1-8 are set de-



pending on how many floppy-disk drives are installed. For 1 drive, both should be on. For 2 drives, SW1-7 should be off, but SW1-8 should be on. For 3 drives, SW1-7 should be on, but SW1-8 should be off. For 4 drives, both should be off.

Two other DIP switches are located on the motherboard. Those switches are not numbered but their locations are labeled "FOR RAM EXPANSION" in Fig. 4. (For your convenience, Fig. 4, which appeared last time, will be repeated here.) Unless you have the necessary expertise to implement alternative ROM/EPROM's, don't disturb the settings.

Now it's time to insert the BIOS ROM in position U35. Be sure to observe the orientation of the notch or dot indicating pin 1.

Now that you have completed the switching configuration process, you're almost ready to install the board in the case. Before you do, locate the jumper block JP1. (See Fig 4.) If you are using the HiTech Power Supply, ensure that a jumper is in place from pins 2 to 3. That jumper enables the on-board power-on reset. If you are using the IBM power supply, install the jumper from pins 1 to 2.

The system board is now ready to be installed. It will be secured by a locking-type, plastic stand-offs and two, 6-32 × 1/4-inch screws. As noted in Fig. 4, one screw will be mounted with an insulating washer separating it from the component side of the board. With the case positioned as shown in Fig. 3 (see the July 1985 issue of **Radio-Electronics**), slide the system board in from the left and line up the plastic locking-type stand offs with the holes in the board. Those stand-offs will slide in their mounts making this task easier. When you have lined the board up and the stand-offs protrude through the holes, press down to lock the board into place.

Refer again to Fig. 4 and install the screw without the insulating washer where shown (point A). In a similar manner install the screw with the insulating washer where shown (point B). Take the two-wire cable coming from the speaker and plug it into the on-board connector as also shown in Fig. 4. That completes the installation of the system board.

Configuring the disk drive

If you have not done so already, carefully unpack the floppy-disk drive. Position the drive as shown in Fig. 6 and locate the power connector and the data-cable connector. Using a screwdriver, gently pry out resistor pack RA1 and discard it; it is not required for use with the HiTech PC. Next, move the jumpers; they should be at the HS and DS1 positions. That's all there is to configuring your floppy-disk drive. If you have purchased a second disk drive, configure it in exactly the same manner.

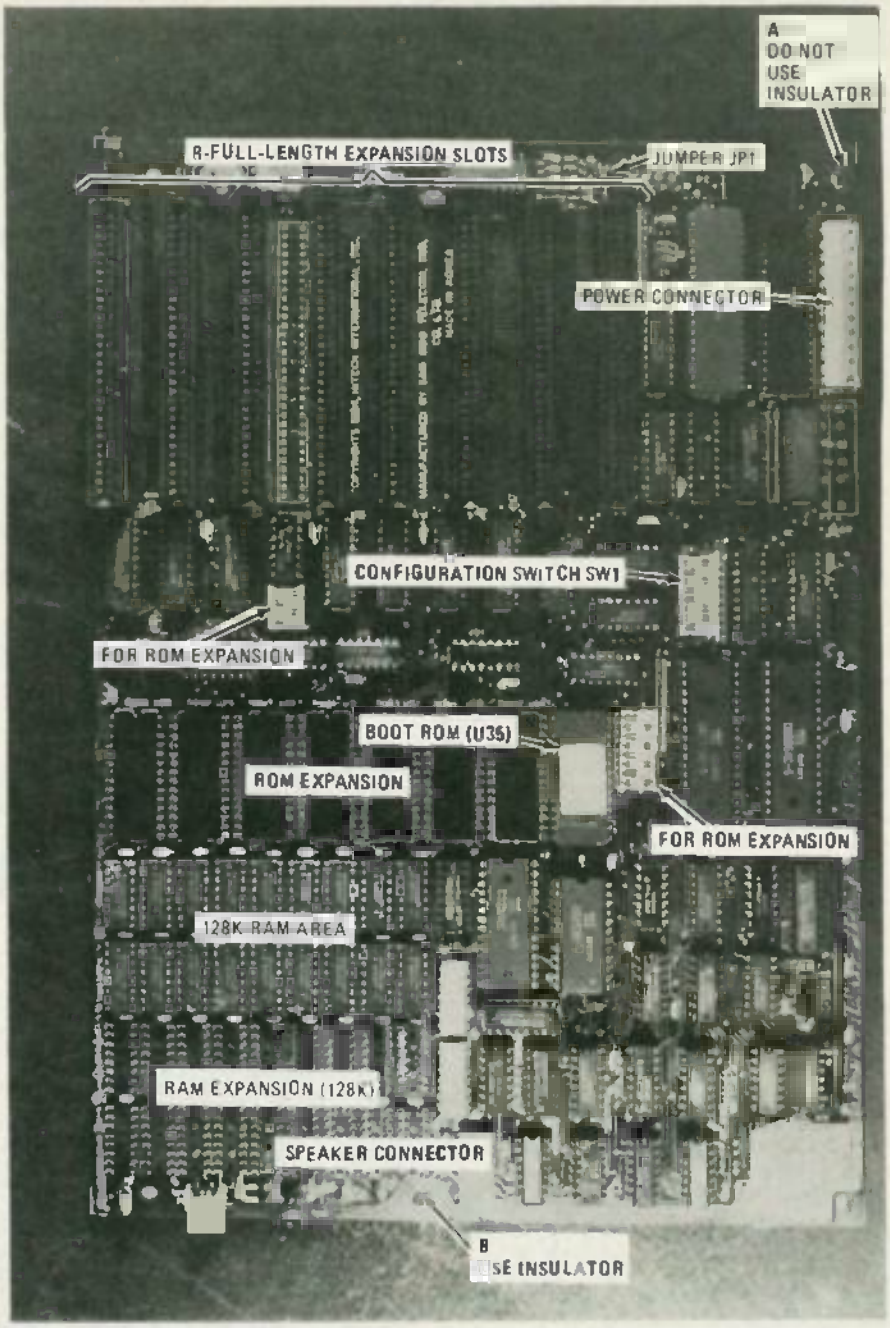


FIG. 4—THE HITECH MOTHERBOARD and some of the features you'll have to be familiar with.

You are now ready to install the floppy-disk drive in the case. Pop out the lower of the two plastic drive faceplates and carefully insert the disk drive, component-side down, through the front of the case. Secure the disk drive using two 6-32 × 1/4-inch screws in the slots (bracket) and tapped holes (disk drive) ensuring that the drive front is lined up with the front of the panel. The direction-indicating arrow on the front of the disk drive should be pointing up. That's all there is to installing the drive. If you have purchased a second disk drive, install it in a similar manner.

Installing the hard-disk drive

Your hard-disk drive, despite its name, is fragile. You should take whatever precautions are necessary to prevent it from jarring or dropping. (Damage can occur if it's dropped from heights as little as two inches!) Unpack the disk drive and remove the plastic front panel cover from your computer.

Refer to Fig. 7 and gently slide the drive into the right-hand side opening (as viewed from the front). Using the supplied mounting screws, secure the drive to the bracket as shown in the drawing. That completes the installation of the drive proper. The next step is to install the controller card.

Hard-disk controller

If you have not done so already, unpack the hard-disk controller card and position it in front of you as shown in Fig. 8. Locate the DIP configuration switch

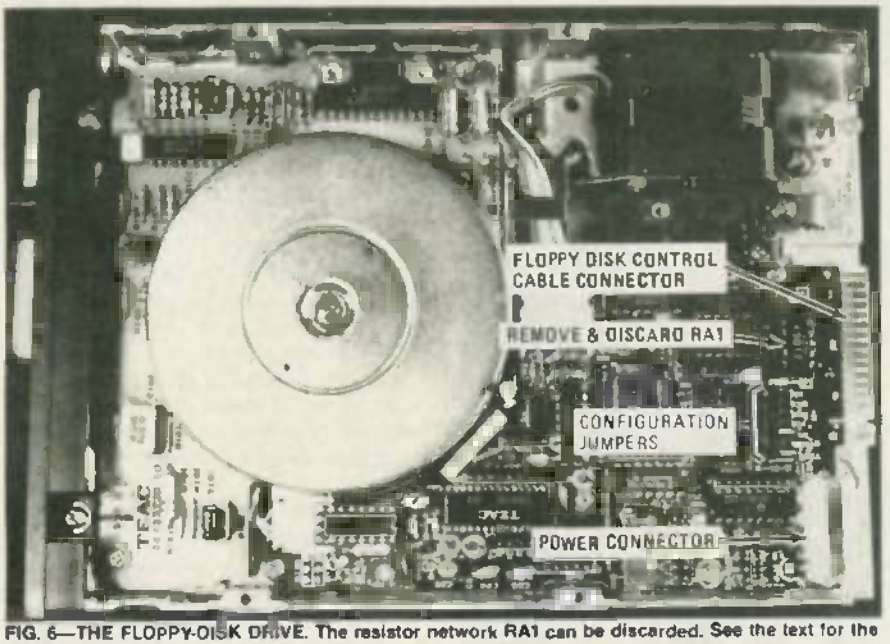


FIG. 6—THE FLOPPY-DISK DRIVE. The resistor network RA1 can be discarded. See the text for the proper jumper configuration.

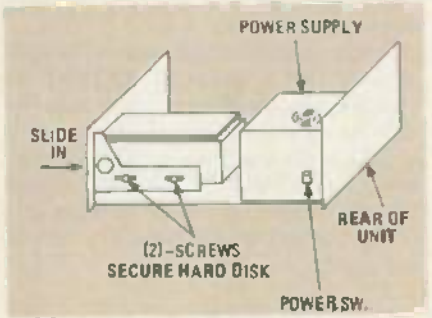


FIG. 7—MOUNTING THE HARD DISK and power supply is straightforward.

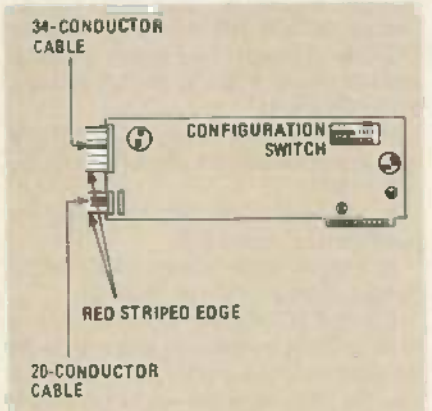


FIG. 8—THE HARD-DISK CONTROLLER CARD. The first four positions of the configuration switch should be set to off, and the last four should be set on.

SW1. (Note that this SW1 is *not* the same SW1 that we set on the system board.) The controller supplied with your computer is capable of accepting hard disks ranging in capacity from 10MB to 30MB. SW1 configures the card to the drive installed. In our case, we will be installing and configuring this card for a 10MB disk, so set SW1-1 through SW1-4 off and SW1-5 through SW1-8 on. That's all you have to do to configure the controller card. Don't change any jumpers on the card. You're now ready to install it, using Fig. 9 as a guide.

Using the supplied cables, plug the 20-pin and 34-pin cables into the card as shown with the red striped end of the cables pointing down toward the card-edge connector. Insert the card into a vacant slot near the hard-disk drive and route the cables as shown toward the hard disk. You will have to remove one of the back slot covers to install the card; save the screw and use it to secure the card with the cable end pointing towards the computer's front panel. Connect the remaining ends of the cables to the hard-disk drive. They are keyed and can only be inserted in the proper manner. Your hard-disk drive and controller card are now installed. We will format the disk shonly.

Installing the power supply

Position the power supply so that the power switch is located to the right rear (as viewed from the front) and protrudes from the rear right hand side of the case. (Refer to Figs. 7 and 10.) Turn the case around and line up the four mounting holes with their corresponding holes in the rear panel. Using four 6-32 × 1-inch round-headed screws, secure the power supply to the rear of the case. Locate the two cable assemblies and connect them to the motherboard as shown. In a similar manner, connect one of the two, 4-line cable assemblies to the rear of the hard disk drive. The assembly's connector is keyed and can only be inserted the correct way.

The remaining 4-line cable assembly will be connected in a similar manner to the floppy disk drive. If you are using two drives, use the y-adapter and carefully match the color codes of the wires and crimp the adapter in place.

The adapter cards

Now it's time to install a color-graphics/monochrome display card and a flop-

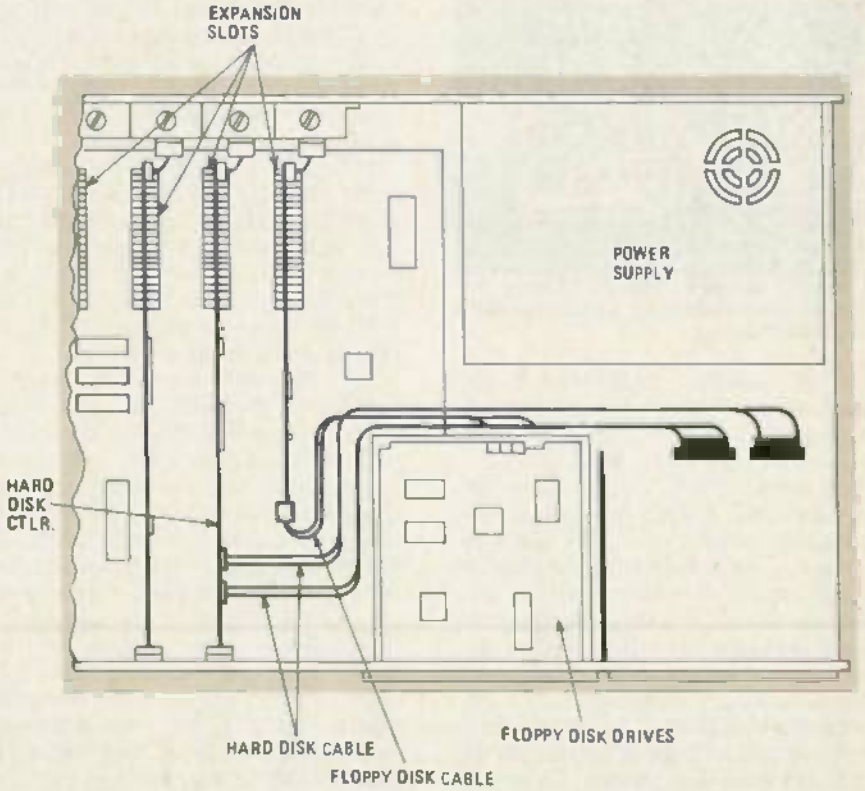


FIG. 9—ROUTING THE RIBBON CABLES for the disk drives is easy if you follow the layout shown.

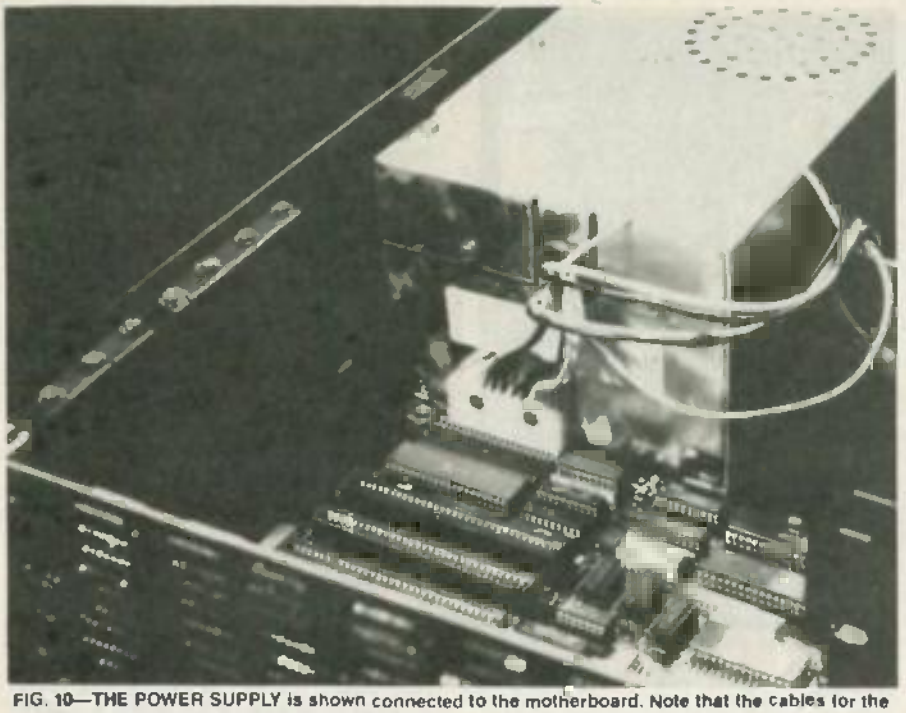


FIG. 10—THE POWER SUPPLY is shown connected to the motherboard. Note that the cables for the floppy- and hard-disk drives are not shown.

FIG. 11—THE COLOR graphics/monochrome adapter is fully compatible with the IBM system.

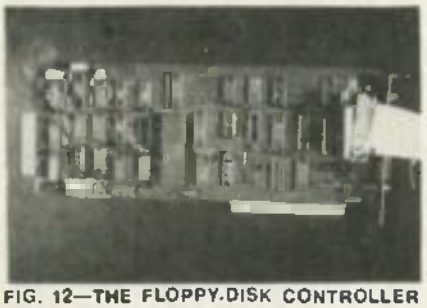


FIG. 12—THE FLOPPY-DISK CONTROLLER adapter shown here also comes equipped with a parallel printer port.

py-disk controller/parallel printer card. Each of those cards is packaged separately with necessary cables and instructions as to use. The color-graphics/monochrome display card shown in Fig. 11 should be installed in the first (leftmost) expansion slot with the two connectors—one for RGB color, the other for composite video—visible from the rear. Remove the screw holding the rear panel cover corresponding to the first slot (right as viewed from the front). Discard the panel cover but retain the screw; it will be used later to secure the adapter card. Position the card with the connectors to the rear and press down firmly. Secure the rear panel bracket.

The last adapter card we'll install is the floppy-disk controller card with a parallel printer port. Remove the third and eighth rear panel covers and save the screws. The left-most opening will be used for the DB25 parallel printer port connector. The remaining (third) opening will be filled with the expansion-drive connector.

Refer to Fig. 12, the controller/printer adapter. The only required configuration would be to change the position of the jumper located nearest the card edge fingers. The purpose and possibilities of that configuration change are more than adequately covered in the documentation that comes with the card and will not be repeated here.

Position the card so that the gold fingers on the long edge of the board are directly above the connector and ensure that the plate attached to the board lines up with the now open rear slot. Firmly press the board down into the connector and replace the screw removed previously to hold the board in place.

Take the cable supplied and place it between the floppy-disk drive(s) and the controller card with the red edge of the cable pointed to the top of the computer. If you are using only one drive, locate the connector at the fold of the cable and press the connector onto the bottom disk drive. The red line should be visible toward the left as seen from the front of the computer (on the disk drive). If you are using a second floppy drive, position the connector at the split end of the cable in a similar manner and press this connector onto the top disk drive. The remaining connector located at the long end of the cable should be connected to the card adapter with the red edge line pointing to the top or up. Route this cable as shown previously in Figure 9. That completes the installation of the floppy disk controller. To mount the DB25 parallel printer port, fasten this connector to the (supplied) bracket with the hardware supplied. Position that connector and bracket in the last opening and secure it with the remaining screw removed previously.

We're now ready to close up the case and try things out! Slip the case cover on from the front and secure with the four 6-32 × ¼-inch black flat head screws. Plug the connector from the keyboard into the socket located on the rear of the cabinet. Figure 13 shows the completed system which is also available ready to use under the name SAM 2001.

The "smoke test"

Now hook up your monitor, plug everything in, slip your operating-system disk into drive A (the top drive), and turn the computer on. The screen display will show the self-test in progress. When the self-test is complete, it will instruct you to insert your system diskette in the drive and to press any key.

At the system prompt, you might wish to enter DIR followed by RETURN to view the contents of your system disk. For detailed information on your system disk and the various uses of the utilities it contains, consult the literature that comes with the diskette, or any of the many fine books available on the MS-DOS operating system.

Formatting the hard disk

Now that everything seems to be working right, it's time to format the hard disk. Leave your DOS disk in drive A and enter "FDISK" followed by a return. A menu will present you with a number of options. Select Option 1.

In response to the prompt asking if you want to use the entire fixed disk for DOS, answer NO.

In response to the prompt asking for partition size, enter 303.

In response to the prompt asking for the starting cylinder number, enter 0.

Hit the ESC (Escape) key to return you to the FDISK options. In order to make the partition active so that the system will load the DOS on power-up, select option 2.

View the partition data and double check it. You will be prompted to enter the number of the partition you want to make active. Select 1. Then hit the ESC key to return to the FDISK options. Use the ESC key again to return to DOS.

Reboot your system by hitting CTRL ALT DEL (the control, alternate and delete keys) simultaneously.

Next we'll use the DOS command FORMAT to initialize the hard disk's directory. First type "FORMAT C:/S."

ADD-ON BOARD SUPPLIERS

ABM Computer Systems
3 Whatney
Irvine, CA 92714
714-859-6531

Apstek Inc.
2636 Walnut Hill Lane Suite 335
Dallas TX 75229
214-357-5288

AST Research, Inc.
2121 Alton Ave.
Irvine, CA 92714
714-863-1333

Byad, Inc.
95 W. Algonquin Road
Arlington Heights, IL 60005
312-228-3400

Christin Industries, Inc.
31352 Via Colina Suite 1
Westlake Village, CA 91362
213-991-2254

IDE Associates, Inc.
7 Oak Park Drive
Bedford, MA 01730
800-257-5027

MA Systems
2015 O'Tolle Ave.
San Jose, CA 95131
408-943-0596

Maynard Electronics
430 E. Semoran Blvd.
Casselberry, FL 32707
305-331-6402

Microlog, Inc
222 Route 59
Suffern, NY 10901
901-368-0353

Orchard Technology
47790 Westinghouse Drive
Fremount, CA 94539
415-490-8586

Personal Computer Products, Inc.
11590 W. Bernardo Court
San Diego, CA 92127
619-485-8411

Persyst
17862 Fitch
Irvine, CA 92714
714-660-1010

Profit Systems, Inc.
30200 Telegraph Rd. Suite 132
Birmingham, MI 48010
313-647-5010

Quadram
4355 International Blvd.
Norcross, GA 30093
404-923-6666

Tecmar
6225 Cochran Rd.
Bolon, OH 44139-3377
216-349-0600

ORDERING INFORMATION

The following are available from HiTech International, Department R-E, 1180 Miraloma Way Suite M, Sunnyvale, CA 94086.

