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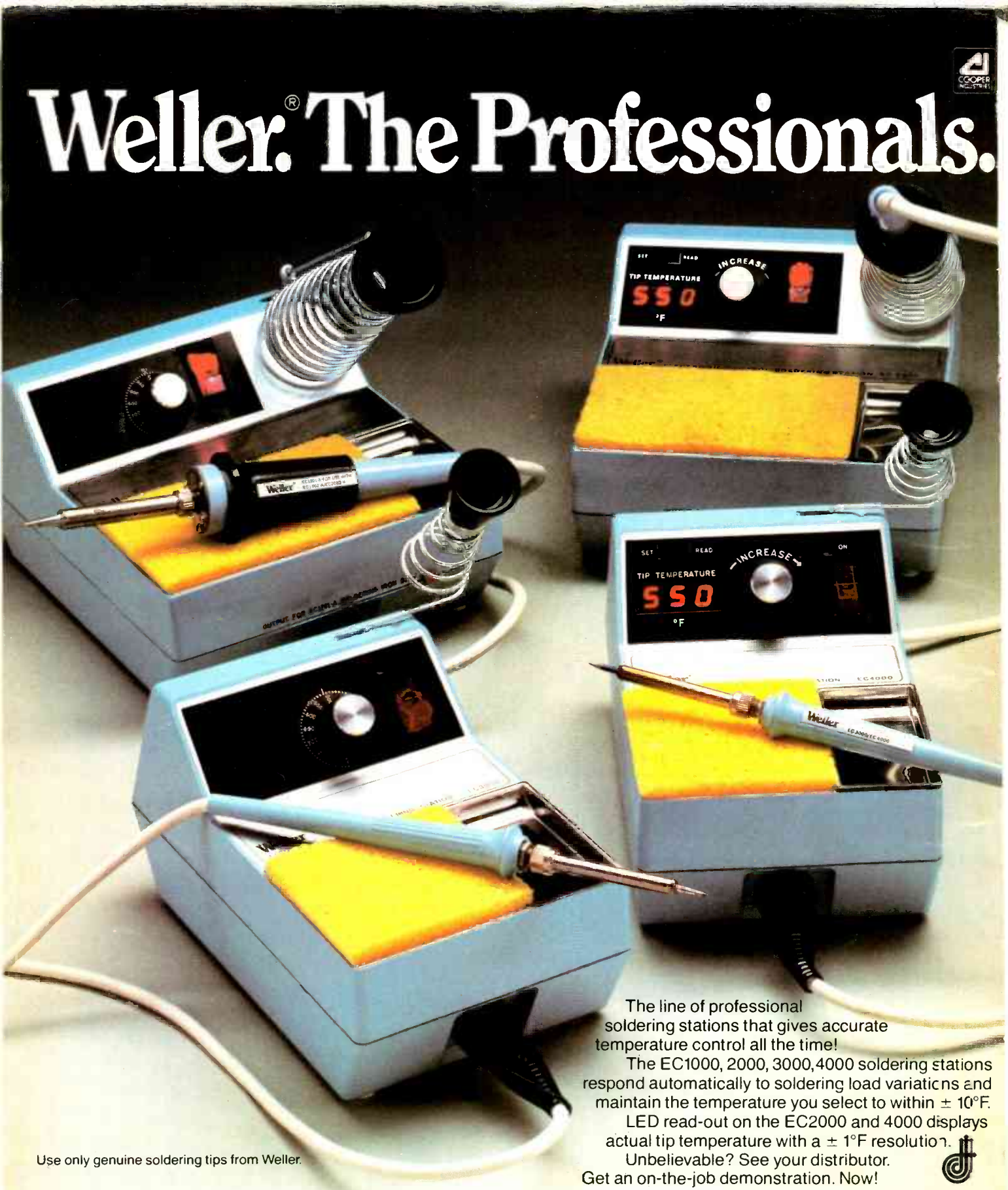

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SSSD = Single Sided Single Density; SSDD = Single Sided Double Density; DSDD = Double Sided Double Density; SSQD = Single Sided Quad Density; DSQD = Double Sided Quad Density; TPI = Tracks per inch.

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CIRCLE 14 ON FREE INFORMATION CARD

Radio-Electronics

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APRIL 1983 Vol. 54 No. 4

ON THE COVER

The fascinating world of microcomputers—whether it be a simple entry-level machine for education or entertainment, or a complex, full-featured computer for your business—there's something there for everyone. And there's something for everyone in our Special Section, "Your Own Computer." This month we take an in-depth look at the hardware and the things you should know before you buy. To round things out, "Your Own Software" takes a look at one of the most popular types of software—the electronic spreadsheet—and a look at some software you may never have heard of, but that's surprisingly useful and/or inexpensive. It all starts on page 57.

A CUSTOM CASE will give your project a professional look and get it the attention it deserves. It can be surprisingly easy and inexpensive to build if you know how. Find out more starting on page 49.

COMING NEXT MONTH
On Sale April 19

- **Build A Talking Clock.** This clock not only tells the time, it says it.
- **Car Alarm.** Connect it to your car to help keep the burglars away.
- **All About LSI Music Synthesizers.** A look at the different IC's available to build your own music synthesizers.
- **And more.**

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VIDEO ELECTRONICS

DAVE LACHENBRUCH
CONTRIBUTING EDITOR

POCKET TV

The first completely tubeless TV destined for the American market is Casio's ingenious LCD model (shown above), due here in July, priced at about $250. The complete set is about the size of a one-inch stack of 3-×-5-inch index cards. The screen measures 2¾ inches diagonally, using a twisted nematic type of liquid crystal display. To solve the problem of viewing in the dark, Casio uses an electroluminescent material as a backlight. It can be operated for three hours from three AA batteries, or can be powered by a 12-volt car battery or an AC adaptor.

The screen resolution is 20,480 picture elements (pixels)—160 horizontal, 128 vertical. The chassis contains 7 LSI IC's, including 5 VSLI IC's all developed by Casio. Weight is 12.35 ounces, and the unit contains a loudspeaker as well. Initial production in Japan will be about 20,000 monthly, and Casio expects to use the same design for computer displays. It promises a color version next year.

END OF VCR BARGAINS?

If you want a low-end VCR at $299 or a full-featured programmable one for under $500 or so, better snap it up now while the snapping is good. At presstime, it appeared that the oversupply crisis that pushed prices to almost unbelievable lows might be coming to an end. During 1982, inventories of excess recorders were sharply reduced by a combination of sharply cut prices and restraint in imports. In addition, the firming of the Japanese yen against the dollar appears to militate against continued low prices. And for the first time, there were no major model changes around New Year's to cause instant obsolescence of older versions and the resulting bargain closeouts.

RCA'S INTERACTIVE VIDEODISCS

RCA says it will introduce an interactive version of its CED videodisc player later this year. Controlled by a remote keypad, the player can be random-accessed to find any individual track (each one of which contains four TV frames). Both the Laservision optical-disc system and the Japanese VHD-capacitance system (being introduced in Japan this spring, but with no US starting date) are designed to allow for interactive use. RCA says its interactive player will accommodate the same types of interactive programs as the other systems. It exemplifies RCA's approach of introducing a basic system, then adding features, such as remote control, stereo, and now interactivity, as opposed to the Laservision approach of fielding a system that initially contains all such features. RCA points out that it interactive discs will play for an hour per side; interactive laser-discs are capable only of a half-hour of playing time per side.

VIDEO VIGNETTES

Miniaturized portable Beta recorders will make their appearance in 1983 as an answer to JVC's VHS-C (for "compact") format, which uses a smaller cassette to record up to 20 minutes. The new Beta machines use the standard Beta cassette that can record for up to five hours. The new machines weigh about 6 pounds without battery, 7½ pounds with.

General Electric, which buys portable VCR's from Matsushita, home units from Hitachi, will depend on Matsushita for all its VCR needs.

Look for "live-action" video games in the arcades in the near future. Those coin-operated thrillers will combine computer-game excitement with the realism of the videodisc. Pioneer will supply the built-in optical players. **R-E**

OK Industries Inc.

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Phone (212) [illegible]

CIRCLE 10 ON FREE INFORMATION CARD

WHAT'S NEWS

Cellular radio license applications inadequate

Seven out of ten applications in the new cellular radio field may be inadequate. simply for failure to show "reasonable assurance" of antenna-site availability. That is the opinion of the Memphis-based real estate consulting firm, McAllister Associates, after a survey of the field.

In the rush to secure licenses, some 3000 documents have been filed. "The smartest companies," says McAllister Associates, "have made sure that antenna-site availability is well documented in their applications. They expect that the FCC will screen applications on that basis, because it is the easiest place to find indisputable errors."

Sites secured only by unenforceable letters of intent constitute the commonest inadequacy found, amounting to 60 percent of the sites surveyed. Another 28 percent showed even more obvious problems, including instances in which the property to which the rights had been signed over was not the property listed in the application.

Random access memory has 3-ns access time

Motorola claims the world's fastest random-access memory in its MC10H145, a new 64-bit bipolar ECL RAM. The access time is typically 3 nanoseconds and is 6 ns maximum. The MC10H145 is organized as a 16 × 4 memory array and is a member of the MECL 10KH family.

The high speeds were attained by a combination of new circuit design and advanced processing techniques. The gate structure was changed to include both constant-current-source gates and a voltage regulator. Those changes and new logic configurations reduce gate delays.

The device is processed in Motorola's new oxide isolated MOSAIC (*M*otorola *O*xide *S*elf-*A*ligned *I*mplanted *C*ircuit) process, which reduces size and parasitic capacitances and improves bandwidth.

Art generator for Apple computers

Visual Horizons has introduced *Computer Slide Express;* that is a service that turns any Apple computer into an art generator, With the new service, any Apple computer user can convert computerized charts, designs, graphs, and graphics, into 35-mm color slides, standard-size black-and-white prints or enlargements, or overhead transparencies.

The information can be transmitted over telephone lines or mailed to Visual Horizons in the form of a floppy disk, which holds material for up to 35 slides. All material is returned through the mail.

The system is especially adapted to an author who might need black-and-white charts for a book, or to lecturers who need slides quickly for a presentation.

Visual Horizons will offer a complete range of software to let Apple users access a variety of type sizes. styles, and background designs. Computer Slide Express programs are also being developed for use with other computer brands.

Information may be obtained from Visual Horizons, 180 Metro Park, Rochester, NY 14623.

RCA develops a new high-power laser

A new high-power semiconductor laser just developed in the RCA Laboratories in Princeton, NJ, is expected to find important uses in optical data recording, high-speed printing, and fiber-optics communications. The new device, a CDH-LOC (*C*onstricted *D*ouble *H*eterojunction *L*arge *O*ptical *C*avity) injection diode laser, is smaller than a grain of salt. It has just been patented and is being offered for sale by the company's Solid State Division.

Invented by Dr. Dan Botez of the RCA Labs Optoelectronics Group, the new laster is fabricated by a single-step deposition of layers of gallium arsenide and aluminum gallium arsenide over grooved gallium aresenide substrates. Thousands of lasers can be obtained from a single wafer.

The CDH-LOC structure provides a stable light source with highly linear power output versus drive current for operating currents above the laser threshold. Emission in both the single lateral mode and the single transverse mode is obtained up to 40 mW in continuous operation and 100 mW in 50-percent duty-cycle conditions. Both represent the highest powers in a single spatial mode that has ever been achieved under such drive conditions.

A unique lasing cavity design allows the device to operate in a large spot size (6 micrometers × 1.4 micrometers) and consequently a narrow beam (6° × 25°). Thus the device is well suited for applications with stringent optical-quality needs. Furthermore the device beam has almost no astigmatism; hence it can be focused to a diffraction limited spot.

It is expected that the new laser will soon replace older gas types as light sources in optical recording equipment used for mass data storage. Another area—high-speed printing—holds great promise. A high-power diode laser permits rapid scanning of the printing drum and thus fast printing. In fiber-optics communications, it could permit light transmission without repeaters over longer distances. It will also be useful for non-fiber communications and guide-wave signal processing.

Computers makes farmers out of urban dwellers

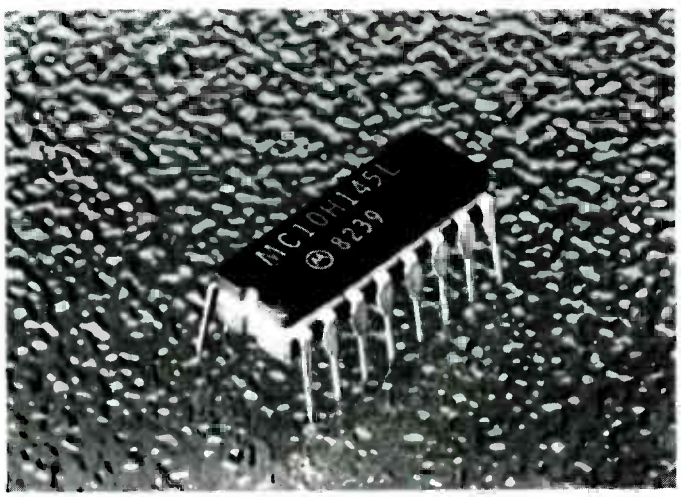
A new type of computer-based agriculture is reported from Israel, where urban residents who lack the most basic horticultural skills are growing magnificent fruits, flowers, and shrubs semi-automatically. The plants are grown in concrete sectional containers. The soil is volcanic tuff—gray absorbent pebbles that provide excellent aeration. The technique can also be applied with excellent results to backyard gardens in ordinary soil.

The brain of the system is a small pocket-size computer that plans and delivers the correct amounts of water and fertilizer. It takes into account air temperature, humidity, and other variables, as well as type of soil (in earth gardens) and other data supplied by the gardener-owner.

The roof or backyard plots are seeded and the computer begins to supply liquid at calculated intervals. The water and fertilizer mixture is applied through small plastic tubes punctuated with drippers directed at the roots of the plants. In container-type gardens, the leftover liquid is recycled. The "farmer" has only to replenish fertilizers weekly or sometimes at longer intervals.

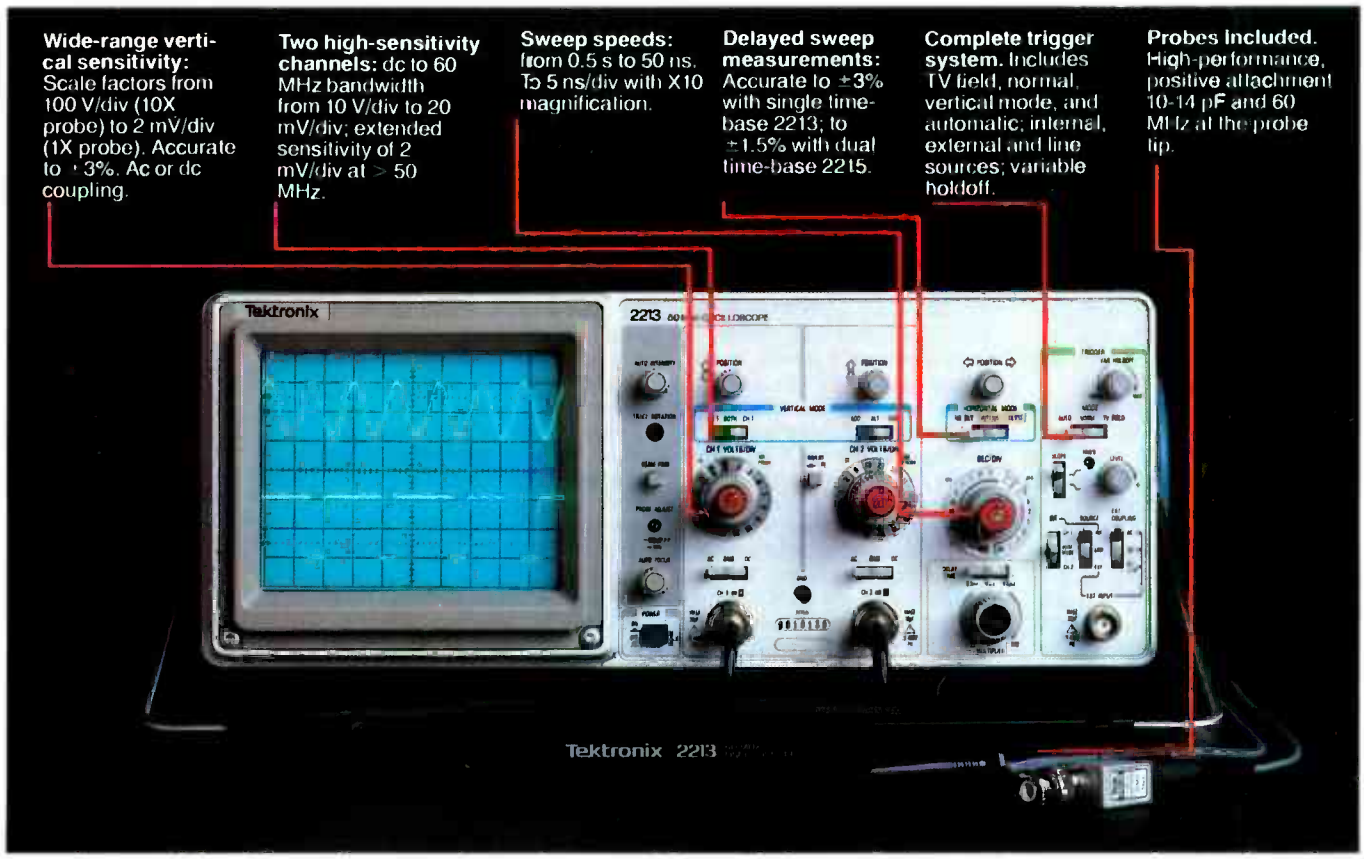
The new agricultural approach was invented by an industrial engineer, Noam Blum, who patented and is now marketing it. Installation on roofs, including all containers and equipment, costs up to about $4,000 for 100 square meters (1,075 sq. ft.) of space. Gardens on ordinary soil cost about half that much.

continued on page 8



MOTOROLA'S MC10H145, a high-speed RAM.

Now! A 60 MHz Tektronix scope built for your bench.



In 30 years of Tektronix oscilloscope leadership, no other scopes have recorded the immediate popular appeal of the Tek 2200 Series. The Tek 2213 and 2215 are unapproachable for the performance and reliability they offer at a surprisingly affordable price.

There's no compromise with Tektronix quality: The low cost is the result of a new design concept that cut mechanical parts by 65%. Cut cabling by 90%. Virtually eliminated board electrical connectors. And eliminated the need for a cooling fan.

Yet performance is written all over the front panels. There's the bandwidth for digital and analog circuits. The sensitivity for low signal measurements. The sweep speeds for fast logic families. And delayed sweep for fast, accurate timing measurements.

The cost: $1200* for the 2213. $1450* for the dual time base 2215. You can order, or obtain more information, through the Tektronix National Marketing Center, where technical personnel can answer your questions and expedite delivery. Your direct order includes probes, operating manuals, 15-day return policy and full Tektronix warranty.

For quantity purchases, please contact your local Tektronix sales representative.

Order toll free: 1-800-426-2200 Extension 50

In Oregon call collect: (503) 627-9000 Ext. 50

*Price F.O.B. Beaverton, OR. Price subject to change.

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APRIL 1983 7

WHAT'S NEWS

continued from page 6

Microsync offers Timex/Sinclair maintenance plan

Owners of Sinclair *ZX81* and Timex/Sinclair *1000* computers can now obtain yearly maintenance agreements from Microsync, in Keene, NH. Microsync—the only Sinclair-authorized service center in the country—repaired over 10,000 Sinclair *ZX81's* last year.

The maintenance agreement offers full service, including all parts. Agreements run for one year after warranty expiration, and are renewable.

Cost for one-year maintenance agreements are $14.95 for any *ZX81* or Timex/Sinclair *1000* less than 90 days old and $34.95 for units more than 90 days old. For 16K RAM's less than 90 days old, an agreement costs $12.95; more than 90 days old, $24.95.

Service agreements are also available on the new Sinclair *ZX* printer that is not marketed in the United States but is available from Canadian distributors.

Further information may be obtained from Customer Service Department, Microsync Services, Keene, NH 03431.

Computer now offers complete home control

A new and improved model of Tomorrowhouse, the complete computerized turnkey home-monitoring and control system that was introduced last summer by Compu-Homes Systems of Denver, is planned for this spring.

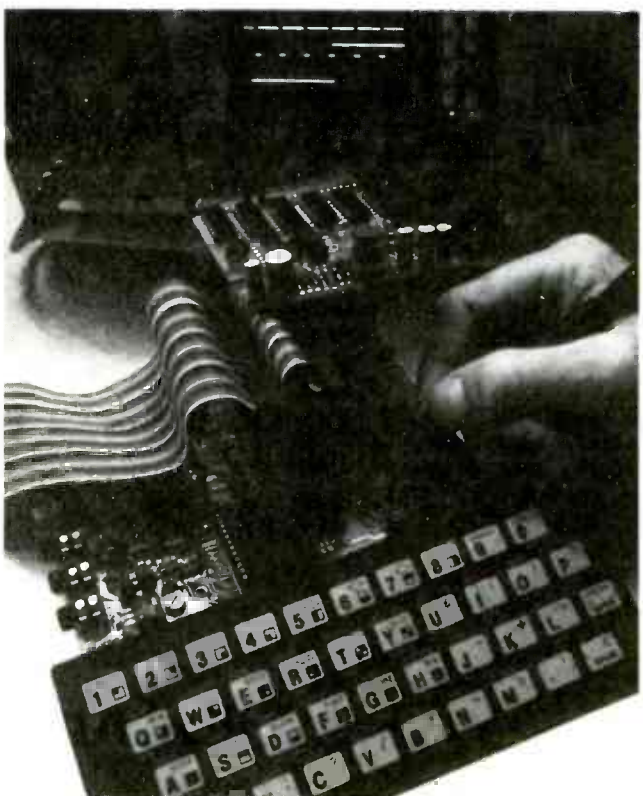
Said by its makers to be the first such system within the reach of the average consumer, Tomorrowhouse is based on the *Apple II* personal computer. It consists of a specially constructed plug-in circuit card, sensors, a junction box and related hardware, the programs necessary to set up and control a house, and installation and user manuals.

The graphic display of the Apple computer shows the exact status of all security and energy-control features at all times. The Security system is extended to include temperature monitoring of critical areas or equipment, and can turn on lights to scare off burglars or light escape routes in case of fire. Heating and air conditioning can be scheduled up to nine weeks in advance. Heating/cooling and lights/appliances schedules can be stored for execution at will, a feat impossible with simple timers. Other convenience features include a wake-up alarm and an appointment calendar.

Since humans are visual and vocal animals, information is presented visually (on the display) and verbally (via a voice synthesizer). Warnings and periodic announcements are made by voice.

The new Tomorrowhouse (model *2.2*) will include remote monitoring via any *Touch-Tone* phone. The user can call home, inquire whether there were any intrusions or power failures, and issue commands or change schedules. Tomorrowhouse can also call the office, vacation number, or neighbor in case of emergency and give an appropriate voice message.

For people who already have Apples, prices start at about $800.



MICROSYNC OFFERS MAINTENANCE AGREEMENTS for Sinclair and Timex/Sinclair computers

Broadcasters' guide heralds teletext push

As part of a stepped-up marketing push of the British World System Teletext, British Video and Teletext (BVT—the marketing and promoting arm of the British videotext and teletext industry) has mailed a new *Broadcasters' Guide to Teletext—the World System,* to executives and engineers of broadcast groups and 1,000 television stations across the U.S.

The guide describes teletext, explains how to make money with teletext, how to get a teletext magazine started, and presents details on British World System teletext receivers, standards, and maintenance.

BVT will continue to make available the Prestel World Service, a videotex system that provides information such as international commodity prices, shipping, and travel data. (Teletext is one-way transmission of information via broadcasting or cable, while videotex is one- or two-way communication of information via phone lines or cable.) But due to the numbers of hardware and software vendors in the United States currently using the Prestel standard, BTV will confine its active promotion to convincing broadcasters that "Today is the day to get into teletext."

AM stereo transmission for "Grand Ole Opry"

WSM, Nashville, Tennessee, which has been transmitting "Grand Ole Opry" since 1925, switched over to AM stereo last December using the Harris system. The station covers 38 states with its 50-kilowatt signal.

"We hope," said Tom Cassetty, WSM's general manager, "that AM stereo radios for homes and cars will be on the market soon."

CBS, Sony join to make audio discs in U.S.A.

A plan to make Compact Disc audio software in the United States has been announced jointly by CBS, Inc. and Sony Corp. of Japan. The discs will be made by CBS-Sony Inc., a corporation owned equally by CBS and Sony.

The Compact Disc is the first commercially produced digital-audio playback disc. The technology uses a small, reflective 4¾-inch disc that is read by a beam from a solid-state optical laser. The dynamic range, signal-to-noise ratio, and channel separation are all over 90 dB. Wow and flutter are unmeasurable, and frequency response is flat over the whole audio range.

Since the playback system is optical, with no surface contact, the Compact Disc will retain its original quality for an indefinite period of time, and is less liable to suffer physical damage.

Under present plans, CBS Records will market Compact Discs imported from CBS-Sony of Japan in 1983, and CBS-Sony will start to manufacture them in the United States some time in 1984. **R-E**

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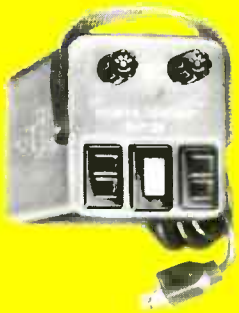

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CIRCLE 19 ON FREE INFORMATION CARD

EDITORIAL

WCES '83

The 4-day Winter Consumer-Electronics Show held in Las Vegas in early January attracted a record attendance of over 78,000 to evaluate the new products being introduced by the major consumer-electronics manufacturers. These products will be showing up on the store shelves during the coming months.

The products that attracted the most attention were computers, telephones and videogames. On the computer front, new personal computers were introduced by such well known names as Hewlett-Packard, Mattel (called the *Aquarius* and it will, of course, play video games), Texas Instruments, (the *TI99/2*, a basic computer that will compete in the under $100 category). Computers were also introduced by manufacturers new to the field, such as Spectra Video (the model *SV-318* contains 32K ROM, 32K RAM, Microsoft BASIC in ROM, 52-graphic symbols, 16-color display, and more for $299.95) and Data-Assette (the Jupiter Ace that will compete with the Timex/Sinclair ZX81).

A horde of new videogame cartridges were introduced at the show. New videogame consoles were also introduced. N.A.P. Consumer Electronics unveiled their *Odyssey Command Center* that is compatible with *Odyssey*^{2} videogame cartridges and features a typewriter-like keyboard and enhanced graphics. Mattel showed their new *Intellivision II*, actually a compact version of the currently available *Intellivision* console. At the same time, Mattel was privately showing their next-generation videogame, called the *Intellivision III*. Watch for our June 83 issue that will feature a special section on videogames.