Part No.	Description	Price
RE-PCB W/C	Motherboard with 128K RAM	$525.00
RE-PS-130	130-watt power supply	175.00
RE-ROM	BIOS ROM	35.00
RE-CASE	Case (complete)	150.00
RE-5150	enhanced keyboard	150.00
RE-MON DIS	RGB video card	175.00
RE-DISK DR.	Teac 360K disk drive	125.00
RE-CTRL-A	Disk controller/parallel port	175.00
RE-HARD DISK	10 megabyte drive with controller	650.00
RE-YAD	Y Adapter (to attach two drives)	5.00
		Total*: 2165.00

*Note that due to last-minute price changes by both IBM and HiTech, the price difference between their two compatible computers does not live up to the $2000 claimed on last month's cover.

FIG. 13—THE COMPLETE HITECH COMPUTER is available fully assembled as the *Sam 2001*.

You'll be prompted to hit any key to begin formatting drive C. When you do, don't be surprised at the amount of time required to format the hard disk. You will be able to tell that the hard disk is working by the drive indicator light being illuminated. When formatting is complete, a status report will be displayed telling you the total disk space, the space marked as defective, and the space currently allocated to files. Note that the amount of space marked as defective must be ZERO. If any bad bytes are found, you should contact HiTech International.

As we have seen, the DOS command FORMAT is required to setup the hard disk, it also initializes it. Initialization could be disastrous if used at the wrong time. The same command is also used to format the floppy disks, so if you used it in error, the hard disk could in fact be erased. To prevent that from happening, change the name FORMAT.COM to FMT.COM. To do so type "RENAME FORMAT.COM FMT.COM."

Next create a batch file to format floppy diskettes. To do so type: "COPY CON: FORMAT.BAT FMT A%1." Then hit the F6 key. That program will enable you to format a diskette or to format and place DOS on your diskette. To only format the diskette type FORMAT; to both format and add DOS, type FORMAT/S.

That completes the formatting and configuration of your hard disk. You are now ready to enjoy your system.

Add-ons, etc.

One of the advantages of building your own system is the ability to tailor accessories to your needs. There are a lot of companies making accessories for the IBM PC/XT and anything that fits the IBM, will work in your HiTech computer. To offer you some assistance, we are including a list of suppliers of accessories that will permit memory expansion, additional ports (serial, parallel, game, etc.) and the ability to configure additional memory as a RAM disk. R-E

DESIGNING WITH DIGITAL IC'S

This month we'll see how simple gates can be combined to form one of the basic circuits of digital electronics—the flip-flop.

JOSEPH J. CARR

Part 5 IN PAST INSTALLMENTS of this series we have discussed logic families, interfacing methods, and elementary gates. Let's now expand our discussion to include combinations of gates. Such combinations of gates can, of course, perform more complex functions than simple gates alone. The first of such circuits that will be discussed are basic flip-flops, specifically two forms of set-reset flip-flops—the clocked set-reset flip-flop, and master-slave (which is also known as the load-transfer) flip-flop. But first, let's review the two basic gates that are used in these circuits—the NAND and NOR gates.

NAND and NOR gates

The two basic gates used in our flip-flops are the NAND and NOR gates shown in Fig. 1. We've previously looked at how those gates operate, but let's briefly review that here:

For a NAND gate, a low on either input forces the output high. Thus, for the output to be low, a high must be presented to both inputs.

For a NOR gate, a high on either input forces the output low. Thus, a low must be presented to both inputs for the output to be high.

Most IC NAND and NOR gates are "quad" units; that is, there are four such gates in a single IC package. The 7400 TTL device, for example, is a "quad two-input NAND gate," while the 7402 is a TTL "quad two-input NOR gate." Both IC's contain four two-input gates that are independent of each other, except for power supply and ground connections.

Set-reset (S-R) flip-flops

The set-reset flip-flop (also called the S-R flip-flop) is a bistable circuit, which means there are two stable output states. Those states are defined as follows: Set—Q = high, $\bar{Q}$ = low; reset—Q = low, $\bar{Q}$ = high

Unless otherwise specified, the set state always makes Q high, and the reset state makes Q low. Of course, $\bar{Q}$ is always the complement of Q.

Figure 2 shows the NAND gate version of the S-R flip-flop, while Table 1 is the truth table that describes circuit operation. The NAND-gate S-R flip-flop rules are summarized as follows:

A low applied to the set (S) input forces Q high, and $\bar{Q}$ low. A low applied to the reset (R) input forces Q low and $\bar{Q}$ high. A high applied to both R and S inputs simultaneously results in no change in the output state. Finally, a low applied to both inputs simultaneously is a disallowed state that confuses the circuit and produces an unpredictable output state.

Even a momentary low will force a change in the output state. Application of a constant low to either input will hold the commanded output state. That tactic is sometimes used to lock a particular state (set or reset) until some other circuit action is completed. The S-R flip-flop is bistable, so it will remain in either set or reset states until commanded to change by application of a low to the appropriate input.

Figure 3 shows several symbols used to denote S-R flip-flops in schematic diagrams. All three are used for NAND-logic S-R flip-flops, even though only Fig. 3-*a* and 3-*b* are technically correct (the inverted inputs of those figures comply with the active-low nature of the inputs). The symbol shown in Fig. 3-*c* is sometimes seen for NAND-logic S-R flip-flops, but is more properly associated with a NOR-logic S-R flip-flops. In **Radio-Electronics**, the symbol shown in Fig. 3-*a* is always used to denote a NAND-logic S-R flip-flop.

TABLE 1

Inputs		Outputs	
S	R	Q	$\bar{Q}$
0	0	Disallowed	
1	0	0	1
0	1	1	0
1	1	No change	

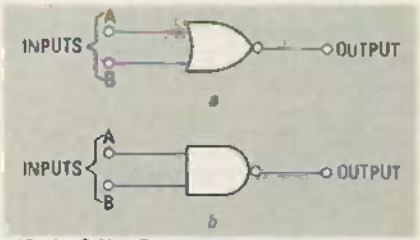


FIG. 1—SIMPLE NOR gates, such as the one shown in *a*, and NAND gates, such as the one shown in *b*, are the basic building blocks of flip-flops.

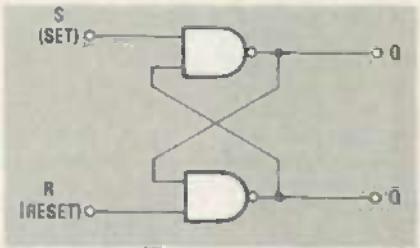


FIG. 2—THIS SET-RESET (S-R) FLIP-FLOP is fashioned out of two simple NAND gates.

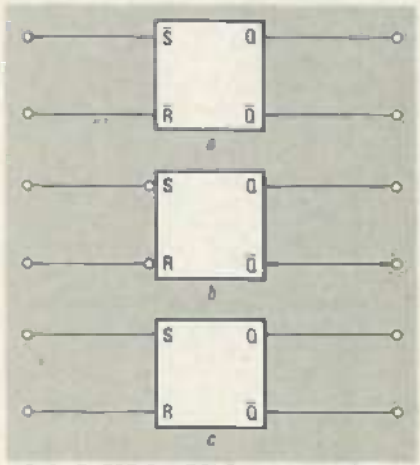


FIG. 3—THESE SYMBOLS are commonly used in schematic diagram to show S-R flip-flops. The symbol shown in *a* is used in this magazine.

An example of a NOR-logic S-R flip-flop is shown in Fig. 4, while the truth table is shown in Table 2. As you might expect, the NOR-logic S-R flip-flop operates in the opposite manner from the NAND-logic version of the circuit. That can be verified by examining the truth tables for the two circuits.

As in the previous case, only a momentary high need be applied to either input to make the NOR S-R flip-flop change output states.

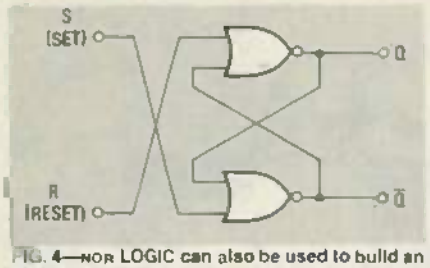


FIG. 4—NOR LOGIC can also be used to build an S-R flip-flop.

TABLE 2

Inputs		Outputs	
S	R	Q	Q̄
0	0	No change	
1	0	1	0
0	1	0	1
1	1	Disallowed	

The S-R flip-flop can be used in a wide variety of applications. One such application is a digital version of a latching switch. Figure 5 shows such a switch based on the NAND-logic S-R flip-flop. The inputs are controlled by pushbutton switches, S1 and S2. Each is a normally-open type that closes when pushed. Since each input is strapped high with a 3300-ohm pull-up resistor, the input will be high as long as its associated switch is open, but will go low when that switch is closed. Once again, due to the nature of the circuit, a momentary low is all that is required for the output to change states.

Note in Fig. 5 that the switches and the outputs are labeled START and STOP. That labeling implicitly assumes that the circuit is used in a machine or instrument that needs "start" and "stop" commands. Assuming an initial state of the STOP output high and the START output low, pressing the START button will cause the

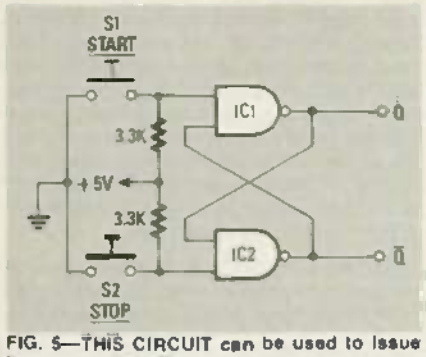


FIG. 5—THIS CIRCUIT can be used to issue "stop" and "start" instructions to a circuit or piece of machinery. Its operation is analogous to a latching switch.

outputs to change states; that is, the START output will go high and the STOP will go low. Those output states will remain "locked-in" even after the switch is released. They will reverse again only when the STOP button is pressed.

Ordinary S-R flip-flops sometimes suffer a problem that besets classical relay circuits: race conditions. In the classical version of the problem, relays that supposedly close simultaneously do not, with unpredictable results. Another problem is that noise impulses can create conditions that may cause the flip-flop to go into the opposite, incorrect state. There may also be a timing problem: that is, we may not want a circuit action to occur until a certain time. All of those problems are either solved or reduced by the use of the clocked S-R flip-flop shown in Fig. 6.

The clocked S-R flip-flop is made from a NAND-logic S-R flip-flop that is gated by a clock signal. Gates IC1 and IC2 are cross-coupled in the manner that is normal for NAND-logic S-R flip-flop circuits. The set (labeled A) and reset (B) inputs, however, are controlled by gates IC3 and IC4, respectively.

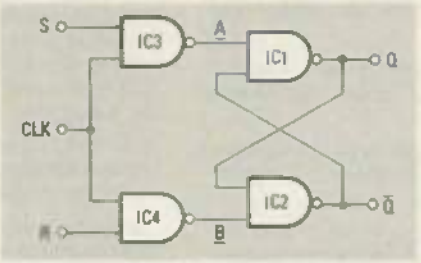


FIG. 6—IN A CLOCKED S-R FLIP-FLOP, the output will change states only when the clock input is held high.

Recall the operation of a NAND logic S-R flip-flop: if point A is momentarily grounded, the flip-flop is set (the Q output is high, the Q̄ is low); if point B is grounded, the flip-flop is reset (Q is low, Q̄ is high). Point A is controlled by gate IC3, while point B is controlled by gate IC4. But both IC3 and IC4 are controlled by the clock line. When the clock line is low, the outputs of IC3 and IC4 are locked high, and will not respond to changes on the other inputs (S and R). Those inputs are thus active only when clock is high. Note that the sense of the S and R is reversed from normal NAND-logic S-R flip-flops. Here, the those inputs are active-high rather than active-low.

The clocked S-R flip-flop solves some of the problems inherent in the regular S-R flip-flop circuit. In any event, the clocked version of the circuit permits synchronous operation (and changes are allowed to occur only at certain discrete times).

Another alternative for synchronous operation is the master-slave flip-flop (also call the load-transfer flip-flop) shown in Fig. 7. That circuit consists of a pair of clocked S-R flip-flops in cascade: i.e. the Q and Q̄ outputs of one S-R flip-flop, IC1, drive the S and R inputs of the second flip-flop, IC2. The clock inputs of the two flip-flops are driven out of phase with each other (one is high when the

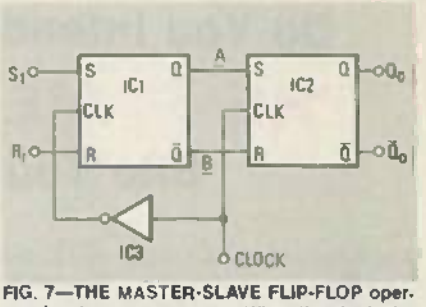


FIG. 7—THE MASTER-SLAVE FLIP-FLOP operates in a two-stage manner. When the clock signal is low, information presented to the inputs is latched into the first flip-flop. When the clock goes high, that information is passed to the second flip-flop, whose outputs change accordingly.

other is low). The CLK input of IC2 is driven directly by the master clock signal (also called load/transfer or L/T signal), while the CLK input of IC1 is driven by the inverted master clock signal.

Recall the operation of the normal clocked S-R flip-flop: The signals applied to either input will only cause an output change when the CLK input is high. Thus, when the master clock signal is low, IC2 is inactive (its CLK line is low) and IC1 is active (its CLK input is high). That situation permits loading of the master-slave flip-flop. State changes at either input of IC1 are reflected by the outputs of that gate.

When the master clock line goes high, the situation reverses—IC2 is active and IC1 becomes inactive. At that time, the outputs of IC1 are "read" by the inputs of IC2. Thus, those outputs will either set or reset the outputs of IC2.

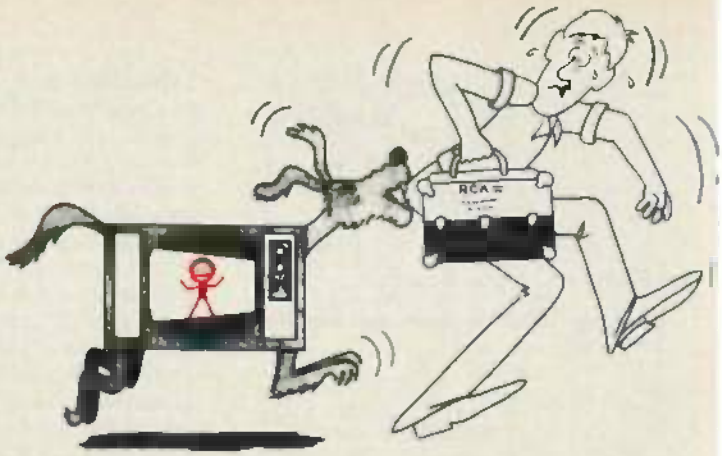
Clocking

Flip-flops are designed to be triggered in one of two ways—either on a leading or trailing edge of a clock signal, or when the clock signal reaches a certain positive or negative level.

Where triggering takes place is important because it tells us where the action of the flip-flop will occur. On a level-triggered flip-flop, the output state changes will occur when the clock is either high or low (according to design), but not during the transition between levels. Thus, a positive-level-triggered flip-flop is active only when the clock input is high: the clocked S-R flip-flop discussed earlier was an example of that type of triggering. Similarly, the negative-level-triggered device becomes active when the clock line is low.

An edge-triggered device acts during either low-to-high (positive edge triggered) or high-to-low (negative edge triggered) transitions. Although edge-triggered devices are not common in the type of circuits discussed thus far, they are used extensively in more complex flip-flops. Those devices will be the subject of our next article. R-E

How Many Times Do You Intend To Let "THE SAME DOG" Bite You ?



★ How many times have you worked all day long trying to diagnose the hi-voltage / LV regulator circuit of a set that is in shut down only to eventually find that a **shorted** video, color, vertical, tuner, AGC, or matrix circuit was causing the set to shut down and, to find that the hi-voltage / LV regulator circuit was working flawlessly all the time?

★ How many times have you spent the day looking for a **short** that was causing the set to shut down, only to eventually find that an **open** vertical, video, matrix circuit or, an **open** HV multiplier was to blame?

★ How many times have you worked all day on the same TV set, only to find out that the set's flyback transformer was defective?

★ How many flyback transformers have you replaced only to find that the original flyback was **not** defective?

★ How many horiz output transistors and Sony SG 613 **SCRs** have you destroyed while simply trying to figure out whether the flyback was good or bad?

★ How many times have you been deceived by your flyback "ringer"? Can you even count the number of hours that your "ringer" has caused you to waste?

★ How many times have you condemned a flyback, only to find that a shorted scan derived B+ source was causing the flyback to "appear" as though it were defective?

★ How many hours have you wasted, working on a TV set, only to find that the CRT had a dynamically shorted 2nd anode (to primary element)?

★ How many new sweep transformers have you unknowingly destroyed because a short existed in one of the scan derived B+ sources?

★ How many times have you said to yourself, "I could fix this - - - -thing if I could only get it to fire up long enough to lite the screen? - - - without blowing an output transistor or a fuse "

★ How many additional bench jobs could you have gotten, had you been able to give an accurate, "on the spot" estimate on sets that were either in shut down or, not capable of coming on long enough for you to analyze them?

If you had been using our all new Super Tech HV circuit scanner, you would have had an accurate evaluation concerning all of the above in about one minute, at the push of **just one** single button.

It's true! Push just one test button and our HV circuit scanner will (1) Accurately prove or disprove the flyback, (2) Check for any possible shorts in any circuit that utilizes scan derived B+, (3) Check the scan derived power supplies themselves for shorted diodes and / or electrolytic capacitors, (4) Check for primary B+ collector voltage and, (5) Check the horiz output stage for defects.

Our HV circuit scanner works equally well on sets with integrated or outboard HV multipliers. It will diagnose any brand, any age, solid state TV set including Sony. The only exceptions are sets which use an SCR for trace and, another for retrace (i.e., RCA CTC 40 etc.). Our scanner will not work on these sets.

In plain English, our HV circuit scanner is even easier to operate than a "plain vanilla" voltmeter.

First off, when you're using a scanner, you **do not** remove the flyback in order to check it. In fact, you don't even unhook any of the wires that are connected to the flyback! All you do is:

(1) Remove the set's horiz output device, plug in the scanner's interface plug, then make one single ground connection. That's all you do to hook it up.

(2) If the primary LV supply is functional and, assuming that the emitter circuit of the horiz output stage has continuity, the scanner will tell you that it is ready to "scan" by illuminating the "ready" light, which is the white button on the test / run switch.

(3) Press the spring loaded (test) side of the test / run switch and the scanner will "look" for any type of a **short** that might exist anywhere on the secondary side of the flyback, including the HV multiplier, any circuit that relies on flyback generated B+ and, including the flyback itself (both primary and all secondary windings). It will simultaneously check for a shorted LV regulator device HV multiplier, or an open o "partially" open safety capacitor.

If a short or, an "excessive load" exists on one secondary winding, al other secondary windings will have "normal" output voltage in spite o the short. Only the shorted winding itself will have zero volts on it. This makes shorted scan derived B+ sources incredibly easy to isolate During this test, the 2nd anode voltage is being limited to approx 5 kv by the scanner.

If a short is present, the red "flyback" light will either lite, or flash (a various speeds), depending on which type of a short exists. If no shorts exist, the "flyback" light will be green.

Assuming that the "flyback" light is green, no **shorts** exist and, it is now time (and safe), to begin looking for **open** circuits which might be causing the set to shut down due to flyback run-a-way. It only stands to reason that if no shorted conditions exist, then one (or more) circuits will have to be open, otherwise, the TV set would be working!

(4) Now that you know that no **shorts** exists, push the "run" side of the test / run switch (the side that latches). Provided all of the other circuits in the TV set are functional, the scanner will now put a picture on the set's CRT screen that has full vertical and horiz deflection, norma audio, video and color.

Keep in mind that during this test, your scanner is:

(1) Circumventing all horiz osc/driver related shut down circuits.

(2) Limiting the set's 2nd anode voltage to approx 20-25 kv.

(3) Substituting the set's horiz osc/driver circuit and, as a result eliminating any need that the set might have for an initial start up o B+ resupply circuit for the osc/driver.

Wait about 15 seconds for its filaments to warm up, then look at the CRT. Any circuits that are **"open"** will now produce an obvious symptom on the screen. Because the scanner has circumvented all of the set's shut down features, you can now use your old reliable "symptom to circuit analysis" technique to troubleshoot the problem, i.e., if the picture has no blue in it - - - repair the blue video or blue matrix circuit If the picture has only partial vertical deflection - - - repair the vertica circuit, and so on. The scanner has effectively removed all of the stumbling blocks that would normally prevent you from diagnosing the problem i.e., start up and shut down features, and allowed you t repair the TV set by using conventional techniques.

When you're using a scanner, all start up, shut down, dead set pro blems are easy to solve. You don't need anyone to tell you just how di ficult these problems can be for those who don't have a scanner!!

Our Super Tech HV circuit scanner normally sells for only $495° Beginning July 4, 1985 thru August 31, they are on sale for only $395°

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As anyone who has ever tried knows, one of the most difficult tasks in building one of the many construction projects featured in **Radio-Electronics** is making the PC board using just the foil pattern provided in the article. True, all sorts of kits and things are sold to let you lift a foil pattern from a magazine page. But, while some of them do work, most of them don't. What usually happens is that you wind up copying the artwork by hand.

Well, we're doing something about it.