Of particular interest was the General Electric display of high-technology products that included a Home Control System with a CRT display. The device controls appliances by sending control signals over the existing house wiring and includes heating and air conditioning control, a security and fire alarm system, and more.

There was also action on the VCR front. Manufacturers of Beta-format VCR's announced a new Beta format with hi-fi sound.

Robots also made an appearance at the show. Nolan Bushnell (founder of Atari, Inc.) introduced his long-awaited home robot. Two models of the *Androbot* were shown. The advanced model, called *B.O.B.*, will sell for approximately $2500 and feature three Intel 8088 16-bit microprocessors, 3 megabytes of memory, and infra-red and ultrasonic sensors. The basic model, called *Topo*, will sell for approximately $1000 and acquires its intelligence from an outboard personal computer via an RF link. Neither the infra-red nor ultrasonic sensors are supplied with the basic model.

With new product introductions of this kind, it appears that the consumer-electronics industry is alive, well, and headed for a banner year. **Radio-Electronics** will be there covering these and other developments as they happen, presenting you with the latest in-depth information.

ART KLEIMAN
Editor

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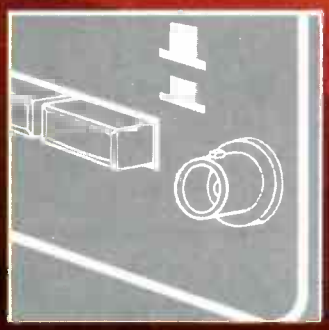

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CIRCLE 24 ON FREE INFORMATION CARD

SATELLITE/TELETEXT NEWS

CBS ACCELERATES TELETEXT

CBS has speeded up its timetable for introducing its "ExtraVision" teletext service, with an eye toward national launch this year. The service, using the North American Broadcast Teletext Standard format, is being transmitted on a test basis aboard lines 15-18 of the vertical blanking-interval of the network feed. The national teletext magazine will include about 100 pages of news, information, advertising, and other data, although CBS is stil pondering how much room to leave for local stations to insert their own teletext material. CBS also plans to put closed captioning into the national teletext feed, offering subtitles so that deaf viewers can follow the dialog in news and entertainment programs.

MORE DBS PROJECTS APPROVED

The Federal Communications has approved the preliminary plans for Direct Broadcast Satellites developed by seven more companies; those tentative OK's follow quickly on the heels of the go-ahead given recently to Satellite Television Corp. Among the companies now authorized to proceed with their DBS plans are CBS, Western Union, DBS Corp., RCA Americom, Graphic Scanning Corp., U.S. Satellite Broadcasting Co., and Video Satellite Systems. The companies have different approaches: For example, CBS is concentrating on the high-definition-TV feature of its system; several others plan only to be carriers for the DBS programming services of other companies.

The current round of FCC approvals is merely the go-ahead to begin developing systems. Launch authorizations, orbital slots, and other technical approvals probably won't come until late 1983 or beyond, after an international meeting hammers out a western-hemisphere agreement for DBS technology.

Among the interesting features of the latest batch of DBS projects are the RCA Americom systems, which will include four satellites, and the four-bird CBS system. In addition, U.S. Satellite Broadcasting, owned by the Minnesota-based Hubbard Broadcasting, proposes a four-bird ad-supported programming service. Graphic Scanning seeks a two-satellite system which will offer two pay-TV channels.

In a separate action involving DBS, the Commission is encouraging public comments about the susceptibility of DBS home receivers to extraneous interference. The research comes in anticipation of this summer's international DBS meeting. In particular, the U.S. committee going to that meeting wants to find out more details about possible problems, such as out-of-band emissions from terrestrial systems in the next higher band which could fall into the 12-GHz frequency range used by DBS. In addition, the committee will examine harmonics of emissions radiated by equipment in lower bands, such as microwave ovens, which could fall into the 12 GHz spectrum.

AROUND THE SATELLITE CIRCUIT

Bell Labs has developed a system that can put two high-quality video signals on a single satellite transponder with no loss in image. In a recent demonstration, Bell scientists showed a time-frequency multiplexing system which squeezes a single TV channel into half the usual transmission time. Using elaborate signal-processing techniques, the system stores material from the first field of each video frame scan then adds only the differential information in the second field. Both the first field and the differential data of the second field are then transmitted simultaneously. The differential data sent in an upper band by means of double-sideband suppressed-carrier modulation. That squeezing technique leaves room within the transmission for a second signal. Bell engineers think that they could even tuck a third video transmission into the same transponder, although there would be some signal-quality loss for all three channels if that happened. Nonetheless, the video-compression technique, which is the latest in a long series of efforts to piggyback channels on a single circuit, is seen as an important step in the search for ways to increase transmission capacity in the crowded skies.

Intelsat has adopted an earth station "Standard Z" intended to make it easier for international satellite operators to design and build reception equipment. Until now, most earth-station antennas used for domestic service have not followed any universal pattern. The new "Standard Z" provides specific guidelines on performance characteristics and differs from previous standards in that such items as the effective radiated power per carrier, modulation methods, transmit gain, and channel quality are not included. **R-E**

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VIDEOGAMES

New life for your Atari *2600*

DANNY GOODMAN, CONTRIBUTING EDITOR

DEDICATED ATARI *2600* ENTHUSIASTS become defensive whenever friends carry on about one of the many systems now on the market that offer arcade-like graphics. By comparison, the *2600* seems a generation or two behind. Even after some wonderfully detailed graphic executions like Parker Bros.' *Frogger*, Atari's *Defender*, and Imagic's *Demon Attack*, the *2600* still lacks the "flash" of the *Intellivison* from Mattel, and the newer systems by Atari and Coleco. That is, however, only until you plug Starpath's *Supercharger* into the cartridge slot (see Fig. 1). It's like discovering a completely new game system, and the cost is only about $70.

FIG. 1

One of Starpath's (formerly known as Arcadia) founders, Bob Brown, is an ex-Atari engineer who had a lot to do with the design of the *2600*. As such, it's not surprising that he's very knowledgeable when it comes to working miracles with that console.

Simply put, the *Supercharger* expands the part of the console's memory that creates a graphic image and sends it to the video screen. The *2600* by itself has only enough "screen memory" to handle new video information every other horizontal scanning-line (a TV picture is made up of a few hundred such scanning lines). Thus, the smallest video element is two scanning lines thick. The *Supercharger*, however, supplements the screen memory to accommodate new video information on each line, greatly improving the graphics resolution.

But the hardware—the *Supercharger* unit itself—is only a small part of the story. First, let's clear up a misconception among many game players—and even retailers—about standard game-cartridges for any home videogame. For one reason or another, perhaps because they resemble the old 8-track tape cartridges, the videogame cartridges are often referred to as "tapes." They are nothing of the sort! I don't recommend it, but if you were to open up a game cartridge, you would see a small circuit board, one or two integrated circuits and perhaps a few other components, but no tape. The IC's are, of course, ROM's, and they store the game program. When the cartridge is plugged into the unit and the game is switched on, the contents of the ROM's are downloaded into the console's main memory and the game begins. And so it has been, until Starpath.

With the advent of the *Supercharger* comes a program-loading technique new to home games, but well known to home-computer hobbyists: downloading from a cassette tape. All you need is a cassette player into which you plug the cable coming out of the *Supercharger*. Turn on the *2600* and TV (the *Supercharger* gets all its power from the *2600*) and you are prompted on the screen to rewind the tape and press PLAY. In about 30 seconds, the screen fills up with color and you're instructed to stop the tape. Presto, you're in the game.

Game play, though, is what makes or breaks a system. And, on that score, Starpath comes through with flying colors. The tape packed with the *Supercharger* is called *Phaser Patrol*. Similar to *Star Raiders* (Atari) and *Star Master* (Activision), *Phaser Patrol* puts you at the helm of a space fighter whose goal is to clear 36 galactic sectors of enemy squadrons. Your on-screen control panel makes full use of the super graphics with sharp, clear status indicators, digital readouts, and a graphically unique relative-time keeper. Flip the COLOR/B + W switch on the *2600* console, and an ultrafine sheet of dots slowly fills your viewing area, indicating that your "shields" are on.

The game play is fast, and is sure to keep your attention. If you "survive," you are rated according to your expended time and energy. I prefer this space simulation over any other for the *2600*, and I place it just a notch under the version for the Atari *400/800* computers.

More recently, Starpath has taken full advantage of its cassette-loading technique with games that require multiple loading as you master each level. It is really like getting two or three complete games on one tape.

Dragonstomper may become a cult classic among home-videogame addicts. It's a graphic adventure-type game in which the player fights several different kinds of enemies, and explores various buildings in search of gold and a scroll to gain access to the next level. When those have been found, you do another load and begin trading and buying provisions for the third and most dangerous part of the journey. The final phase (this is a three-load game) is a completely different screen layout with almost insurmountable hazards on your way to face the dragon. In the tradition of adventure-type games, instructions are minimal, so be prepared to spend many hours finding your way around using trial and error.

As cassette tapes are less expensive to produce than ROM cartridges, games range in price from $14.95 to $18.95. And when you consider that, for the most part, the games offer better displays and more involved play than the $35 high-end cartridges, suddenly the initial $70 investment for the *Supercharger* and *Phaser Patrol* doesn't look so bad.

Astrocade's The Incredible Wizard for Astrocade

LIFE FOR THE *ASTROCADE* (FORMERLY *Bally Arcade*) console and its owners has not been too easy of late. For one thing, there have always been pretty slim pickings when it came to cartridges. For another, the manufacturer's (Astrocade, Inc.'s) precarious financial situation, which has become common knowledge in these past few months, has put the future of the machine in doubt. However, to paraphrase Mark Twain, reports of its death may have been greatly exaggerated. The company, at press time, was undergoing reorganization and is hopeful that it can continue producing the console and even introduce some new cartridges in the near future.

In any event, most of the cartridges that

continued on page 20

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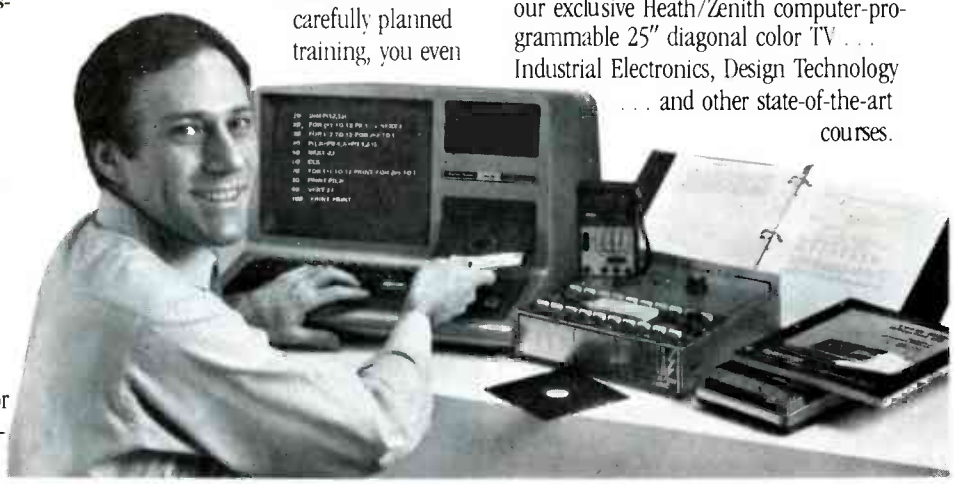

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VIDEOGAMES

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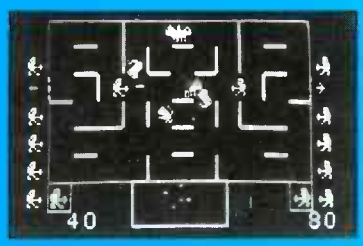


CIRCLE 101 ON FREE INFORMATION CARD

do exist are of high quality, owing largely to the vast graphics and sound resources of the *Astrocade* console electronics. One such cartridge is *The Incredible Wizard*, Astrocade's home version of the mildly successful Midway arcade game, *The Wizard of Wor*.

The game can be played by either one or two persons.

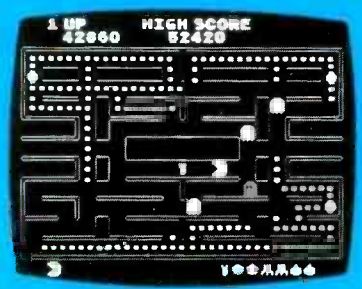
In the game, your warrior descends through many different mazes, battling three different kinds of creatures. The farther you get in the game, the faster and more numerous the creatures become. Some of the creatures are invisible unless you're in their line of sight (when it may be too late), so a radar screen without maze walls indicates the approximate locations of the unseen menaces. When all the creatures have been blasted by your "concentrated unified-field-disturbance rifle" the flying Worluk appears. You've got to shoot him before he either runs you down or escapes through one of the side escape doors. If you get him, the next maze scores double point-values. At random maze levels, the hooded Wizard will appear, racing about like crazy, hurling lightning bolts. If you are good enough to shoot him, you'll exprience a fantastic light and sound show as the dungeon trembles, and your next maze will be worth quadruple points. At higher levels, mazes show up that have no visible walls. As in the arcade game, those are called Pits.

Graphic detail is fine enough to see that your warrior is suited up in a helmeted space suit with a back pack. When he shoots, the kick from the rifle blast sets him back on his heels for a half second.

A diverse sound package adds to the appeal of the cartridge. The chirp-like sound of some of the creatures, the rifle blasts hitting a target, the disorienting sound of the trembling dungeon, and musical interludes all help to keep things interesting.

In many respects, including *Astrocade's* rather nice hand controller, *The Incredible Wizard* is much more enjoyable than its arcade ancestor.

Atari's Pac Man for Atari 5200



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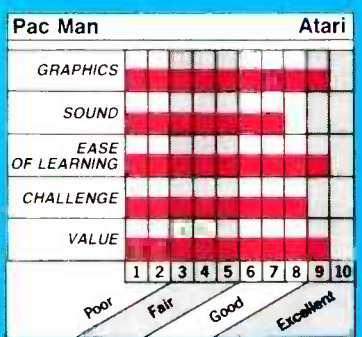

ATARI'S NEW *5200* GAME SYSTEM has the advantage of having some of the best home versions of arcade classics in its cartridge library, and *Pac-Man* is no exception. Arcade addicts who were disappointed with Atari's version for the *2600* will have little to complain about in this rendition. The game designers took great care in copying arcade features such as board-level indicator (standard fruit symbols until you get near the top range—where an Atari logo is the symbol—and keys at highest range); bonus point symbols appear under the monster pen twice during each board; monster "blue time" varies as difficulty levels increase (including some where there is no blue time); 1UP, 2UP, and HIGH scores are shown; maze walls flash between levels; etc. Even intermissions appear between some levels (something even the Atari home computer Pac-Man cartridge doesn't do).

The basic difference between the home and arcade versions is that some of the arcade sounds are missing, like the "wocka-wocka-wocka" of Pac-Man eating dots and the sound of a deflating Pac-Man that's been captured by a monster. Another minor difference is that the monitors used in the arcade version were oriented vertically, while your home color-TV display is horizontal (because your TV is wider than it is tall). But, while the maze is slightly different, it's just as challenging as the original.

A tendency you'll have to overcome is working the joystick too hard. It's not easy when all four monsters are after you and you're a long way from an energy pill, but the controllers on the *5200* need only a very light touch to get Pac-Man moving in the right direction. But for about $40 on the $250 console, you've got the closest thing to the $2500 arcade game you can get. **R-E**

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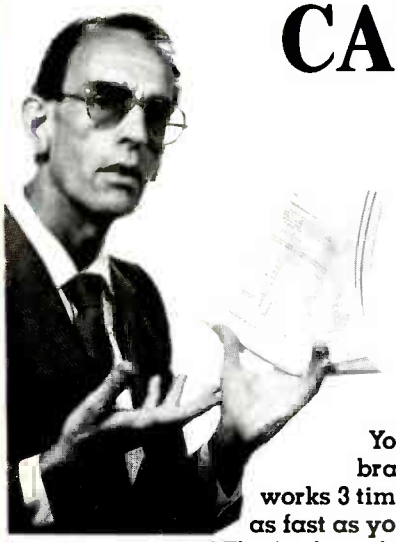
CALCULATOR MATH?



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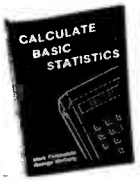

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LETTERS

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NO SELLOUT

Thank you for not selling out and becoming another computer magazine.

Even if computers are now everywhere, not everyone has an interest in those things. For those who are computer buffs, there are many publications devoted entirely to that field. I would suggest that they read them and leave the electronics magazines to those of us who appreciate the fact that the world of electronics doesn't revolve around just one specific technology.

RANDALL FRASER
Worcestor, MA

THE FCC

I was very disappointed at the ignorance about the facts, and the shallow thinking that was exhibited in **Radio-Electronics'** January 1983 editorial: "Committing Suicide—FCC Style."

In dealing with the FCC for over 20 years, I have found their current overall policy attitude to be the most progressive, commonsense, and up-to-date so far.

Even taken out of context, the quotes of Chairman Fowler that you used do not support the conclusions that you derived from them. Mr. Fowler did not say (or imply) that either technical or basic licensee qualifications would be reduced. Instead, he recognizes that a great portion of the licensees' time and money are spent on paperwork and compliance to superfluous and outdated rules—as is the commission's time also. If you have ever filed an application, or maintained a license for a station other than a CB station, you should know how needlessly time-consuming it is.

The only way that the public will interpret Mr. Fowler's words as an approval of homebrew broadcast stations, or 1 kW CB stations, is when they read it in publications such as yours, and assume that you are knowledgeable on the subject.

I have read **Radio-Electronics** (and its earlier titles) for close to 30 years and will continue to do so as long as the articles are as good as the ones in this issue—despite the poorly-thought-out content of the January editorial.

How about some positive thought and constructive comments in the editorials? (Anyone can sit on his or her butt and complain!) What's *your* answer toward properly using and balancing the radio spectrum? How are we going to accommodate future technologies and spectrum requirements? Do you even care?

JACK K. DANIEL
New York, NY

Of course we care! And I wish I had a solution for every problem currently facing the FCC—but I don't. I also applaud any attempts to reduce much of the needless and wasteful bureaucratic red tape that currently exists at the FCC. However, across-the-board general deregulation is not the answer.

Chairman Fowler's statements, coupled with recent FCC decisions (or, shall I say non-decisions), such as teletext and AM stereo, indicate that across-the-board deregulation is the ultimate intent.—Editor

This is in response to the editorial, "Committing Suicide—FCC Style," in the January 1983 issue. I think that you have misinterpreted Chairman Mark Fowler's comments. My understanding is that those comments refer to getting the FCC out of regulating the *non-technical* aspects of broadcasting. To that end, I applaud Chairman Fowler. The FCC should be solely a technical regulatory agency—not an agency that deals with social policy.

Unfortunately, Chairman Fowler's deregulatory juggernaut does not want to stop at getting the FCC out of social engineering—the momentum is carrying through to bona-fide regulatory areas such as standards, operator licensing, type approval, operating, and maintenance logs.

If Chairman Fowler's unregulation/deregulation/reregulation approach turns out to work, I for one will gracefully acknowledge the validity of his premise that the "forces of the market place" are preferable to artificial regulation by a government agency. However, if he is wrong, and the wisdom of the Communications Act of 1934 is vindicated, we will certainly have an incredible mess to clean up.

DANE E. ERIKSEN
Alameda, CA

FASTER THAN LIGHT?

In regard to the article, "Faster Than Light," by Harold W. Milnes, Ph.D., in the January 1983 **Radio-Electronics,** I believe that he made a misinterpretation of what was observed.

Refer to Fig. 2 on page 56 of the January 83 issue of **Radio-Electronics.** When a positive pulse was applied to point A by the generator, current flowed into the delay circuit. Since the ground of the generator was connected through resistor R to point B, current flowed through R, producing the same positive pattern at B as was observed at A, and through the other end of the delay circuit. Superimposed on the scope picture was a mixture between a standing wave and a traveling wave produced by these signals entering both A *and* B. That accounted for what Dr. Milnes attributed to line distortion.

In other words, he did *not* observe anything traveling faster than light.

HARVEY GLUCKMAN
Montauk, NY

Radio-Electronics' recent article, "Faster Than Light?" (January 1983) does the readers and staff writers of your magazine a disservice. I am especially concerned about your younger readers, who may consider as gospel that seriously flawed sojourn into pseudo-science. As any scientist, engineer, or for that matter any well-trained technician conversant in electromagnetics knows, the wire "delay line" referred to in the article is neither a delay line nor a transmission line. It is a crude antenna, which serves to radiatively couple the two oscilloscope channels. The author's conclusion that signals travel faster than light is based on an incorrect and naive analysis of data obtained from a flawed and simple-minded experiment. The wire may be made as long as the author wishes, and the same apparent result would still be forthcoming.

Literally hundreds of crank articles dealing with the speed of light and relativity are written every year. It is unusual, however, to see such an article in a technical publication—especially in a magazine of the stature of **Radio-Electronics.** By publishing such nonsense, the accuracy and usefulness of all articles in the magazine are thrown into question.

DR. THOMAS D. ROBERTS,
University of Alaska,
Fairbanks, AK

COMPATIBILITY

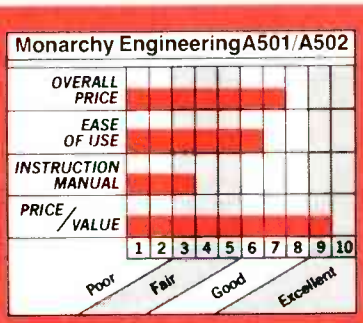
While your computer buyers' guide in the October 1982 **Radio-Electronics** is full of useful information not easily obtained eslewhere, I feel that you could say more about compatibility. For example, in the Commodore line, the MAX and the 64 are compatible, so that programs on cassette and cartridge written for the MAX will also run on the 64. However, neither machine is compatible with the VIC-20. In fact, the cartridge port on the VIC-20 is of a different configuration. Such information could be a highly important factor in deciding which machine to buy, especially at the low end where CP/M is not available and where each machine typically has its own version of BASIC. And I wonder: Why don't companies such as Commodore point out those important differences in their advertising?

HAROLD MILLER
Clayton, GA

R-E

EQUIPMENT REPORTS

Monarchy Engineering A501/A502 Power Amp and Preamp



CIRCLE 103 ON FREE INFORMATION CARD

FOR MOST AUDIO ENTHUSIASTS, SETTING up an audiophile's sound system means laying out a very large amount of cash. For those interested in electronics, however, there is an option—build one of the high-quality units currently available. If you do that, you'll not only cut the cost of your system, but gain the added pride and satisfaction of listening to components you built yourself.

Among the better units we've seen lately is a pair of matching components from Monarchy Engineering (380 Swift Ave, Unit 21, South San Francisco, CA 94080). Those are the model *A501* power amplifier and the model *A502* preamp/control-center. The sound quality of those units compares favorably with high-quality assembled units on the market. There are some problems with the construction, however, particularly with the instruction manuals, but we'll get to that later. Let's first take a closer look at the units and their features.

Model *A501* power amplifer

The power amplifier (shown) offers several unusual features. For instance, it offers switchable Class A or Class AB operation. In the stereo mode, the output power is 25 watts-per-channel Class A and a hefty 100 watts-per-channel Class AB. In the monaural mode, the two stereo channels are connected together in a bridge configuration and the power out-

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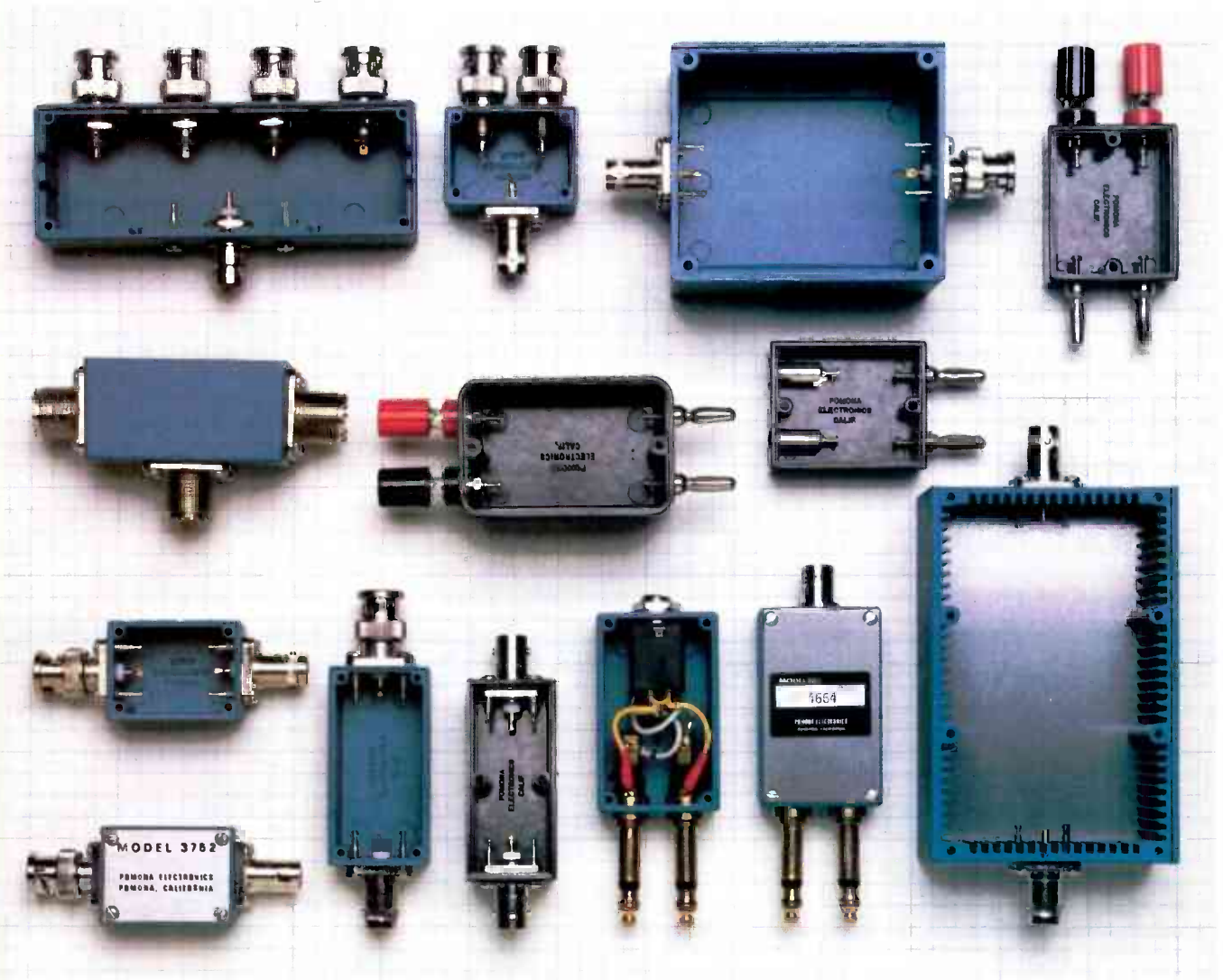

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put is 100 watts-per-channel Class A and 300 watts-per-channel Class AB.