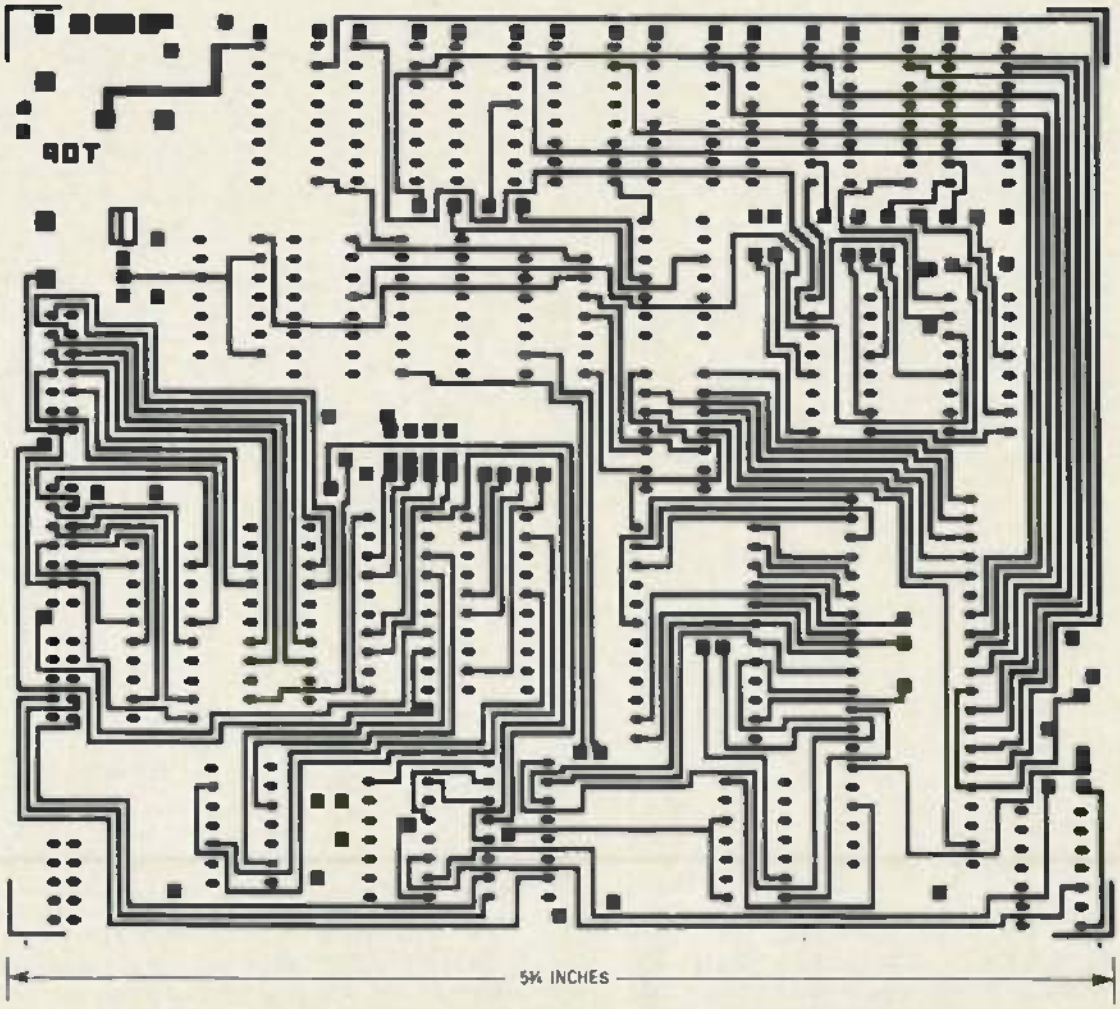
We've moved all the foil patterns to a new section of the magazine. They'll be printed by themselves, full sized, with nothing on the back side of the page. What that means for you, is that the printed page can be used directly to produce PC boards!

Actually the method you'll need to use to etch directly from printed artwork is a little bit different from the one you're probably used to using to produce PC boards, but we've done some testing and it works!

In order to produce a board directly from the magazine page, you first need to do a little bit of work on the foil pattern. The first thing to do is remove the page from the magazine and carefully inspect it either under a good light or on a light table. As a matter of fact you should really do both of those since each one will show up different kinds of imperfections in the artwork. What you're looking for are breaks in the traces, bridges between traces, and in general, all the kinds of things you look for in the final etched board. You can clean up the published artwork the same way you clean up you own artwork. Drafting tape and graphic aids can fix incomplete traces and doughnuts, and you can use a hobby knife to get rid of bridges and dirt.

Once you're satisfied that the artwork is clean, take a little bit of mineral oil and carefully wipe it across the back of the artwork. Don't get any on the front side of the paper (the side with the pattern) because you'll contaminate the sensitized surface of the copper blank. (If you *do* contiminate it, you won't notice anything when you make the exposure, but when you develop the board, the oil can act just like resist and keep the developer from dissolving the unwanted resist on the board.

After the oil has "dried" a bit—patting with a paper towel will help speed the



COMPONENT SIDE OF PRINTER BUFFER board is shown here in a full size mirror image. This side must go toward the board to be exposed. See page 59.

PC SERVICE

process—place the pattern front side down on the sensitized copper blank, and make the exposure.

The mineral oil is optional, but it does do two things for you. It makes the paper much more translucent and it makes the foil pattern appear darker. A successful exposure depends on having as much contrast as possible in the exposure mask and that's exactly what the mineral oil does.

Even though the mineral-oil treated paper is translucent, it's still not anywhere as clear as lithographic film (which is what's normally used in producing PC boards). That means that you're going to have use a longer exposure time than you are probably used to.

We can't tell you exactly how long to make the exposure time, because we don't have any idea what kind of light source you use. A simple rule of thumb is to figure that there's a 50 percent increase in exposure time over lithographic film. But that doesn't necessarily mean you'll need a 50 percent increase. If you're used to taping up a pattern on mylar sheets, you'll find that rubbing the paper with mineral oil makes it just about as translucent as mylar.

Note that sensitizers vary as well. Mineral oil isn't as transparent to ultraviolet light as it is to other parts of the spectrum. If your sensitizer wants to see ultraviolet, you may find using mineral oil to be more trouble than it's worth.

You'll have to experiment to find the best method to use with the chemicals you're familiar with. And once you find it, stick with it. Don't forget the "three C's" of making PC boards—care, cleanliness, and consistency.

Finally, we would like to here how you make out using our method. Write and tell us of your success, and failures, and what techniques work best for you. Address your letters to:

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Department PCB
200 Park Avenue South
New York, NY 10003

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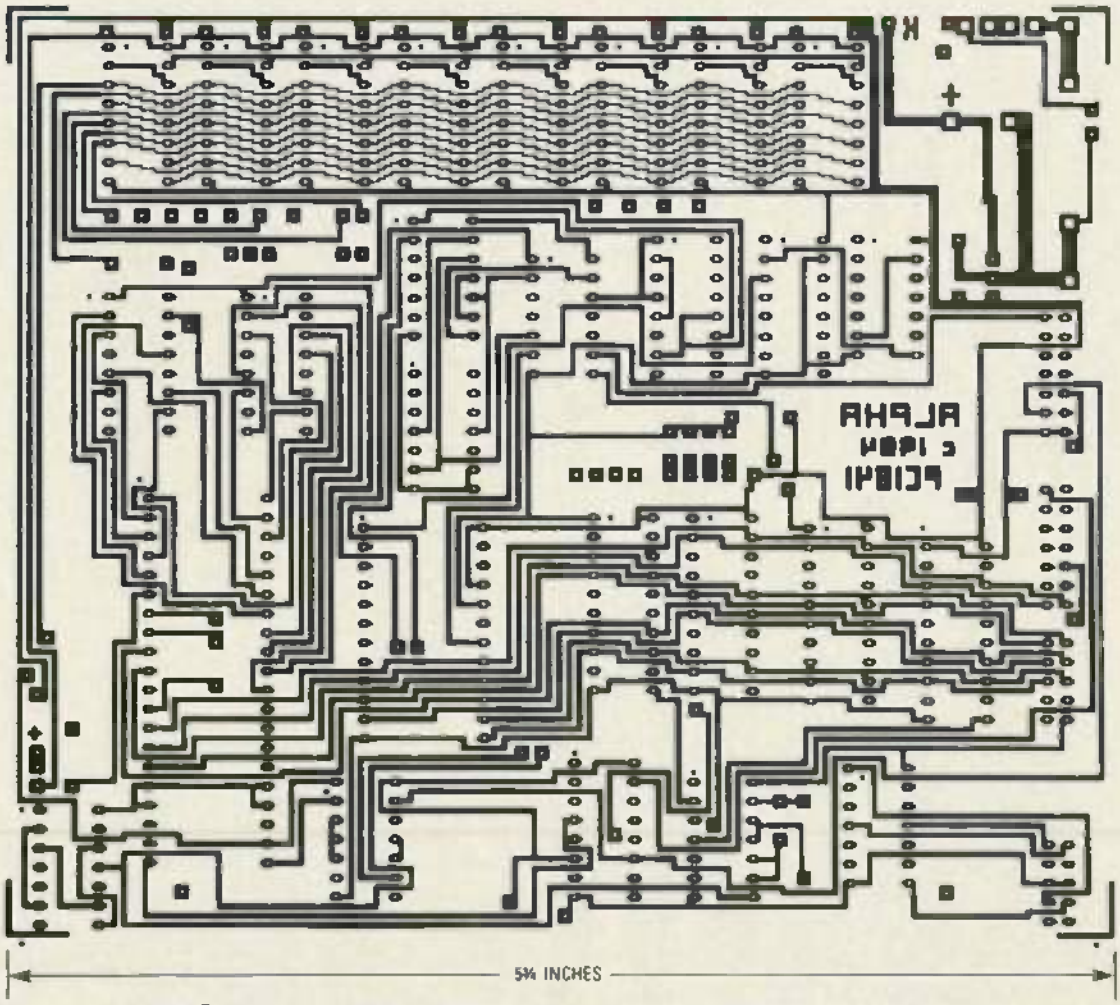

SOLDER SIDE OF PRINTER BUFFER board is shown here in a full size mirror image. This side must go toward the board to be exposed. See page 59.

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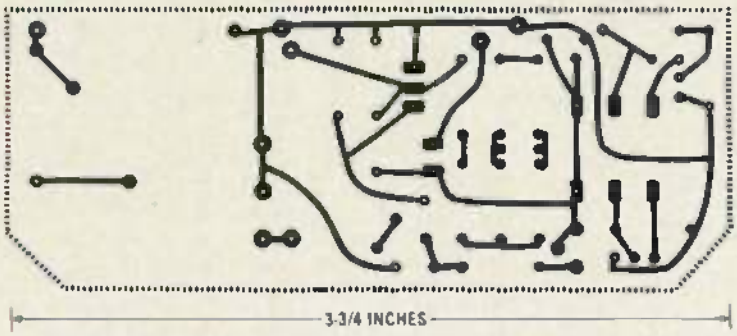

SOLDER SIZE OF THE INFRARED VIEWER board is shown here in a full-size mirror image. This side goes toward the board to be exposed. See page 49.

ROBOTICS

MARK J. ROBILLARD
ROBOTICS EDITOR

Setting up a robotics design lab.

ANYONE WHO EXPERIMENTS WITH PERsonal robots soon finds that plenty of space is a necessity. Although you may already have a workshop set up for your electronics experimentation, it just won't do for robotics. An area free of obstructions and large enough for your creation to wander about is what you need.

If, on the other hand, you experiment exclusively with arm-like mechanisms, some clear bench space is all that's called for. Even then, it may be necessary to move solder irons and various other tools each time you want put the machine to work.

Therefore, this month we'll turn our attention to setting up a small robotics laboratory. In no way, will our lab compare with a typically well outfitted, sophisticated university robotics laboratory. But, it will suffice for experimental purposes.

Lab layout

When setting up a robotics lab, the first thing to consider is what equipment you'll need. The most important parts of any robotics lab are the power supplies. Typically you will need one or more supplies that can deliver at least 5 amps at 5 and 12 volts. The 12 volts is required to power motors; most motors on the market are designed to operate from a 12–24-volt supply. Note that a motor supply need not be well regulated. The 5-volt source is, of course, to power the robotic control circuits.

The current rating we just specified should be observed. The 12-volt supply will be used to power various motors, and those tend to use lots of power. Even though your robot will eventually be "scooting" around on battery power, its nice not to worry about constantly having to charge batteries while experimenting.

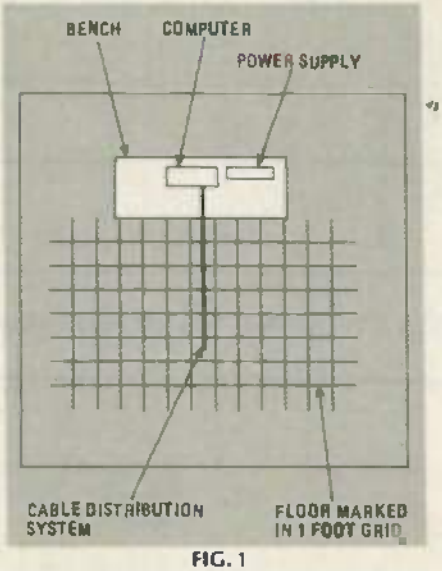

FIG. 1

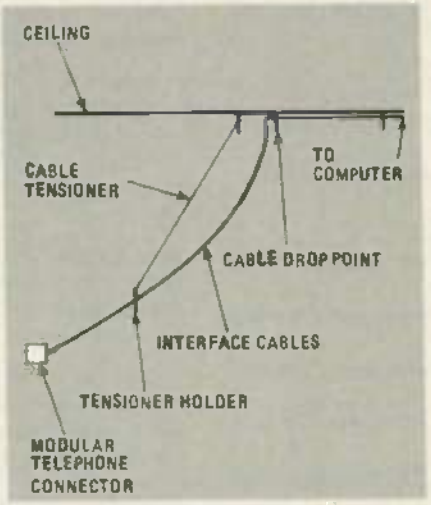

FIG. 2

The 5-volt supply should have sufficient power to handle any kind of logic circuitry that you might need. If you've a very sophisticated control system with many motor drivers and microprocessors in mind, you'll definitely need the 5 amps. Of course, If all you are working with is low-power CMOS logic, you probably won't draw anything more than about 1.5 amps. But with a 5-amp supply, you won't have to replace or upgrade the power supply as your robotic system expands.

The supply can be of the "homebrew" variety. (We'll show you to build a universal 5-amp power supply from a few simple components in the future.)

You'll also need (and may want to build) a workbench, and what I call a "cable-distribution system." Figure 1 shows the basic setup of a simple robot lab with a table in the upper half of the figure.

The table can be something as simple as two wooden horses supporting an unfinished door. Coming down from the center of the table is the cable- distribution system (a harness containing all the interface cables you could possibly need). Those cables make the task of debugging the robotic circuits (during experimentation) easier by allowing individual testing of the control circuits. The robot is tested by writing a simple BASIC program to it from an inexpensive computer to exercise the circuits.

Within the cable-distribution system, there should be two 4-wire, telephone-type hook-up cables with modular plugs on one end for connection to the control circuits. The other end should be terminated in a 25-pin D-type connector for easy connection to the serial port of a computer.

Why two serial cables? Con-

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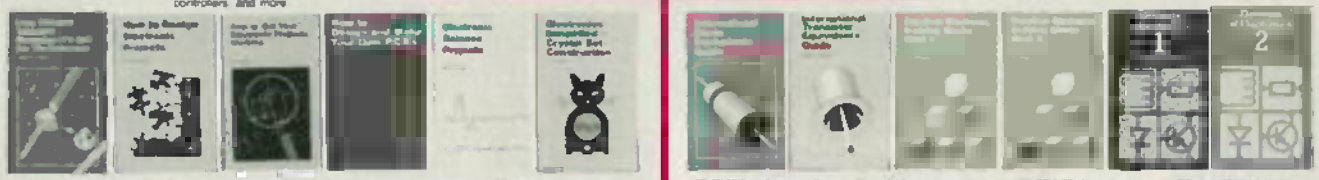

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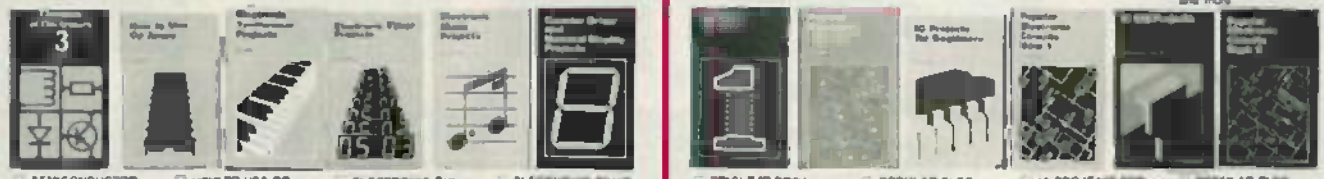

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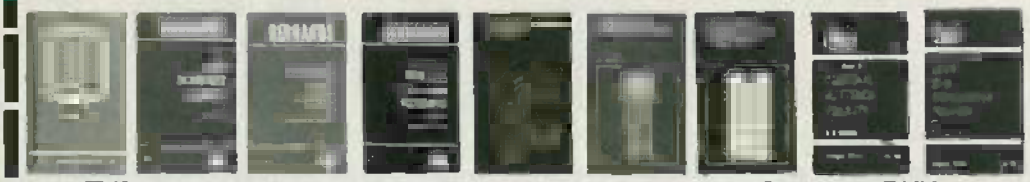

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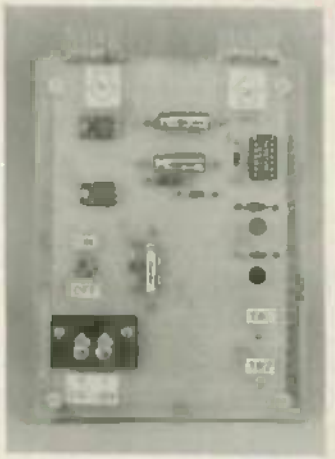

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ON THE COVER

Inputting without the classic keyboard can be done in many ways. Here we see the Koala Pad from Koala Technologies being used with an IBM computer. See page 8.

COMING NEXT MONTH

Touch Screens
Sensitive Video Display Terminals provide still another—simple—way to input information.

Voice Reproduction
Here's how to get more than 5 seconds of synthesized speech with 16 K.

Emulating Printer
The easy way to resolve problems of incompatibility!

EDITORIAL

Hackers.

A "Computer Hacker" is a thief. A crook who uses his computer to attempt to break into other computers and leave evidence that he has done so. These low-lifes try to get into bank computers and louse up the records, one even got into a hospital's computer and did so much damage to the records that lives were actually jeopardized. They try to get into school computers and screw up those records too.

Some of them have successfully broken into classified government computer systems, endangering the security of our country. They form clubs and swap coded information, they have magazines that offer tips to improve their skills.

We'd like to go on record. We're anti-hacker. These thieves, for that's exactly what they are, are giving *all of us* a bad name. They've been getting a lot of publicity lately, and it's all bad. Sure, they try to come off as "boy genius" types that are so adept at using their computers that they can foil the most-professional anti-hacker security systems. But break down what they're doing and how they're doing it, and you see that all they do is nothing but drudgery, repeating and repeating with minor changes until they break in. There is nothing at all intelligent about what they do, and especially the way in which they do it. If they *do* manage to break a code, it's usually the result of a freak accident. Certainly not the product of any intelligence on their parts.

Hackers are morons with computers. They've got nothing else to occupy their minds, they're hungry for a little notoriety, and for my part, they should be treated as exactly what they are—crooks. There's no redeeming quality at all in them, they are *not* to be admired, and what they're doing hurts all of us.

How? I saw the same thing happen in amateur radio, later in CB. The good guys have to take the heat for the bad guys. Some guy with a signal squirter louses up every TV in the neighborhood, and any ham that tries to put up an antenna gets dirty looks from the neighbors.

It's the same with computers. If your neighbors know you have a computer, and they see the news stories about what the horrible hackers are doing, you're going to be painted by the same broad brush.

You may have a friend who hacks. If you do, do him a favor. Redirect his thinking into something more substantial. Get him involved in baseball, or stamp collecting, or introduce him to a girl.

Just get him away from his computer.

Byron G. Wels

Byron G. Wels
Editor

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LETTERS

Can Someone Help?

I own a Timex 1000 and a TVRO Earth Station. I'm searching for a program to plot stationary satellite positions from different parts of the U. S. I'm sure lots of **your** readers would be interested in a program such as this.—William Scott, Manteca, **CA.**

Bill, that sounds like a great idea! I'll refer it to our Software Review Editor, and if he can't come up with something, perhaps one of our readers can.

Archival Programs?

I don't know if anybody has ever done this before, but I've put my family tree on a disc, along with some personal annotations and I'd like to store this for posterity. How can I protect that disk?—Martin Resnick, St. Paul, MN.

We've never heard of this before Martin, so all we can do is make some suggestions: Begin by using the very-best quality disk that you can buy, and then wrap it in aluminum foil twice. The second sheet covers the wrapped and folded areas of the first sheet. This should help protect against stray magnetic fields. Put it between sheets of heavy cardboard to protect it from bending, and place it in an envelope sealed with heavy tape. Add a few packets of silica gel too. And good luck!

Understanding guy

I understand that mistakes can happen, Lord knows I've made my share too. But how can a reader tell if there's a mistake in the project he's planning to build from a magazine? It isn't just your magazine—it happens in all of them! Is there a way to protect against this?—Roger Touhey, Sioux Falls, SD.

Roger, thanks for being so understanding. Yes, authors can make mistakes, editors can let something slip, the proofreaders might not catch an error, and typesetters have been known to hit the wrong keys occasionally. Errors do creep in, despite our best efforts. But it doesn't happen as often as you might think, for we do try to be careful! One way is to save the "hot project" for a couple of months and watch the magazine for corrections.

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

COMPATIBLE VIDEO I/O BOARD, model *DT2803,* is a video frame-grabber and display board for the IBM PC and PC/XT. The model *DT2803 captures a 256 × 256 × 6 black-and-white image, and the R-G-B output handles 64 colors × 64 intensities and includes cursor control. In combination with the Videolab* software package, the model *DT2803* is ideal for applications in industrial robotics, inspection, and assembly, as well as medical imaging and graphic arts.

The *Videolab* package is an easy-to-use software for real-time video digitization and display with the DT2803. It is divided into two major sections: Videotutor and Videosub. Videotutor is an interactive, command-driven tutorial program that allows first-time users to become familiar with the model *DT2803* video I/O board within a user-friendly programming environment. Videosub is a comprehensive

CIRCLE 81 ON FREE INFORMATION CARD

library of subroutines for user-defined applications programs; callable from BASIC (interpreted and compiled), C, PASCAL, and FORTRAN, Videosub supports all the functions of the model *DT2803.*

The model *DT2803* board is shipped complete, with a comprehensive user manual and demonstration diskette, including sample programs. The single-unit price for the model *DT2803* is $1495.00. Videolab is shipped on a single-sided, double density diskette, and includes a comprehensive user manual; the price is $995.00.—*Data Translation,* 100 Locke Drive, Marlboro, MA 01752.

PROTOTYPING BOARD, the *eZ Card,* is a blank circuit board for computer hobbyists or engineers who wish to build a prototype board according to specific design. The board provides the means to interface prototype circuitry for the IBM-PC with several features. A switch-selectable address decoder frees the user to concentrate on design. Selector switches permit up to eight boards to be installed in a single PC system.

Two areas are available for building prototype circuits on this large, full-slot sized board, one of which is situated for installation of I/O connectors. The larger prototype area consists of a grid of over 2,300 plated-

through holes on 0.1-inch centers, suitable for installing over 60 wire-wrap sockets.

CIRCLE 22 ON FREE INFORMATION CARD

The *eZ Card* uses sockets for all buffer IC's and a gold-plated edge connector for maximum reliability of operation.. A mounting bracket is provided for permanent installation into the PC system housing. The board comes with documentation that includes experimental circuits and related basic application programs for each circuit. It is priced at $89.95—$5.00 shipment from stock to four weeks —*Sabadia Export Corporation*, PO Box 1132, Yorba Linda, CA 92686.

DISK DRIVE, the Commodore *SFD 1001*, is enclosed in a 1541-sized case and has a one-megabyte storage capacity on a double-sided, double

CIRCLE 23 ON FREE INFORMATION CARD

density format. A utility disk with 64 and 8032 utilities is included with the disk, and an optional serial IEEE connector and cabeling is available. The *SFD 1001* is priced at $399.95—*Progressive Peripherals & Software, Inc.*, 2186 South Holly, Denver CO 80222.

PERSONAL-COMPUTER MODEM, the *IntelliModem EXT*, is a standalone 300/1200 baud communications system suitable for use with *any* serial RS232-equipped computer or terminal. It features an exclusive voice-insert capability, which allows use of an ordinary phone to add integrated voice to a personal-computer work station. The user may talk and listen, or send and receive data without having any need to hang up and redial.

A front-panel multicolor line-quality bargraph display dynamically monitors the telephone-line condition. Call-progress detection lets the modem electronically sense telephone-system

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signals such as Busy, Dial Tone, Remote ringing, and Voice, and display those conditions on the computer screen. Thus, the user always knows what is happening as the call progresses.

The *IntelliModem EXT* is priced at $499.00—*Bizcomp*, 532 Mercury Drive, Sunnyvale, CA 94086.

EDUCATIONAL PROGRAM, *In The Chips*, is available for owners of IBM PC, PCjr., and Commodore 64 home computers. It challenges both children and adults to create a profitable software business. An initial investment of $100,000 is used to develop, inventory,

CIRCLE 25 ON FREE INFORMATION CARD

price, and advertise computer games. Using the joystick, players manipulate assistants, who go from building to building carrying out orders. At the end of each quarter, a balance sheet appears so that players can see how well their companies are doing.

In The Chips is priced at $29.95.—*Creative Software*, 230 East Caribbean Drive, Sunnyvale, CA 94089.

RADIATION SHIELD, the *Eye-Guard*, is a device that protects people from the glare and radiation that is emitted

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from video-display terminals (VDT's). The anti-glare screen is made from nylon netting while the anti-radiation shield is made with lead-impregnated acrylic. (*Eye-Guard* contains 30% lead by weight.)

Eye-Guard is affixed to the face of the terminal with Velcro tabs. It eliminates glare and cuts off all the X-rays, microwaves, and ultraviolet waves that VDT's emit. (It is estimated that a worker who sits in front of a black-and-white terminal for 35 hours per week could receive the equivalent of 30 chest X-rays in a year's time.

The Eye-Guard is priced at $129.95, and comes with a 100% money-back guarantee that it will stop even the worst case of eye fatigue resulting from unshielded VDT's.—*Langley-St. Clair Information Systems, Inc.*, 132 West 24th Street, New York, NY 10011.

DISK MARKERS, the *Diskribe* (shown) and the *Label Pen* are designed specifically for use on computer software. The *Diskribe* can be used directly on computer software disk sleeves for safe identification and reference. The ink is quick-drying and permanent, and the markings do not affect information on the disk itself. The *Label pen* is designed for use on slick-finish and other hard-to-mark labels currently being used on disks, diskettes, and VCR cassettes. The fine point and high-intensity permanent ink makes writing easier to read on small labels.

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The *Diskribe* is priced at $2.50; the *Label Pen* costs $1.00.—*Sanford Corporation*, 2740 Washington Boulevard, Bellwood, IL 60104.

SOFTWARE REVIEW

Seekeasy

SEEKEASY is a free-form database designed for rapid storage and retrieval of randomly-entered reference information.

Unlike conventional data management programs which cannot search using *keywords* having little relationship to the original data entries, SEEKEASY can locate entries if only a few characters of a *keyword* are correct.

For example, assume that it was possible to load a conventional database with randomly entered data, and over a period of time you had entered many references for an article on test equipment. Now you want to extract the data on a particular meter that you key in as *Simsun*. To the typical database there is no way it will know you mean *Simpson*. But a free-form database such as SEEKEASY will locate the closest matching string anywhere in the file, and in a few seconds it will match *Sim* to *Simpson* and extract the correct information.

In searching for data SEEKEASY doesn't care care if the original entry, the search criteria, or both are incorrect. Somehow, it will locate the data quicker than you can look up the correct spelling of a *keyword*(s) in a dictionary because it attempts to match every possible string in the keyboard entry to every conceivable string in the data record. Assume you are using SEEKEASY as an electronic Rolodex and entered the continuous string record:

Buck Rogers, Colossal Mfg., 456 Third St., Muggersville, NY 11217, 1-212-555-5555. Manufactures gizmos.

You need to purchase gizmos but can't remember anything about the manufacturer. SEEKEASY will locate the data even if you make a mistake and key in *giztes* instead of *gizmo*. It might be buried in a screen display containing 99 other items with the string *giz*, but it will be on the screen.

While *giz* is a partial string, even a complete string locates many matched entries. If you wanted to extract the data on a *drill bit* and only entered *bit* as the *keyword*, SEEKEASY will locate *drill bit, drillbits, bridle bit, bitter, bite, illegal* and *illness* (the *ill* matches); it will locate the entry for your friend Bill (the *bil* match). SEEKEASY will often come up with a list of matches which have no relationship to what you're looking for, but the desired data record will be in the list. The greater the degree of matching in one or more *keywords* the closer the desired data will be to the top of the listing. In the above instance, *Bill* would be well down on the list of matches.

The only limitation on matching are one and two letter words—they must be an exact match. An *A* cannot locate a *W* and *at* will not locate *an*. Other than these conditions anything goes.

Regardless of the number of records in a file—it might be thousands—SEEKEASY displays up to a maximum of 100 records at the rate of seven records per screen: pressing *RETURN* scrolls the next seven onto the screen. The speed with which SEEKEASY can locate a data record depends on the length of the data file and the storage media. Floppy disks are searched at 5-KB/second; hard disks at 7-KB/second, and RAMdisk at 10-KB/second. Dump a full 360-KB floppy data disk into a RAMdisk the longest it takes to locate a data record is 36 seconds.

SEEKEASY data records are limited to two lines of 155 characters. Records are prepared directly by SEEKEASY's own internal and somewhat rudimentary word processor, with editing done through the cursor positioning keys. While the simple editing commands don't make for much of a word processor, it does what's needed and beats having to prepare files with a separate word processor. Pressing *RETURN* enters the record in the data file and resets the program for the next data record, with the previous entry displayed at the top of the screen so the user can keep track of the entered records.

Old records can be deleted. A special *Check File* mode displays the free space on a disk in available characters, and the number of characters in the active data file. When the disk holding the data file is almost full, SEEKEASY prints warnings on the bottom line of the screen during store and edit operations. If the user insists on ignoring the warning (about 5-10 more records) SEEKEASY refuses to store additional records until more disk space is made available.

While the supplied manual generally refers to a single data file, the user can create several individual data files on the same disk, of which several or all can all be merged into larger files if desired.

Finally, SEEKEASY can find any 7/8 bit ASCII character in any data, .COM or .EXE file. If it's in a disk file and it's in ASCII SEEKEASY will find it.

SEEKEASY is entirely menu driven. A CONTROL-T prints hardcopy of either the screen display or the entire datafile.

That's all there is to SEEKEASY. There are no complex commands, no unusual text files, and no structure of any kind. But it is extremely fast and convenient. In fact, Seekeasy is so fast and easy to use that it can be learned from a short *doc* disk.

SEEKEASY, Price $90 postpaid U.S. and Canada, $18 for demo disk (refunded on purchase). Correlation Systems 81 Rockinghorse Road Rancho, Palos Verdes, CA 90274. Available for PC-DOS and MS-DOS Requires: DOS 2.0 or higher, 128K of RAM, One or more floppy drives, Monochrome or color monitor.

DIGITIZING TABLETS

All you ever wanted to know about digitizing tablets—and didn't know who to ask!

MARC STERN

One of the long-sought developments in the world of microcomputers has been the marriage of hand input with the small-computer system. Hand input makes a small computer system more flexible. A hand input device allows anyone to work as if using a pen and paper.

In the last two years, this has come about thanks to the digitizing tablet. Manufactured by companies such as Koala and Pencept, Inc., digitabs take the theory of dynamic character recognition technology, an outgrowth of artificial intelligence research, and put it into practice.

A device such as Pencept's *Penpad* or Koala's *Koalapad* is actually a digitizer with a stylus or pen and a connection to its host computer. Such a device can easily send drawings, special commands and cursor controls to a host IBM Personal Computer or compatible, such as the Compaq. The *Penpad* can also double as a touch-pad or mouse.

Older input methods

In the past, users relied on optical character recognition devices (OCRs) or bar-code readers to input handwritten data from a sheet of paper into a small-computer system. While these methods of handling data-capture are fast compared to more laborious manual input methods, they still aren't totally acceptable.

One drawback with OCRs is that the hand-printing has to be recognizable to OCR optics or the input is unusable. Users receive special training to ensure their hand-printing styles match OCR specifications. OCRs also force users to invest in reading devices that are expensive and difficult to maintain in some environments. Finally, OCRs are incapable of instant information updates.

Instead of direct entry into a system, the information must first be printed on a special form and then read into the system for processing.

Bar-code readers can speed information input, but, like OCRs, need special equipment and software. Bar-code readers require a light wand or pen to read coding strips called Universal Product Codes (UPCs)

FIG. 1—UNIVERSAL PRODUCT CODES are one method of data input. Special readers interpret the strip and convert the information into useable data for a computer.

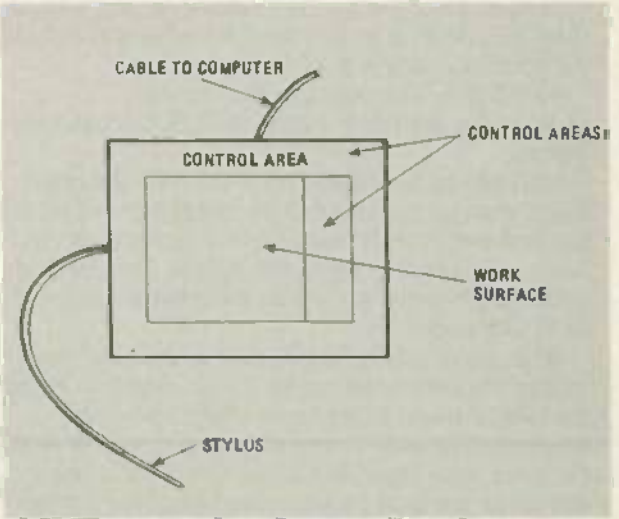


FIG. 2—WORKING WITH A STYLUS, a Digipad will turn written or printed information into data on a screen.

(See Figure 1.) These readings are interpreted by software that recognizes each UPC strip and determines its significance. Any time UPCs change, the reader's software is updated. For some users, bar-code readers are alternatives to OCRs.

Digitizing tablets offer many advantages over both OCRs and bar-code readers. Like a bar-code reader, they allow quick information input to an IBM PC's 8088 central processor, but, unlike a reader, they have greater flexibility in the variety of input, much like an OCR. Although digipads (DIGitizing penPADS) are more sophisticated than either device, they boast a simple design, consisting of a writing tablet, pen or stylus, an interface board that slips into one slot in the PC and the software. (See Figure 2.)

Digipads are as easy to use as applying pen to paper. The computer keyboard is replaced by the tablet and stylus—attached to it by a cord—resembling the traditional clipboard-and-chained-pen. Digipads can recognize a variety of handwriting and can acknowledge capital letters A-Z, numerals 0-9, and other characters. Some pads, such as the *Penpad*, use fixed height reference points to determine if the input is capital or lowercase. *Penpad* assumes lowercase when uppercase letters are written at half-height (Fig. 3). These devices also handle deletions with special

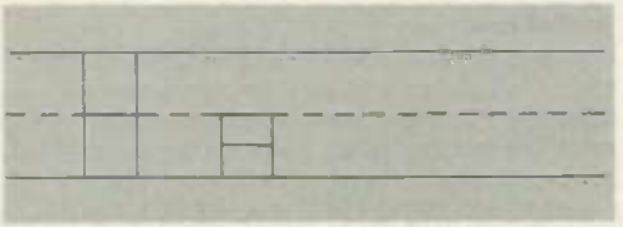


FIG. 3—IN MOST CASES, letter height determines a letter is capitalized or is lower case.

command characters or the input can be overwritten, as with a keyboard and screen. Digipads can enter calculations, documents, forms and more directly into the computer, bypassing third channels.

Digipads function as graphics digitizers by providing the computer with information about the location of the stylus relative to its surface. This is translated into a specific address in the computer's memory; the cursor is then moved to that location on the monitor. So it is possible to send freehand drawings or tracings such as map contours or circuit drawings to a host PC. You can use pre-prepared or hand-drawn forms and turn them into quality graphics with a few sweeps of the pen across the tablet's face. The digitizer's built-in intelligence blends both graphics and hand-printed text to create presentation-quality material.

Digipads can also function as touch pads. A touch pad is a low-resolution digitizer that recognizes when the stylus touches specified areas on its surface. On a device such as the *Penpad*, the pen is equipped with a pushbutton that acts as a trigger to transform it into a "mouse that writes." The "mouse-mode" offers quick cursor movement to any spot on a page, by drawing a line with the pen in the appropriate direction on the tablet. As it is moving, the *Penpad* analyzes penstrokes as they are being made, identifies the characters being formed and presents them to the host computer in a manner indistinguishable from routine keyboard input.

Making it work

The digipad recognizes characters that vary greatly in form through dynamic character recognition (DCR) technology. Using the *Penpad* as an example, the designers used both common generative and perceptive OCR rules to create the algorithm that allows *Penpad* to work. The generative rules deal with character formation; the perceptive rules describe the way people see characters. The first concept is based on set patterns of character generation (for example, the letter A is usually formed in a similar manner by most persons); while the second relies on the fact that most persons generally perceive letters or graphics in the same manner.

In many aspects, the digipad acts as a computer terminal, except that the writing tablet and pen, which form the basis of the unit, replace the keyboard. It supports a high enough X-Y resolution (200 points per inch) as well as a high enough point-sampling rate (200 points per second) to handle the rapid movements a user makes when writing with quick short strokes, as in forming small characters, or when using letters with long strokes (capital letters).

A digipad usually employs its own microprocessor—the *Penpad* uses an MC-68000—whose speed is fast enough to respond to up-and-down pen movements up to eight times per second.

A digitizing tablet is capable of capturing as much as 2,000 bits of raw data and this data must be processed before it is used by the computer. It is at this point that Read-Only Memory (ROM)-based firmware takes over. It preprocesses the raw data, removing unimportant hooks, loops, swirls and extraneous electronic noise. It standardizes the size of the characters that are printed on the tablet. Further processing cleans the raw data making it look like ink images on paper as closely as possible.

At this point, the generative and perceptual rules used by the device are brought into play. The algorithms used in the software determine which letters the data represent. The software must analyze the structure of the input and select the letter the structure represents. For example, the numeral 2 is almost always formed starting at the top, and this is the only way the software will recognize it, even though a normal-looking 2 might be formed starting at the bottom or from any other position. See Figure 4.

Systems revealed

If you look at a typical digipad, you will see it's a little larger than the standard three-ring notebook. The writing surface is subdivided into grids, an example of which might be six boxes per inch horizontally and four per inch vertically. The digipad's surface is programmable and allows the user flexibility in resetting these parameters. A user can also define some areas of the digipad's surface to accept only certain characters and some digipads also are capable of

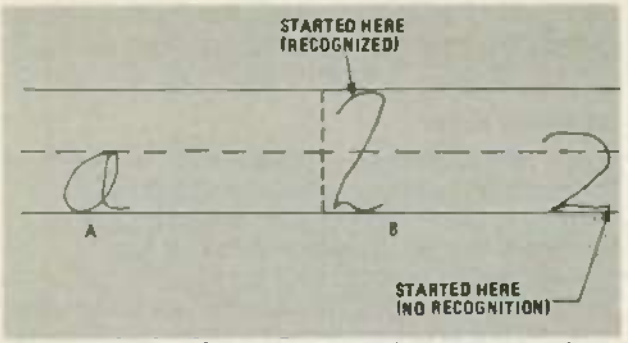


FIG. 4—A DIGIPAD'S ALGORITHM can interpret hand-written data. Since letters are formed in the same manner, the program will recognize the loops of an "A." Likewise, it will recognize a "2" which is usually started at the top. If somebody starts a "2" at the bottom, the program can't recognize it.

handling macros.

(Macros are programmable routines in which one stroke handles several functions. Suppose you have several complicated command sequences in a program which also has macro capability and you want to streamline things. Using the program's macro capability, you can establish a one- or two-key sequence to handle the multi-command sequence by opening the macro and entering all the complicated commands you must. When you are finished, you close the macro and either assign it a name or key and every time you need the complicated command sequence, rather than hitting many keys, you only have to hit one and the program handles it for you.)

Using a digipad's macro capability lets you transmit a string of user-defined characters at the touch of the stylus.

If you look at the surfaces of some digipads, you will see a control area. This area allows you total control of editing and alphanumeric, as well as program functions. It acts in place of the keyboard.

To work with an IBM PC or compatible system, you or the company providing the system will have to write a driver routine. It is this program which lets the digipad act as the "front end" of your system. With the PC, it's easy, because you can take advantage of DOS 2's (and higher) CONFIG.SYS routine. With this routine, you open a small text file and input the following line DEVICE = XXXXX and then close the file. You install this file on the disk you are using and the PC will look for it every time you boot your system. This structure is enough to tell the PC to install the digipad. The CONFIG.SYS routine also eliminates the need to write complicated patches to the operating system, although some manufacturers may do that for you in the software they provide for their pad.

Typically, a digipad is driven by a microprocessor. Whatever microprocessor is used, it gives the digitizer its capability. In an IBM-PC this controlling circuitry interfaces with the IBM bus through one of the expansion slots on the motherboard. This add-on board will contain the microprocessor and any ROM-based firmware needed by the system to handle its chores. For instance, the *Penpad*'s 68000 microprocessor is on this board, as is its 128K of ROM firmware, 128K of Random-Access memory for user input and 4K of nonvolatile memory used to store format and command information, as well as parameters for setup as a terminal. Input and output to the digipad is handled as straight ASCII information.

A typical digipad can be interfaced as either a serial or a parallel device. As a serial device, it can be made functionally equivalent to an RS-232C port—as is done with the *Penpad*—without tying up the port itself. The developers will locate the device's input at the memory address of a serial port and the system thinks there is a serial port attached, in reality, any other serial devices are free. The IBM-PC supports up to three serial ports and a digipad can reside at any of those locations. Usually, it will be port 2 or 3 because port 1 is taken up by a communications card.

As a parallel device, it is functionally equivalent to a peripheral such as a parallel printer and will reside at the printer's location in memory. Of course, a parallel device is capable of communicating at higher speeds than a serial device because of the parallel data stream used, but, a serial device can be used a greater distance away.

Typically, a digipad will operate in parallel with the keyboard and you can usually use it with the keyboard installed.

Implications

A digipad will eliminate redundant keyboard input in many situations where data entry forms must be rekeyboarded or read into a computer system through an OCR. It provides instant, real-time data updating and will increase system efficiency and throughput.

Further, it will prove attractive in graphics, scientific or electronics work. In graphics, it gives a computer user the ability to design attractive lettering or figures quickly and easily, without the necessity of using a keyboard. It frees the designer to sit and use a device much like a pen and paper and the designer will be able to use the freeform methods he's used to. The same is true of the computer user who wants to design his own graphics output. In a scientific atmosphere, a digipad user can enter equations and computations from a "scratchpad" and could have the new information displayed immediately. An electronics enthusiast will be able to design a circuit on paper and have it immediately translated into a high quality output. If he makes any changes to the circuit, they will be displayed immediately.

The digipad will prove very attractive in situations which don't lend themselves to transition to keyboards or terminals. Data entry, in these environments, often lends itself more readily to the freeform modes allowed by handprinting, rather than the rigid standards imposed by a traditional keyboard. Often simple inventory can be handled more easily by a simple form than by a computer terminal.

Digipads provide an easy interface to computers and their capabilities. It speeds data entry time and allows much more freedom than a traditional keyboard. In the future, such devices will become more and more common for more users.

COMPUTER BOOKS

For more details use the free information card inside the back cover.

MICROPROCESSOR BASED ROBOTICS, By Mark J. Robillard. Howard W. Sams & Co., Inc., 4300 W. 62nd Street, Indianapolis, IN 46268. 220 pages including index. 8½ × 11 inches; softcover; $16.95.