The manufacturer's specifications for total harmonic distortion (THD) is less than .007% Class A (.01% Class AB). Other important specifications include a frequency response of 5 Hz to 200 kHz (− 1 dB), a signal-to-noise ratio of 105-dB Class A (115-dB Class AB), channel seperation of better than 80 dB at 1 kHz, and internal noise of less 0.3 mV Class A (0.2 mV Class AB).

All of the supply voltages in the voltage-amplification stage are regulated. The unit is protected from overheating by a rather interesting high-efficiency *liquid* convection-cooling system. It may be a bit disconcerting to find that if you listen very carefully to the unit (assuming there is no input, of course) you can hear it "bubbling away" much like a radiator. Rest assured, however, that this is normal; what's more important is that the system works, and works well, affording excellent thermal stability. Other protective features include a DC-sensing speaker protection circuit and an excessive-current limiter.

Model *A502* preamp

The matching model *A502* preamplifier is actually called a "control center." Like the power amp, the preamp's features and specifications compare favorably with assembled units on the market.

The model *A502* will work with both moving-coil and moving-magnet phono cartridges and includes separate RIAA input-amplifers for each type of cartridge. Also, all capacitors have been eliminated from the audio-signal path so that direct coupling from input to output (or from cartridge to speaker when used with the *A501*) is achieved. The use of independent left- and right-channel power supplies reduces crosstalk.

Looking at the manufacturer's specifications, the unit's frequency response (phono) is 20 Hz to 20 kHz (± 0.2 dB). Both total harmonic distortion and intermodulation distortion are less that .005% at 3 volts. The maximum output-level from the unit is 15 volts and the maximum phono-input level is 16-mV RMS for the moving coil input and 270-mV RMS for the moving magnet input.

Let's next turn to the layout of the control panel. Among the more interesting controls on that panel is the CARTRIDGE-SELECT/PHONO-STRAIGHT switch. The actual function of that switch is chosen during construction. If you use it as a CARTRIDGE-SELECT switch, you can connect either a moving-coil or moving-magnet cartridge to either of the rear-panel inputs—the switch is then used to choose between the inputs. If it is used as a PHONO STRAIGHT switch, moving-coil cartridges must be connected only to INPUT 1 while moving-magnet cartridges must be connected only to INPUT 2. In the PHONO-STRAIGHT mode itself, the phono signal takes the most direct route from the input to the output of the unit, bypassing (and thus disabling) most of the controls with the exception of the VOLUME control.

Another feature is a subsonic filter that cuts off frequencies below 15 Hz. The front panel also includes a MODE REVERSE switch that flip-flops the right and left channels as well as three-position bass and treble TURNOVER-FREQUENCY switches that are used to select the frequencies at which the BASS and TREBLE controls become effective. These turnover frequencies are 150 Hz, 300 Hz, and 600 Hz for the BASS control and 1.5 kHz, 3 kHz, and 6 kHz for the TREBLE control. A TONE switch can be used to defeat the BASS, TREBLE, and TURNOVER controls and provide flat frequency-response.

Construction

Each kit is designed to be built in stages and all parts are prepackaged in easily identified clear-plastic bags. Each bag is opened only as it is needed, and each stage of construction follows logically.

That does not mean all is well, however. For those familier with the "can't fail" instructions provided with some kits, such as those from Heathkit, the difference between those and the ones provided with these kits will be im-

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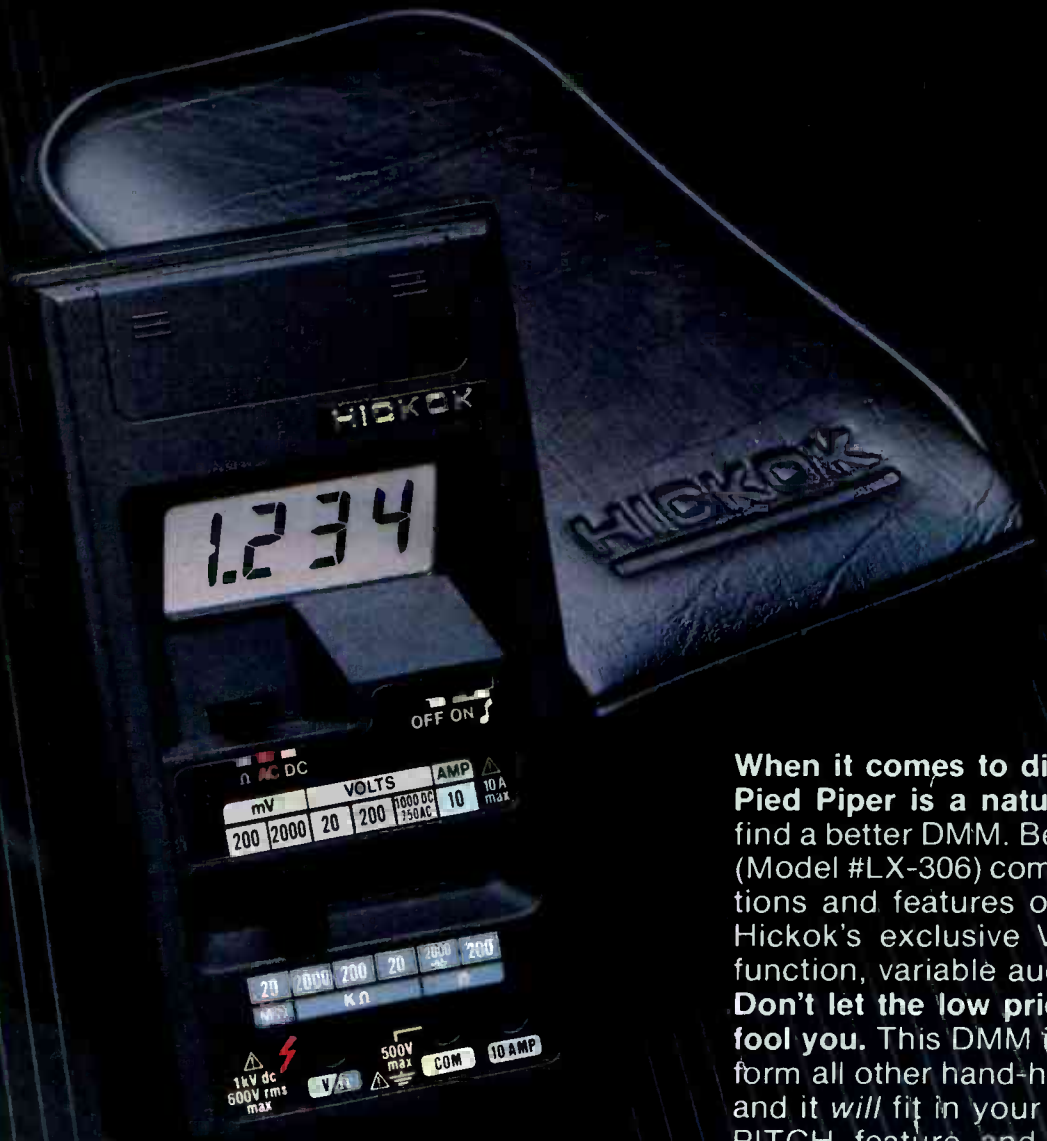

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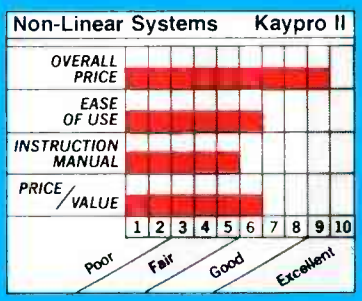
mediately obvious. For another thing, the primary instruction manuals are written in *Japanese*. An English translation is provided, to be sure, but the manual and the translation must *both* be used if the kit is to be successfully built. For another thing, all of the illustrations appear only in the Japanese manual, and those illustrations are, of course, vital.

Another, and perhaps more critical fault, however, is the quality of the translation. It appears to have been translated literally from the original Japanese and as a result can be difficult to read and confusing. You'll find yourself rereading an instruction several times just to be sure you completely understand it. Finally, a few typographical errors and a few ommisions of information were spotted (you'd be surprised at how much Japanese you can "learn" just studying the diagrams). All of those can be spotted before any damage is done, but you must pay careful attention to both the original and the translation or you might run into trouble.

All that aside, however, the finished products are well worth the time and effort put into building them. They are two truly sophisticated units, with both impressive specifications and performance. The *A501* sells for $299.95, the *A502* for $349.95. Both units are available directly from Monarchy. **R-E**

Non-Linear Systems Kaypro II Portable Computer



ADAM OSBORNE CREATED A SENSATION IN 1981 when he brought out the first truly portable microcomputer. People said it couldn't be done, but he did it, offering with it a powerful assortment of applications software. The most unbelievable part to many observers at the time was the price—$1795 for a full 4-MHz Z80 microcomputer that was capable of running the industry-standard operating system, CP/M.

Other companies are following the path that Osborne paved. One of them is Non-Linear Systems (533 Stevens Ave., Solana Beach, CA 92075). The company is best known for its line of test equipment and oscilloscopes, but it has also leaped onto the portable-microcomputer bandwagon with its *Kaypro II*. That portable, which also comes with a powerful set of applications software, is aimed directly at the Osborne market with a price of $1795.00. The Osborne computer and the *Kaypro II* have a number of features in common—and a number of significant differences.

Similarities

The *Kaypro II* is comparable in size and weight to the Osborne—roughly 18 inches wide by 8 inches high by 14 inches deep, and weighing about 26 pounds. Neither unit has a cooling fan, although the *Kaypro II* seems to have more vents. (However, that doesn't mean that they run hot; instead, they keep their cool even after hours of use.) Both are similar in that their covers are actually detachable keyboard units, and each has a similar number of keys, arranged in the familiar

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typewriter-style QWERTY layout. The *KayPro II* has a 62-key soft-touch keyboard with a separate 14-key numeric keypad.

Both portables come with 64K (64,000 bytes) of memory and use Z80 CPU's, and both run the CP/M operating system, which allows users a wide selection of pre-packaged, off-the-shelf applications software. However, the average user may not even need further applications programs because each portable comes with a standard word-processing package, a financial-spreadsheet package, a powerful BASIC programming package, and, of course, CP/M.

More than one wag has suggested whimsically that the user is actually paying for the software and getting the computer free. That's not exactly true, but for the relatively small amount of money he has to spend, the user gets a great deal.

Both machines take advantage of existing technology. They are not among the new wave of 16-bit or 16-bit/8-bit machines now coming to the market and they break no new ground. Instead, they build on the resources of existing hardware and software. The average user of each machine should find either more than adequate for his needs.

Differences

Similarities aside, the *Kaypro II* is an interesting machine in its own right. It attempts to correct some of the things that have been criticized in other portables. In some cases it succeeds, while in others it doesn't. Take the display, for instance. Rather than rely on a tiny five-inch CRT and horizontal scrolling, as does the Osborne computer, NLS has used a nine-inch screen with a full 80-column display capability. That makes the machine much easier and less disconcerting to use. NLS has apparently been able to use a larger-size screen because of the placement of the computer's built-in mini-floppy disk drives. They are stacked vertically to the right of the screen, while Osborne chose to mount the drives horizontally, one on either side of the display, and thus had to save space with a much smaller CRT.

NLS also took the *Kaypro II* several steps farther than Osborne did his original unit. When the Osborne computer was first released, it came equipped with single-sided, single-density disk drives. That limited mass storage to about 180K, which also limited the usefulness of the system. Although Osborne later opted for a single-sided, double-density format, NLS had the foresight to equip its machine with single-sided, double-density drives from the start, thus increasing its usefulness greatly. Mass storage on the *Kaypro II's* two drives is 382K. Obviously, NLS learned from the Osborne experience.

What it didn't learn from Osborne shows up in the usefulness of the larger nine-inch CRT screen. Osborne's screen is matte-finished so there is a minimum of glare, while NLS uses a normal glass-like outer screen that's subject to glare spots and can be hard to read. Also, the "green-on-green" display can be somewhat difficult to make out in some light. Granted, the actual surface of the *Kaypro II's* screen is matte finished, but the outer CRT covering is glass, and that defeats the purpose of the matte finish on the inner surface.

Furthermore, the display picks up a great deal of noise that appears as raster scan-lines that run across the face of the CRT when the disks are accessed. That can prove disconcerting if you are trying to follow a user help-menu. And, it's not limited to isolated incidents; it happens every time the read-write head of the disk is accessed. The problem is something that should be looked into, because the fact that the screen "hears" the controller circuitry indicates that it is noisy from an RF standpoint.

You would also think that because of the all-metal enclosure the system would be quiet from an RF standpoint, but it isn't. When the computer was used near a VHF-FM amateur-radio transceiver, it easily overcame the receiver's quieting circuitry and popped the squelch, especially when the read-write head was accessed. The noise continued even with the squelch control turned all the way up.

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Has self contained A&B and bypass switch. Many movies, concerts and special programs for sale or rental are copy guarded. This removes copy guard and allows you to make copies. Many TV sets will not play prerecorded tapes because copy guard causes picture to roll and jitter, turn to snow or disappear. Video Guard Stabilizer removes copy guard from signal.

BP VIDEO GUARD STABILIZER/ RF CONVERTER

MODEL V-1877

OUR PRICE $69.95 each

Same as above but with a built-in RF Converter that gives the model V-1877 an RF output which can be fed directly to the antenna terminals of a TV set. This enables you to remove the copy guard from a pre-recorded tape and view it on a TV using only a VCR.
Use as an RF Converter only. Used in conjunction with your TV, you can feed direct audio and video signals from any video device such as video camera, computer, portable VCR, etc.

BP VIDEO COMMAND CENTER

MODEL V-4803
OUR PRICE $59.95 each

A switcher that can accept 6 inputs and direct them to 3 outputs. Utilizes switch similar to one used on home VCR's. You avoid signal loss incurred by using splitters.

JERROLD 60 CHANNEL CORDLESS TV CONVERTER

MODEL DRX-3-105

CALL FOR PRICES

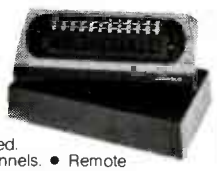
• Receive up to 60 TV channels • Remote TV Control • Attach to any age or model TV in minutes. • No tools required. • On/Off button. • Channel selection. • Channel Stepping. • Fine Tuning.

JERROLD JRX TV REMOTE CONVERTER

MODEL JRX-3C105 (SWITCH)

OUR PRICE $79.95 each

Consists of two units - a receiver and transmitter. 20 ft. connecting cord is detachable at one end to help you position the unit. May be attached to any age or model TV in minutes. No tools required.

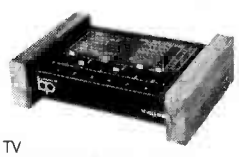


• Receive up to 36 channels. • Remote TV control.

BP VIDEO CONTROL CENTER

MODEL V-4802
OUR PRICE $19.95 each

Provides remote control access of all Video, TV or Cable inputs to TV or Big Screen TV from one location by flipping switch.



• One output, your TV set or Big Screen TV • Four inputs • Completely passive, i.e. no AC power required to operate • Auxiliary input and output provides added flexibility.

BP UHF CONVERTER FOR TV AND VTR

MODEL V-5736
OUR PRICE $24.95 each
5 FOR $100.00

Use your VCR to its maximum capability. Record VHF, UHF, Cable or Pay TV while watching any other mode.

FEATURES • 36 channels • Allows complete programming of VTR • Super color quality • Watch or record any combination of selectable channels. • Receives midband, superband/Pay and all VHF channels on UHF. • For Beta/VHS type recorders or TV set • Record and use TV's remote control.

BP IMAGE ENHANCER

MODEL V-1860

Dramatically improves performance of video cameras and VCR's (off-the-air or second generation recordings), by compensating for deterioration of detail and sharpness. Includes video distribution amplifier with two video outputs, allowing you to make two copies at once without loss in signal level.

OUR PRICE $59.95 each

BP RF CONVERTER/MODULATOR

MODEL V-1885

OUR PRICE $39.95 each

Allows your TV to receive video and audio signals from image enhancer, guard stabilizer, video camera, computer, VCR, etc.

The outputs of many video components cannot be directly hooked up to the VHF antenna terminals on your TV set. This problem is solved by using the Model V-1885 RF Converter. Converts video signal from any video component to adjustable RF signal at antenna terminals. Allows your VCR output to feed two TV sets at the same time, with virtually no signal loss.

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and indicates a deficiency in the unit's RF shielding. It should be noted, though, that normal television viewing wasn't interfered with greatly, although there were some signs of stray RF entering the front end of the television receiver. That isn't a minor quibble: other computers tested and used regularly within the same area produce only limited RF-interference on the same equipment, and it is easily quieted.

Performance

Setting up the computer is very easy. Since it is an all-in-one unit, all you have to do is take it out of the carton, plug it in, and flip a switch. After that, you insert the system disk (the one that contains the CP/M operating system) and start ("boot") the machine. In addition to the 64K of RAM, the *Kaypro II* also has 2K of ROM (*R*ead-*O*nly *M*emory) that stores the bootstrap routine that allows the operating system and programs to be loaded into memory. The ROM also runs any start-up self-test diagnostics. That portion of memory, since it is read-only, is not user-modifiable.

Like the Osborne portable, the *Kaypro II* comes with a powerful set of applications software. A set of four programs from Perfect Software includes *Perfect Writer, Perfect Speller, Perfect Calc and Perfect Filer*. The first two are a word processor and its associated spelling checker. *Perfect Calc* is a spreadsheet program, and *Perfect Filer* is a relational data-base program.

Also included is Chang Labs' *Profit Plan*, a simplified business spreadsheet, an *S-BASIC* compiler for user-written programs, and, of course, CP/M.

The *Perfect Speller* word-processing program comes with a "teaching disk" that leads the first-time user by the hand through the steps he needs to make the best use of the program. The lessons are thorough and while, in my opinion, the presentation could have been better, they do do the job.

The soft-touch keyboard used on the *Kaypro II* lacks a positive feel. The impression is as if the keys are somehow vaguely disconnected from the keyboard, although there is a software-driven beep to indicate a keystroke. If NLS had used stronger springs, the overall feel of the keyboard would have been better. While that may slow the touch typist, it should pose no problem to the average two-fingered typist.

Communications and printer input-output are handled via either a standard RS-232C serial port or a standard parallel printer port.

One of the nice features of the machine is its memory-mapped display. That means that for every spatial element on the screen there is a corresponding block reserved in the memory. That would indicate that there is the possibility of making use of computerized graphics, which will make the computer valuable in a scientific or engineering setting. It further means that a user can manipulate screen elements in any manner he desires.

For those potential computer-users who are familiar with well-bound and presented documentation, what comes with the *Kaypro II* may be a great disappointment. The manual is limited and only glosses over the capabilities of the system. It is necessary to wade through the other documentation before the system becomes very understandable. Further, the documentation isn't bound. Instead, it is merely stapled together and arrives in three separate envelopes. That contrasts greatly with the Osborne's bound, notebook-type documentation that promotes much easier use. It should be noted, though, that what I received may have been preliminary versions of the final product.

Overall, the *Kaypro II* is a fairly good attempt at emulating and improving upon the *Osbrone I*. However, while it sets an ambitious course for itself, it seems to fall down on some counts—such as RF noise, documentation, screen usability, and keyboard feel. When NLS corrects those problems, it will have a very, very powerful and useful system that is just right for the person on the go who needs true computing power. **R-E**

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My father always told me that there were certain advantages to putting all your eggs in one basket. "John," he said, "learn to do one important thing better than anyone else, and you'll always be in demand."

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I'll tell it to you straight. If you think electronics would make a nice hobby, check with other schools.

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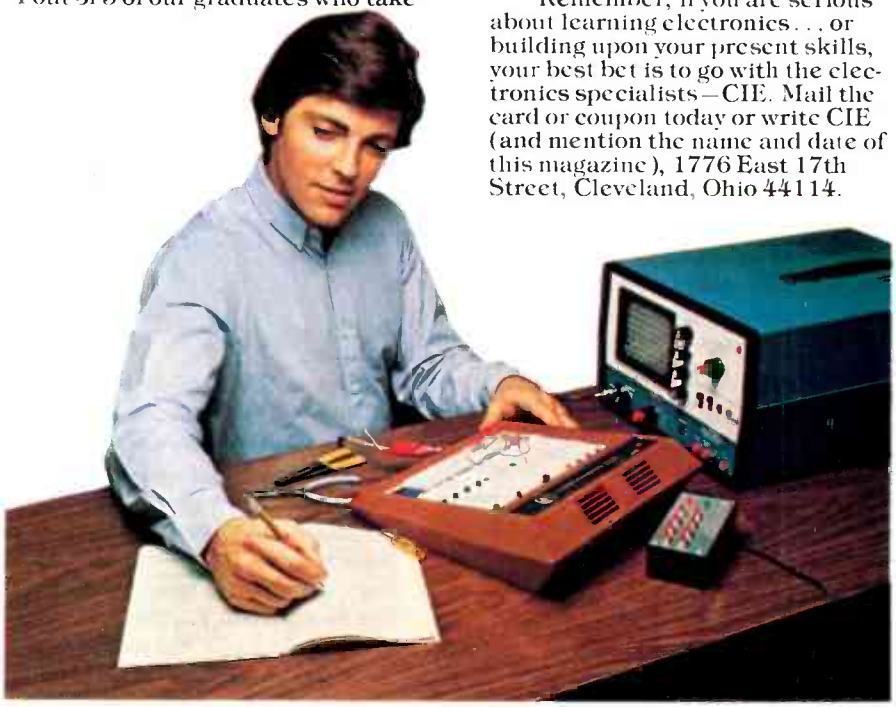

Pattern shown on oscilloscope screen is simulated.

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WITH A 6-FOOT ANTENNA SYSTEM THAT *WORKS!* – AND MAKES SATELLITE TV AFFORDABLE *NOW!*

Hovering overhead at this very moment is an arc of 11 satellites, like giant mirrors reflecting over a hundred channels of video onto your yard and roof. The signals are there *now* . . . live sports, Hollywood movies, entertainment specials . . . continuous news, sports and weather channels . . .

7600A	6 Foot Antenna
• Receiver frequency range: 3700 to 4200 MHz	• High gain
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. . . channels specializing in programming for various ethnic and religious groups . . . channels specializing in adult films plus major independent t.v. stations from Atlanta, Chicago and New York, and channels carrying the programming of the major broadcast networks, ABC, CBS, NBC and PBS . . . Canadian Channels . . . over 100 in all. This kaleidoscope of everything you've always wanted from your t.v. is at your home now and all you need to bring it in is a Gillaspie Satellite T V Earth Station.

Don't be Fooled by the Low Price.

The Gillaspie is not a toy or kit you have to assemble. It is a complete *system* which includes the same 6-foot "dish" antenna which was the sensation of the recent Satellite TV Trade Show in Atlanta. Of some 150 antennas demonstrated, from 8-foot to 20-foot diameter, Gillaspie's was the *only* 6-foot. Sophisticated t.v. engineers approached this easily installed antenna, suitable for nearly any home, in utter disbelief, but their skepticism vanished when they viewed the studio-monitor quality pictures it delivered when coupled to the Gillaspie 7600A receiver that is the heart of your Gillaspie Satellite TV Earth Station.

Bonus for Audiophiles:

As an added bonus to your ownership of a Gillaspie state-of-the-art satellite t.v. receiver system, you'll be able to add an optional stereo adaptor that lets you receive any of several audio-only "subcarrier" channels for continuous music in your home in full fidelity stereo and your choice of classical, easy-listening, rock, country, and nostalgia formats.

Here are just some of the advantages you'll enjoy with Gillaspie's new 6-foot antenna:

- ✓ An aesthetically pleasing appearance in your yard or on your roof.
- ✓ Easy mounting where larger dishes can not go, such as rooftops, apartments, condos and even R.V.'s!
- ✓ Complies with more local zoning ordinances.
- ✓ Greater safety, even in bad weather.
- ✓ Easily moved when you do.
- ✓ Commercial-grade spun aluminum . . . just like the professional antennas used by cable systems and t.v. stations.
- ✓ Will not rust, warp or lose accuracy.

Perhaps Only a Receiver as Good as the Gillaspie can deliver good video from a 6-foot antenna, but deliver it does, and we guarantee it with our money-back-if-not-satisfied warranty*. The Gillaspie 7600A receiver has been proven the standard of the industry with over 8,000 units in use by t.v. stations, cable systems, industrial users, and individuals throughout the world.

The Model 7600A Satellite Receiver is the new look from Gillaspie, state of the art technology, distinctively styled, successful integration of the most sought after high performance characteristics and ease of operation capabilities. Attractively packaged, affordably priced, experience the difference performance makes!

The Model 7600A introduces more high performance characteristics to its price range than ever before, like uni-board construction for maximum reliability and easier service, full frequency tunable audio for cleaner crisper sound with less distortion, a new temperature compensated oscillator to eliminate drift, advanced circuit design for improved video sensitivity, and more.

On the 7600A, All Channel Selections are controlled from the comfort of your easy-chair by the convenient optional remote control unit. Ask your dealer about handy satellite program guides, published weekly and monthly. Provisions have been made for sharing of an antenna among neighbors for even further savings!

Sounds Too Good to Be True: Is It Legal? Perfectly, as long as you don't charge admission and open a theatre in your home. The Federal Communications Commission has specifically de-regulated satellite t.v. reception by private individuals for personal enjoyment.

The Gillaspie Model 5800 Portable is a completely self contained high performance satellite receiver, t.v. set, signal meter, signal scanner, with rechargeable battery pack and charger all in one small portable unit! It is light weight, fits under an airplane seat and is perfect for site surveys, R.V.'s, antenna alignment and system trouble shooting.

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(Gillaspie #7600A System, including receiver, low-noise amplifier and 6-foot diameter dish antenna sold as a unit. May be installed by customer or by dealer at slight additional cost. *Gillaspie systems are warranteed by the manufacturer to be free from defects for 90 days. See dealer for details of warranty and optional dealer installation.)
Note: Satellite TV reception may vary in certain locales. Check with your nearest Gillaspie dealer.