If you want to learn more about intelligent machines, this book serves as an excellent introduction to the subject. Designers, experimenters, and students will find the work equally valuable. Robillard disects robotics into their logical, scientific areas of engineering, and shows how they can be made to achieve pseudo lifelike mechanization to control such things as mechanical, electrical, electronic or computer-based operations.

He covers specific subjects within each technical discipline and explains in detail, each robot-element of the construction. Many hands-on projects are included, making this an ideal classroom text.

CIRCLE 31 ON FREE INFORMATION CARD

SOFTWARE MASTER FOR PFS: By Ted Leonsis and LIST Magazine. Warner Software/Warner Books, 666 Fifth Avenue, New York, NY 10103. 221 pages, 8 inches × 9¼; softcover; $14.95.

Software Master for PFS offers reviews of each program based on critical and lengthy interviews with actual users in the field. With added editorial comment on each program's documentation and tutorials by the authors, the result is useful and reliable.

CIRCLE 32 ON FREE INFORMATION CARD

A HOBBYIST'S GUIDE TO COMPUTER EXPERIMENTATION: By John D. Lenk. Prentice-Hall, Inc. Engiewood Cliffs, NJ 07632. 283 pages including index. 6 × 9¼ inches; hardcover; $25.95.

John D. Lenk is a long-time author in the electronics field, and in this work, it's easy to see why. The book is complete, innovative, and fascinating reading that will prompt you to attempt some of the experiments as soon as you put the book down. Everything is clearly explained, and lucidly illustrated with easy to follow diagrams and photographic illustrations. Prentice-Hall, the Publishers, have done the work proud.

CIRCLE 33 ON FREE INFORMATION CARD

VIC 20 USER GUIDE: By John Heilborn & Ran Talbott. Osborne/McGraw-Hill, Inc., 2600 Tenth Street, Berkely, CA 94710. 250 pages including index, 6½ × 9 inches; softcover; $14.95.

If you own or plan to own a Commodore VIC 20 you'll find that this guide is an almost essential tool. You'll find detailed operating instructions, both for the basic computer and its peripherals.

CIRCLE 34 ON FREE INFORMATION CARD

INTERFACING TO S-100 IEEE/696 MICROCOMPUTERS: By Sol Libes & Mark Garetz. Osborne/McGraw-Hill, 630 Bancroft Way, Berkeley, CA 94710. 321 pages including index, 6½ × 9¼ inches, softcover; $15.00.

The popularity and wide acceptance of the S-100 IEEE/696 Bus warranted the need for this new title. The book helps users expand the utility and power of their systems. It describes its mechanical, functional and electrical design along with bus interconnections, bussing techniques and interfacing to RAM, ROM and the real world. This is a must for any designer involved with the S-100 bus.

CIRCLE 35 ON FREE INFORMATION CARD

FREE SOFTWARE FOR THE IBM-PC: By Bertram Gader & Manuel V. Nodar; Warner Books, 666 Fifth Ave., New York, NY 10103. 466 pages including glossaary. 5¼ × 8 inches, soft cover; $8.95.

If you have or contemplate purchasing an IBMPC, then this book can quickly pay for itself. It's a listing of more than 600 software programs that you can get free via telephone hook-up. All are in the public domain, so there are no legal problems in availing yourself of them.

CIRCLE 36 ON FREE INFORMATION CARD

COMPUTER COMMUNICATION TECHNIQUES: By E. G. Brooner & Phil Wells; Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268. 142 pages including index. 6 × 9 inches, soft cover; $15.95.

This valuable text, fully illustrated with photographs and line drawings, will tell you how to get your computer to "talk" to another computer, what hardware and what software you need, how to tell what will or won't work with your computer. How to connect your computer to telephone lines, the "standards and protocols" used by information services and time-sharing networks, how to access and use information services such as CompuServe and The Source. How to use Videotex and teletext systems and how they operate.

CIRCLE 37 ON FREE INFORMATION CARD

8088 ASSEMBLER LANGUAGE PROGRAMMING:THE IBM *PC*: By David C. Willen & Jeffrey I. Krantz; Howard W. Sams & Co., Inc. 4300 West 62nd Street, Indianapolis, IN 46238.235 pages including index. 8 × 9½ inches, soft cover; $15.95.

This well-illustrated book teaches you how the IBM Personal Computer works, all about the 8088 microprocessor and other important computer components. ◀CD▶

CIRCLE 38 ON FREE INFORMATION CARD

CASSETTE-TO-CASSETTE INTERFACE

Here's a way to make bulk copies of programs and save all that tedious work.

BILL TULEJA

Making back-up copies of programs on tape cassettes can be a real chore. The program must be loaded into the computer from your original cassette, then the blank back-up cassette must be swapped for the original and the program saved on the back-up. This process must be repeated for each program on the original. The circuit described here permits bulk back-up copying. It is an interface circuit that allows two Commodore cassette tape recorders to be connected for directly reading and writing.

The connection between a Commodore computer, and its data cassette recorder is shown in Figure 1. This shows the cassette recorder's cable connector as it would be seen if you held it looking into the hole in the connector housing with the contact fingers at the top of the hole. The edge-connector of a Commodore computer is also shown as it would plug into the cassette cable's connector socket—with the contacts on top of the board. Contacts are identified by the numbers 1 through 6 along with their function names and signal directions (the computer supplies power and ground to the cassette recorder so the direction of both of these signals is from the computer edge-connector to the cable connector attached to the recorder). Connections to pins 1, 2, 3 and 4 are needed to read data out of the data cassette recorder and connections to pins 1, 2, 3, and 5 are needed to write data into the recorder.

The Commodore cassette tape recorder does not use the two-frequency FSK (Frequency Shift Keyed) system found on many other computers, but uses a digital pulse sequence to store data. The interface shown in Figure 2 is a digital circuit. Using an external power supply, it provides the DC voltages and logic level signals needed to interface two Commodore data recorders.

The most important part of this circuit is IC3—a 74LS14 hex Schmitt-trigger inverter. Its main function is to accept a READ input on IC3 pin 1 and produce a WRITE output on IC3 pin 2.

The circuit (see Fig. 2) is powered externally by 9V to 15V brought into terminal strip TS1. Switch S1 provides power control so the external power supply does not have to be turned on and off. Diode D1 protects the circuitry against reverse polarity if the power supply is accidently connected backwards to TS1. Capacitor C1 provides filtering for the inputs of the voltage regulators IC1 and IC2. IC1, R1 and R2 produce +6V for the cassette recorder motors. IC2 produces +5V for the logic in the cassette recorders and the circuitry on the interface board. Since IC3 contains six inverters, it was convenient to provide buffered outputs for driving LEDs. LED1 is on when connector pin 4 of the READ cassette is inputting a logic low. LED2 is on when the READ cassette is inputting a logic high. Test points TP1 and TP2 provide a buffered output for connecting an audio amplifier or oscilloscope to monitor.

Construction

The prototype was assembled on a plug-in

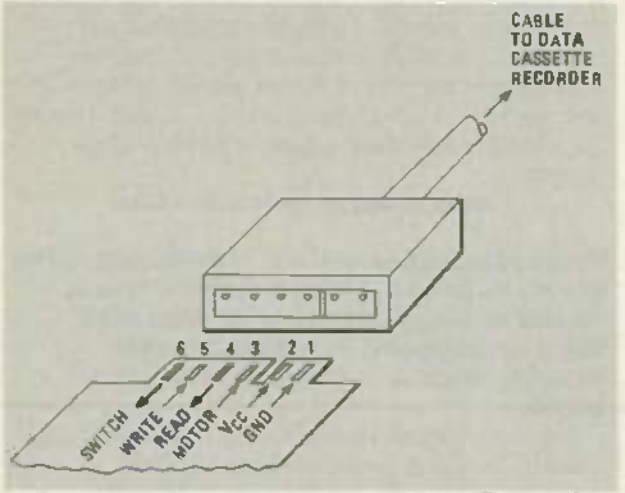


FIG.1—COMPUTER CIRCUIT BOARD edge-connector and cable connector from data cassette recorder showing pin numbers, function names and signal directions.

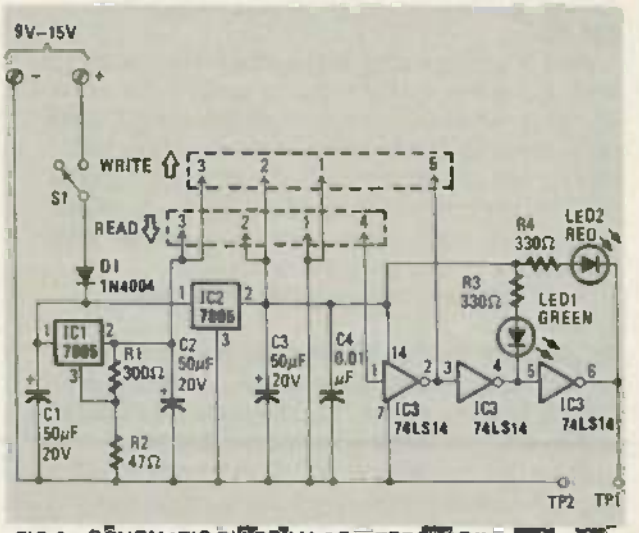


FIG.2—SCHEMATIC DIAGRAM OF INTERFACE through which two Commodore data cassette tape recorders can be interconnected to read out of one and write into the other.

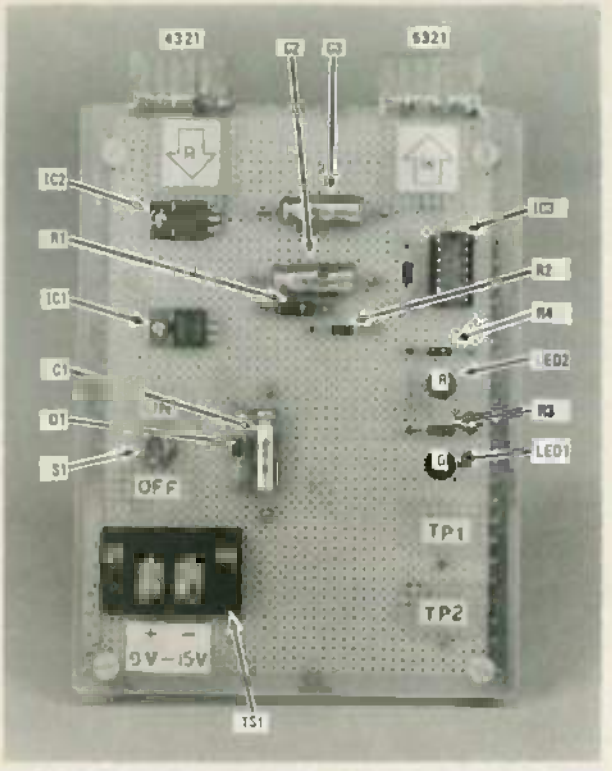


FIG.3—COMPONENT LAYOUT for point-to-point wiring of the interface board.

perfboard having a 22-pin edge connector with 0.156-inch (5/32-inch) spacing between the centers of the connector pins. A coping saw was used to trim the circuit board edge connector to accommodate the cable connectors of two data cassette recorders. A slot must also be cut between pins 2 and 3 so the keyed cable connectors will fit on the circuit board.

Parts layout is not critical. Figure 3 identifies the component locations on the prototype. The components were mounted on flea clips and point-to-point wiring was used. It is advisable to use a 14-pin DIP socket to avoid soldering directly to the pins of IC3. Another perfboard (without an edge connector) was fastened to the bottom of the interface board, using

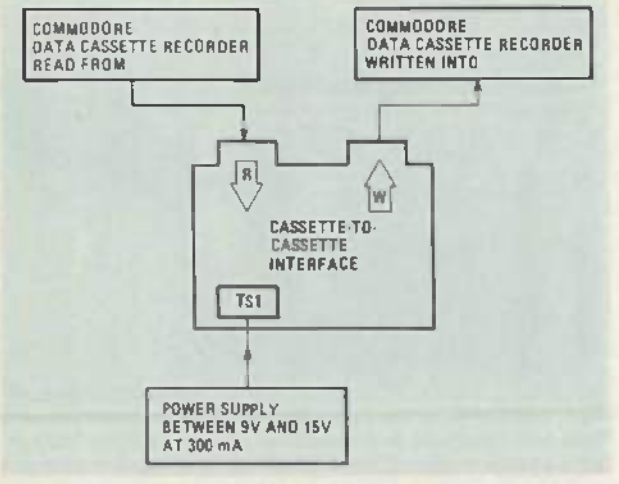


FIG.4—CASSETTE-TO-CASSETTE Interface showing connections to power supply and data cassette recorders.

spacers to protect the wiring side of the board.

Testing

After construction is completed, check all wiring and verify that polarized components like D1, C1, C2 and C3 are installed correctly. Leave IC3 out temporarily

PARTS LIST

Resistors
All resistors are 1/4-watt 10% unless otherwise indicated
R1—300 ohms ± 5%
R2—47 ohms
R3, R4—330 ohms
Capacitors
C1–C3—50 uF, 20 volts electrolytic
Semiconductors
D1—1N4004 Diode
LED1—Green LED
LED2—Red LED
IC3—74LS14 Hex Schmitt-trigger
IC1, IC2—7805 5-volt regulator
Miscellaneous
Plug-in perfboard with 22-pin edge connector with 0.156-inch spacing between centers of connector pins, 14-pin DIP socket, connectors, terminal strip, miniature toggle switch, mounting hardware.

and connect a power supply to terminal strip TS1 that can provide between 9V and 15V at 300mA (see Fig. 4). Close the power switch S1 and measure the DC voltages between pins 1 and 3 of both READ and WRITE connectors—pin 1 is the ground and pin 3 should be at +6V if IC1 is wired properly. Also measure the voltage between pins 1 and 2 of the connectors—pin 2 should be +5V if IC2 is working correctly. Measure the voltage between pins 7 and 14 of the socket for IC3—pin 7 is ground and pin 14 should be +5V. Open S1 and check that all voltages decrease to 0v.

Plug in IC3 and close S1 again—the red LED2 should be lit. Measure the voltage between pins 1 and 5 of the WRITE connector—pin 5 should be less than +0.5V. Use a clip-lead to short pins 1 and 4 together on the READ connector while still observing pin 5 on the WRITE connector—it should now measure more than +2.7V, the red LED2 should be off and the green LED1 should now be lit.

Turn S1 off and connect the READ and WRITE data cassette recorders to the interface board as shown on Figure 4. Insert your master cassette into the READ recorder and a blank cassette into the WRITE recorder. Turn S1 on, push RECORD and PLAY on the WRITE recorder and then push PLAY on the READ recorder.

A small audio amplifier and speaker can be connected across TP1 and TP2 for more convenient monitoring. A high-pitched tone appears on a cassette tape at the beginning of each program. This tone is used to synchronize the computer to the tape during a read operation to allow for variation in tape speed during a read from tape cassette. The sound of data which follows the tone can be described between a hiss and a buzz.

DELUXING THE RADIO SHACK COLOR COMPUTER

AFTERMARKET UPGRADE AND RETROFIT ACCESSORIES make Radio Shack's Color Computer into a full-blown business system.

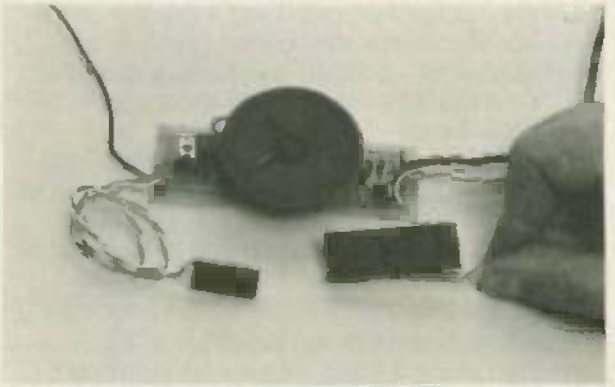
Aftermarket retrofits can upgrade the CoCo to a full business system.

Herb Friedman

While most home and family computers can be used for little more than games because they are simply too slow or inconvenient for "business use," Radio Shack's Color Computer—affectionately known as the CoCo—can be easily retrofited into a high performance system suitable for "serious" use. Since the CoCo has been a popular gift, chances are there's one tucked away on a shelf because the kids are tired of using it for games. This is the perfect time to upgrade the CoCo so it can be used for business applications—the "serious use."

If you do the upgrade with Radio Shack hardware the system will eventually cost more than it's worth—it would be less expensive to purchase a new "business" computer. But you can come out ahead of the game by using CoCo retrofit kits and components available from non-Radio Shack sources.

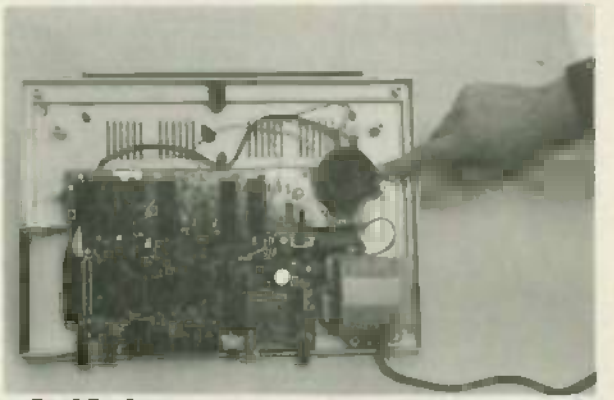
The photographs show how to install the most popular and useful retrofit and upgrades. The computer shown is the latest version of the basic $99 CoCo, the one with minimum BASIC and only 16K of RAM. Since Radio Shack continuously changes the CoCo's design, your model might be different from the model shown in the photographs. In particular, Radio Shack eliminates IC sockets, so certain "plug in" retrofits may have to be soldered in your CoCo.



THE FIRST THING YOU'LL NEED is a composite video output so you can use a conventional monochrome monitor. The Video Pal retrofit provides an external video output and an internal sound system. It is prewired to sockets for the CoCo's video and sound ICs. These components are soldered rather than socketed in the latest CoCo. Mark the wires carefully and unsolder them from the sockets. They will be soldered directly into the CoCo.

Four major upgrades

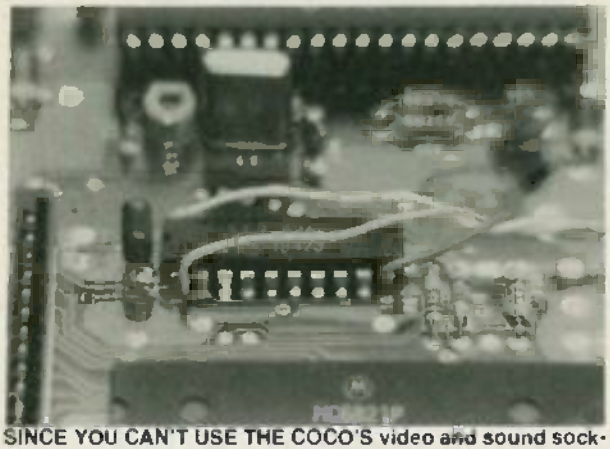
There are four major upgrades for serious use of the CoCo. The first one is a conventional composite video monitor output; the second is expansion to 64k RAM; the third is an upgrade of BASIC to Extended Color Basic; the fourth is the addition of a disk system. Because the CoCo's conventional TV receiver screen display runs out of resolution at about 50 characters, which makes word processing somewhat less than convenient, the composite video monitor output is probably the most important upgrade because it



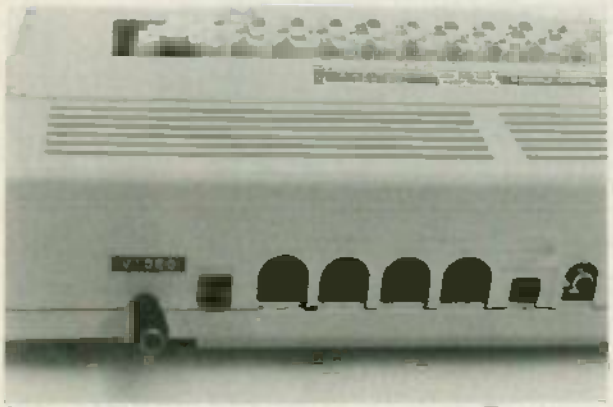
THE VIDEO PAL is too large and heavy to be mounted with tape, as suggested in the supplied documentation. Instead, flip it upside down and use RTV adhesive or caulk to secure it to the case directly in front of the power transformer. (Notice that the keyboard has been removed for protection.)

permits the use of a conventional wideband monochrome monitor that can display up to 80 razor-sharp characters.

Several composite output retrofit kits are available for under $30, The Video Plus Composite Video Interface (Computerware, Box 66, Encinatas, CA 92024) is about the size of a postage stamp and has separate output cables for video and sound. (The sound output can be connected to a small solid-state amplifier.) The Video Pal (RGS Micro, Inc. (Main Street, Derby Line, VT 05830)—the retrofit shown in the photographs, which



SINCE YOU CAN'T USE THE COCO'S video and sound sockets, the connections from the Video Pal must be tack soldered to the terminals of the video and sound ICs. We really mean tack solder: No fancy wraps around the terminals, and the connection is made using a needle-point soldering tip and just a touch of solder. Make certain there are no solder bridges across adjacent terminals.

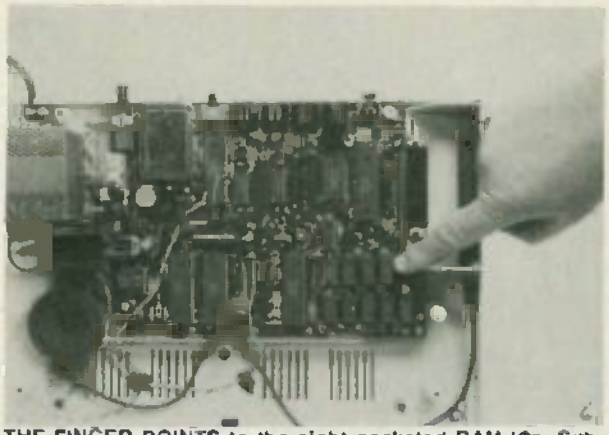


CUT A NOTCH in the rear of the cover so the shielded cable terminated with a phono jack can pass through. The video monitor output can be used simultaneously with the TV output.

also sells for under $30—has a small on-board amplifier and speaker which eliminates the need for an external amplifier.

The RAM upgrade.

64k of RAM is needed for both Extended Color Basic, a disk controller, and decent word processing capability. All you need to do to increase RAM from the supplied 16k to 64k is to substitute 4164 RAM chips for the eight existing RAM ICs and solder a wire across the "64k" solder pads at "J1," which is located at the lower left of the main circuit board. If you get the RAM chips from Spectrum Projects (95-13 86th Drive, Woodhaven, NY 11421) they'll provide RAM upgrade documentation for the various models of the CoCo. While it's easy enough to substitute the 4164s because

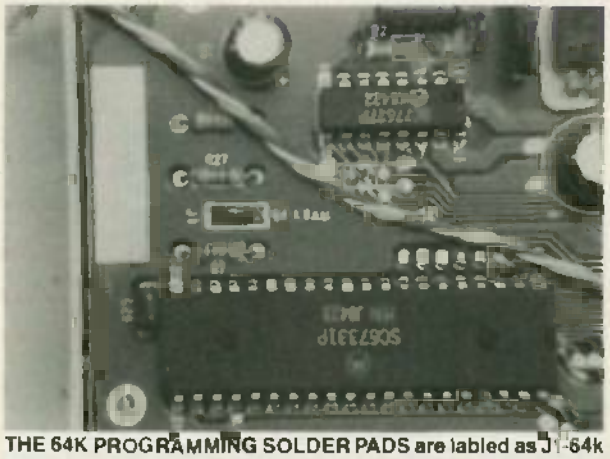


THE FINGER POINTS to the eight socketed RAM ICs. Substitute 64k 4164 RAM chips and short circuit the 64k programming solder pads.

the RAM is socketed, to avoid bending or damaging a terminal the use of an IC insertion tool is recommended. (Don't forget to wear a ground strap when handling ICs.)

Extended color BASIC.

Serious programming, some professional quality software, and a floppy disk system requires the computer to have "Extended Color Basic." A prewired socket for this upgrade is built into the CoCo: All you



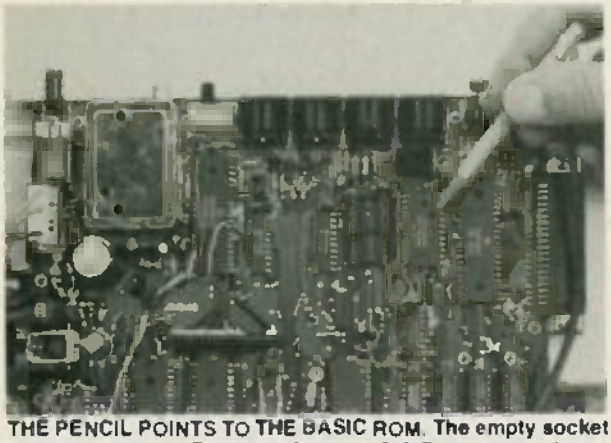
THE 64K PROGRAMMING SOLDER PADS are labled as J1-64k RAM. Just tack solder a small jumper across the pads to program the CoCo for 64k of RAM.

have to do is obtain the IC and plug it in. While Radio Shack stores supposedly sell the part, in reality it's not the easiest thing to get, and Radio Shack charges for an installation you can do yourself in about 60 seconds. (Ten seconds if you already have the cabinet open.) You can purchase the same Extended Color Basic IC with do-it-yourself installation instructions (how to plug it in) from Spectrum Projects and other aftermarket suppliers of parts for the CoCo.

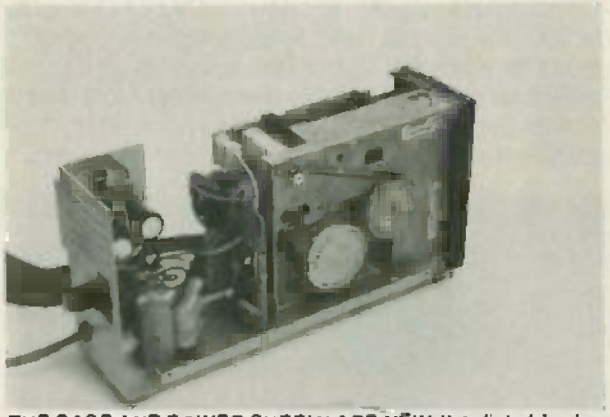
The Floppy disk system.

Finally, we come to a disk controller and disk drives. Any drive that is compatible with IBM, Radio Shack or Zenith computers can be used with the CoCo; in particular, the Shugart SA400, which is flooding the market at ridiculously low prices because it won't work with the newer business-quality computers.

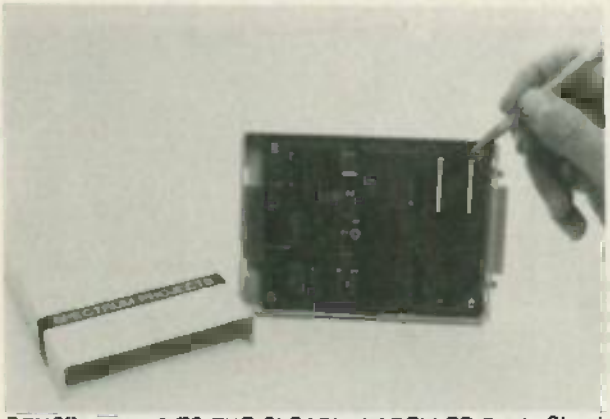
Combination disk drive cabinet/power supplies can be purchased for under $50 from Software Support, Inc. (One Edgell Rd., Framingham, MA 01701). If you use a presently owned drive, or one of the surplus models such as the SA400, you'll need to provide a disk controller. The best buy is Radio Shack's own controller, which as far as I know cannot be purchased independent from a package that also contains the first drive (Drive 0) except from Computer Plus (480 King Street, Littleton, MA 01460). Alternately, you can subsitute an aftermarket disk controller, but unfortunately, one of the best known non-Radio Shack CoCo controllers won't run some of the most popular business-quality software such as Telewriter-64 and most of the Elite line of software. However, other aftermarket disk controllers work well with all software because they actually include the same controller IC that Radio Shack uses. Also, the Radio Shack based controllers function directly with the 30 mSec. drives such as the SA400: The non-Radio Shack controller defaults for the newer mSec. drives and must be programmed for the slower drives. (A 30 Msec. controller works automatically with all drives from 30 to 5 mSec.) If you can't get Radio Shack's controller we suggest you get an aftermarket unit that uses Radio Shack's chip, or one that exactly duplicates the Radio Shack IC. The aftermarket controller shown in the photographs is the DSS ULTRA Controller, which is sold by Spectrum projects (among others).



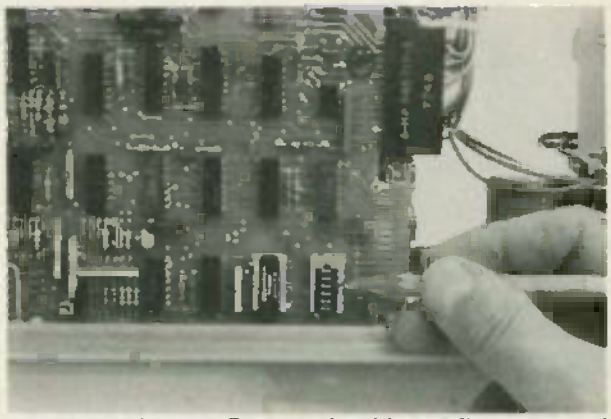
THE PENCIL POINTS TO THE BASIC ROM. The empty socket to its left is for the Extended Color BASIC ROM, which simply plugs into the empty socket. Do it yourself: There's no need for a factory installation of the Extended BASIC ROM.



THE CASE AND POWER SUPPLY ARE NEW, the disk drive is a "surplus" SA400 that was purchased for a fraction of its usual price. The combination case and power supply sold by Software Support, Inc. has a little extra length and will fit any disk drive we have seen, including most hard disk units.



PENCIL POINTS TO THE CLEARLY-LABELLED Radio Shack Disk Controller integrated circuit, the primary reason why most aftermarket disk controllers work so well. But be careful, a controller that doesn't use Radio Shack's IC might not run some of the most popular software.



IF YOU USE ONLY ONE floppy disk drive don't mess around trying to program the disk drive's selector jumpers. If all the DIP jumpers on the drive selector block are left shorted the drive will automatically function as Drive 0. If you want to use two or more drives get one of Radio Shack's preprogrammed disk drive cables and use all jumpers on every drive, but make certain only Drive 0 has a terminating resistor block.

On with the upgrades.

Let the photographs guide you through the upgrades, but keep in mind that the layout and/or design of your CoCo can be different from the one shown in the photographs. ◀CD▶

venience and flexibility is the answer. Say you have a control circuit hooked up and you want to experiment with an automated vision system. Instead of controlling them as a single unit, you might want to exercise them separately. That's where's the other cable comes in. It's unlikely that both cables will be needed, but you shouldn't have to upgrade the laboratory as your experiments become more sophisticated.

You'll also need a 50-conductor flat ribbon cable, terminating in a standard 50-pin D-type connector, for use in controlling parallel processing. If you build your robot in two parts, with separate motor-driver and controller boards, you may need several parallel lines to control the different drive circuits.

The cable assembly also contains the wires that feed power to the system. An extra power cable that I've added (and you may also find necessary) is a simple 2-wire AC cord with a TV chassis connector at one end. (You may know that type of cord as a "cheater cord".) That cable is used to supply AC power to a video camera that's used when doing vision experiments.

Once completed, the cable assembly should be positioned so that it runs from your workbench, along the ceiling, and then to the area where the robot is located. Be sure to provide enough slack in the cable to allow the robot to access the four corners of the lab space. The slack in the cable tends to lie on the floor and obstuct the robot's movement; therefore, a tensioner (elastic band attached to the cable to take up the slack) is needed.

When attaching the tensioner, suspend the wires from the ceiling, as shown in Fig. 2, and then place the elastic band so that the length of wire provided doesn't touch the floor. (An elastic band of the type used to hold luggage together works fine.)

Floor layout

In doing vision experiments or path navigation, the floor should be marked off in known distances. An easy way to mark off distance on a floor is to use standard masking tape or drafting tape. Mark off the floor in 1-foot squares until you have completed a grid like that shown in Fig. 1. That allows you, with little effort, to see whether your robot has really moved.

Types of robots

If you're new to robotics, your first project should be a small rover—a robot that moves around on two wheels—that can run forward, reverse, and turn left or right. (A future article in **Radio-Electronics** will cover the construction of a simple rover.) Although there are robot kits on the market, it is best to build it yourself to get the full benefit of your work.

Purchasing a robot, even the kit type, is a lot easier than building one, but you miss out on the learning experience of the building process. Even so, there's still lots of research that can be done. Completely assembled robots, with or without arms, and some complete with voice synthesizers and radio control interfaces are available at a lower cost than you think.

Control systems

Computers make it a lot easier to control complex processes. All you need is a parallel interface tied between the robot and your computer. Building your own control system, however, can be much more fun. Simple switch boxes or very exotic microprocessor-based control systems are easily built.

In the coming months, some of the subjects that we'll cover are: simple path navigation and complex path navigation, manipulation of objects and, of course, vision. With vision systems, you can experiment with ways to pick out particular parts from a bin of many different types—a very complex experiment of the type currently being done in university laboratories. And since there's no clear solution to many of the problems confronted in robotics, you could be the first to come up with a gimmick that works.

Well, that's all we room for this month. Until next time, why not start building that laboratory so that we can get right into our first project. R-E

LETTERS

continued from page 32

probably OK. Do the tape-monitor outputs work? Then you have isolated the problem to the power output stage. And so on.

Finally, you can "shotgun" the unit—check all the components. It may sound like a chore, but you can physically remove all the parts in a section, check them out of circuit and replace them in a lot less time than you might think. I recently repaired a switching-type power-supply module for a customer's commercial videogame, in the field, without a schematic, by simply removing all the semiconductors from the board and testing them. Two diodes, a transistor, and forty minutes later his game was back in operation and my service call was complete (and I got paid). Of course, the next morning I ordered a schematic for the module and received it three weeks later.

Good troubleshooting skills will get you through times with no schematics better than schematics will get you through times of no troubleshooting skills.

DOUGLAS ENZO McCALLUM
East Lansing, MI

MISSING DESIGN

I read with interest Ray Marston's article, "CMOS Clock Circuits", in the November 1984 issue, but noticed that he missed one design that has been my favorite for reasons of its simplicity; that design is shown in Fig. 1.

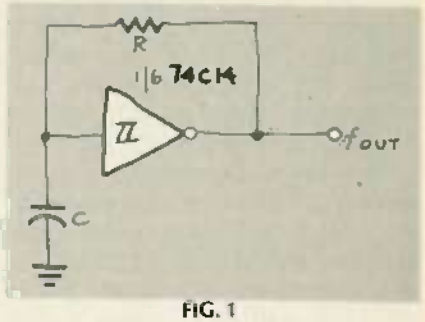


FIG. 1

Using the 74C14 gives you six oscillators to each IC package. Duty cycle is typically 50%, and frequency is given by the equation:

$$f_{OUT} = \frac{1}{RC\ln\left[\left(\frac{V_{CC}-V_{TL}}{V_{CC}-V_{TU}}\right)\left(\frac{V_{TU}}{V_{TL}}\right)\right]}$$

where: V_{TU} = Upper trip point
V_{TL} = Lower trip point

This oscillator was described by Gerald Buurma in "AN-140 CMOS Schmitt Trigger—A Uniquely Versatile Design Component", appearing in the 1977 National Semiconductor *CMOS Databook*.

ANTHONY CHARLTON
Cornwall Bridge, CT

SCHEMATIC NEEDED

I have a PhoneMate *Circle of Safety* alarm system that needs some troubleshooting. I am in need of a circuit diagram or other service information. I checked with Sams *PhotoFacts*, and they never published any data on that system.

I am willing to pay the costs for any reproduction and postage. R-E

ROBERT DINGLE
657 Dell Ridge Drive
Dayton, OH 45429

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ANTIQUE RADIOS

You can't judge a book by its cover!

RICHARD D. FITCH

JUST AS YOU CAN'T JUDGE A BOOK BY its cover, you can't judge the condition of an antique radio's chassis, or even its type, by the cabinet. Most of the radios we've covered here have been of the pre-WWII, wooden-cabinet type; after all, those are this author's preference. There are other collectors who seem to prefer the plastic-cased table-top units from the 50's.

Now, you can be sure that all of those plastic-cased radio's are superheterodyne units (or can you? more on that in a moment), but what of the older radios? Before the superheterodyne, came the *Tuned Radio Frequency* (TRF) chassis. Although superheterodyne was a development of the late 20's, TRF remained on the scene through a good portion of the 30's. There were many reasons for that. For one thing, there were patent problems. In addition, a TRF chassis was simpler to manufacture, and therefore more economical. In the depression of the 1930's, a company that could produce an affordable radio had an edge. Later, because of increased crowding in the broadcast band, more shielding became necessary, increasing the cost of manufacturing a TRF chassis.

As you might imagine, though chassis designs changed in the 1930's, cabinet designs did not necessarily follow suit. The new superheterodyne chassis continued to be installed in wooden cabinets. Outwardly, unless you are familiar with the cabinet design, there is no way to tell whether that wooden cabinet houses a superheterodyne or TRF unit.

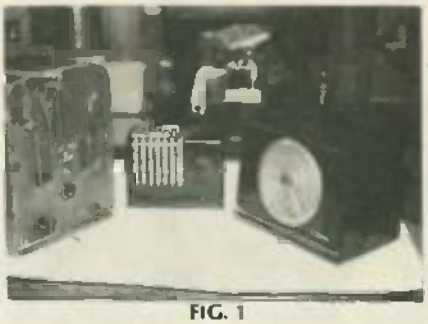

FIG. 1

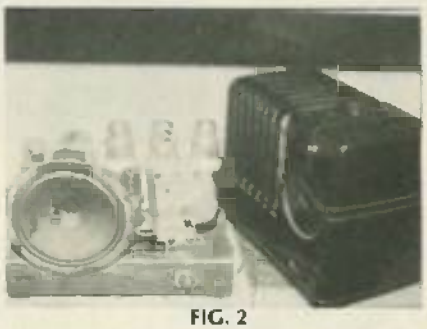

FIG. 2

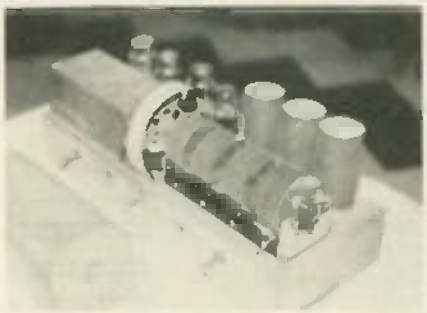

FIG. 3

As it turns out, you also can't always be sure that that plastic-cased table-top unit has a superheterodyne chassis either. One example is the little table-top radio that is shown in Fig. 1 (it is the unit in the center). That unit turned out to be not as modern as it first appeared. For one thing, the case, which at first look appeared to be plastic, was actually made of something that was more like Bakelite. Secondly, and more important, it was not a superheterodyne unit. It was a genuine old-time TRF unit, complete with a series-connected filament string.

The five-tube chassis is a fairly simple one. As such, let's step back a moment and see what problems we might possible run into when restoring or servicing it. First, after slipping the little chassis out of the bottom of the case (see Fig. 2), we can see the handy grid caps of the two RF tubes and the detector. The plate on the bottom of the chassis, besides its obvious uses, is part of the shielding. A heat-mutilated tube diagram was also located on the bottom plate.

If the filaments don't light, then one is likely to be open. Remember, since the filaments here are series-connected, one open filament will cause all of the filaments to fail to light. The best way to track down the open filament is to remove each tube from the chassis and test with a continuity tester.

If all of the tubes test out as good, but the filaments still don't light, the problem is likely in the power supply (assuming, of course, that you've checked out the tube sockets and the associated wiring). The transformer, line cord, and switch should be checked out for continuity and proper operation.

Anyway, the point of all of that is that you can't simply look at a radio and tell what you will find inside. Looking back at Fig. 1, the TRF unit in the center appears to be more modern than the two units flanking it, yet those other, larger units have more modern su-

perheterodyne chassis and are newer.

Finally, as you might infer from the discussion above, that tiny radio generates quite a bit of heat. The vents in the cabinet help cool the tube envelopes. The upper chassis parts dissipate their heat through the metal chassis and bottom shield. Thus, if you own one of those radios, or one of the many that were manufactured using a similar design, be aware of its heat-generating capabilities. While the metal bottom won't get hot enough to start a fire, its not a good idea to display that unit on top of your piano or other piece of highly finished furniture. Also, it is important to keep the cabinet vents clear to ensure adequate air circulation.

More on tuning capacitors

We've previously looked at tuning capacitors and mentioned that it was important that the plates on those be straight. This month, however, we are going to take look at deliberately bending those plates, and why you might want to do that in some instances.

On some early radios, alignment was not done using a trimmer capacitor. Instead, the last plate on the tuning capacitor was divided by slots into as many as six sections by the manufacturer (see Fig. 3). Sections of those slotted end plates were bent in or out to align the tuned circuits.

The bending of those plates could be a tedious operation, and some sort of output meter was a big help if the job was to be done properly. And while some units provided a set screw to make the operation easier, many did not. That left you to you own devices if alignment was needed.

Note that even though those sectioned end plates are intended to be bent, they still cannot be allowed to touch the stator plates. As with all capacitors of this type the air dielectric between the plates must be there. If the plates touch, you will short the capacitor just as if you shorted the foil in a paper capacitor.

Incidently, the type of capacitor shown in Fig. 3 is called a gang capacitor. It features several tuning capacitors on a single shaft. Such capacitors were not always used on the oldest sets. If you are lucky enough to get a real "antique" antique radio, it might have up to five tuning capacitors. Each of those had its own shaft and dial. As you might imagine, back then it was an evening's project just to tune in a station.

Help!

I recently heard from a fellow collector who is in need of a power transformer for a Sylvania *Model 29* electric tube tester. If any of you out there can help, please write and I will forward the information to him.

By the way, it goes without saying that I'm always glad to hear from fellow antique radio enthusiasts and collectors. Just write to me in care of this magazine and if you require a personal reply, please enclose a stamped self-addressed envelope. **R-E**

PRINTER BUFFER

continued from page 62

indicated part should be inserted in the proper location, and should be properly oriented. The leads should be soldered and clipped, if appropriate. "Connect," as applies to wires, implies that you are to strip and tin the wire and insert it into the proper hole, solder it, and clip off the excess length. One caution: MOS devices should be handled properly to avoid damage from static discharge.

The easiest way to build the buffer is to use a printed-circuit board. You can buy one from the source mentioned in the Parts List, or you can etch your own. The foil patterns for the double-sided buffer and EPROM programmer boards are shown in our special "PC Service" section on page 75.

To assemble the buffer board, follow the parts-placement diagram in Fig. 4. Install sockets for all IC's (except the voltage regulator), but don't install the IC's in the sockets! If you are using 128-cycle refresh 4164's, do not install sockets for IC17 and IC18, instead install a jumper between pins 3 and 4 of the location for IC17. (If you're not sure what type of 4164 RAM's you have, install the two sockets.) Install PL1, PL2 (14-pin) and PL3 (10-pin) right-angle, double-row male header strips on the board. If you plan to wire your computer and printer cables direcctly to the board—or if you plan to use chassis connectors on the back panel—do not install those header connectors. But if you plan to use the EPROM programmer board, then install PL4, a 12-pin header. Note that there are only 10 holes in the board for that connector! The right-angle part of the first two pins should be cut off. The bottom pin is left unconnected, but the top pin must be connected to the source of 9 volts AC indicated in Fig. 4.

Next install the fuse clips and the fuse. Install D1, keeping in mind that it's polarized. Install the resistors, noting that most are mounted vertically; they will not fit if mounted horizontally.

Next install all of the capacitors except C1. When installing C3, C4, C5 and C6, do not cut off the leads because they'll connect to the 5-volt bus. Instead, slip tubing over them, bend them down and install in the holes near pin 9 of the IC's on the solder side of the board. That's done to place the decoupling capacitance as close as possible to the power and ground pins of those IC's. Next, install the crystal, and the voltage regulator and its heatsink. Finish up the board by installing C1, spacing it 3/16" away from the board. That will allow just enough clearance for the mounting screw near C1.