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NEW PRODUCTS

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INTER SWITCH for the Apple computer rmits hard copy to be routed easily to either etter-quality daisywheel or high-speed, t-matrix printer.

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To install, the user plugs the interface cable m a single parallel board within the Apple mputer to a connector on the rear panel of *Printer Switch*. Each of the two built-in oot cables from the switch are then ached to the selected printers.

The *Printer Switch* is enclosed in a plastic se colored to match existing Apple hard- re. It is priced at $150.00.—**Centronics,** ra Computer, 101 West 31st Street, New rk, NY 10001.

TENNA PREAMPLIFIER, *Model PRE-1,* designed to provide high-gain, low-noise plification for received VHF and UHF sig- ls; it boasts a midband gain of at least 15 , with a noise figure of only 1.8 dB. The *odel PRE-1* consists of a lightweight

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tenna-mounted preamplifier module and indoor control unit. Switch-selectable high d low gain allows the user to customize his her signal-enhancing needs. The *Model RE-1* comes with all necessary hardware, nnectors, and instructions, and is priced at 9.00 (plus $2.00 UPS shipping).—**Grove nterprises, Inc.,** 140 Dog Branch Road, asstown, NC 28902.

EREO RECEIVER, The Realistic *Model A-204,* fine-tunes FM stations and locks m on-frequency. An FM-mute circuit eli- nates noise when tuning between stations.

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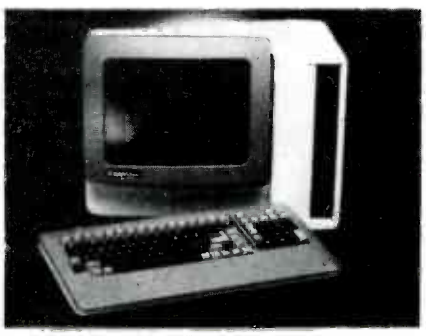
Special circuitry automatically activates a unique rumble filter when the bass control is moved from its center position. A high-filter reduces hiss, and a loudness pushbutton boosts high and low frequencies for improved sound even at low-volume levels.

The Realistic *Model STA-204* features a 10-segment LED AM/FM signal-strength meter, separate 11-step bass and treble adjustment controls, center-detent balance control, FM stereo LED indicator, lighted dial, and pushbutton controls for mono/stereo, tape monitor, and A/B speaker selection. It is priced at $199.95.—**Tandy Corporation/ Radio Shack,** 1800 One Tandy Center, Fort Worth, TX 76102.

MICROCOMPUTERS, model *TS800* and model *TS803* (shown) are CP/M-based, eight-bit microcomputers that allow small- and medium-sized businesses to grow from their first single-user computer station to a full network, without making the entry computer obsolete. Both models have 14-inch screens and detachable keyboards engineered to reduce user error and produce maximum speed. Standard interface features on both models include one RS-232 serial port for modem or serial printer, one parallel Centronics-compatible printer port, and an RS-422 port capable of 800 kilobits-per-second communications to either of the TeleVideo multiuser service processors.

The model *TS800* can serve up to 15 additional users as a satellite station once the user is employing MmmOST (*M*ultiuser, *m*ultitasking, *m*ultiprocessing *O*perating *S*ystem *T*echnology). Because the model *TS800* needs no additional storage, it provides high performance at a low incremental price. It is priced at $1495.00.

The model *TS803* is a complete stand-alone system with two 500 kilobyte floppy disks and graphics with high resolution (640 × 240 pixels); it serves not as a stand-alone, but can connect into a series processor to use TeleVideo's proprietory network manager, MmmOST. It is priced at $2495.00—**Televideo Systems, Inc.,** 1170 Morse Avenue, Sunnyvale, CA 94086.



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EPROM PROGRAMMER, *Model 2300,* permits programming of EPROM's and EEPROM's from memory, disks, or directly from the keyboard when used with an *Apple II* computer. Most currently available EPROM's can be copied or programmed using the *Model 2300.* Any program, ROM, or EPROM in the computer's memory can be copied without removal. When programming an EPROM, the *Model 2300* verifies each byte by a "read after write" operation, and automatic reprogramming is initiated if an error is encountered. An erase verify mode is also provided so that a partially erased EPROM is not accidentally programmed.

The *Model 2300* requires no external power, yet it meets the Apple computer's power requirements for a peripheral card. The *Model 2300* is supplied complete with Programmer, Apple II + interface card, operating software on disk (DOS 3.3), and an operating manual. Free software upgrading is provided as new EPROM's become available.

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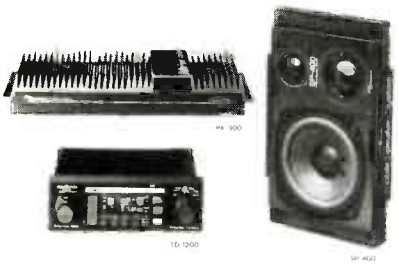
The *Model 2300* is priced at $429.00 FOB factory.—**Software Specialties, Inc.,** Box 329, Springboro, OH 45066.

MOBILE SOUND SYSTEM is in three parts: the model *TD-1200* tuner/cassette deck, the model *PA-300* power amplifier, and the model *SP-400* speaker system.

The model *TD-1200* tuner/cassette deck combines an AM/FM-stereo tuner with 10-station memory, a preamp/control section designed to correct acoustic flaws that are typical of automotive environments, and an auto-

reversing cassette deck. The frequency response is from 20 Hz to 22,000 Hz ±3dB in both directions; wow and flutter is less than 0.045%, and signal-to-noise ratio is better than 70dB with Dolby-C. The model *TD-1200* is priced at $1260.00.



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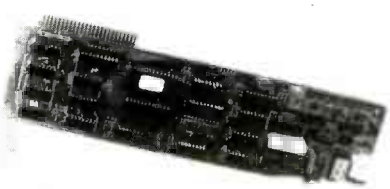
The model *PA-300* power amplifier delivers 70 watts-per-channel with a distortion figure of 0.005%. It is priced at $340.

The model *SP-400* 3-way speaker system spans the range from 50 Hz to 22 kHz. It is priced at $390 per pair.—**Nakamichi U.S.A. Corp.,** 1101 Colorado Avenue, Santa Monica, CA 90401.

MODEM, the SSM 110/300 baud *ModemCard* for the Apple II features half and full duplex, auto answer/auto dial *Touch Tone* and pulse dialing, and audio monitoring to provide increased flexibility for use with many systems, including PBX. The *ModemCard*



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plugs directly into any Apple slot (except 0) and requires no additional external devices. The SSM Apple *ModemCard* is priced at $299.00.—**SSM Microcomputer Products, Inc.,** 2190 Paragon Drive, San Jose, CA 95131.

COMPUTER SYSTEM, model *QDP-200,* has a standard 64K of RAM and its CP/M operating system is an enhanced version fully compatible with all other CP/M systems. It also offers on-line HELP for CP/M and MP/M systems, which makes the unit user-friendly, plus an easy-to-use menu program.

Two 8-inch, double-sided/double-density floppy disk drives are standard, but the model is also available as a single-drive, dedicated system. All connections needed to add a 10- or 15-megabyte 5¼-inch hard disk are built in. A programmable floppy disk shut-off extends drive and media lives. An additional feature is a filtered cooling system.

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Using a Z80A microprocessor, the model *QDP-200* features two serial and two parallel ports, plus a real-time clock. The single-user system also has exclusive "cache memory" disk buffering available.

The model *QDP-200* has a suggested retail price of $3495.00 with the dual drive; the system with a single drive is priced at $2995.00.—**Quasar Data Products Computer Systems,** 10330 Brecksville Road, Cleveland, OH 44141.

OSCILLATOR, model *SG 505 Option 2,* provides a high-level, fully balanced output from a selection of three source impedances: 600 ohms, 150 ohms, and 50 ohms.

The addition of those features to the standard model *SG 505* is in direct response to user demand. Most professional audio-communication systems—broadcast, telephone, professional recording studies—use 600 ohms as their standard line impedance. Proper testing of microphone inputs requires 150-ohm source impedance. And 50 ohms is a common source impedance in many generalized signal applications which do not require impedance matching: audio-amplifier design, two-way radio, etc.

The model *SG 505 Option 2* provides a fully balanced, fully floating output with a maximum calibrated amplitude of +22 dBm from 600 ohms into 600 ohms and +28 dBm from 50 ohms into 600 ohms. Into 150 ohms, more than +30 dBm can be achieved. While +18 dBm is a fairly common test level in broadcast systems, proper testing should verify sufficient headroom for program peaks by driving the system at significantly higher levels. More than 100-dB attenuation of the output level can be achieved with the built-in step and variable attenuators.

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The key performance features of the standard model *SG 505* have been retained in the *Option 2*—0.0008% maximum THD (typically 0.003%) from 20 Hz to 20 kHz and ±0.1 dB flatness from 10 Hz to 20 kHz.

The model *SG 505 Option 2* is priced at $1360.00.—**Tektronix, Inc.,** PO Box 500, Beaverton, OR 97077.

TOOL KIT, model *030-2,* contains a straight prober, sharp tip; a bent prober, sharp tip; and a triangular scraper with sharp cutting edges and sharp tip. The tools are made from hardened tool steel, nickel plated, and are .032 inch in diameter, with integrated hexagonal anodized aluminum handles.

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Applications for these tools include miniature instruments and meter work, strain-gauge work, integrated-circuit artwork repair, camera repair, model work, and any manner of miniature hobby project.

The model *030-2* is packaged 3 tools per kit in a plastic shipping and storing container, and is priced at $9.95. Single tools can be ordered from the kit in quantity.—**Minitool Inc.,** 1334/F Dell Avenue, Campbell, CA 95008.

PROTECTOR, the *Master AC Control Console.* (MACC) provides surge protection plus master control for the delicate circuitry of electronics components, amplifiers, stereos, and personal computers—all of which are extremely vulnerable to high-voltage surges. (Such surges can be caused not only by nearby lightning, but also by distant storm fronts, as well as by transient currents produced by electric motors, fluorescent lights, wind-driven snow, transformers, and power outages.)

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The MACC's 3-stage automatic restorable circuitry clips off power surges and spikes to provide clean AC power. Its resettable circuit breaker adds further protection for word processors, small computers, and other sophisticated communications and electronics equipment.

Eight plug-in "U" ground outlets are provided on the back of the MACC, including one "hot" one for a continuously powered application such as a clock. Seven "on-off" rocker switches let the user control individual components from one station. The entire system can be turned on or off with a single master switch, and all switches light up when "on" to confirm condition.

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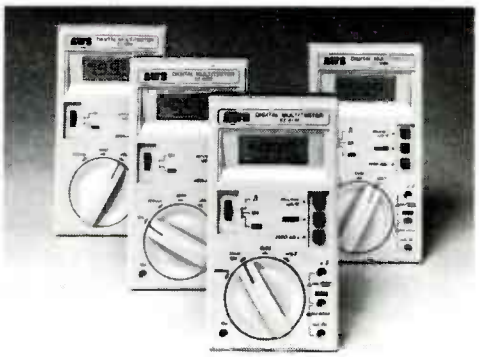

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Modify your TV to include a direct video input for your computer or VCR—and still have it function as a receiver.

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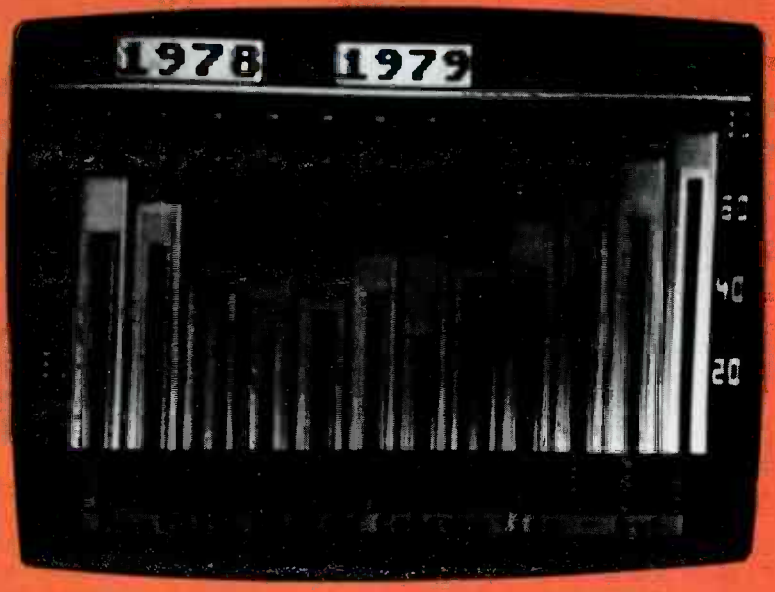

Add A Video Input To Your TV

ARE YOU ONE OF THE MANY THOUSANDS of owners of personal computers, VCR's, videodisc players, etc. whose eyes have been bothered because of color shift, signal beat, ghosts, and RF interference showing up on your TV screen? The source of your problem is probably the fact that you are RF-modulating the video signal from your device to get it into your TV set. Fortunately, there's a low-cost solution for you. With this easy-to-build direct-video modification for your TV set, you can rid yourself forever of the "RF syndrome."

Until recently, the most common and economical method of obtaining a display from a video source (computer, VCR, etc.) has been through an RF modulator, by means of which the video-source signal is fed through the antenna terminals of a standard TV set. By using a TV set in that manner—thereby eliminating the need to purchase an expensive display monitor—one could save hundreds or even thousands of dollars. However, as many users have come to realize, the RF-modulator method has several significant drawbacks. Most of the problems are related to RF radiation and the interference it causes, which degrade picture quality.

Theory of operation

In this direct-video modification, the tuner and IF sections of your set are bypassed. The video-source signal is injected directly into—or as close as possible to—the first-video-amplifier stage in your set. To provide electrical isolation between the input and output sections (both for safety and to protect your video source), two special-purpose opto-isolators (optical couplers) are used; there is no electrical connection between the two sections. One optoisolator is a wide-bandwidth coupler for the video channel; the other is a narrow-bandwidth device for the audio channel.

Figure 1 shows a block diagram of the system. The output section is powered directly from the set's own DC power supply. The input section has an on-board rectifier and is powered by inductively-coupled AC that you get by placing a few turns of insulated wire around the exposed ferrite core of the flyback transformer (we'll talk more about how to do that later).

A schematic of the direct-video modification board is shown in Fig. 2. The video signal is applied across R1 and is coupled via C1 to the Q1–Q2 power-driver stage. That transistor pair steps up the input-signal level enough to modulate the input LED (in IC1) and also provides a low impedance for best frequency response. Resistor R5 determines the amount of modulation drive-signal, and R6 and C2 provide additional boost at frequencies above 2 MHz for improved video response. The signal is coupled through C3 to the LED in optoisolator IC1. Resistor R7 provides the DC-bias point about which the input signal will be modulated.

Inside IC1 are an LED and a phototransistor that are optically coupled by a light pipe. There is no internal electrical connection between the two devices. The modulated light strikes the detector surface and the resultant current flow appears at pin 5 of IC1 with a signal being developed across R20. That signal is typically 200 to 300 mV peak-to-peak and requires amplification to bring it up to a

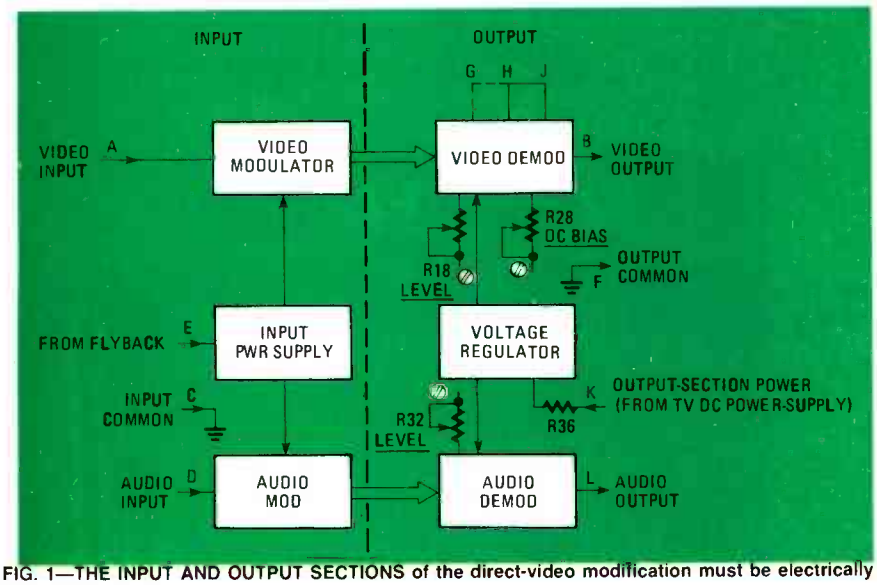

FIG. 1—THE INPUT AND OUTPUT SECTIONS of the direct-video modification must be electrically isolated.

usable level. Transistor Q5 performs that function. Resistor R18 sets the video-output level. The signal at that point is inverted with respect to the input and is coupled to Q6 through C9. The signals at the collector and emitter of Q6 are equal in amplitude but are inverted with respect to one another. Thus, an in-phase signal is available at pad "J" while the signal at "G" is out of phase. The signal with the desired phase is coupled through C12 and C13 to the output, where it is mixed with a DC component whose level is set by R28.

The audio portion of the circuit functions similarly. But, because of audio's narrower bandwidth-requirements, a simpler circuit is used. An audio signal is applied to C4. Transistor Q3 amplifies that signal and sets the DC-bias point for optoisolator IC2's LED simultaneously. Resistor R11 sets the drive-current range. The modulated light falling on the detector of IC2 produces an output current at pin 5. The output level is set by R32.

As mentioned earlier, to isolate the input and output sections, separate power supplies are used. The output section can usually take low-voltage DC directly from within the set, while the input section gets its power from inductive coupling to the TV's flyback transformer. A few turns of wire are wound around the flyback's ferrite core and the resulting signal is rectified and filtered by D3, R12, and C6. The voltage at that point will be approximately 12 volts, if two turns of wire are used.

Transistor Q4 and its bias network, along with LED1, form a low cost go/no-go indicator that is especially helpful for those who do not have an oscilloscope or VOM at their disposal. When the voltage is approximately 12 volts, LED1 will begin to glow dimly. If it glows too brightly, there are too many turns on the flyback and thus too high a voltage.

The output power is controlled by D4, a Zener diode that limits the voltage to the output stage to a maximum of 12 volts. Resistors R38 and R36 provide the voltage drop necessary to ensure safe operation of D4. The value of R36 depends

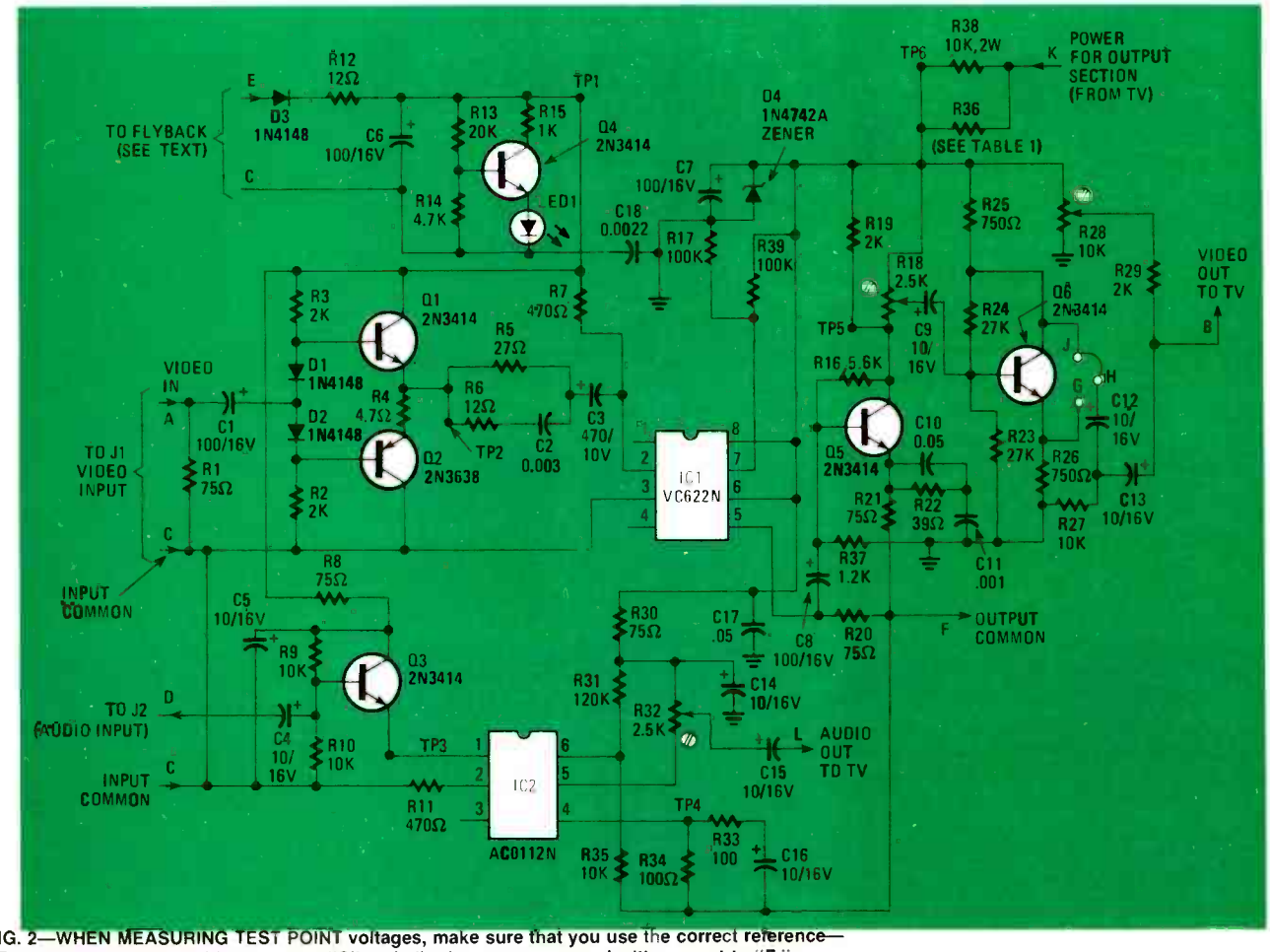

FIG. 2—WHEN MEASURING TEST POINT voltages, make sure that you use the correct reference—TP1-TP6 are measured with respect to "C" and all others are measured with respect to "F."

upon the value of the input voltage. See Table 1 for help in selecting a resistor of the correct value.

Construction

A foil pattern for a single-sided PC board is shown in Fig. 3, and a parts-placement diagram in Fig. 4. Install all components on the component (non-foil) side of the PC board. Start by inserting all of the resistors except R36 (that will be installed once we have determined the output-section power source). Next, install all of the capacitors as indicated, except for C16 (and R33), which can be installed later if your set requires a boost in audio output. Install the remaining components as shown in the parts-placement diagram. When mounting the transistors and diodes be sure to orient them correctly. Once you have completed the board assembly you can proceed to the next phase—converting the set.

TABLE 1

Receive-section input voltage	R36
10 to 11.9 VDC	Jumper
12 to 17 VDC	27 ohms, ½W
18 to 24 VDC	100 ohms, ½W
105 to 165 VDC	10K ohms, 2W

Set modification

As an example, we'll show the conversion process for a 13-inch Samsung color receiver. However, the process will work for any other set. Before you start tearing apart your TV, it would probably be a good idea (actually, it's just about essential) to get the appropriate Sams *Photofact* folder, which will provide you with a schematic for your model and show you where all the components are located.

With that in hand, several points will have to be located and marked off for future reference. Remove the back panel of your set so that you can find and verify those points. For your own safety, unplug the set and to discharge the high-voltage power supply prior to performing any work on it.

The first point to locate is the power source for the output section. Begin by finding the power supply on your circuit diagram. Most transistorized TV sets will either have a low- or high-voltage output (or both) present at the power supply, but a vacuum-tube set may have only a high voltage output. *Do not* use the 6.3-volts AC heater windings on tube sets for a power supply; the direct-video PC board requires DC, preferably 12 volts. By using Table 1 and choosing the appropriate resistance value for R36, you can use other DC source-voltages to power the converter board.

PARTS LIST

All resistors ¼-watt, 5% unless otherwise specified

R1, R8, R20, R21, R30—75 ohms
R2, R3, R19, R29—2000 ohms
R4—4.7 ohms
R5—27 ohms
R6, R12—12 ohms
R7, R11—470 ohms
R9, R10, R27, R35—10,000 ohms
R13—20,000 ohms
R14—4700 ohms
R15—1000 ohms
R16—5600 ohms
R17, R39—100,000 ohms
R18, R32— 2500 ohms, trimmer potentiometer, PC-mount
R22—39 ohms
R23, R24—27,000 ohms
R25, R26—750 ohms
R28—10,000 ohms, potentiometer, PC-mount
R31—120,000 ohms
R33, R34—100 ohms
R36—see text and Table 1
R37—1200 ohms
R38—10,000 ohms, 2 watts

Capacitors

C1, C6, C7, C8—100 μF, 16 volts, electrolytic
C2—.003 μF, 50 volts, ceramic disc
C3—470 μF, 10 volts, electrolytic
C4, C5, C9, C12, C13, C14, C15, C16—10 μF, 16 volts, electrolytic
C10, C17,— 0.05 μF, 50 volts, ceramic disc
C11—0.001 μF, 50 volts, ceramic disc
C18—0.0022 μF, 400 volts, ceramic disc

Semiconductors

IC1—VC622N wideband opto-isolator
IC2—AC0112N opto-isolator
Q1, Q3–Q6—2N3414
Q2—2N3638A
D1–D3—1N4148
D4—1N4742A 12-volt Zener
LED1—jumbo red LED
S1—DPDT miniature toggle switch (on–on), 125 volts, 3 amperes
J1, J2—phono, BNC, UHF, or phone jack

Miscellaneous: PC board, 75-ohm coax (RG-59/U), hookup wire, single- and two-conductor sheilded audio cable, hardware, etc.

The following are available from V.A.M.P. Incorporated, P.O.Box 411, Los Angeles, CA 90028: Complete kit with PC board and all components (DVM-1), $64.95; PC board and optoisolators (VC622N and AC0112N), $29.00; optoisolators only, $19.95. Please add $2.00 for shipping and handling within U.S.A. Foreign orders please add $4.00. California residents please add 6% sales tax.

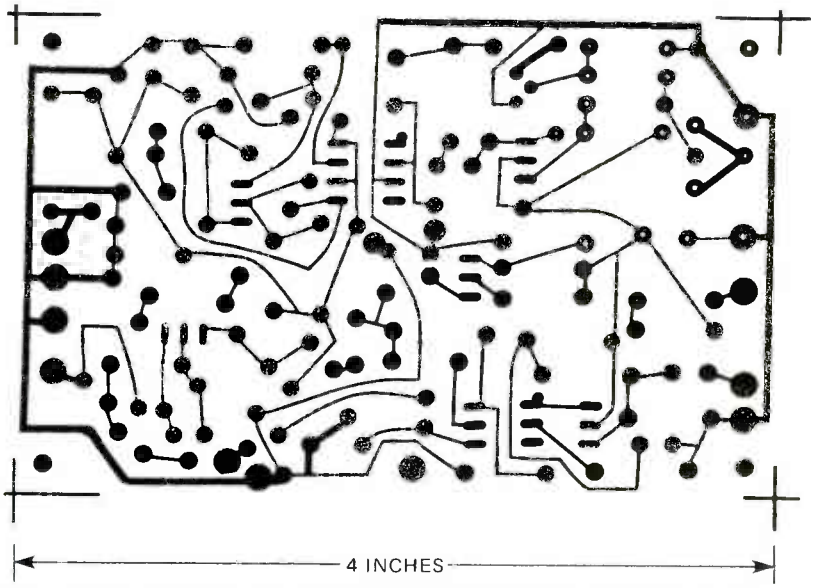

FIG. 3—SINGLE-SIDED PC BOARD is small enough to fit comfortably inside most TV sets.

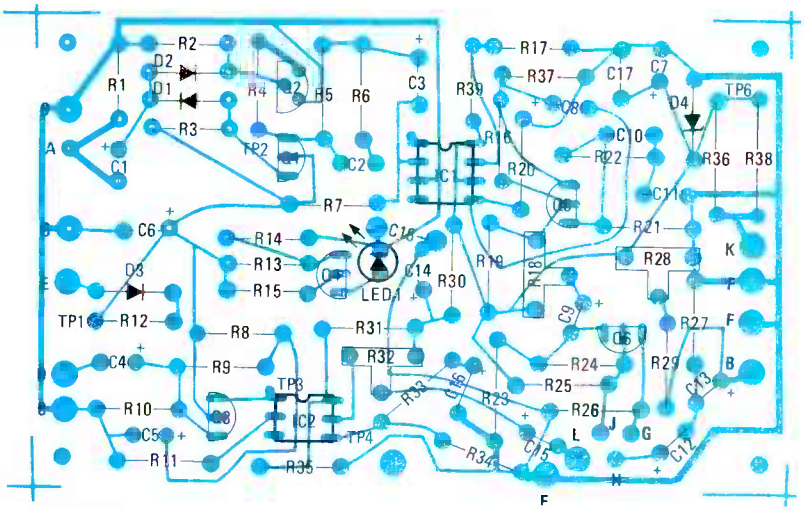

FIG. 4—ONLY THE BYPASS switch and input jacks are not contained on the circuit board.

For our Samsung set, we selected an input voltage of 12 volts. The appropriate value for R36—determined from Table 1—in our case was 27 ohms. Mark on your circuit drawing the point from which you will tap your power and then find that point in your set. Be sure that your value for R36 is correct, and install the resistor on the PC board. Then strip one end of a three-foot length of red wire and connect it to pad "K" on the PC board. Connect a similar length of black wire to pad "F." (Longer lengths may be required if you are working with a large console.) Do not connect the free ends of the red and black wires to your set at this time.

Next, you have to determine the point for external-video injection. Due to design differences, that point will vary from one set to another. The objective, in any case, is to get as close to the first video-amplifier as possible. At that point the signal-level within the set closely matches that of the signal that will be injected. The circuit impedence must be greater than 1000 ohms—otherwise the ability of the direct-video PC board to provide the appropriate video level and DC bias may be hampered. A high impedence is usually found at the base of a transistor or at the input of an integrated circuit. In general, when you choose the injection point, select it so that it will eliminate all (or most) of the set's bias networks when the BYPASS switch is thrown to its EXTERNAL position. Doing that will leave only the video signal and the DC bias from the direct-video board at the injection point. Mark your injection point on your own circuit diagram, and locate and mark it in your set.

Once the video-injection point has been determined, you'll have to determine whether positive or negative video is required. (Positive video means that the video-information signal is positive with respect to ground, and the sync signal negative; the opposite is true for negative video.) If you are unable to determine which type of signal your set needs at the injection point, assume for the moment that it's positive video. To select a positive-video output, connect pads "H" and "J" on the PC board with a jumper. For negative video, connect pads "G" and "H."

The final injection-point to be located is the one for external audio. The simplest place to inject the audio is usually at the high side of the volume control. However, some sets—as was the case with our Samsung—use an IC to control the volume level. In such sets the audio should be injected at a point after the detector de-emphasis network, and the level controlled through R32 on the PC board.

Some sets may require that you feed the driver stage directly. In that type of installation, the DC bias to the audio power-stage must be maintained. That can be done easily with a resistor network like

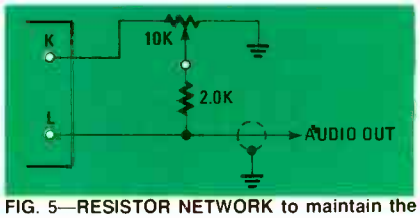

FIG. 5—RESISTOR NETWORK to maintain the DC bias to your set's audio power-stage.

the one shown in Fig. 5.

Having selected the injection point for your set, mark it on your circuit diagram and make sure you know where it is in the set.

Installation

Find a convenient place inside your set to mount the PC board, and drill the appropriate mounting holes. Figure 6 shows how the board was mounted in our Samsung. Place as much distance as is practical between the PC board and the flyback transformer to avoid any possibility of interference. Do not mount the PC board at this time, though.

Next, mount the audio and video input-jacks. Install them in a convenient location either on the back panel or side of the set. The jacks should be as close as possible to the PC board. Make sure that the video-input jack is mounted on an insulated surface (preferably plastic) if you are converting a hot-chassis type set. In our installation, we used a standard ¼-inch phono jack requiring a ⅜-inch hole, but BNC- or UHF-type connectors can also be used, as long as they are mounted on an insulated surface.

The miniature DPDT BYPASS switch, S1, should be mounted as close to the input jacks as possible. That switch will allow you to select either the RECEIVE or EXTERNAL mode. Once again, if you are converting a hot-chassis set, make sure that you mount the switch on an insulated surface.

You can now proceed with the wiring phase of the installation. Earlier, you determined the power source for the output section of the PC board and inserted an R36 of the appropriate value. Now, you must consider the power source for the input section of the PC board. If you are converting a set which is already transformer-isolated from the power line (as opposed to a hot-chassis set), the input portion of the direct-video board can use the same power source as the output section. In that case, take a piece of insulated

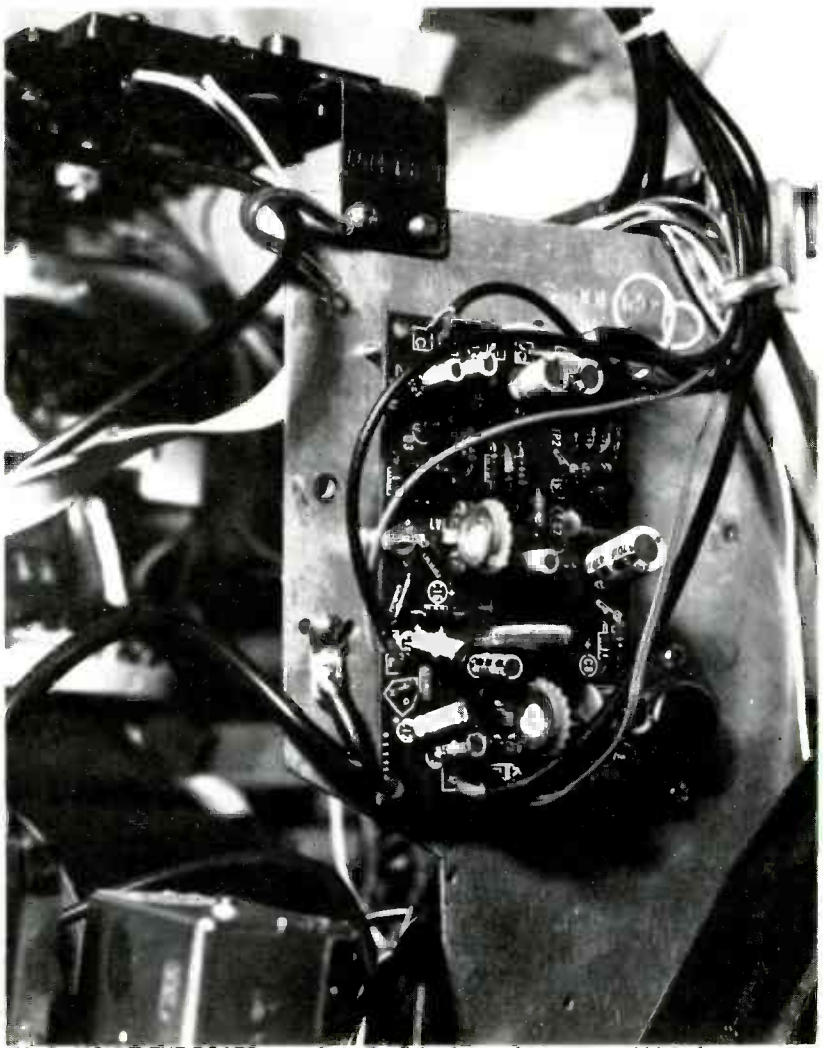
FIG. 6—MOUNT THE BOARD away from the flyback transformer to avoid interference.

wire and connect pads "C" and "F" which are the input common and outout common respectively. Use a second piece of insulated wire to connect pad "E" with the pad at TP6. Remember, those connections should be made only if the set you are converting is transformer isolated.

If the set you are converting is *not* transformer isolated, but is a hot-chassis type, then the power for the input section can be obtained from the flyback transformer. That will involve work in the high-voltage section of the set. Any time you are working in that area, be sure to unplug the set for safety. (*It would be a good idea to have the set unplugged* anytime *you're working inside it*—Editor.) As a further precaution, discharge the power supply. That is done by connecting one end of a wire to the chassis of the set and then carefully slipping the other end under the rubber high-voltage cap on the picture tube itself. Don't forget to remove the wire afterward.

Take a 6-foot length of (white) insulated single-conductor wire and fold it in half. Slip one end of the wire through the ferrite core of the flyback transformer so that there are two equal lengths on both sides of the core. Then take one of the ends of the wire and loop it twice around the ferrite core so that you end up with approximately 2½ turns around the core. (For console sets with screens larger than 19 inches you may require only 1½–2 turns.) Twist the wires together for their entire length and connect them to the direct-video board at pads "E" and "C." Figure 7 shows the windings around the core of the flyback in the Samsung set that we converted.

The next step is to determine whether there is a sufficient number of turns around the core of the flyback, and whether the wires to the board are phased properly. During the following test make sure that the PC board is clear of the set, to prevent any accidental shorts. Apply power to the set and turn it on. Indicator LED1 should light. If it does not, unplug the set and interchange the wires at pads "E" and "C." If the LED still doesn't light, unplug the set and add an additional ½–1 turn around the core of the flyback. If the LED still doesn't light, unplug the set again and interchange the wires on pads "E" and "C" so they're back in their original positions. (If you have an oscilloscope at your disposal, connect the leads from the windings so that the flyback pulse is positive with respect to ground.) If the LED *still* doesn't light, measure the voltage at TP-1. It should be positive with respect to ground. Increase or decrease the number of turns until the voltage at TP-1 reaches a value between 12 and 15 volts DC. The LED should light when the voltage exceeds 11-volts DC.

In the event that you can't get at the ferrite core of the flyback transformer, you will have to add a step-down transformer (120 volts:12 volts) or use a commercially available portable 12-volt DC power-adapter so that the input section can be powered directly from the AC line.

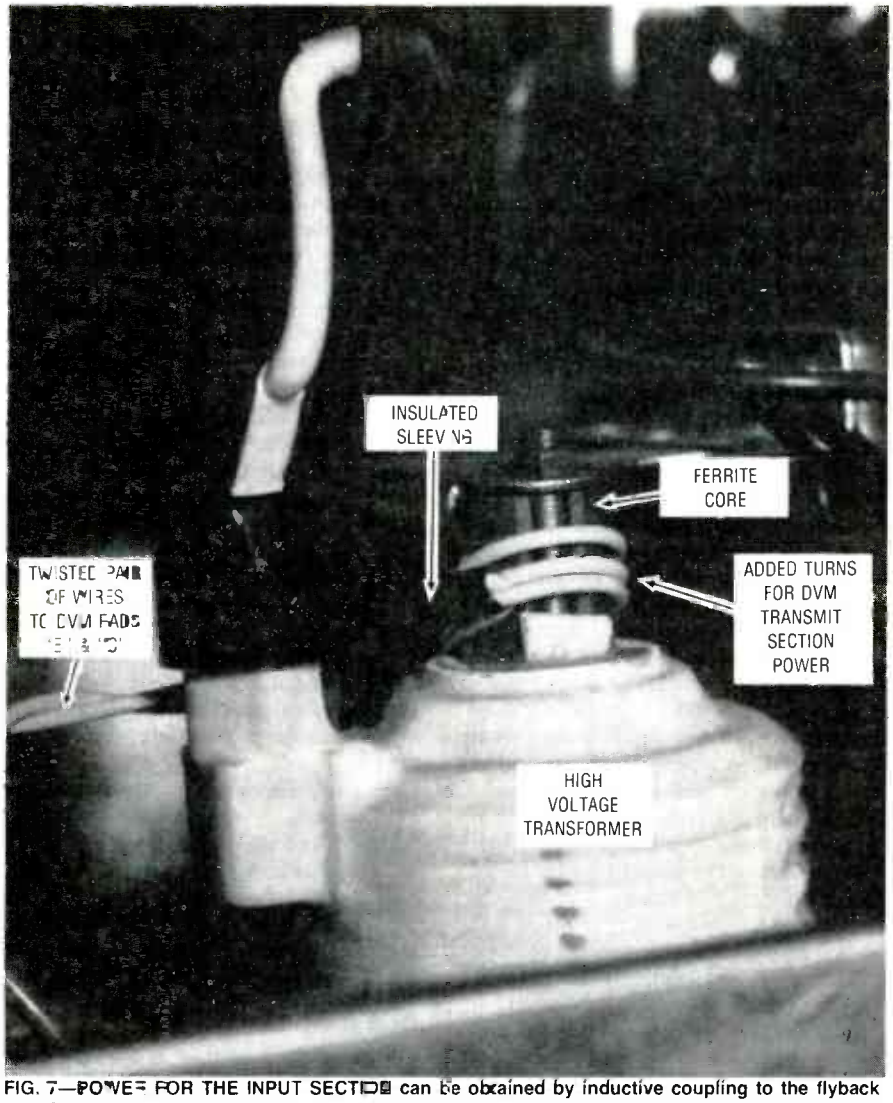

FIG. 7—POWER FOR THE INPUT SECTION can be obtained by inductive coupling to the flyback transformer.

Using Fig. 8 as a wiring guide, you can now start the final phase of the installation. First, cut two equal lengths of video cable (RG-59/U) long enough to reach from the video injection-point to S1. We'll refer to that as the DEMOD/RETURN cable pair. Label and set those cables aside momentarily. Next, cut a length of video cable that will reach from the S1 to the video output of the PC board at pads "B" and "F." We shall refer to it as the "B" cable. Label it accordingly. Cut an-

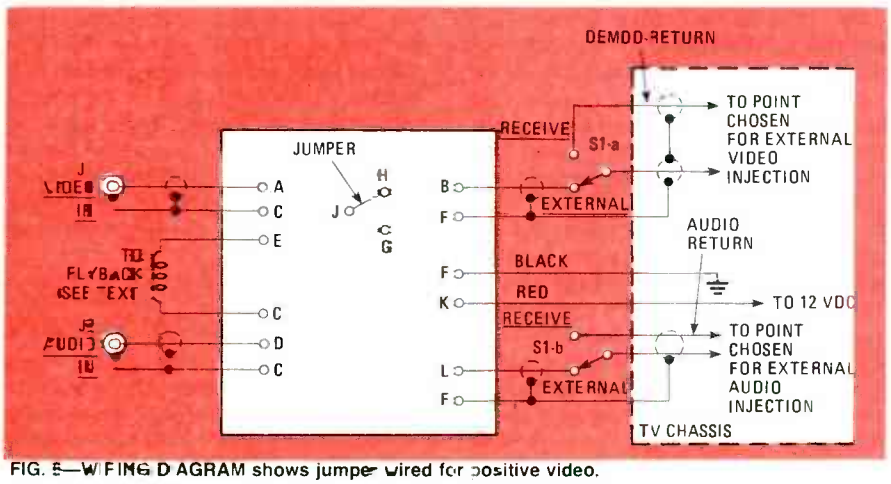

FIG. 8—WIRING DIAGRAM shows jumper wired for positive video.

other length of cable that will reach from the VIDEO-IN connector J1 to pad "A" on the PC board and label it as the "A" cable.

Strip one end of the "A" and "B" cables, making sure that you have a sufficient length of outer conductor (shield) unraveled. Then connect those ends to the PC board as shown in Fig. 8. Make sure that the center conductors of the cables are connected to the correct pads ("A" to "A" and "B" to "B"). Do not connect the other ends of the cables yet.

Prepare the audio cables next. Cut a length of *two-conductor* shielded cable long enough to reach from the BYPASS switch (S1) to the audio-injection point. We shall refer to this as the AUDIO-RETURN cable. Label it and set it aside momentarily. Now cut a length of *single-conductor* shielded audio cable long enough to reach from pads "D" and "C" on the PC board to the AUDIO-IN (J1) connector. We will refer to that as the AUDIO-IN cable. Cut another length of single-conductor shielded cable to reach from pads "L" and "F" on the PC board to the BYPASS switch; we will refer to that as the AUDIO-OUT cable. Strip one end of the AUDIO-OUT and AUDIO-IN cables, making sure that you have a sufficient length of outer conductor unraveled. Then connect those ends to the PC board as shown in Fig. 8. Make sure that the center conductors of the audio-in and audio-out cables are connected to pads "D" and "L," respectively. Do not connect the other ends of the cables yet.

You can now mount the PC board permanently using 4-40 machine screws and nuts. Use ¼-inch fiber spacers to insulate the board from the TV chassis, and make sure that the PC-board foil doesn't touch any metal surface. Once you have secured the PC board, strip one end of each of the DEMOD/RETURN cables you set aside earlier. At the external-video injection point remove a small portion of the copper trace that connects the two points between which you wish to insert the BYPASS switch. (Instead of breaking a trace you may have to cut a wire; it depends on your TV set.) Connect the center conductor of the demodulator cable to the side that comes from the set's own IF/demodulator circuits. Connect the center conductor of the return cable to the side that goes to the video amplifiers and the circuits that eventually drive the picture tube. Twist the shields of that cable pair together, and then solder them to a convenient ground point.

At the audio-injection point, cut the trace that connects the two points between which you'll insert the BYPASS switch. (Again, a wire instead of a copper trace may have to be cut.) Connect the *dark* center conductor to the side that comes from the set's own sound IF demodulation circuits and connect the *light* center conductor to the circuits that eventually terminate at the set's speaker. Route the AUDIO-RETURN cable and the DEMOD-RETURN cables through the set and connect them to S1 as shown in Fig. 8. Now strip the free end of the "B" cable and connect it to the switch. Next, strip the free end of cable "A" and connect it to the video-input connector. Then, strip the free end of the audio-out cable and connect it to the BYPASS switch; also strip the free end of the audio-in cable and connect it to the audio-input connector. Finally, connect the red wire from the PC board to the voltage-source point you selected earlier, and connect the black wire to chassis ground.

If your installlation used the inductive pickup from the flyback transformer, be sure to route the wires to the board so they avoid, as much as is practical, the RF and low-level video demodulator circuits; that will minimize interference. Also, make sure that the pair of wires is twisted its full length—all the way from the flyback to the PC board.

Connect the appropriate cables to the video- and audio-input connectors. Make sure that you connect the center conductor of each cable to the center pin of the connector.

That completes installation of the conversion board. Check all your connections, and also make sure that the PC-board foil pattern is not touching any metal surface. Finally, make sure that the input connectors and BYPASS switch are insulated from the TV chassis, especially if you are converting a hot-chassis set.

Operation

Having checked your installation thoroughly, apply power to the set. Place the BYPASS switch in position for normal TV operation. If the set does not work properly, you have wired something incorrectly (most likely the switch). Retrace your steps through the installation instructions.

Once the set operates normally as a receiver, use a voltmeter to measure the DC-bias voltage at the center terminal of the BYPASS switch with respect to chassis. Then apply a standard video signal to the VIDEO IN jack. Set the BYPASS switch to the EXTERNAL position. Adjust R28 so that the DC voltage measured at the center terminal of the switch matches the value you obtained when operating the set as a receiver. Then adjust R18 for the desired picture contrast. Finally, apply a tone to the AUDIO IN jack J1 and adjust R32 to obtain a comfortable listening (or operating) range. If you cannot get satisfactory video or audio, see the troubleshooting section that follows.

Troubleshooting

If the LED will not light, check to see that it is properly inserted into the board and is not reverse biased. Also make sure that D3 is properly inserted and that the voltage at the cathode (TP1) of the diode is positive with respect to ground.

If you have no video, or if the picture quality is poor, the problem may be due to an incorrect DC bias (that can result in complete picture loss or heavy picture tearing). To correct the problem, adjust R28 for the appropriate bias level.

If you have no video in either mode (RECEIVE or EXTERNAL), the problem is probably a mis-wired BYPASS switch. Check the wiring, referring to Fig. 8.

A streaky, clipped, or washed-out picture may be caused by too high a video level. Adjust R18. Sometimes a misadjusted bias level (R28) can cause similar problems.

Interference may be due to ripple from the low-voltage source used to power the receiver section of the direct-video board. Changing the board to operate from a DC source in the 105–165-volt range usually clears up the problem. Also check the shields of the cables for proper connections. Another source for possible interference is the route selected for the twisted pair of wires that runs from the PC board to the inductive loop on the core of the flyback. It is important that the pair be twisted over its entire length, and that the bundle be kept away from the demodulator, IF, and RF circuits.

TABLE 2
Test Point Voltages

	VDC Min.	VDC Max	
TP1	11.0	15.0	Ref. "C"
TP2	5.0	8.0	
TP3	5.0	7.5	
TP4	0.2	0.35	Ref. "F"
TP5	5.0	7.0	
TP6	10.0	12.5	
B	Adjustable		
G	2.2	4.0	
J	7.0	9.0	

Low audio output can be caused by your set requiring a higher signal level at the audio-injection point than is currently being supplied. Install C16 to boost the board's audio output.

Should your set not display external video and you have wired everything correctly, check the direct-video board for failure. Refer to Table 2 and measure the voltages at the appropriate test points. Note that the voltages at test points TP1, TP2, and TP3 are measured with respect to pad "C." The voltages at all other test points are measured with respect to chassis common or pad "F." Check to make sure you have not installed the transistors or optoisolators incorrectly.

After you've made any adjustments necessary, replace the rear cover of the set. Your newly converted set is now ready for use. Rest easy and let your eyes relax. **R-E**

BUILD YOUR OWN CUSTOM CASES

ROBERT GROSSBLATT

If you want your project to be appreciated by others, it must be packaged properly. Here's how to make custom cases that are sure to get your project the attention it deserves.

IF YOU'VE EVER BUILT AN ELECTRONIC PROJECT YOU KNOW THE feeling. After hours spent at your workbench, the magic moment arrives—you're finished. You go running to the rest of the house and round up the family. You gather them at the table and excitedly demonstrate your new mousetrap. Again and again you send small mechanical mice in and your new invention does all that you promised but no one seems impressed. When you start looking around for real mice the kids go back to watching TV, and your wife shrugs her shoulders, sighs, and leaves the room.

Sound familiar? What went wrong is something that even the most junior executive on Madison Avenue would recognize—poor packaging. It's sad but true. What something looks like is just as important as what it does. If you've spent every evening for a month buried in the back room building a gadget, you've also built something else—expectation.

The mistake you made with your mousetrap was simple. The project wasn't finished when you thought it was. It wasn't packaged properly. If you had spent as much time on the case as you had on the circuit, you would have gotten the desired "oohs" and "ahs" from your family. Unless your project is something for your bench—a special front end for your scope or meter, for example—something that will never see the light of day, the case is as important as the circuit.

You could just stuff everything into a standard chassis box or plastic case but the result will always be the same. A standard box gives a standard appearance. Besides, there is no such animal as a commercially available custom case. Think about that for a while.

Building a case for your project involves as much planning as any other part of the job. Once the circuit has been breadboarded and you've gotten rid of all of the glitches, it's time to consider the case. The first decision you have to make is the shape of its case. Often that will determine the shape of the circuit board and the material you're going to use for the case. Let's go back to our mousetrap. Housing it in a square box would be really boring. The nature of the project is such that it calls for something much more whimsical. We need some sort of box to hold the mice but supposing the actual entrance to the trap were shaped like a cat with its mouth open. Not only would that be eye-catching but chances are that the finished project would be on a table in the living room rather than behind the refrigerator.

Once the shape is decided, we have to choose the material. Metal is an obvious choice but it has its problems. It's hard to shape and harder to work. Unless you have access to a machine shop, precision pieces are going to be very difficult to make. And if you don't weld the different pieces together you're going to have lots of screws and tabs showing. Metal cases also have a

nasty habit of shorting parts of the circuit and blowing up those components it took you three and a half weeks to get by mail.

Wood is a possibility. The grain and color are attractive and it's easy to work with standard tools. The problem here is joining pieces together. Screws still have to be used and glue takes a while to dry thoroughly. That means that the pieces will have to be made and fitted together over a period of days. And any curved pieces are going to be a real problem.

Our last alternative is ideal for case making—acrylic plastic. It can be easily cut and shaped using ordinary tools, and solvent cement will immediately bond pieces together. As a matter of fact, the cemented joint is often stronger than the piece itself. The plastic can be bent and shaped by heating it and is extremely forgiving of mistakes. Repeated heating and bending won't even weaken the material. Scratches and abrasions are inevitable when working the plastic but they are easy to sand away. The plastic can be buffed and polished to any degree of luster you want.

Acrylic is available from a wide variety of sources and comes in an overwhelming assortment of thickness, colors, and shapes. Most lumber yards and stores that specialize in products for the "do-it-yourselfer" will carry a good range of acrylic as well as all the material you'll need to work it. The plastic itself can be found in flat sheets, tubes, pipes, and other shapes ranging in thickness from 1/16 to over two inches. Cubes and other solids can be found in every size and color imaginable.

There are a variety of techniques you should be familiar with to successfully work with acrylic. Before trying to use them, practice on some scrap material to get a bit of hands-on experience.