At this point in time, all of the on-board components should be mounted. Our next step is to turn our attention to the front-panel mounted switches. Unfortunately, we have run out of room for this month. So, that topic will be the first one we will tackle next time. In addition to that, we'll show you how to assemble the EPROM programmer option, and how to use our buffer/converter to its fullest possible advantage. **R-E**

"My husband built it as a refuge from noise, air pollution, the general unrest, and me."

DRAWING BOARD

ROBERT GROSSBLATT

Designing with dynamic RAM's

THE MORE THAT YOU MESS AROUND with memory, the more uses you find for it. And the more uses you find, the more memory you want. That kind of reasoning led to the development of the *D*ynamic RAM (DRAM). Computers, for example, are memory-hungry machines, and every IC manufacturer has jumped into the race to develop a memory that packs more storage in less space.

At first glance, DRAM seems to be the answer to everybody's memory problems. The cost per bit of storage is much lower than that of static RAM, and manufacturers are constantly finding new ways to stuff more storage space into a standard package.

In no time at all, DRAM went from 16K to 256K per package. While the initial cost per unit was high, prices have dropped dramatically. For instance, the price of a 4164, 64K × 1 DRAM went from $50 to about $5 in less than 5 years!

With all obvious advantages of DRAM—plenty of storage, small packages, all at a reasonable price—why doesn't everyone use them? The answer is that they're a pain in the neck to use. Unless mountains of memory is an absolute necessity, you can save yourself plenty of brain damage by sticking to the reliable static RAM.

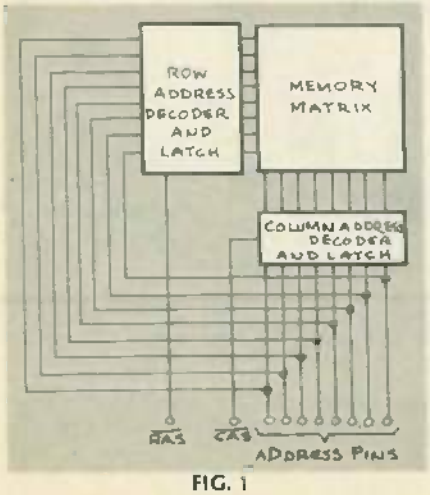

FIG. 1

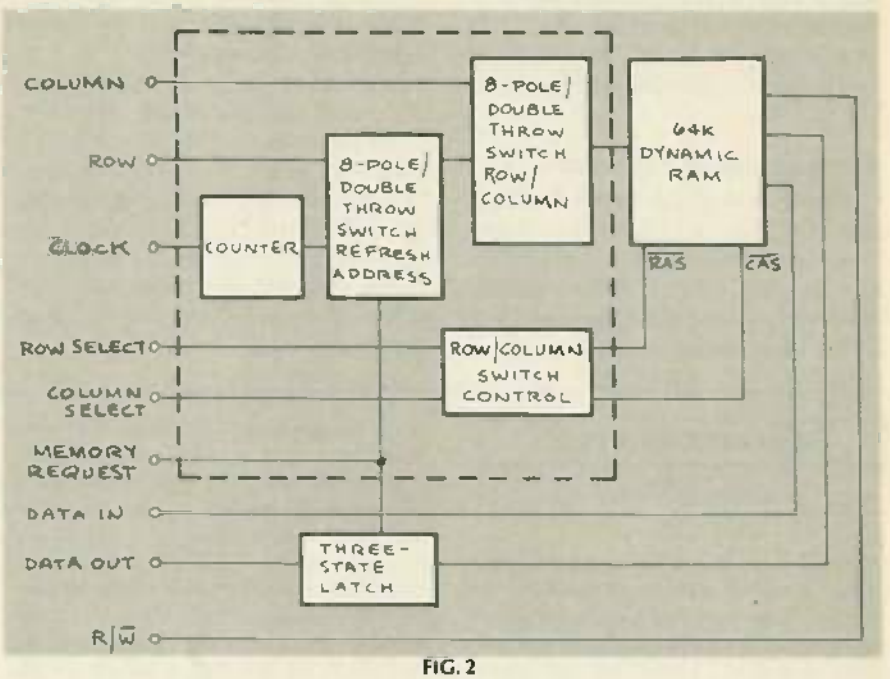

FIG. 2

Using dynamic RAM

There are two main hassles that must be dealt with to use DRAM's: data refresh and address multiplexing. The former is a consequence of the way data is stored, and the latter is a result of practical considerations.

When you start talking about packing up to 256K of storage (for now) in a single IC, you're rapidly going to run out of available pins. To illustrate, take a look at a 4164 and count the number of pins needed to make it work.

Since 4164 is organized in an 8K by 8K matrix, sixteen address lines are needed (8 rows and 8 columns) to access any particular bit in the matrix. Add to that pins for the I/O, power, ground, and a read/write control and we wind up needing 21 pins for a bare-bones memory.

Obviously, more pins are needed as storage capacity is increased. IC designers came up with a way to cut the pin count by using address multiplexing. That means that the internal row and column decoders are connected to the IC's address pins. The decoders are really latches that are controlled by the *R*ow *A*ddress *S*trobe (RAS) and *C*olumn *A*ddress *S*trobe (CAS) pins on the IC.

That may sound complicated, but if you look at Fig. 1, you'll have a much clearer understanding. Al-

though address multiplexing makes things theoretically simple, it creates nightmares from a practical point of view because of the very strict timing requirements. Things are further complicated by the second DRAM hassle—memory refresh.

DRAM uses tiny capacitors as memory-storage elements. But the charge on any one cell leaks quickly. Therefore, each cell must be refreshed at least once every two milliseconds.

There are three basic approaches to successfully using DRAM—gates only, dedicated IC's, and microprocessors. The first two approaches are similar. If you use only gates to take care of the basic RAM requirements, the block diagram of your circuit will be similar to Fig. 2. Notice that the system-address bus has been split into separate row and column lines going to the memory matrix.

Most modern DRAM's are set up so that when a cell is accessed in a particular row, the entire row of cells is automatically refreshed. If your circuit accesses each row often enough to meet the refresh requirements, then you don't have to worry about that problem. That kind of "hidden" refresh is the simplest solution to the whole problem.

But, not all circuits meet those requirements so the problem of refresh has to be (excuse the pun) addressed directly. In Figure 2, the row portion of the address bus goes through an 8-pole, double-throw switch that's controlled by a MEMORY REQUEST line. When that line is inactive, RAS (ROW ADDRESS SELECT) is enabled, read is selected, and the memory-address pins are connected to the output of the counter by the refresh switcher.

That counter cycles over and over at a rate fast enough to refresh the memory. When the memory is accessed, the correct address is put on the address bus; the refresh switcher disconnects the counter, and feeds the row information to the row/column switcher. The row and column data is clocked into the memory by the system logic that controls the row/column select, and the appropriate data is stored in the output data latch. As soon as that happens, the memory-request line shifts back to the refresh setup.

If things are done too slowly, too quickly, or out of logical sequence, you'll probably lose your data and you're guaranteed to lose your temper. And that brings us to an unwritten law that should be immediately jotted down: You can't design with DRAM without using a data sheet.

The complexity of using DRAM has brought about a series of LSI IC's designed to take care of the whole business. Among those IC's are the 3200 series from Motorola and Intel, which contain all the circuitry needed to handle the refresh and address multiplexing requirements of mainstream DRAM's.

At a cost of under $10, they can go a long way toward simplifying your memory-support circuitry. You should remember, however, that it's possible to do the whole job with a handful of logic IC's as well. For a first-time designer or experimenter, it's better to use the gates-only approach. It's a good exercise in digital design.

Most DRAM's generate valid data as soon as the addressing is completed, but lack the chip-select controls found in static RAM. As a result, three-state latches or some other type of arrangement are always necessary to manage the data from the memory. That's particularly true if data has to flow two ways on the system data bus.

Computers are always loaded with bidirectional buffers and drivers since data is constantly going to and from the memory. The last method for massaging DRAM brings us to the next topic that we'll cover—microprocessors. Instead of using tons of gates or dedicated IC's, the whole problem can be handled with a microprocessor and a little software.

In fact, some microprocessors, like the Z80, have built-in routines for refreshing DRAM. People constantly forget that computers are *only* one special application for microprocessors. When we come back next time, we'll see how they can be used to control RAM, keyboards, power supplies, and even the light on the back porch. R-E

STATE OF SOLID STATE

ROBERT F. SCOTT

A new COMFET

THE WORLD'S FIRST P-CHANNEL COMFET has been announced by RCA's Solid-State Division and RCA Labs at Princeton, NJ. The new COMFET (*Conductivity Modulated Field-Effect Transistor*) complements the N-channel COMFET. (See the September 1984 issue of Radio-Electronics for more on that device.) Switching speed, forward blocking voltage, and on-resistance characteristics are similar for the N- and P-channel types.

An unusual feature of the P-channel COMFET is that its chip area is the same as that of the N-channel device. Normally, in conventional MOSFET technology, the P-channel devices require a larger chip area than N-channel devices because of the mobility of "holes" (the primary current carriers) is less than the mobility of electrons (the primary current carriers in a conventional N-channel MOSFET).

In the new device, the conductivity modulation effect nullifies the mobility factor, permitting both chips to have the same on-state resistance with the same size die. Since they have identical active areas, their input capacitances are identical, thus permitting their use in complementary applications found in many types of power-control circuits. The P-channel device can also be used alone in variety of power-switching applications.

Another noteworthy characteristic of the P-channel COMFET is its extremely low DC on-resistance (0.35 ohm at 20 amps) at forward blocking-voltages between 200 and 400 volts (see Fig. 1). That is the lowest on-resistance of any P-channel power MOSFET, including

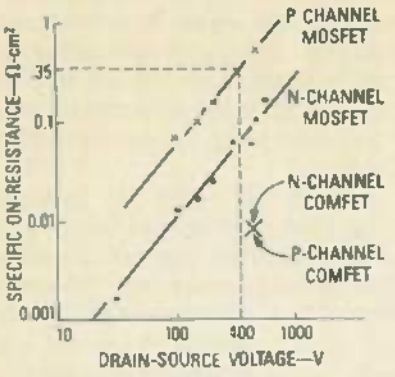

FIG. 1

those with blocking voltages of only 100 volts. Furthermore, its on-resistance can be as much as 25 times lower than that of a conventional P-channel MOSFET having a comparable blocking voltage.

Generally, a COMFET and a conventional power MOSFET operate in basically the same manner. However, in a conventional MOSFET, the on-resistance increases with the increasing drain-to-source voltage capability. That limits its use as a power-switching device above 200 volts. In a COMFET, that limitation is negated by greatly increasing the conductivity of the epitaxial drain region through the injection of minority carriers due to the additional P- or N-type substrate. Now, in a typical N-channel COMFET, the on-resistance is typically about 1/10 that of a conventional MOSFET with the same chip area, and maybe as little as 1/25 of that value.

DC/DC converter/inverter

The S17660, from Siliconix, is a highly efficient low-voltage CMOS DC/DC power converter/inverter intended for use as a voltage inverter. However, with the addition of a few components, the inverter circuit can be rearranged to provide several voltage levels at once. Voltage inversion, voltage doubling, supply splitting, and simultaneous inversion and doubling are possible with the device.

The S17660 operates as a low-cost negative power supply for low-current applications, and it is less expensive, smaller, and uses fewer parts than a dedicated negative power supply. With the addition of only two capacitors and a small-signal diode, the device performs voltage conversion for an input range of +1.5 to +10.0 volts to a complementary output range of −1.5 to −10.0 volts.

The device's output source-resistance is low and allows a drain current of up to 40 mA with a 5-volt input. The low output source-resistance provides high conversion efficiency—95% at 10 mA or 99.7% with no load.

The S17660 contains a voltage regulator, R-C oscillator, voltage-level translator, four power MOS switches, and a logic network on a single IC. The logic network senses the most negative voltage in the device and ensures that the output N-channel switch substrates are not forward-biased. The oscillator, when unloaded, oscillates at a nominal frequency of 12 kHz for an input supply voltage range of 1.5 to 10.0 volts. The osc terminal may be connected to an external capacitor to lower the frequency, or it may be driven by an external clock. The LV terminal may be tied to ground to bypass the internal regulator and improve

low-voltage operation. At +3.5 to +10.0 volts, the regulator is made operational by leaving the LV pin open.

The SI7660 is available in TO-99 and 8-pin DIP packages. In 100-piece lots, the cost is $2.73 each for TO-99-packaged units; as an 8-pin DIP, the cost is $1.89 each.—**Siliconix Inc.**, 2201 Laurelwood Road, Santa Clara, CA 95054

Transistor Selection Guide.

Ferranti's 6-page *MOSFET Selection Guide and Cross Reference List* offers design data on complementary N- and P-channel transistors. Arranged as an easy-to-read chart, it provides data on key parameters of over 150 MOSFET-devices in TO-92, TO-39, TO-220, and TO-3 packages.

Included in the guide are low-voltage threshold devices for telecommunications, superfast (1-ns) switching devices, and high-voltage, low-leakage devices for use in test instruments. It also contains key parameters of the various devices covered, among those specifications are: continuous current, I_D; breakdown voltage, BV_{DSS}, and on-resistance, $R_{DS(on)}$.

The guide also includes a cross-reference to help the user in selecting equivalent or near-equivalent devices.—**Ferranti Semiconductors**, 87 Modular Ave., Commack, NY 11725

New power MOSFET family

RCA has introduced a new family of power MOSFET's designed to operate directly from logic supply-voltage levels of +5 volts. Called logic-level power MOSFET's or L²FET devices, they are the first designed specifically to produce full-current outputs with a 5-volt gate drive.

The new L²FET family includes 32 N-channel devices with current ratings ranging from 1 to 15 amperes, and V_{DSS} ratings ranging from 50 to 200 volts. The devices are available in TO-3, TO-39, and TO-220 packages. Prices in 100-piece lots range from about $0.75 to $4.00. For copies of the L²FET data sheet, call RCA's toll-free number: 1-800 526-2177: or write **RCA, Solid State Div.**, Route 202, Somerville, NJ 08876.

Fast-turn-ofF SCR's

Recently Motorola introduced a series of SCR's that can turn off ten to twenty times faster than standard types. This latest line of SCR's, available in TO-220 packages, consists of 28 devices included in the MCR2080-A (8 amps) and MCR2150-A (15 amps) series with repetitive reverse voltages ranging from 200 to 800 volts. The maximum turn-off time is 4.0 μs for devices in the MCR2150-A series and 6.0 μs for those in the MCR2080-A series. The turn-off time for the non-"A" devices is 10μs. Prices for the 8-amp, 200-volt version start at $0.87 in 100 piece lots, and range up to $4.84 for a 15-amp, 800-volt part.—**Motorola Semiconductor Products Inc.**, PO Box 20912, Phoenix, AZ 85036.

Op-amp power buffer

The LT1010 is a fast op-amp buffer that has unity voltage gain but can amplify an op-amp's output current from typically +10 mA to +150 mA. It makes fast amplifiers less sensitive to capacitive loading, reduces thermal feedback in precision DC coupled amplifiers, and is recommended for a number of fast and slow applications.

When incorporated within the op-amp's feedback loop, the buffer can isolate almost any reactive load. Applications include driving headphones or long cables, powering small motors, operating proportional actuators, and use in operational amplifier based power supplies.

The LT1010 has a 20-MHz bandwidth and a 100 V/μs slew rate. Its quiescent current is 5 mA, while its output can swing ±10 volts into a 75-ohm load. It maintains its inherent high stability while working into capacitive loads exceeding 1 μF. The device operates from a single supply of at least 4.5 volts or from dual supplies delivering up to a total of ±22 volts.

Diagrams including such applications as track-and-hold, voltage and current regulators, integrators, and power-supply splitters are included in the 16-page LT1010 data sheet and application note.—**Linear Technology Corp.**, 1630 McCarthy Blvd., Milpitas, CA 95035-7487. R-E

SERVICE CLINIC

JACK DARR
SERVICE EDITOR

Troubleshooting sync problems

IN RUMMAGING THROUGH THE OLD mailbag, I find that many of our readers are experiencing difficulties related to sync signals. Although we have covered that subject before, it appears that it's time to go over it again.

In your letters, several of you have provided voltage readings, etc., but make no mention of the sync waveforms. For sync-related problems, an oscilloscope is one instrument that's almost indispensable. When symptoms like poor vertical sync, weave or hum in the sync, and other such problems show up, it's time to look at the sync waveform. (That's before you draw any conclusions as to its cause.) A scope is the only instrument that allows you to view the waveforms. And since you've got to see the signals before you can tell anything about them, the scope is the only way to go.

I'm not saying that it's impossible to fix a sync problem without a scope, only that the job is easier with one! The scope lets you see what the sync separator is doing, and whether the correct signal is being sent to the points where it's needed. No other instrument can do that.

Repairing sync problems

When correcting troubles that appear to be sync related, use your scope to make sure that all the inputs to the sync separator are correct. The proper amplitude is usually shown on the schematic. (The horizontal sync is governed by the phase of the signal, while the vertical sync depends on its amplitude.)

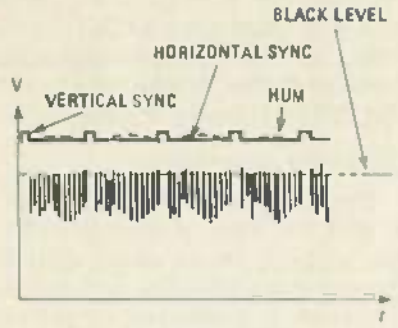

FIG. 1

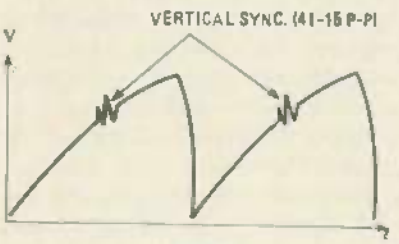

FIG. 2

First check the signals at the output of the sync separator: That's where the signal first appears as sync only. You should use a time base of about 50-Hz. That allows you to see the horizontal-sync signal as a straight line (blur!) with the vertical sync showing up as little pips above it. Figure 1 shows the composite sync as seen at the output of a sync separator.

The horizontal sync is the waveform just below and parallel to the black level reference; the dashed rippling lines indicate hum in the sync. If there is any bending or ripple in the signal, look out. Ripple in the horizontal sync may mean that some of the 60-Hz hum (from the AC line) is getting into the signal. Such an occurrence is bound to show up as weaving or bending in the raster.

As for that other important signal, since the vertical sync is dependent on amplitude, you must be sure that it is high enough. If it is too low, you'll have rolling in the video and poor vertical hold. I have found sync troubles that were caused by a low video input to the sync separator. If the signal is too low, the separator can't shear the sync off properly. That usually causes vertical sync problems, with horizontal sync OK.

Always be sure to trace the sync signal through any amplifier stages; they too can contribute to vertical-sync problems. With the scope properly connected across the input to the vertical oscillator, turn the set's vertical-hold control (if there is one) until the picture rolls down slowly. Figure 2 should give you some idea of what you should see. It shows the vertical sync—the tiny squiggle riding on the waveform—which should measure about 4–5 volts peak-to-peak.

If that signal is not there, find out why! You can always look at the sync, both vertical and horizontal, and see what is wrong. For instance if the horizontal-sync waveform has video in it, the video can be seen on the rising portion of the sync. Such problems are almost always located in the sync separator.

Video can show up in the sync when, for instance, the video input to the sync separator is not high enough to allow the separator to clip off the upper 25% of it, where the sync is found. Because of that, the separator cuts too deeply into the waveform allowing some of the video to sneak into the

sync signal. A "dirty sync" (as that condition is called) can cause all of those mysterious cases of jitter (weaving, etc.) in the raster.

So, whenever you get a set with really mind-boggling symptoms, get out the scope first and follow the waveform through the circuits, looking very closely for any and all of the things just mentioned. Once you find the point where trouble first shows up, then get out your trusty voltmeter and check for the correct DC voltages. The sync separator is one stage that is extremely critical as to voltages. If the schematic calls for 25 or 112 volts at a particular point, make sure that that voltage is there. Once you've found a voltage that's missing or incorrect, that's when you get the ohmmeter and start checking resistors.

So, don't let that scope just sit there gathering dust. Instead, use it to make the most useful test of all on any stage—signal in vs. signal out—the true test of whether any particular stage is working the way it should. R-E

SERVICE QUESTIONS

LOW BRIGHTNESS AND CONTRAST

A Midland TV, model 10M46, has me completely out-foxed. The set shows low contrast and brightness, with little control over the brightness. The 40-volt Zener diode off the low side of the tripler is missing. Any help you can give me will be deeply appreciated.—G.P., Los Angeles, CA

That Zener diode is part of the automatic brightness limiter (ABL). The schematic shows it with dotted lines to suggest that it's not necessarily included in all models, so we need not concern ourselves with it.

As for the brightness control, it varies the base voltage of the video emitter follower (Q700) and that, in turn, causes the collector voltage to vary. The coupling that exists from Q700 through Q701 and Q702 right on into the three color outputs and the kine, translates control movements into brightness changes.

Start at the control itself and work your way forward to see where the voltage swing disappears. Now back to the ABL; that stage basically consists of Q703 tied to the video preamp. In normal operation, that circuit senses changes in beam current and influences the bias of transistor Q701. So in tracking down your problem, look to that circuit as a possible trouble spot.

SERVICING AN ELECTRONIC FLASH

How can I check the SCR's in my electronic flash unit. I would also like to know how I can get a schematic of the circuit.—W.W., Charleston, WV

To easily check SCR's, first connect the negative lead of an ohmmeter—set on the ×1 scale—to the cathode of the SCR and its positive lead to the anode. The meter should show an infinite (very high) resistance reading. Short the gate lead to the anode and observe the reading. The displayed resistance should drop: A reading of 15–50 ohms is normal.

With the anode still connected to the ohmmeter, disconnect the gate lead. The reading should be unchanged until either the anode or cathode is disconnected. When either the anode or cathode is disconnected, the display should then return to the infinite resistance reading. As for service information on your unit, I can only suggest that you contact the manufacturer.