Raw material

The acrylic comes in sheets measuring up to four by eight feet and in thickness up to greater than two inches. Both transparent and opaque plastic are available in many colors. The brown paper covering both sides protects the glossy finish put on the plastic by the manufacturer and also lets you mark your cuts (see Fig. 1). In general, 1/8-inch plastic is the most widely available and is more than strong enough for making cases, although occasionally a structural piece will require thicker material; because of the strength of the bond made with solvent cement, you can, if you wish, glue thinner pieces together in those instances. If a thinner piece is needed, you can always sand down one of the 1/8-inch pieces.

Glues

Although all of the glues shown in Fig. 2 will work with acrylic, without doubt the best glue to use is the solvent cement; you can get that cement at the same place you bought the plastic. It isn't really a glue in the strict sense of the word. What solvent cement does is soften and partially dissolve the plastic. When the two pieces being joined are put together the bond formed between them is as strong, if not stronger, than the plastic itself. The joint hardens in a minute or so and can be sanded or shaped immediately. The solvent action of the cement can cause problems, however. If you press your finger against any part of the plastic that has been softened by the cement, you'll leave your fingerprints in the surface. They can be sanded out but it's better to avoid doing it in the first place.

Remember though, solvent cement *only* works with pieces of acrylic. Anytime you want to glue some other material to the plastic, a different glue will have to be used. Both two-part epoxy and any of the instant-bonding cyanoacrylate glues work well. The choice depends on the particular application. The two-part epoxy will fill in empty spaces and can be sanded smooth, but the instant glues are contact types; that means that they will only work when the two surfaces being joined mate together perfectly. One interesting feature of the epoxy cements is that they can be colored. Powdered fabric dyes work well but be careful—a little dye goes a long way. The best method I've found is to mix the two parts of the epoxy together with a small amount of the dye and stir them until the color has become uniform. *Slowly* add more dye, mixing it in continuously until you get the color you want.

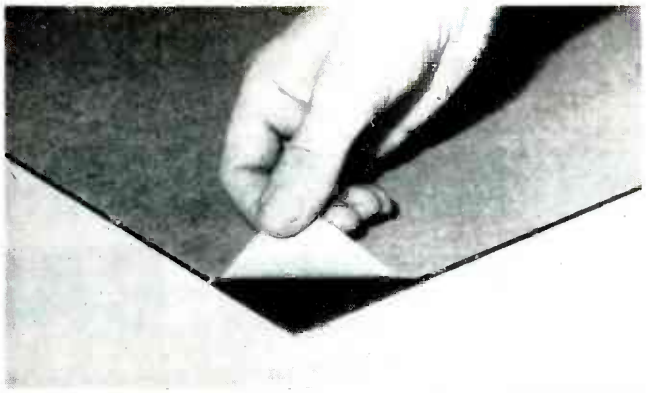

FIG. 1—WHEN YOU BUY IT, acrylic plastic is usually covered with brown paper to protect its surface. That paper is easily removed.

FIG. 2—ALL OF THESE GLUES will work with acrylic plastic, but the solvent cement is best for joining two pieces of plastic.

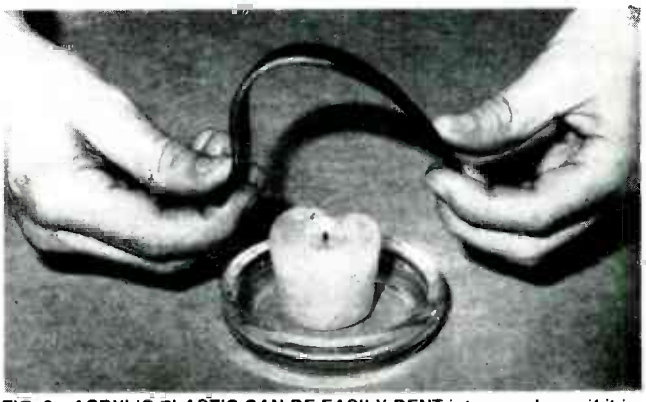

FIG. 3—ACRYLIC PLASTIC CAN BE EASILY BENT into any shape, if it is heated.

Tools

Any tool used for woodworking can be used with acrylic plastics, including power and hand tools. The only thing to watch out for is heat. If you are using power tools there are two basic precautions to be aware of. Make sure to use only the bits and blades that have been specially rated for use with acrylic. That usually means that the blades have fine teeth and are not hollow ground. The bits should be sharp enough to bite into the plastic without having to apply an undue amount of pressure. Rough cutting blades and bits will crack and shatter the plastic

and dull ones will generate so much heat that the plastic will melt at the cut and the waste, rather than falling away, will melt together and harden behind the blade.

Sanding and polishing

Acrylic is easily sanded. The key to success here is to avoid the build-up of heat. For general work, I've found that a medium grit paper is the best to start with. Coarser papers score the plastic and leave sanding marks that are almost impossible to remove. If you use a sanding disc on an electric drill, you'll get the best results by use the drill's highest speeds—the higher the speed, the less pressure you have to apply. Do the sanding in short bursts to keep the heat down; if you have to sand off a ¼ inch of plastic, do 1/16 inch at a time. If you try to do it all at once, you will generate so much heat that the plastic will melt at the surface and leave deep marks. That is to say nothing of the blocking up that will happen to the paper. There will be so much build-up of hardened plastic on the sandpaper that you'll have to replace it. If you've ever sanded paint you know what I'm talking about.

Polishing the plastic is similiar to polishing metal. Use successively finer grits and then use fine steel wool. Always sand in the same direction. The last bit of polishing you need to do is with a kitchen steel wool pad. Use a new one that's loaded with soap. That will leave a very high luster on the plastic and the sanding marks will be just about invisible. If you want to go farther, use 0000 steel wool and oil and do the final polish with a soft cloth and pumice. Keep in mind though, that the plastic is really susceptible to scratches and there's nothing like a mirror-smooth finish to show off imperfections.

Bending and shaping

Now we get to one of the best reasons for using acrylic plastic. Anyone who has ever tried to get uniform curves in flat pieces of metal, or shape a smooth curve in wood, will appreciate the ease with which it can be done in plastic. There are two basic ways to shape the plastic—sanding and heating. If you want to round a corner or taper something, sanding is your best bet. Use a medium-grit paper on a sanding disc and carefully shape the plastic. Examine your work frequently because it goes very quickly and it's easy to go too far. Remember that a little bit of impatience on your part when sanding something to shape will ruin both the last three hours work and the rest of your day.

Creating a curve, or some other complex shape, from a flat piece of plastic is done by heating. Acrylic becomes bendable when it gets to a temperature of about 350 degrees Fahrenheit. That isn't particularly high and there are several commercially available tools made especially for heating plastic to that temperature. Basically, they are all heating elements that have some sort of guard on them to keep the plastic about ¼-inch away. You hold the plastic against the guard and bend it when it softens. Those are fine for creating a simple corner or lip but are useless when you're trying to bend the plastic to conform to some complex jig.

There are several ways to heat the plastic so it can be wrapped around a bending jig. You can use a hair dryer but that takes a long time, because the hair dryer has to be kept away from the plastic so the air flow isn't restricted. If you hold it too close, the motor will load down and the dryer will blow its thermal fuse. You can heat the plastic over a high-wattage lamp but it's hard to work with spots in front of your eyes, and there's always the danger of the plastic touching the lamp and either sticking to it or breaking the glass.

The simplest way to heat the plastic is over an open flame from either a candle or the top of the stove, as shown in Fig. 3. The only problem with that is that the plastic can start to burn; but that can be avoided by moving the plastic rapidly in and out of the flame and only using the cooler part of the flame (at its base). If the plastic *does* start to burn, it's a simple matter to blow it out or douse it in water. The advantages of doing it that way are that the plastic heats quickly and the flame provides only localized heat, which means that a long complex bend can be made a little at a time. The acrylic is a good insulator and only the area in the flame will get hot enough to bend. As a result, as you work your way along a complex bend, previously curved areas will stay that way. As you finish each part of the bend, set it by immersing it in cold water. That will immediately cool the plastic and make it rigid again. Don't force the plastic to bend because it will break. There's absolutely no way you can be mistaken about when the plastic is hot enough to bend—it will flap around like a piece of wet cardboard and stay that way more than long enough to let you make your shape. Wear protective gloves because not only can you burn yourself, but it's impossible to have any control over the plastic unless you can hold it firmly while you're bending it. And remember that you have to hold it until it cools off enough to become rigid again.

Cutting

The best way to cut acrylic is with a saw, as shown in Fig. 4. That sounds a bit trivial but it isn't. Plastic suppliers sell a scribing tool that's used to score the plastic so it can be broken much the same as glass—I've never gotten that tool to work. When I went back to the supplier to ask if I was using it correctly I noticed that they always used a saw—case closed. As long as you make sure that the blade is designed for acrylic, and you don't force the cut you'll find it easier to cut plastic than to cut wood.

FIG. 4—THE BEST WAY to cut acrylic plastic is with an ordinary power saw, as shown here.

FIG. 5—ONE THING YOU'LL APPRECIATE about working with plastic is that you can correct mistakes with an easy-to-make paste.

"Welding" and embossing

That technique is extremely useful and can only be used with plastic. Because we're all human, we make mistakes and cuts aren't always made as smoothly as we'd like. If a gap turns up along a joint there's an easy way to correct it. Save the plastic "sawdust" and soak it with solvent cement. Work it around with a brush and you'll wind up with a pasty gunk like that shown in Fig. 5. That can then be used to hide any minor mistakes, such as mis-cuts, imperfections, and even small holes. As shown in Fig. 6, work the gunk into the gap with brush that is kept soaked in cement—if the brush gets too dry it will start pulling the gunk out of the gap. A bit of brushing back and forth, and the gap will be entirely filled with plastic gunk. The color will be the same as the surrounding area and, after sanding, will be flush with the surface. Make sure to allow time for the repair to dry before sanding it—since you've really soaked it with cement you'll find it takes longer to dry than a regular joint. That "welding" technique will go a long way toward correcting errors in measurement and slips of the saw. After a bit of practice you'll find that corrections made by welding are virtually invisible.

Embossing is a technique that also takes advantage of the solvent action of the cement. If you brush cement repeatedly over an area of plastic it will get soft enough for you to press in a design, as shown in Fig. 7. The only precaution here is to make sure that whatever you press into the plastic is unaffected by the cement. You want to remove if after you've pressed in the

FIG. 6—TO FIX ANY CRACKS OR HOLES, fill them with plastic shavings soaked in solvent cement. After it dries and is sanded smooth, the repair will be almost invisible.

design. Coat the embossing piece with some thin oil before pressing it in the plastic. That ensures that the plastic won't stick to it and ruin the transfer of the design. After the acrylic has hardened, brush it lightly with fine steel wool to remove any burrs.

Screws and hinges

Although regular hinges *can* be used, it's much neater to use pins or brads. If your case requires a door, design it so that the door fits snugly and flush between two other pieces. Drill thin holes through the side pieces and the edges of the door. Push in small wire brads as shown in Fig. 8. If you're careful about your sizes, the brads will fit tightly and you won't have to use any glue. Don't force the brads in, because you'll only crack the plastic. If they're not tight enough, use a drop of cyanoacrylate glue on the side piece to hold the brad in place. Make sure not to cement the brad in both the side piece and the door. When the glue dries, grind the end of the brad flush with the side piece. Make sure that the door opens easily and stays in position when it's closed.

The same precaution against forcing things applies to screws. Acrylic is rigid and won't compress, so the hole sizes for screws are more critical than they are with wood. Make the screw hole

FIG. 7—IF YOU SOFTEN THE PLASTIC with solvent cement, you can emboss any designs you wish into the surface.

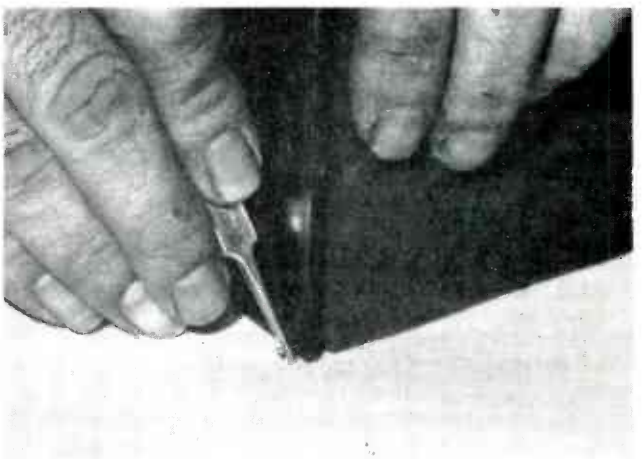

FIG. 8—IF YOUR PROJECT requires hinges, make them by inserting small brads into pre-drilled holes.

at least as wide as the inner shaft of the screw. It goes without saying that you shouldn't use tapered screws. If there's any doubt about the size of the hole, make it larger and stuff in part of a toothpick. The screw will compress the wood and that will keep the whole thing tight.

Lettering

Transfer-type lettering is available in a wide variety of fonts, sizes, and colors. You can even get sheets with graphic designs, borders, lines, and so on. The secret to making lettering look good is simple—keep it straight. Put a piece of masking tape on the case about a ¼-inch below the line for the lettering and use it as a guide. A fairly wide burnisher will lessen the chances of having hairline cracks develop in the letters. Once lettering is applied, it has to be protected because it is fairly easy to scrape it off—that is great for correcting mistakes but when you finally get it straight on the tenth try you want a bit more permanency. Any art-supply store will sell you a protective spray, or you can get a can of spray lacquer. Use it sparingly and avoid runs. Spray the entire case to make the finish uniform, and don't handle it until it's dry. An easy test to see if the case is dry is to smell it—if it is wet, you'll know it. When the lacquer is dry it will no longer have an odor.

With a little bit of practice you will be able to make cases that do justice to your electronics handiwork. And I'm sure that you'll even find that your projects work better. You can be sure that housing your project in an imaginative case will make all the difference—everyone in your family will want to be first in line to try it, instead of first in line to leave the room. **R-E**

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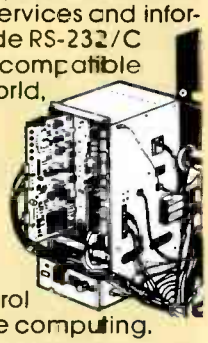

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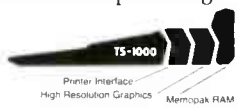
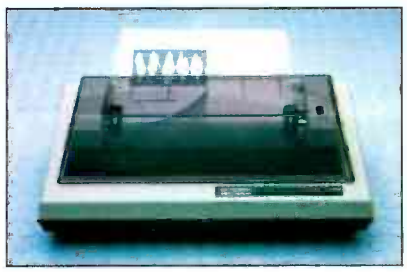


MEMOPAK RAM All Memopak RAMs are directly addressable, user transparent and are neither switched nor paged. No additional power supply is required. **16K RAM BASELINE** The 16K Baseline is our most economical way to add memory to your TS-1000. It is fully compatible with Memopak 16K and 32K RAMS to provide you with up to 32K or 48K of RAM respectively. **16K RAM** The Memopak 16K RAM offers expansion capabilities through its "piggy back" connection and is fully compatible with Timex or Memotech 16Ks to give a massive 32K of RAM. **32K RAM** The 32K Memopak enables you to execute sophisticated programs and store large data bases and like the 16K RAM is fully compatible with Timex's or Memotech's 16K RAMs to give you a full 48K of RAM. **64K RAM** The 64K Memopak is powerful enough to turn your TS-1000 into a computer with capabilities suitable for business and educational use. It accepts such BASIC commands as 10 DIM A (9000). **MEMOCALC** Memocalc, our spreadsheet analysis software, enables TS-1000 users to perform complex number crunching routines with ease. With the 64K RAM a table of up to 7000 numbers with up to 250 rows or 99 columns can be specified. Quick revisions can be achieved by entering new data to your formula.

MEMOTECH KEYBOARD For ease of operation, the Memotech keyboard is a high quality standard typewriter keyboard, with TS-1000 legends. The keyboard is cable connected to a buffered interface which is housed in a standard Memopak case and plugs directly into the back of the TS-1000 or other Memopaks. **MEMOPAK HRG** The Memopak High Resolution Graphics, with up to 192 by 248 pixel resolution, enables display of high resolution "arcade game" style graphics through its resident 2K EPROM, programmed with a full range of graphics subroutines.

CENTRONICS PARALLEL AND RS232 INTERFACES Memotech's Interfaces enable your TS-1000 to use a wide range of compatible printers. The resident software in the units gives the complete ASCII set of characters. Both Memopak Interfaces provide lower case character capabilities and up to 80 column printing. The RS232 Interface is also compatible with modems and terminals.

SEIKOSHA GP 100A PRINTER The Seikosha GP 100A uses a 5x7 dot matrix printing format with ASCII standard upper and lower case character set. Printing speed is 30 characters/second with a maximum width of 80 characters. The printer uses standard fanfold paper up to 9-1/2 inches wide. The GP 100A is offered as a package including cable and interface. Other printer packages are also available through Memotech.



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Code:	Price	Qty.	Total
16K RAM Baseline	$ 49.95		
16K RAM	59.95		
32K RAM	99.95		
64K RAM	149.95		
Memocalc	49.95		
Keyboard with Interface	99.95		
High Resolution Graphics	99.95		
Centronics Parallel Interface	74.95		
RS232 Interface	99.95		
Printer Cable	19.95		
GP 100A Printer Package**	399.00		
Shipping and Handling	4.95		$4.95
Tax (Colorado residents only)			
TOTAL			$

*All prices quoted in U.S. dollars Prices and specifications subject to change without notice
**Please add an additional $5.00 for printer shipping charges.
☐ Check ☐ MasterCard ☐ Visa

Account No. _____ Exp. _____

( )

Name _____ Phone number

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MEMOTECH
CORPORATION

7550 West Yale Avenue, Denver, Colorado 80227, 303/986-1516, TWX 910-320-2917

Radio Electronics YOUR OWN Computer APRIL 1983

Computer Basics

Are you considering buying a microcomputer? Then, you should first learn how a microcomputer operates. Once you have even a basic understanding, it is easier to ask the right questions when it comes time to buy the system.

MARC STERN

IN WHAT HAS SEEMED LIKE AN EXPLOSION, THE COMPUTER revolution has arrived. In only the last eight years, the personal computer has moved from the province of hobbyists and "hackers" to take a place in business offices and—what has really made it a revolution—the computer has moved into thousands of homes.

Whether that has been due to the videogame explosion, or the marketing efforts of major manufacturers, or the public's recognition of the power and capability of the microcomputer, we will not go into. But, suffice it to say that hundreds of thousands of people, who, a few years ago, didn't know BASIC or the meaning of ROM or RAM (and maybe they still don't!), are now using personal computers.

And it seems that each week thousands more are jumping onto the microcomputer bandwagon. They are buying not only low-end, home systems, but also high-end systems such as the IBM *Personal Computer*. Further, it seems that for every person who does buy a computer, two or three more are considering a purchase. However, they are hesitating because they lack information—they have many questions that need to be answered. In the following pages we will attempt to answer some of those questions and familiarize you with some commonly-used terminology.

Overview of a computer system

For the first-time buyer, perhaps the best way to visualize a system is to break it into its major parts. In general, a computer consists of the CPU (Central *P*rocessor *U*nit)—and the *motherboard* or system board that connects the CPU to other devices for input and output (I/O) and storage. Figure 1 shows a block diagram of a basic microcomputer system.

The CPU, which is sometimes called the MPU or microprocessor unit, is the "heart" of the system. But that by itself would not make a computer. It is also necessary to have, among other things, *memory*. There are two basic types of memories: RAM and ROM. RAM (*R*andom *A*ccess *M*emory) is memory in which data can be either *written* or *read*. It is like a large holding area of information. It either holds active information for immediate use, or it stores data for later use by the CPU. A ROM (*R*ead-*O*nly *M*emory) on the other hand is a memory that can only be read. Once the information is put in the ROM it cannot be changed. The mass storage device is another type of memory. An example of a mass storage device is the floppy disk drive, which allows you to store great quantities of information and programs on a magnetic disk.

A CPU with memory still does not make up a computer. There must be some way to input information to the computer and for the computer to output information. One way that is accomplished is by parallel and serial interfaces. Those interfaces connect the microcomputer to other devices such as printers, keyboards, etc.

That, then, is the basic outline of a personal computer. Of course, there is much more that we could have included, but for starters, that outline will suffice.

With those basic concepts established, let's look more closely at the personal computer, beginning with the CPU and progressing to the other areas of the system.

The CPU and bus structure

The CPU includes the microprocessor and any necessary support circuitry. The "standard" CPU is an 8-bit device (a *bit* is a binary digit). That CPU handles information eight bits (or one *byte*) of data at a time. (Thus the data bus shown in Fig. 1 actually consists of eight data lines.) A byte is often referred to as the "word size" of the microprocessor.

The address bus, on the other hand, consists of 16 lines. That lets the microprocessor address 2^{16} memory locations. Although 2^{16} is referred to as 64K (64 kilobytes), the actual number is a little over 65,000, because 2^{16} or 1,024 bytes of information is commonly referred to as 1 kilobyte or 1K of information.

The third standard microprocessor bus is the control bus. It consists of from 10 to 12 lines, depending on the particular CPU. It is mainly used to carry synchronization signals between the microprocessor and other system components. Typical signals are: read, write, interrupt, and reset.

With all of this said, a question probably has arisen in your

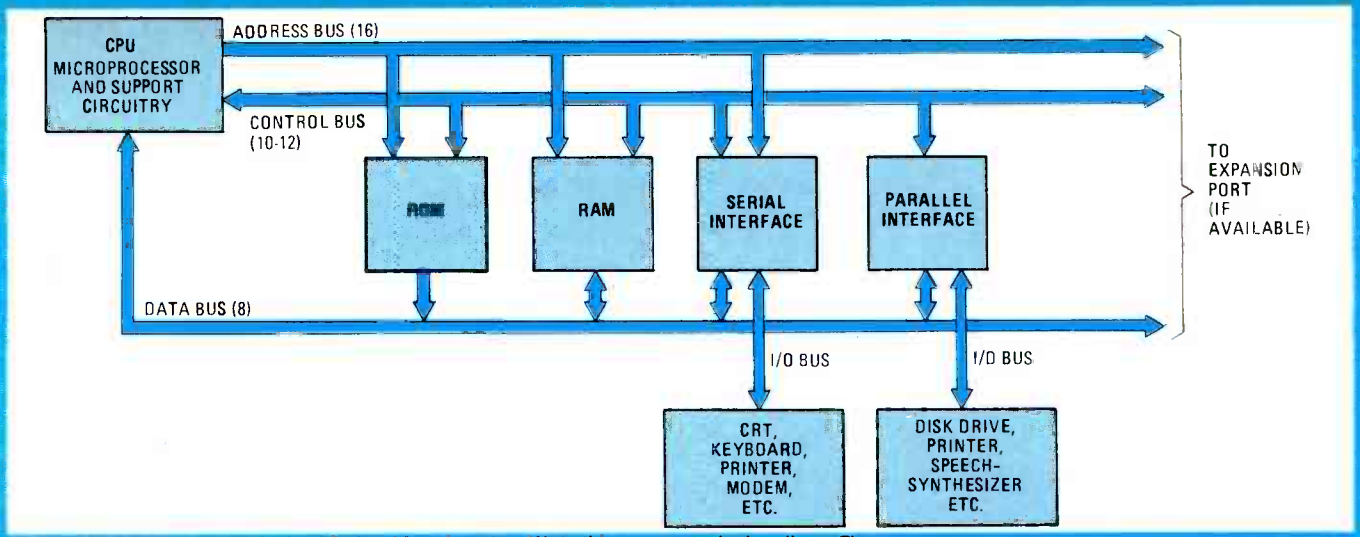

FIG. 1—BLOCK DIAGRAM of a basic microcomputer system. Note the arrows on the bus lines. They indicate the direction of information flow.

mind as to which type of CPU is best. The answer is that for most personal computing uses, it makes little difference what type of CPU is used. In a given situation, a 6502 will work just as well as a Z80 or an 8080.

There is a "but" in this situation, though, and that is for the computer user who wants access to, say, the broad range of CP/M programs. CP/M (*C*ontrol *P*rogram for *M*icrocomputers) is the standard *operating system* of the 8-bit-system world and many business programs are written under it. It was written for the 8080 series of microprocessors and is also compatible with the Z80 series. Thus, if you want access to those programs you must use one of those microprocessors. There are *emulators* that allow you to use CP/M with other CPU's, but the programs will work slower when that is done.

We will not discuss operating systems in great detail. What we will say is that the operating system effectively isolates the computer user from the computer hardware. It also makes the particular computer "invisible" to the software. What that means is that if two different computers—even with different microprocessors—use the same operating system (say, CP/M) they will both be able to run the same software, as long as the software is written for that operating system.

The CPU world is changing. Although it is still dominated by 8-bit microprocessors, 16-bit systems are starting to appear in increasing numbers. Chief among the 16-bit units is the 8086/8088 family, which is capable of running under the MS-DOS operating system. That is the operating system that has been adopted by IBM. Because so many systems are being designed to run under it, it is likely that MS-DOS will become the "standard" of the 16-bit microcomputer world. However, a 16-bit version of CP/M—CP/M-86—may give MS-DOS a run for the money.

Memory

Although we previoulsy mentioned ROM and RAM, we did not say what each one was used for. First, we'll give an example where you would want to use read-only memory (ROM).

There are some programs that you would never want to change. An example is the bootstrap loader routine (that program gets the system up and working when the computer is first turned on). That routine is stored in ROM. ROM, as its name implies, is not user-modifiable (you cannot *write* to it). It is important to note that ROM also is *non-volatile*. In other words, ROM will not lose its memory contents even if the power is turned off. Another example of where ROM is used is in videogames. The program that runs the game computer is stored in the videogame cartridge in ROM.

The contents of RAM, on the other hand, are constantly changing. It is in RAM that you would store, say, a BASIC program. RAM can be thought of as the microprocessor's work space. It is essential to a microcomputer because the system needs a way to store and frequently update information as it is used. RAM is volatile; when power is turned off, the contents of the memory will be lost—unless you record it on disk or other storage medium.

One of the most often asked question by the first-time microcomputer buyer is how much RAM is sufficient? The answer is as much as you can comfortably afford—but there is no such thing as enough memory. A bare minimum, good for games and some applications programs, is 16K. However, 48K or 64K is a much better place to start. No matter how much memory you have, though, sooner or later you're going to run up against a program that needs more memory. Or, you may use a program, which, while it runs with the memory you have, it would perform better with more memory.

Inputs and outputs

There has to be a way to communicate with the computer, and for the computer to communicate with you. The communication is called input and output (I/O). Let's now look at some possible inputs.

First, we'll look at the keyboard. When you input data via the keyboard, the information is first sent to the *keyboard processor*, where the electrical impulses that are generated by the keys are turned into codes that can be read by the microprocessor. Once the keystrokes have been encoded, they are then directed not only to the display, but also to RAM where they are stored until they are processed by the CPU.

Another possible source for an input is a mass storage device, such as a disk drive. The data stored on the floppy disk is first read by the read/write head and is then sent on its way to the system bus. The data may either be used immediately by the CPU or it might be stored in RAM until it's called by the CPU.

Other inputs can also be entered via the input/output interfaces (I/O ports). There are two basic types of interfaces: *parallel* and *serial*. A parallel port transfers the data eight-bits (one byte) at a time. A serial port transfers the data one-bit at a time.

In a microcomputer system, input is generally handled via a serial port, while output-only is usually handled by a parallel port—although either port can be used for both input and output.

One example where you would use a serial port for information input is for connection to a modem (*MO*dulator/*DEM*odulator). With a modem, it is possible to communicate with other computers using a telephone line. (See article on modems, elsewhere in this section.)

That pretty much completes the general picture of the input side of the microcomputer, but that is only half of the picture.

We must take a look at how data is output.

Again the two ports, parallel and serial, are used for output. When a user decides to output something to a printer for hard-copy purposes, he requests that action from the CPU. That keyboard request is then processed and the CPU searches RAM for the information to be output through the printer. When that information is found the CPU not only flashes a message on the CRT, but it also sends the information to the port that is to be used. If the data arrives too quickly for the printer to handle, the overflow is shunted into a *buffer* where it is stored until the printer or plotter can handle it. Either a parallel or serial port can be used for output to the printer. However, a parallel port handles data much more speedily than a serial port because the data is transferred eight bits (one byte or word) at a time. However, there are disadvantages to using the parallel port. First, it is prone to picking up stray noise that can cause data-transmission errors. That is especially true if you are trying to communicate over long distances.

A second disadvantage is that there is no set standard for parallel ports—each microcomputer manufacturer has his own idea of the type of interconnection to use with a printer or other parallel device. Of course, there is the Centronics-compatible standard for printers, but once you have wired up a connector for such a device, you will find that about the only thing agreed upon with this standard is the type of connector. It seems that each microcomputer handles things just differently enough to cause problems. Another standard parallel interface is the IEEE-488 bus. That bus is most commonly used for scientific peripherals.

The more reliable, although slower, interface is the serial interface. That type of interface uses fewer wires and is much less sensitive to stray noise pickup. Further, since fewer wires are used, cabling costs can be reduced. The key disadvantage when compared to parallel transmission is its speed. It is slower because information is sent serially—one bit after another.

There is a standard to cover serial communications interfaces and make them all compatible (the RS-232C standard). However, while the RS-232C protocol is standard, some manufacturers do not use all of the lines, and others may tie some lines high or low. Keep that in mind when interfacing peripherals.

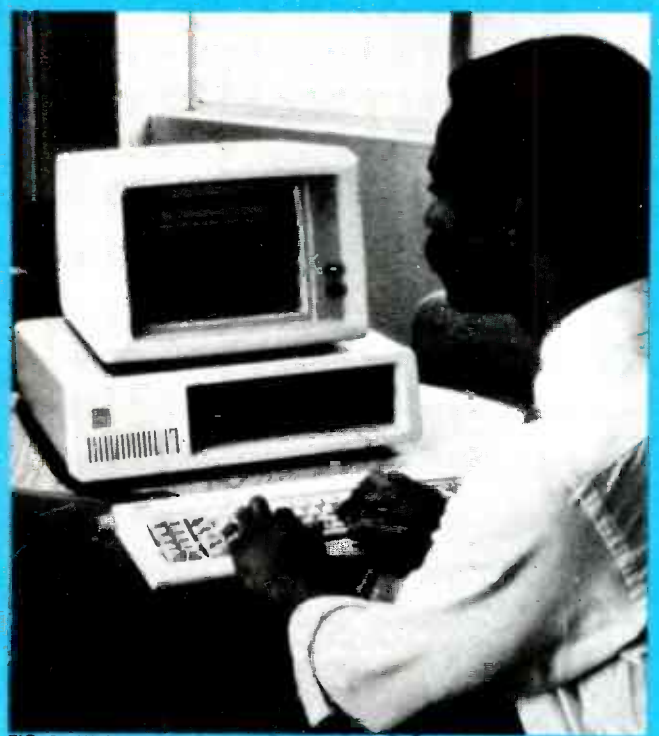

FIG. 2—With a monochrome display, the IBM *Personal Computer* can be used for word processing or other applications that require high-resolution graphics. (See Fig. 3.)

FIG. 3—Often, the display can limit a computer's capabilities. For example, when used with a TV, the IBM *Personal Computer* cannot be used for word processing. (See Fig 2.)

Other considerations

There are other questions that you should ask yourself before buying a personal computer. Of course we cannot cover all situations here, but we will give some examples of things you might want to consider.

Many computers are meant to be used with a TV. That, while reducing the cost of the system, is not all that desirable. The limited bandwidth of the TV does not allow it to reproduce high-resolution graphics. (See Figs. 2 and 3.)

What, then, is the best display? That very much depends on what you plan to do with with the computer.

Let's first presume that you want to use your computer mainly for word processing and record keeping, and thus do not need a color display. Then, the question you should be asking is what type of monochrome (single color) display you should use. Experts have long noted that a black-and-white display is the hardest on the eyes. Although it is highly visible, that type of display is the most fatiguing to use. A green-on-black monochrome display is better on the eyes. It is easier to read and use under conditions of glare, and it is much less fatiguing. There is a current controversy, however, about whether an amber-on-black display is easier on the eyes than the green-on-black. In fact, just about all of Europe has mandated the amber-on-black type of screen format. In reality, though, the jury is still out on the question and it is probable that both displays will come out about even in the final analysis. Definitely, though, either is better than a black-and-white display.

Whichever type of display you choose, it should be capable of reproducing 80 columns by 24 lines of text for word processing. The reason is that that is the industry standard and it is also about the number of columns you can reasonably expect on an average piece of paper.

There are systems which only display 40, 52 or 60 characters and those require special add-on boards to make them capable of 80-column display. Further, many of those units generate capitals-only, which makes them almost useless for true word processing, unless the correct hardware fix is made.

Perhaps you plan to use the computer to generate color charts and graphs, or for other color computer graphics. Therefore, you need a color monitor (of course your computer must be capable of generating color graphics to use that). Although some color computers can use a color TV for a display, a monitor with R-G-B (*R*ed-*G*reen-*B*lue) inputs should be used because it permits higher-resolution graphics. A color TV, because of its narrow bandwidth, is not capable of high-resolution graphics unless it is modified.

Of course, a monitor cannot reproduce high-resolution graphics if the computer cannot generate them. Conversly, it is important to remember that the monitor should be capable of reproducing the graphics that the computer can generate.

Don't forget the keyboard; it should be typewriter-like in its features. That's because that type of keyboard is one with which most of us are familiar. Try to avoid those keyboards which have nonstandard placement of important function keys. A useful convenience on a keyboard is the separate numeric keypad. If you do a great deal of number entry, that feature is a necessity more than simply a convenience.

Another feature that you might find convenient is a detachable keyboard. That would allow you to use the keyboard in your lap or to move it to a convenient place on a desktop. However, on some systems, that's not possible.

Do not forget some type of mass storage device when shopping for a computer. Two popular mass storage devices are the disk drive and the common cassette recorder. Although you might be able to get along for a while using a cassette recorder, you will really need a disk drive if you want to use your computer for serious applications. To handle as much information as possible, double-sided, double-density drives are preferred for mass storage. However, if those are beyond your means, make sure the single-sided drives you buy are at least capable of double-density data encoding. It gives you far greater data storage.

The microprocessor that the computer is based on can be important. There is no definitive "best" microprocesser. As we mentioned before, though, if you want access to the wide spectrum of CP/M-based business programs, then your obvious choice is a Z80 or 8080-based system because these are the microprocessor units for which the CP/M operating system was devised.

What about the 16-bit CPU's that are becoming more popular? You've probably heard that 8-bit systems aren't as capable as 16-bit devices. In truth, the answer is that the microcomputer industry still hasn't taken advantage of the full power of the 16-bit CPU and most of the programs those systems run are really rewritten 8-bit programs. Eight-bit microcomputers will perform for you equally as well in a single-user situations, so don't worry about it. However, the 16-bit CPU does have an advantage in that it can address more memory—it can address more than 16 megabytes, while the 8-bit CPU is limited to 64K.

What peripherals are most necessary and useful? Probably the first item you should choose is a good printer. The second should be a good modem. Those will allow you to have not only hard copy printouts, but also with the modem you will be able to have access to remote databases, friends' computers, and information services.

Microcomputer buying doesn't have to be frustrating. The key to making it easy is to learn and to take the time to ask questions. Then, you have to ask yourself what you really need. Once you know the answer to that, you'll be able to join the microcomputer revolution that is here—to stay. **R-E**

Entry-Level Computers

If you want to learn about computers and programming, but are not interested in paying a large price to own your own system, take a look at some of these "entry-level" computers. For learning purposes, they offer a value that is hard to beat.

HERB FRIEDMAN

NO MATTER WHERE YOU WORK, OR WHAT YOU DO, ONE THING has now become very clear—your chances for advancement, promotion, or making a success of your own business may depend on how well you adapt to, or understand, modern computerized equipment and programs. Sorry to say, you will not be able to sit out the computer age—even just trying to prove the bank made an error on your checking account will require some understanding of the type of errors computers make.

Start small

Of course, the best way to learn what computers are all about is to simply use one. Unfortunately, to most general-audience newspapers and magazines that usually means a "minimal system" consisting of a color computer with at least 48K of memory, two disk drives, a printer, a color monitor, and about $3500 to pay for it all—anything less "simply isn't worth the expense." In truth, by using a rock-bottom-priced "entry level" computer—a model specifically intended for someone getting started in personal computing—you can attain "computer literacy" for as little as $85; and by the time you're finished you'll have an excellent understanding of how computers and their programs work. You'll also be able to program in BASIC quite competently.

Many of the best known consumer-electronics and personal-computer companies provide models specifically intended for the newcomer to personal computing: among them are, Atari (1265 Borregas Ave, Sunnyvale, CA 94086), Commodore (487 Devon Park Rd., Wayne, PA 19087), Radio Shack (One Tandy Center, Ft. Worth, TX 76102), Texas Instruments (PO Box 225012, MS-84, Dallas, TX 75265), and Timex/Sinclair. Except for the computer from Timex (1579 Straits Turnpike, Middlebury, CT 06762)—the Timex/Sinclair *1000*, perhaps bettter known as the Sinclair *ZX81* (50 Staniford St., Boston, MA 02114)—all entry-level computers are "color computers" that can generate multi-color backgrounds, characters, and graphics, although the nature of the color capability varies from model to model. And, again with the exception of the Timex *1000*, entry-level computers have some form of a musical-tone generator that allows the user to create sound effects for games, or even compose music.

While each manufacturer agrees that computer literacy starts with an understanding of BASIC programming, that's one of the few areas of agreement. As you'll see, each has its own ideas about what an "entry-level" computer should offer. Neither their software nor peripherals (accessory equipment such as printers, modems, etc.) are interchangeable. Also, in most instances, most popular peripherals cannot be used at all without purchasing a relatively expensive interface device. (We'll have more on that subject later.)

It's on TV

Though there are no standards as such, most models have several features in common. To start off, all use a standard TV-receiver for the display, and all come with the necessary switch-box so that the TV can function normally when the computer is not in use.

That display system works this way: A video modulator built into the computer, or one attached through a cord that provides the power and video from the computer, converts the computer's video output to an RF signal on TV Channel 2, 3, or 4. (Two of those three—usually 2 and 3 or 3 and 4—are provided; the user selects the channel not being used in his or her area.) The modulator is really a low-power TV transmitter that "broadcasts" the computer's output to the TV through a shielded patch-cord. As far as the TV is concerned, it is receiving an authentic TV signal so it displays the computer's output as a TV "picture." Also, sound effects and/or the output from the music synthesizers found in those computers are "transmitted" as a TV sound-carrier and are heard over the TV's speaker.

Whether the signal the computer receives is from the computer or a TV-antenna is determined by a switch-box as mentioned earlier. It's exactly the same as the ones provided with videogames: a small metal box with a slide switch that has connections for a TV antenna and the computer's output signal, and an output connection for hooking up the switch to the TV set (see Fig. 1). Whether the switchbox is intended for use with 300-ohm twinlead or 75 ohm coax, depends on the particular computer rather than the price. If you don't get the one you need with the computer, you can buy one at a nominal cost from an electronic-parts or video-tape retailer.

As to the type of TV set or monitor you need, a color unit is required only if you want to take full use of the machine's color

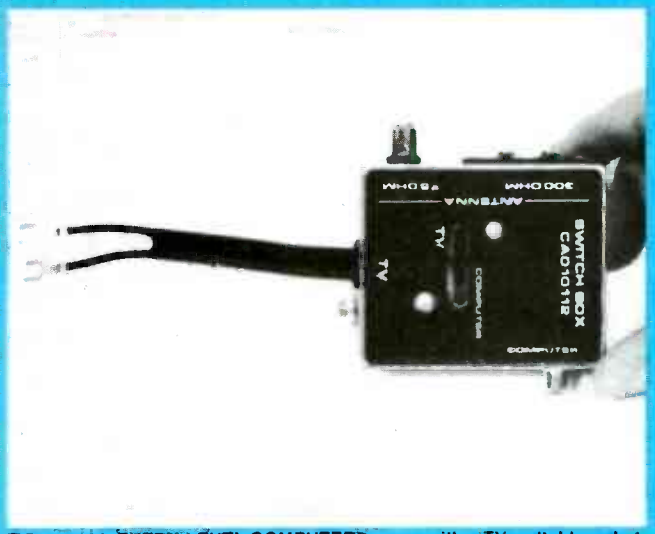

FIG. 1—ALL ENTRY-LEVEL COMPUTERS come with a TV switchbox that allows a standard TV set to serve as a computer monitor as well.

FIG. 2—ANY INEXPENSIVE CASSETTE RECORDER can be used with some entry-level computers. Others require a dedicated cassette-recorder that has a special connector that mates with a special socket on the computer as shown. Surprisingly, the dedicated recorders are an excellent value; they are well made and notably easy to use.

capability. Otherwise, a black-and-white unit will work perfectly well.

Another feature common to all machines of this type is a cassette I/O (*I*nput/*O*utput) connection. All entry-level computers provide some means for using a cassette recorder for mass data-storage. Programs and data written by the user can be saved (stored) on cassette tape, or pre-recorded programs and data can be loaded into the computer from a cassette tape. The cassette I/O connections on the Timex and Radio Shack computers are standard phono jacks, and virtually any cassette recorder—even a cheap $20 model—will work just fine. The Timex uses the least sophisticated system of all and the user must manually start and stop the recorder. On the other hand, the motor of a cassette recorder used with Radio Shack's *Color Computer* is under program (computer) control: It is started and stopped by the computer, or it can be manually controlled (whichever is more convenient for the user).

The computers from Atari and Commodore use what is known as a "dedicated" recorder, a model specifically intended for use with one or more of the manufacturer's computers (see Fig. 2). The dedicated recorders range in price from approximately $70 to $100, and while they aren't any more reliable than a $20 recorder, they can be more convenient because the recorder has been designed specifically for use with the computer. The dedicated recorder connects to the computer through a single cord that carries the input and output signals, the motor on/off switching, and quite possibly the power supply for the recorder. Depending on the model, most or all of the dedicated cassette-recorder's motor functions and video screen cues to the user are controlled directly by the computer; the computer even senses if the recorder is on-line and ready for whatever it's supposed to do. If it isn't, a screen cue to turn on the recorder appears.

Texas Instruments requires that you buy a special dedicated-cable if you want to use a cassette recorder for mass storage.

Another common feature is a port, slot, or connector for a plug-in ROM (*R*ead *O*nly *M*emory) module containing a complete software package (see Fig. 3). (Timex/Sinclair does not offer any of those ROM's, for the *TS1000*, but some independent manufacturers do.) When a program module is connected the computer "comes up" with the program rather than with BASIC. Software in ROM for entry-level computers is available for everything from arcade games, to home- and family-budget management, to elementary business programs, to high-fidelity system spectrum analyzers, to—well, you get the idea: just about anything you can think of is available. The advantage to ROM software is that it doesn't have to be loaded from tape or disk: simply turn on the power and it's running. The problem, however, is that the quality of ROM software ranges from absolute "garbage" to "decent," and it's almost impossible to know what you're getting until you buy it. (Did you realize that computer software is the only product sold for which there is no performance guarantee of any kind? Think about that.)

A lot for the money

Let's now take a closer look at what the entry-level computers have to offer.

For one thing, there's the price. To say that they are inexpensive is an understatement—they are, for the most part, an out-and-out bargain. At discount, prices range from about $80 for the Timex/Sinclair *1000* to perhaps $250 for the Atari *400*. (If you chose to pay a "suggested retail" price of $299 for a computer that can be purchased for as little as $179 maybe you need a computer to oversee your family's finances.)

Radio Shack's *Color Computer* is a somewhat special case, however, because it is sold only by Radio Shack and there is virtually no local competition between stores—although mail order is often discounted about 18%. To meet the competition from the other brands, Radio Shack has sharply reduced the price of their *Color Computer* models. You'll have to decide for yourself whether the higher cost for that machine is justified for your particular needs.

Keep in mind that the least expensive Atari package does not include BASIC: the computer comes with 16K of "empty" memory and BASIC is available in an optional extra-cost ROM module. The advantage to that, at least from Atari's point of view, is that a full 16K of RAM is available for arcade-game modules, and Atari has some of the very best games—such as *Missle Command*. Naturally, the cost of Atari's BASIC module is added to the cost of the computer itself.

Timex/Sinclair *1000*

The least expensive computer is the Timex/Sinclair *1000* computer. It features a very powerful, underrated built-in BASIC, and a membrane keyboard. The best way to describe a membrane keyboard is a plastic sandwich with switch contacts between the "slices." The corresponding "keys" are imprinted on the top directly over the associated switch (see Fig. 4). Obviously, one cannot touch-type on a membrane keyboard.

The only difference between that computer and the Sinclair *ZX81* is that the Sinclair version has 1K of built-in RAM while the Timex version has 2K. But that difference is more substantial than you might think—a skilled programmer can do a lot more with 2K of memory than he can with 1K. In any event,

FIG. 3—TO USE A ROM program-module, just plug it into a special port, slot, or connector built into the computer. When the computer is turned on, the machine will come up running that program rather than the resident BASIC.

however, most will want to purchase the optional 16K RAM pack regardless of which machine is owned.

The use of a membrane keyboard would slow programming down to a crawl except for one thing: Every essential BASIC command (LOAD, PRINT, GOTO, IF, etc.) is entered at the touch of a single key. Each key has up to five functions and the computer automatically recognizes when the touch of a key should enter a command or a character. (I know that sounds unbelievable but it really works.) That automatic command-recognition is particularly valuable for young children learning programming. They can just key in the commands and learn to program much more rapidly than if they had to sweat out a precisely spelled key word.

The computer has an expansion port for, among other things, an optional 16K memory-module (about $45) that provides a total of 16K memory (not 2K or 1K plus 16K). Larger RAM modules are available from several independent suppliers.

Evaluating the computer overall, it is a wonderful trainer, for which some rather good software is available at a rock-bottom price (like $18 for a "Calc" type program). But before investing in any expansion peripherals other than the memory module, keep in mind that the lack of touch-typing is a serious limitation for advanced uses.

Commodore *VIC-20*

The Commodore *VIC-20*, which now sells at discount for about $179, is sheer dynamite for the money. It has an excellent version of MicroSoft BASIC, outstanding color capabilities, an excellent typewriter-style keyboard, expansion ports, a serial-output port, a plug-in ROM port, and a port for two game paddles. It comes with 5K of RAM, which is more than adequate for a good amount of moderately advanced programming. It has both a video and an RF output, which means that it can be connected directly to either a video monitor or a TV receiver. Compatible peripherals include additional memory, a printer, modem, cassette recorder, and a disk system.

Unfortunately, it uses an IEEE-488 output bus. To connect a "standard" Centronics-type printer it is necessary to go through the additional expense of an IEEE-488-to-Centronics-type interface. It's an extra cost that you must consider if you plan on expanding the system. On the other side of the coin, Commodore offers a relatively inexpensive plug-in modem. Commodore also sells a direct plug-in printer, but at last look it didn't use standard 8½ × 11-inch paper.

The manual gives excellent operating instructions, and has a great introduction to color-control, but says almost nothing about programming in BASIC: you must also purchase the Commodore book, *Introduction to BASIC Programming*.

FIG. 4—A MEMBRANE KEYBOARD such as this one used on the Timex/Sinclair *1000* (Sinclair *ZX81*) has character, graphics, and BASIC key functions imprinted directly on the membrane—there are no "real" typewriter keys.

Texas Instruments *TI-99/4A*

This Texas Instruments computer system, which when first introduced included a color monitor, started out with a price tag close to $1000. TI's latest version of their personal computer, the *TI-99/4A*, is sold without a monitor but can be purchased at discount for as little as $199. It comes with 16K of RAM and has expansion ports for ROM modules as well as for the usual assortment of peripherals. It also accommodates two game paddles.

The computer has an approximation of a standard typewriter-keyboard (see Fig. 5) that isn't as bad as it's often made out to be, but isn't all that good or easy to use, either. (Why TI, with years of experience in consumer electronics, chose to go with a non-standard typewriter-style keyboard remains one of the mysteries of merchandising.)

One thing TI has going for it is a tremendous assortment of software—over 1000 items at last count—available on cassette tape, disk, and in ROM modules. Texas Instruments has many years experience with their *Speak-and-Spell*-type devices and they know how to select quality software for children as well as adults. They also have separate classes—called "clubs"—for children and adults that teach about computers and programming for a very reasonable price; that's one of the real strong points of the company and the machine.

Texas Instruments has also just announced a new computer, the TI-99/2—the first 16-bit computer selling for less than $100.

FIG. 5—EVEN IF THE CHARACTER ARRANGEMENT isn't standard, as is the case in this Texas Instruments *TI99/4A*, typewriter-style keys are the easiest type to use.

FIG. 6—EXCEPT FOR THE ATARI *400*, entry-level computers have BASIC built in and "come up" in BASIC when the computer is turned on. The Atari *400* contains only memory and a small "start up" software routine. All software, including BASIC, is installed by plugging in a ROM module as shown.

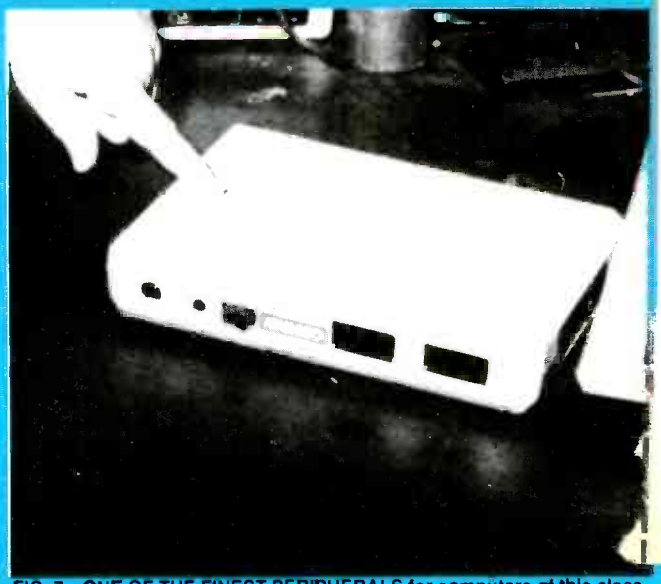

FIG. 7—ONE OF THE FINEST PERIPHERALS for computers of this class, the Atari *850* is more than worth the extra cost, as its four serial-ports and one Centronics-type printer-port allow for serious expansion.

That computer, designed primarily as a teaching computer, will also be well-supported with educational, personal-management, and entertainment software available both as plug-in cartridges and on cassette tapes. The TI-99/2 produces only a black-and-white display, but a 4-color X-Y printer plotter is available.

Atari *400*

The Atari *400* is a personal computer with strong roots in the area of videogames. It has superb high-resolution color capability and videogames run on that machine look as good as they do in the arcade. As mentioned earlier, BASIC is optional and is supplied in a ROM module (see Fig. 6).

The computer has a membrane-type keyboard but the "keys" are not only imprinted but indented. It looks almost like "the real thing," but the user still cannot touch-type. That is a serious limitation when programming in BASIC, because the commands must be spelled out.

There are provisions for four game-paddles. All peripherals, which include a modem and a printer, connect to the computer through an optional, accessory interface, the Atari *850*, shown in Fig. 7. The interface is an outstanding concept, even though an extra cost is involved. Among other things it provides four serial ports with programmable baud rates, and a Centronics-type parallel port.

An excellent assortment of game, educational, and general software is available, with more coming on-stream every week. Atari was a slow starter, but they now have a large, continuously expanding software selection. The only problem here is that if you're interested in the *400* you should really be looking at the Atari *800*, a highly under-rated computer with notably good features and performance. It does, however, sell for considerably more.

Radio Shack *Color Computer*

Finally, we come to Radio Shack's *Color Computer*. The lowest priced model, which sells for about $300, has 16K of memory, a good Color BASIC (Extended Color BASIC costs another $100), inputs for two game paddles, a serial port used for both a printer and a modem, and a socket for ROM modules and/or a disk system. Though priced considerably above other entry-level computers, it has the most potential for low-cost growth, and that's the reason we've included the machine in this survey.

Unlike the other entry-level computer manufacturers, Radio Shack's own software selection is relatively limited and somewhat elementary. Fortunately, there is an extensive software aftermarket for which Radio Shack has recently announced full, unfettered support. Some notably excellent software is rapidly coming on-stream.

Radio Shack, like the other computer manufacturers, has always tried to restrict peripherals to their own brand. One reason why Radio Shack computers have become so popular, however, is their inability to do it: aftermarket vendors have made Radio Shack one of the great names in personal computers. Not learning from experience, Radio Shack tried again to restrict peripheral selection for the *Color Computer* to their own brand. The serial output for a printer is a "Mickey-Mouse" circuit that works either with a $400 printer best suited for listing, or an $800 line printer. For those who prefer something inexpensive but great, like an Epson or Okidata printer, there's a *PC180C* parallel-printer interface from The Micro Works (Box 1110, Del Mar, CA 92014) that converts that output to standard Centronics.