PICTURE PULLING AND TEARING

I have a Magnavox T982-12 chassis that shows a dark vertical bar running down the left side (just off center) of the screen, accompanied by pulling and tearing in the picture. The filters in the 148-volt B+ supply have been replaced. And I've also tried new vertical, horizontal, and signal modules. Please help!—R.N., AZ

Have you checked the low-voltage supply filters?—I see at least four in the schematic. The trouble sounds like something that you might expect from a dirty supply. Your letter describes distorted waveforms coming from the horizontal module. That's another reason to look to that module for the cause. R-E

ELECTRIC SHOCK

continued from page 58

Microshock

Microshock is electrical shock caused by very small amounts of current. As is shown in Table 1, currents of less than 1 milliampere are usually of no consequence. If a shock is delivered directly to the heart, however, even 20 microamperes of current can be dangerous. Current can be delivered directly to the heart through a pacemaker wire. Wires for use with external (temporary) pacemakers

TABLE 1—EFFECTS OF A 60 Hz ELECTRIC SHOCK

Current held one second	Effect (current applied to skin, unless otherwise noted)
20 μA	Ventricular fibrillation if applied directly to the heart
1 mA	Sensation
5 mA	Maximum harmless current
1–10 mA	Mild to moderate pain
10–20 mA	May cause muscular contractions, preventing release from shock source
30 mA	Breathing may stop
75–300 mA	Ventricular fibrillation may occur
5 A	Burns tissues

FIG. 5—IF A PACEMAKER'S LEADS accidentally contact a voltage source, it is easy to deliver a dangerous voltage (greater than 20 mA) to the heart.

come out of the body through the chest wall or through veins that lead to an arm, the neck, or elsewhere (see Fig. 5). If such a wire were touched by a person who was holding onto a light switch, electric bed frame, television set, or other appliance, many microamperes could be conducted to the pacemaker wire.

Many appliances will supply a good fraction of a milliampere to someone who is grounded. To see that for yourself, connect an ammeter between the metal parts of an appliance and ground. (Start on a high range to protect the meter.) Unless there is a very good third wire ground, significant currents will be measured.

Why electrical shock occurs

It is easy to receive an electrical shock. All that is required is to come into contact with two different voltages. Electrical shock can occur in a variety of settings. Electronics technicians and hobbyists can be exposed to many situations in which shock can occur. Capacitors and CRT's, for instance, store large voltages for days or longer. Tools held in the hand may conduct electric currents from objects touched. High voltages may arc across space to cause shocks.

Even if you are someone who doesn't do much electronics work or experimenting, there are many "opportunities" around the house to receive a shock. Damaged line cords, defective appliances, or accidents, such as dropping an AC-powered radio into a full bathtub, can quickly teach anyone about the dangers of electrical shocks. **R-E**

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COMPACT, WELL-REGULATED SWITCHING POWER SUPPLY DESIGNED TO POWER TEXAS INSTRUMENTS COMPUTER EQUIPMENT.
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*ALSO COMPATIBLE WITH RADIO PC-8201A AND OLIVETTI M10

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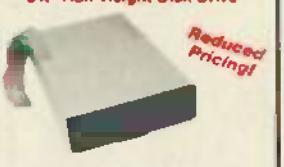

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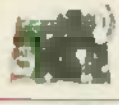

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MEMORY EXPANSION KITS

IBM PC, PC XT and Compatibles
The IBM64K Kit will increase memory in 64K byte increments. The Kit is simple to install — just insert the 9 - 64K RAM chips in the provided sockets and set the 2 groups of switches. Comprehensive documentation included.

IBM64K (Nine 200ns 64K RAMs). $19.95

IBM PC AT
Each kit comes complete with nine 128K dynamic RAMs and documentation for upgrading.

IBM128K (Nine 250ns 128K RAMs). . . . $133.95

IBM PCXT Equivalent 130 Watt Power Supply
UPGRADE YOUR PC!
• Input: 110V @ 60Hz • Output: +5VDC @ 15A, −5VDC @ 0.5A, +12VDC @ 4.2A, −12VDC @ 0.5A • Plug compatible connectors • Fits into IBM PC • Weight: 6 lbs.

IBM-PS. $159.95

Prometheus Modems

The ProModem 1200B/BS is a 1200/300 baud modem card which plugs into IBM PC and XT. Provides a third serial Comport. Two versions available: 1200B (without software) and 1200BS (with software). The PM1200BS is supplied with powerful MITE communications software from Mycroft Labs.

PM1200B (without Software). $239.95
PM1200BS (with MITE Software). $274.95

IBM Compatible! DISK DRIVES

Documentation Included

RFD480	(Remex 5¼" DS full-ht.).	$ 89.95
FD55B	(Tesc 5¼" DS half-ht.).	$139.95
SA455	(Shugart 5¼" DS half-ht.). . . .	$139.95
TM100-2	(Tandon 5¼" DS full-ht.). . . .	$159.95

5¼" DISK DRIVE ENCLOSURES
Complete with power supply, switch, power cord, fuseholder and connectors

DDE-1FH (Houses 1 full-ht. 5¼" drive). $69.95
DDE-2HH (Houses 2 ½-ht. 5¼" drives). $79.95

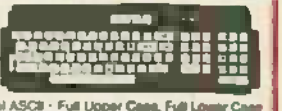
General Application Keyboards

Mitsumi 84-Key Unencoded All-Purpose Keyboard

• SPST keyswitches • 20 pin ribbon cable connection • Low profile keys • Features cursor controls, control, caps (lock), function, enter and shift keys • Color (keycaps): grey • Weight: 1 lb. • Pinout incl. • Size: 13¾"L x 4¼"W x ¾"H

KB84. . . . . $14.95

74-Key ASCII Cherry Keyboard



• 7-bit parallel ASCII • Full Upper Case, Full Lower Case except l, m, n, o and p. • Cursor keypad • SPST mechanical keyswitches • 26-pin header connector • Color: white • Size: 18"L x 6¾"W x 1⅜"H • Spec included

KB8201. . . . . (N/A available). $29.95

UV-EPROM ERASER

8 Chips - 21 Minutes

1 Chip - 15 Minutes

Erases all EPROMs. Erases up to 8 chips within 21 minutes (1 chip in 15 minutes). Maintains constant exposure distance of one inch. Special conductive foam liner eliminates static build-up. Built-in safety lock to prevent UV exposure. Compact — only 9.00"L x 3.70"W x 2.60"H. Complete with hooking tray for 8 chips.

DE-4 UV-EPROM Eraser. $74.95
UVS-11EL Replacement Bulb $16.95

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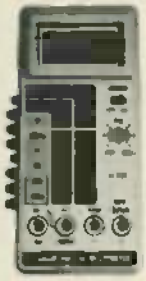
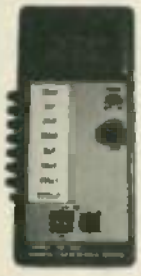
DROP PROOF DIGITAL MULTIMETER
■ DC input impedance 10M ohm ■ Shock-mounted LCD display ■ Overload protection ■ Auto polarity ■ Backed by our 1-year limited warranty ■ For more specifications see MCM catalog #10, page 122

#72-057 **$29.95** each



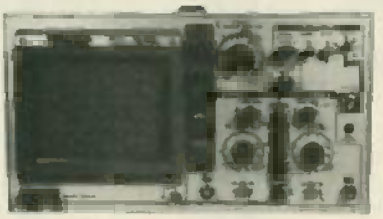
TENMA®
3½ DIGIT LDC MULTIMETER
■ DC input impedance 10M ohm ■ Diode and HFE transistor tests ■ Overload protection ■ Auto polarity ■ Backed by our 1-year limited warranty ■ For more specifications see MCM catalog #10, page 122.

#72-050 **$36.80** (10-up)
$39.80 (1-9)



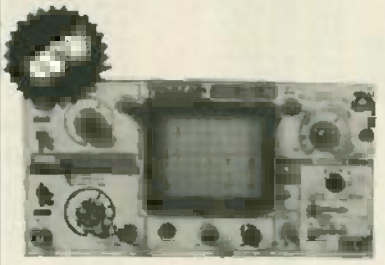
TENMA®
DIGITAL CAPACITANCE METER
■ Measures capacitors from 0.1pF to 1999mFd ■ Accuracy 0.5% typical ■ Fuse protected ■ Checks capacitors in and out of circuit ■ Backed by our 1-year limited warranty ■ For more specifications see MCM catalog #10, page 122

#72-040 **$54.95** (2-up)
$59.80 each



TENMA®
20 MHZ DUAL TRACE OSCILLOSCOPE
■ Two High Quality 10:1 probes included ■ Backed by our 2-year limited warranty ■ For specifications see MCM catalog #10, page 121

#72-320 **$389.95**



TENMA®
15 MHz DUAL TRACE BATTERY OPERATED OSCILLOSCOPE
■ Two High Quality 10:1 Probes included ■ Backed by our 2-year Limited Warrranty ■ Internal rechargeable batteries provide 2 hours of continuous operation without the need for any outside power source. ■ For specifications see MCM Catalog #10, page 121

#72-335 **$489.95**

TENMA®
35 MHZ DUAL TRACE OSCILLOSCOPE
■ Two High Quality 10:1 probes included ■ Backed by our 2-year limited warranty ■ For specifications see MCM catalog #10, page 121

#72-330 **$569.00**

HIGH VOLTAGE TRIPLER

■ Replaces: ECG® 526, ECG® 523 ■ Zenith 212-141-021/212-141-031/ 212-141-04/212-141-05 ■ Two-year warranty

#ERS526A **$9.95** (10-up)
$12.90 (1-9)

INFRARED DETECTOR CARD
■ Used for testing TV, VCR and other infrared remote controls ■ Test area will glow pale orange if infrared is present

NEW

#72-005 **$3.95** (6-up)
$4.50 (1-6)

REPLACEMENT FOCUS DIVIDER FOR SANYO AND SEARS
■ Replaces Sanyo Part #ESPA-98-F1 #Z0064 ■ Also replaces #ESPA 94 and ECG® 568

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2112	256x4	(450ns)	2.99
2114	1024x4	(450ns)	8/9.95
2114-25	1024x4	(250ns)	8/10.95
2114L-4	1024x4	(450ns)(LP)	8/12.95
2114L-3	1024x4	(300ns)(LP)	8/13.45
2114L-2	1024x4	(200ns)(LP)	8/13.95
TMM2016-200	2048x8	(200ns)	3.25
TMM2016-150	2048x8	(150ns)	3.75
TMM2016-100	2048x8	(100ns)	4.75
HM6116-4	2048x8	(200ns)(cmos)	3.69
HM6116-3	2048x8	(150ns)(cmos)	3.95
HM6116LP-4	2048x8	(200ns)(cmos)(LP)	3.95
HM6116LP-3	2048x8	(150ns)(cmos)(LP)	4.25
HM6264P-15	8192x8	(150ns)(cmos)(LP)	9.75

LP = Low Power

DYNAMIC RAMS

4116-250	16384x1	(250ns)	8/8.95
4116-200	16384x1	(200ns)	8/8.95
4116-150	16384x1	(150ns)	8/10.85
4164-200	65536x1	(200ns)(5v)	9/10.50
4164-150	65536x1	(150ns)(5v)	9/13.60
TMS4164	65536x1	(150ns)(5v)	4.95
41256-200	262144x1	(200ns)(5v)	5.25
41256-150	262144x1	(150ns)(5v)	5.60

5v = Single 5 Volt Supply

EPROMS

2708	1024x8	(450ns)	3.95
2716	2048x8	(450ns)(5v)	3.50
2716-1	2048x8	(350ns)(5v)	4.95
TMS2532	4096x8	(450ns)(5v)	4.95
2732	4096x8	(450ns)(5v)	3.95
2732A-4	4096x8	(400ns)(5v)(21vPGM)	4.95
2732A-35	4096x8	(350ns)(5v)(21vPGM)	4.85
2732A	4096x8	(280ns)(5v)(21vPGM)	6.95
2732A-2	4096x8	(200ns)(5Y)(21vPGM)	10.95
2764	8192x8	(450ns)(5v)	4.25
2764-250	8192x8	(250ns)(5v)	4.95
2764-200	8192x8	(200ns)(5v)	6.95
27128	16384x8	(250ns)(5v)	7.85
27256	32768x8	(250ns)(5v)	12.95

5v = Single 5 Volt Supply
21vPGM = Program at 21 Volts

SPECTRONICS CORPORATION EPROM ERASERS

	Timer	Chip Capacity	Intensity (uW/Cm²)	
PE-14		9	8,000	83.00
PE-14T	X	9	8,000	119.00
PE-24T	X	9	9,600	175.00

8000

8035	5.95
8039	5.95
8080	3.95
8085	4.95
8085A-2	11.95
8087-3	129.00
8087-6	119.00
8088	19.95
8155	6.95
8156-2	7.95
8156	6.95
8748	24.95
8755	24.95

8200

8203	39.95
8205	3.50
8212	1.80
8216	1.75
8228	3.49
8237-5	15.95
8243	4.45
8250	10.95
8251A	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8259	6.90
8259-5	7.50
8272	18.96
8275	29.95
8279	6.95
8282	6.50
8284	5.50
8286	6.50
8288	14.95

Z80 2.5 Mhz

Z80-CPU	2.49
Z80-CTC	2.95
Z80-PIO	2.95
Z80-SIO/0	9.95

4.0 Mhz

Z80A-CPU	2.49
Z80A-CTC	3.95
Z80A-DART	8.95
Z80A-PIO	3.95
Z80A-SIO/0	10.95

6.0 Mhz

Z80B-CPU	8.95

6500

6502	4.95
6520	2.95
6522	5.49
6532	9.95
6551	9.95
6502A	5.95
6522A	9.95
6551A	11.95

6800

68000-8	39.95
6500	2.95
6802	7.95
6809	8.95
6809E	8.95
6821	2.95
6845	12.95
6850	3.25
6883	22.95

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1771	18.95
1791	23.95
1793	23.95
UPD765	19.95

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ADC0809	4.49
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MC1408L8	2.95

SOUND CHIPS

76477	3.95
76488	5.95
AY3-8910	12.95
SSI263	39.95

74LS00

74LS00	.24	74LS157	.65
74LS01	.25	74LS158	.59
74LS02	.25	74LS160	.69
74LS03	.25	74LS161	.65
74LS04	.24	74LS163	.65
74LS05	.25	74LS164	.69
74LS08	.28	74LS165	.95
74LS09	.29	74LS166	1.95
74LS10	.25	74LS169	1.75
74LS11	.35	74LS173	.69
74LS12	.35	74LS174	.55
74LS13	.45	74LS191	.89
74LS14	.59	74LS192	.79
74LS20	.25	74LS193	.79
74LS21	.29	74LS194	.69
74LS26	.29	74LS195	.69
74LS27	.29	74LS197	.79
74LS32	.29	74LS221	.89
74LS33	.55	74LS240	.95
74LS37	.35	74LS241	.99
74LS38	.35	74LS242	.99
74LS40	.28	74LS243	.99
74LS42	.49	74LS244	1.29
74LS47	.75	74LS245	1.49
74LS51	.26	74LS251	.59
74LS73	.39	74LS253	.59
74LS74	.35	74LS257	.59
74LS75	.39	74LS258	.69
74LS76	.39	74LS259	2.75
74LS85	.69	74LS260	.59
74LS86	.39	74LS266	.55
74LS90	.55	74LS279	.49
74LS92	.56	74LS280	1.98
74LS93	.56	74LS283	.69
74LS107	.39	74LS290	.89
74LS109	.39	74LS293	.89
74LS112	.39	74LS298	1.75
74LS122	.45	74LS323	3.50
74LS123	.79	74LS365	.49
74LS124	2.90	74LS367	.45
74LS125	.49	74LS368	.45
74LS126	.49	74LS373	1.39
74LS132	.59	74LS374	1.39
74LS136	.39	74LS377	1.39
74LS138	.55	74LS390	1.19
74LS139	.56	74LS393	1.19
74LS145	1.20	74LS640	2.20
74LS148	1.35	74LS645	2.20
74LS151	.58	74LS670	1.49
74LS153	.55	74LS682	3.20
74LS154	1.90	74LS688	2.40
74LS155	.69	81LS95	1.49
74LS156	.69	25LS2521	2.80

7400

7400	.18	7492	.50
7401	.19	7493	.35
7402	.19	74100	1.75
7403	.19	74107	.30
7404	.19	74116	1.55
7405	.25	74121	.29
7406	.29	74122	.45
7407	.29	74123	.49
7408	.24	74125	.45
7409	.19	74126	.45
7410	.19	74132	.45
7411	.26	74145	.60
7413	.35	74148	1.20
7414	.49	74150	1.35
7416	.25	74151	.55
7417	.25	74153	.55
7420	.19	74154	1.25
7421	.35	74155	.75
7425	.29	74157	.55
7427	.29	74159	1.65
7430	.19	74161	.69
7432	.29	74163	.69
7437	.29	74164	.65
7438	.29	74165	.85
7442	.49	74166	1.00
7445	.69	74173	.75
7447	.69	74174	.89
7448	.69	74175	.89
7473	.34	74185	2.00
7474	.33	74192	.79
7475	.45	74193	.79
7476	.35	74194	.85
7483	.50	74259	2.25
7485	.59	74367	.65
7489	2.15	74368	.65
7490	.35	74393	1.35

74S00

74S00	.32	74S112	.50
74S02	.35	74S124	2.75
74S04	.35	74S132	1.24
74S05	.35	74S133	.45
74S08	.35	74S138	.85
74S10	.35	74S139	.55
74S11	.35	74S140	.55
74S20	.35	74S151	.95
74S32	.40	74S153	.95
74S37	.66	74S157	.95
74S74	.50	74S158	.95
74S86	.50	74S240	2.20

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5.0	2.95
5.0688	2.95
6.0	2.95
6.144	2.95
8.0	2.95
10.0	2.95
10.738635	2.95
14.31818	2.95
15.0	2.95
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LM307	.46	LM566	1.49
LM308	.69	NE592	.98
LM309K	1.25	LM733	.98
LM310	1.75	LM741	.35
LM311	.64	LM747	.69
LM317T	1.19	LM1310	1.49
LM317K	3.95	MC1330	1.69
LM318	1.49	MC1372	6.95
LM323K	4.95	LM1458	.89
LM324	.59	LM1488	.69
LM331	3.95	LM1489	.69
LM334	1.19	LM1496	.85
LM335	1.40	LM1800	2.37
LM336	1.75	LM1812	6.25
LM337T	1.95	LM1889	1.95
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LM339	.99	XR2206	3.75
LM348	.99	XR2211	5.25
LM350K	4.95	CA3146	1.65
LF351	.60	LM3900	.59
LF353	1.00	LM3911	2.25
LF356	1.10	LM3914	3.95
LF357	1.40	MC4024	3.95
LM358	.69	MC4044	4.50
LM359	1.79	RC4136	1.25
LM377	1.95	75150	1.95
LM383	1.95	75154	1.95
LM386	.89	75188	1.25
LM393	1.29	75189	1.25
LM394	1.29	75451	.39
TL497	3.25	75453	.39
NE555	.34	75477	1.29
NE556	.65	75492	.79

T = TO-220 K = TO-3

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10	50v	.15	22	16v	.14
47	35v	.18	47	50v	.20
100	16v	.18	100	15v	.20
220	35v	.20	150	25v	.25

50v MONOLITHIC

.01uf	.14	.1	.18
.047	.15	.47	.25

50v DISC

10pf	.05	470	.05
22	.05	560	.05
25	.05	680	.05
27	.05	820	.05
33	.05	.001uf	.05
47	.05	.0015	.05
56	.05	.0022	.05
68	.05	.005	.05
82	.05	.01	.07
100	.05	.02	.07
220	.05	.05	.07
330	.05	.1	.12

BYPASS CAPS

.01uf disc	50v	100/6.00
.1uf disc	12v	100/8.00
.01uf mono	50v	100/12.00
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NEC JB1201M 20 MHz Green Monitor	169.00
BMC BM-AU9191U Comp. 13" Color Monitor	279.00
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VERBATIM DATALIFE DISKETTES DS/DD	34.95
DISKETTE FILE Holds 70 Diskettes	9.95

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100 PIECE MINIMUM

41256 150ns

$5.50 ea.

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PS-ASTEC MODEL AA 12110	PS-3 ASTEC AA11190
+12V @ 2A	+5V @ 4A
-12V @ .1A	+12V @ 2.5A
+5V @ 2.5A or	-5V @ .25A
5A if 12V not used	-12V @ .30A
19.95	39.95

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	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 Pin ST	.30	.27
26 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call
ST=SOLDERTAIL		
8 pin WW-	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
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PN2222	.10	2N3055	.79
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2N2907	.25	2N3906	.10

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4016	.39	4047	.95	4093	.49	74C14	.59
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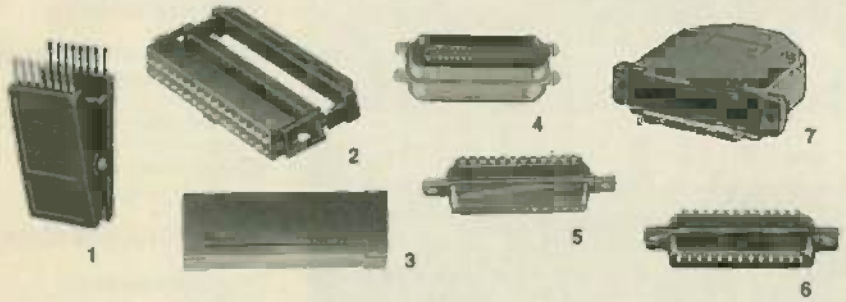

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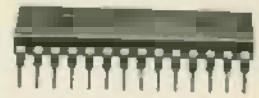

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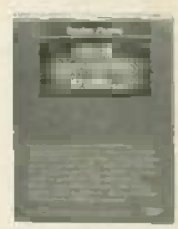

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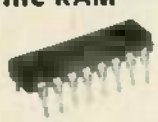

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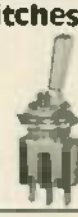

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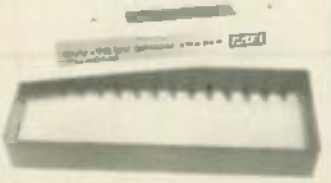

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