While Radio Shack's own word-processing software for the machine leaves a lot to be desired (which is putting it kindly), *Telewriter* by Cognitec, (704 Nob Ave., Del Mar, CA 92014) turns the *Color Computer* into the lowest cost, high-performance word processor on the market (it works with virtually any serial or parallel printer—it restructures the machine's serial output).

The *Color Computer* is supplied with a notably excellent instruction manual for color BASIC (and Extended Color BASIC). Also, Radio Shack computer centers offer outstanding low-priced courses in elementary BASIC, advanced BASIC, and disk BASIC.

Summing up

All the entry-level computers will give you a solid foundation in computer fundamentals as well as in BASIC programming. If learning is your primary goal, and you have no interest in upgrading, then by all means purchase the lowest-cost computer. But if you plan to upgrade, to add peripherals such as a printer that can handle 8½ × 11-inch paper, or if you plan to experiment with complex home- and business-software, consider very carefully the cost/value ratio for the peripherals and software. As a general rule of thumb, the peripherals for entry-level computers—with the possible exception of the *Color Computer*—do not give the best performance for the lowest price. If you plan to upgrade, consider purchasing the least expensive version of a more advanced model. R-E

Radio Electronics YOUR OWN Computer APRIL 1983

Is an all-in-one computer system better than a component system? While there is no definite answer, we may be able to help you decide which is better for your needs.

MARC STERN

All-in-One vs. Components

THERE IS AN IMPORTANT QUESTION TO PONDER IF YOU ARE thinking of purchasing a microcomputer system—whether to buy a complete, turnkey (ready-to-run) system or to "build" a system from individual components. Each course has its advantages and disadvantages. We'll take a look at each type of system, the advantages and disadvantages of each, and propose some questions for you to ask yourself (and the computer salesmen) before you buy.

All-in-one systems

The greatest advantage to buying a turnkey system is convenience. In one package you get a keyboard, cathode-ray tube (CRT) display, the motherboard and its central-processor unit (CPU), plus input and output ports (if they are standard with the system) and, possibly, one or two disk drives. Usually such a system comes equipped with the minimum amount of RAM (*R*andom *A*ccess *M*emory) the manufacturer thinks you'll need.

An example of an all-in-one system is the Radio Shack *TRS-80 Model III* (Fig. 1). The system is available in different equipment configurations, but we'll examine the version with 48K (kilobytes) of RAM and two disk drives for mass storage. That system is priced at $2295 and, as it comes from the box, it is a fairly powerful, ready-to-run unit.

In fact, for most home uses that system will be more than adequate. But, for the serious microcomputer user, the amount of RAM may be fairly limiting. Some sophisticated programs, such as word-processing or spreadsheet programs, really require at least a 64K machine to run properly.

The *Model III* includes a standard RS-232 serial port that allows the user access to network communications, and a

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Save now by building the Heathkit H-100 yourself. Save later because your computer investment won't become obsolete for many years to come.

Save by building it yourself. You can save hundreds of dollars over assembled prices when you choose the new H-100 16-Bit/8-Bit Computer Kit money you can use to buy the peripherals and software of your choice.

H-100 SERIES COMPUTER SPECIFICATIONS:

USER MEMORY:
128K-768K bytes

MICROPROCESSORS:
16-bit: 8088
8-bit: 8085

DISK STORAGE:
Built-in standard 5.25 disk drive, 320K bytes/disk

KEYBOARD:
Typewriter-style, 108 keys, 13 function keys, 18-key numeric pad

GRAPHICS:
Always in graphics mode, 640h/225v resolution; up to eight colors are available

COMMUNICATIONS:
Two RS-232C Serial Interface Ports and one parallel port

DIAGNOSTICS:
Memory self-test on power-up

AVAILABLE SOFTWARE:
Z-DOS (MS-DOS)
CP/M-85
Z-BASIC Language
Microsoft BASIC
Multiplan
SuperCalc
WordStar
MailMerge
Data Base Manager
Most standard 8-bit CP/M Software

128K bytes standard. Optional

The H-100 is easy to build the step-by-step Heathkit manual shows you how. And every step of the way, you have our pledge "We won't let you fail." Help is as close as your phone, or the nearest Heathkit Electronic Center.

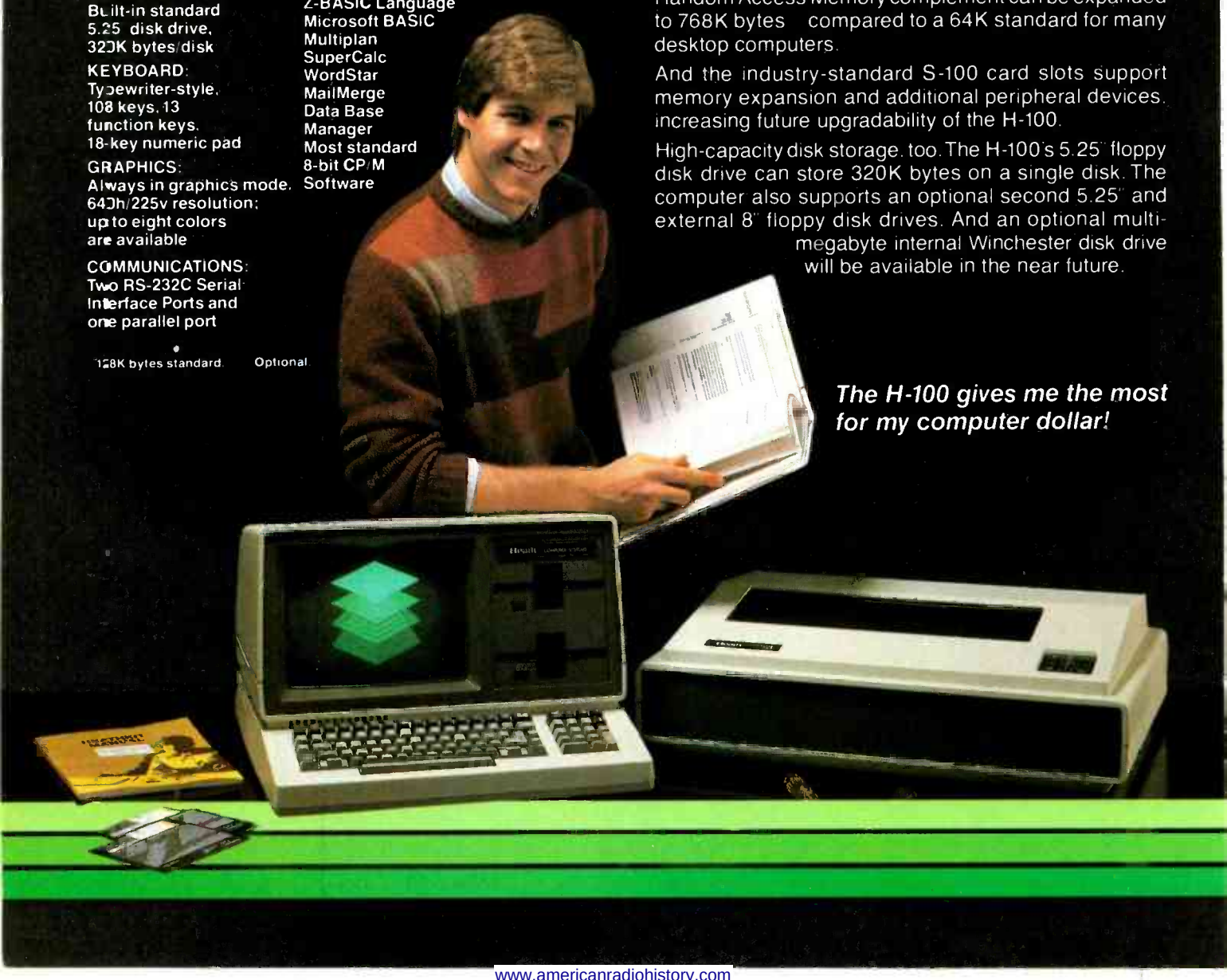
And what better way to learn state-of-the-art computing techniques than to build the world's only 16-bit/8-bit computer kit? To run today's higher-speed, higher-performance 16-bit software, you need an H-100. It makes a significant difference by processing more information at faster speeds.

Dual microprocessors for power and compatibility. The H-100 handles both high-performance 16-bit software and most current Heath/Zenith 8-bit software.

Want room to grow? The H-100's standard 128K byte Random Access Memory complement can be expanded to 768K bytes compared to a 64K standard for many desktop computers.

And the industry-standard S-100 card slots support memory expansion and additional peripheral devices, increasing future upgradability of the H-100.

High-capacity disk storage, too. The H-100's 5.25" floppy disk drive can store 320K bytes on a single disk. The computer also supports an optional second 5.25" and external 8" floppy disk drives. And an optional multi-megabyte internal Winchester disk drive will be available in the near future.



The H-100 gives me the most for my computer dollar!

Critical circuits are pre-assembled, making the H-100 easier and faster to build!

Want beautiful high-resolution graphics? You can create extensive charts, drawings, graphs and symbols to meet your needs – using the H-100's bit-mapped graphics and its 640 x 225 pixel video display.

The H-100 gives you total communications flexibility. Three interface ports let you plug in dot-matrix and letter-quality printers, as well as other peripherals.

Compare the H-100's exceptional capabilities with other desktop computers:

COMPUTER:	Heathkit H-100	IBM Personal Computer	Apple III
MICROPROCESSORS:			
16-bit:	8088	8088	–
8-bit:	8085	–	6502
RANDOM ACCESS MEMORY:			
Minimum:	128KB	16KB	128KB
Maximum:	768KB	576KB	256KB
FLOPPY DISK STORAGE:			
Per Diskette:	320KB	320KB	140KB
Maximum Internal:	640KB	640KB	140KB
8" Floppy Support:	Standard	—	—
EXPANSION SLOTS:	Five S-100 (four available)	Five (three available)	Eight
I/O PORTS:			
Parallel:	1	Optional	–
Serial:	2	Optional	1
VIDEO DISPLAY:			
Line Columns	25 x 80	25 x 80	24 x 80
Pixels Colors	640 x 225 (8 colors)	640 x 200 (2 colors) 320 x 200 (4 colors)	560 x 192 (16 colors)
OPERATING SYSTEMS:	CP/M-85, Z-DOS (MS-DOS)	CP/M-86 PC DOS (MS-DOS) UCSD P-System	Apple SOS

Information current as of 8/31/82. External disk storage available soon.

Learn by building. When you build and operate the H-100, you learn more about this sophisticated computer system and its unique 16-bit/8-bit software capabilities.

Learn from outstanding documentation. One of the most important parts of any computer system is documentation – and Heathkit documentation is among the industry's best. Our instruction and operating manuals are fully detailed, in the world-famous Heathkit tradition.

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See the H-100 in action. Visit your nearby Heathkit Electronic Center, which has the world's first 16-bit/8-bit computer kit, peripherals and software programs on display. See your telephone white pages for the nearest store location. Or mail the coupon today for a FREE, full-color Heathkit computer catalog.

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FIG. 1—RADIO SHACK'S *TRS-80 Model III* is a popular all-in-one computer system.

FIG. 2—A COMPUTER IN KIT FORM might be the right choice for you if you don't mind a little work. Shown here is the *H-89* from Heathkit.

parallel printer-port. Dual minifloppy disk drives are also included with the system; they allow 368K (184K per disk) of mass storage. They are not, however, double-sided, double-density drives, which would permit 320k (or more) of storage per disk.

One advantage that may especialy appeal to many first-time buyers is that, because there are fewer separate components, an all-in-one system is easier to buy. And, since everything in the system is made by one manufacturer, there is the advantage of having it all warranteed by that manufacturer, rather than having several different warranties and service networks to deal with. Another advantage of a one-piece system is that it often takes up less space than a component-type system. For instance, rather than having a system box for the CPU (*C*entral *P*rocessor *U*nit), and a separate CRT, keyboard, and drive(s), everything is in one cabinet.

While the all-in-one concept is appealing to many potential personal-computer buyers, it also has a few drawbacks that should be considered. Usually, when you opt for an all-in-one system, you are locked into whatever configuration you first purchased, unless you want to go inside the system and "get your hands dirty" to make the changes needed (such as adding an accessory board or resetting system switches). If you do that, you may run the risk of damaging the unit and losing its service while it is being repaired. Furthermore, if the system is still under warranty, then merely opening the unit can void that warranty. However, if going inside the computer to make additions and changes doesn't scare you, maybe you should consider building an all-in-one computer from a kit. One of the few such computers is the Heathkit *H-89* (also available fully assembled from Zenith as the *Z-89*). That computer is shown in Fig. 2.

A further question arises as to the ultimate expandability of the system. If you opt for an all-in-one system, you may not be able to add more RAM, or output ports or disk drives, and you may not have access to the system bus. If you opt for an all-in-one system, be sure there is at least an expansion box or some other potential for expansion.

We should mention that even if the manufacturer does not offer expansion options, other companies may. Those options usually require going inside the computer to make additions and/or changes, especially in all-in-one systems.

Another important consideration is the operating system that the computer uses and the software that's available to run under that system. If you opted for the Radio Shack unit, you would get a disk operating system called *TRSDOS* (pronounced "triss-dos"). It supports a large library of Radio Shack programs, as well as programs from outside sources. Other operating systems are available which expand on *TRSDOS*' capabilities, but still allow you to run most *TRSDOS*-compatible programs.

If you want even more flexibility in your choice of software, though, you should consider a disk operating system called CP/M. It is especially valuable if you are going to be using your computer for business purposes, for the amount of "serious" software available to run under CP/M is enormous. To run CP/M on a Radio Shack computer, though, you have to make some hardware modifications. CP/M can be run on most computers, but many of them require considerable reworking, and the conversion can become expensive.

The CRT display must also be considered. The one supplied with the system will probably be more than adequate for the first-time microcomputer user. But, after a while, if you want to use any sort of graphics, you may find the resolution of the display too limited for the task. With an all-in-one system, you could be locked into a situation where there are no options because the CRT is built into the cabinet. The same is true if you want a different type of display (or just want to move the one you have—see Fig. 3). For instance, it has been found that a black-and-white display is more fatiguing to use over a long period than a green or amber one. But, changing a black-and-white display to one of the others cannot be done reasonably unless a replacement is offered by the manufacturer. One alternative is a colored plastic shield that will change the color of the display; unfortunately, it will also cut down on its visibility.

Despite its limitations, though, the all-in-one computer is still a viable option for many.

Component computer-systems

The heart of a component system is a system box that houses the CPU, RAM, and—possibly—disk drives, and has built-in card slots for easy expandability. The keyboard and CRT are separate, although the two may be combined into one unit. The biggest advantage that component systems have over all-in-one systems is flexibility—the ability to upgrade or modify the system easily.

Although you may think of a system such as the IBM *Personal Computer* (see Fig. 4) as being at the mid-to-upper end of the microcomputer scale, a prudent buyer can put together a system that isn't very much more expensive than many all-in-one microcomputers.

The first building block in the IBM system is the system unit. In its simplest form, that box houses the 8088 16-bit microprocessor and 16K of RAM. It contains no disk drives, but has a built-in port for connecting a cassette recorder for data storage. The unit also features space for two drives, and for up to five IBM-compatible cards (for memory expansion, various types of video displays, etc.). A separate keyboard is also included in the basic configuration, but a CRT is not. A user has the option of using his own television set (through the addition of an RF modulator) or he can opt for any of the monochrome or color monitors on the market.

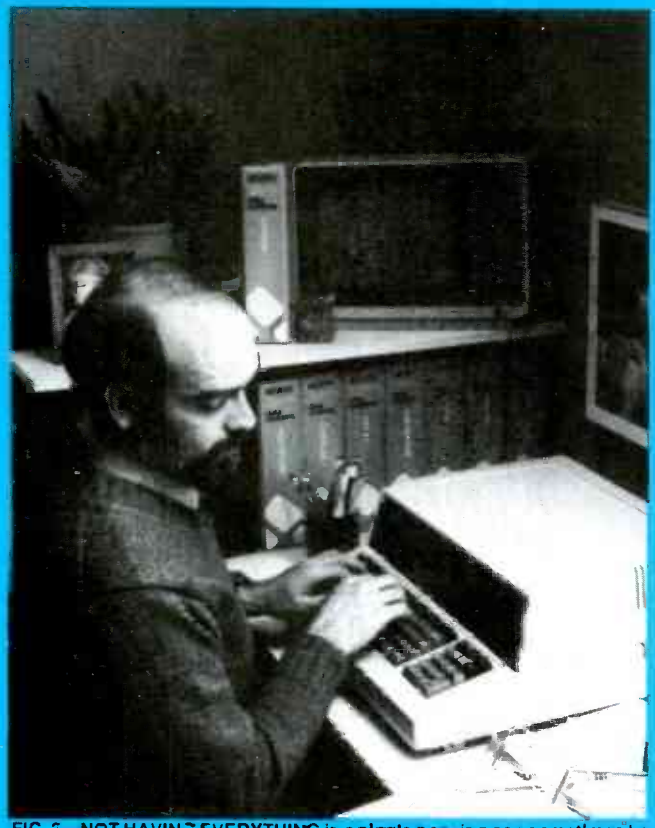


FIG. 3—NOT HAVING EVERYTHING in a single housing can sometimes be an advantage.

FIG. 4—THE IBM PERSONAL COMPUTER is a component-type system that can use a standard TV for display.

In its basic configuration, the IBM *Personal Computer* can be purchased for a little over $1250. However, you may soon find the basic configuration limiting. Your first move will probably be to add more RAM, bringing the total system RAM up to 80K. That requires an investment of only about $150. In that configuration, the computer becomes far more flexible, and capable of running sophisticated programs.

At the same time, you may also find cassette storage restrictive, and may want to add a disk drive or two for mass storage (see the discussion of disk drives elsewhere in this section). One drive and a controller card for it will cost about $420 and, with careful shopping, a second drive can be added for as little as $250. The disk operating system and BASIC bring the total cost of the system up to about $2110, but it now consists of 80K of RAM, a disk-controller card (which can support up to four drives, as can the Radio Shack TRS-80), and two double-sided, double-density disk drives, for a total external storage-capacity of 640K.

Still lacking at this point is a communications option. The computer package has yet to include either a parallel printer-port or an asychronous (serial) communications port. Often—but not always—an all-in-one microcomputer will include those ports as part of the package. Adding them to the IBM component-system will increase its cost by about $480 (bringing the total to $2550), but they will also increase the functionality and flexibility of the system tremendously. And the system box will still have two slots available for other add-on cards (the disk-controller card and both port cards are plugged directly into the main system-board).

There is still something missing from the picture—a computer-grade CRT capable of displaying high-level graphics; the user is still tied to his RF modulator and television set. Fortunately, the video interface has already been taken care of—the parallel printer-port board also contains a monochrome-display interface. That saves you from tying up an extra slot on the motherboard. Monochrome (black-and-white—or -green, or -amber) monitors—capable of delivering high-quality displays—are available for as little as $95. (You can also pay $350 for the IBM-compatible unit, which sports one of the best displays in the business.)

You might want to change the configuration of the computer to include high-level color graphics capability by adding a $499 color-graphics monitor/printer interface instead of the $350 monochrome/printer interface. That would raise the cost of the system to the $2800 to $3150 range. Of course, a quality color-monitor will further increase the cost of the system. In fact, depending on the type chosen, a color monitor can add from nearly $300 to $1,000 to the price of the system.

Further considerations

While an all-in-one system offers convenience, it does so at the expense of flexibility.

Consider this: in the two examples we've just given, the owner of the component-type of system still has further slots left for other functions to increase his system's versatility. You can add a game-controller card for computer-game use, and still have another slot available for memory expansion. It must be admitted that game-controller access is built into many all-in-one systems, but if it isn't, then you must find out whether you can add one to your system, and whether and where the add-on is available.

Each type of system has its attractions and advantages, but the component or building-block system seems to offer much more flexibility—and the differential in price over the all-in-one type isn't all that great. Component systems can be found in all price ranges, ranging from Commodore's *VIC-20* to the Apple series, and on to the IBM and S-100-bus computers. In fact, just about all of the new generation 16-bit microcomputers are appearing as component-type systems.

Portable computers

There is a special type of all-in-one system that does merit a

look from the business-oriented user who wants to keep costs down, but also wants a great deal of performance from the start—the portable.

The portable-computer trend was started by author and microcomputer-industry pioneer Adam Osborne, who launched the *Osborne I* portable computer nearly two years ago. That computer, shown in Fig. 5, comes with standard features that include 64K of RAM, dual disk-drives, a Z80 microprocessor, the CP/M operating system, a full ASCII keyboard, a built-in miniature black-and-white CRT, and CP/M-based software that includes word processing, a spreadsheet program, the CBASIC programming language and, of course, CP/M and its utilities. All of that could be purchased for the unheard-of price of $1795. (The computer's capabilities have recently been increased through the addition of double-density drives and the inclusion of a data-base program in the software package, but the price has remained unchanged.)

When the computer was announced, industry skeptics said the concept would never get off the ground. But Osborne proved them wrong. His system took off, and his California manufacturing facilities were stretched to the limit. The business community knew a bargain when it saw one, and leaped at it...as did many serious home-computer users.

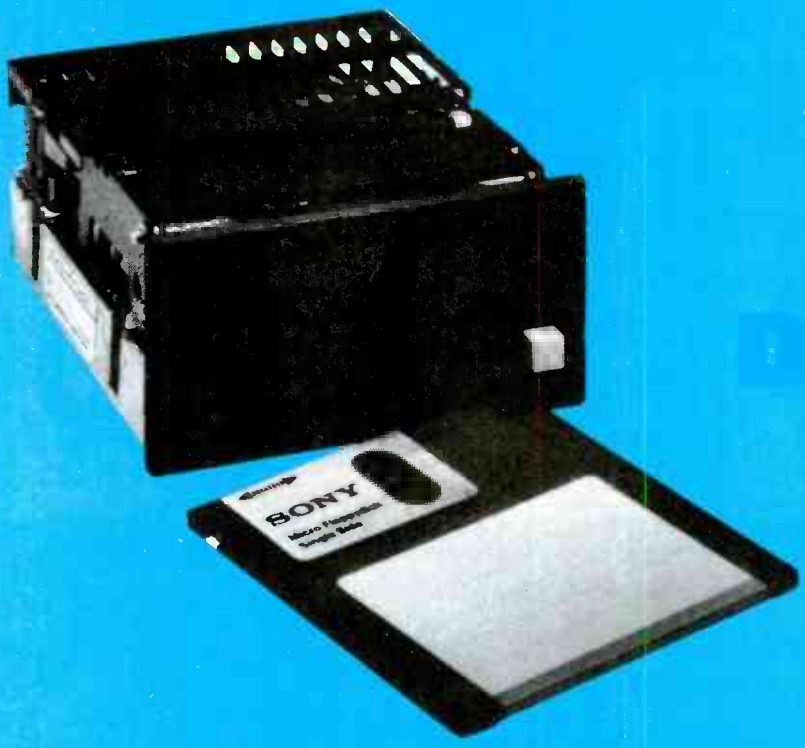
The system is powerful not only in its own capabilities, but also in its ability to allow the user to access remote data-bases via a built-in serial port. About the only item detracting from the appeal of this portable personal computer is its tiny, five-inch display with its limited display-width—while it can display the industry-standard 24 lines, it's limited to a width of 52 columns; you have to scroll the display sideways to access the full 80-column work area. The size problem can be overcome by using an optional external display, and Osborne is, reportedly, making an 80-column-display feature available.

FIG. 5—THE PORTABLE COMPUTER is growing popular among both business users and home-computer users. Shown here is the *Osborne I.*

Which is for you?

If you are considering the purchase of a microcomputer, which way should you turn? The question really revolves around what you want to do with your system. If it is to be used for casual purposes and game-playing, then any of the inexpensive color microcomputers on the market—whether component-type or all-in-one—should fill the bill. If, on the other hand, you want more power and don't want the inconvenience of piecing the system together, then an all-in-one (or, perhaps a powerful, yet still inexpensive portable computer) is the way to go. If, though, you want the ability to tailor a system precisely to your needs, then a component system is your best bet. **R-E**

Radio Electronics YOUR OWN Computer APRIL 1983



Disk Drives

An invaluable peripheral for the serious computer-user is a disk-drive system for program and data storage. Here's a look at the more popular types, and a discussion of how they work.

MARC STERN

TODAY'S MICROCOMPUTERS ARE TRULY POWERFUL DEVICES. Many come with 64K (64,000 bytes) of RAM as "standard equipment." (In the old days, 4K was *a lot*!) RAM (*R*andom *A*ccess *M*emory) is the part of the computer that holds programs and data when they are in use. In it, data can be manipulated and modified almost instantaneously.

RAM has a serious drawback, though—it needs power to retain its contents. If the computer is turned off, those contents are lost, disappearing forever into the proverbial "bit bucket." Such storage is termed *volatile*, and if you want to retain its contents, you must keep the computer on 24-hours-a-day—not an inexpensive proposition.

There are nonvolatile types of semiconductor memory such as ROM's (*R*ead *O*nly *M*emories) and EPROM's (*E*raseable *P*rogrammable ROM's), but they are intended to be programmed once, and their contents left unchanged afterward. Because of that, and their relatively small capacity and high cost, such IC's are used for programs that will be used again and again without modification, like the computer's operating system or a built-in BASIC language.

What's the alternative for long-term data and program storage? Ideally, it should be fast, reusable, and fairly inexpensive. Fortunately, magnetic media—tape and disks—meet those criteria.

Tape vs. disk

Back in the early days, personal computer users relied on cassette tapes for storage. They could use readily available equipment, and the storage medium was very inexpensive and fairly reliable. Disks, at the time, were an expensive luxury.

But, those early users soon found that tape had several shortcomings. First, because the data was stored serially, one bit after the other, it was necessary to read all the information on a tape until the material that was desired was located; there was no easy way to tell where on the tape that material was. If a program were stored at the end of a tape, all the programs preceding it had to be looked at by the system before the one that was wanted was accessed. If a C-60 cassette were used, that process could take almost half an hour.

Using tape for mass-storage for personal computers also had another drawback, and that was speed. Typically, the data-transfer rate for tape is about 30 to 150 characters-per-second or about 300 to 1500 baud (bits-per-second). Thus, loading a 10K program into the computer required over five minutes.

So, it's evident that using cassette tape—even though it has a potential for about 500K of storage (on one side of a C-60 cassette) isn't very efficient.

To illustrate that another way, suppose you had a database consisting of names and addresses, and you wanted to access a particular name. If that name were stored somewhere near the end of the tape, it could take as long as 30 minutes to find it. In addition, if you wanted to add even just one more item to the database, you would have to re-record *all* the records.

Contrast that with the capabilities of a floppy disk, now an affordable and commonly used mass-storage device. It can access data at random, and its transfer rate is much faster than that of tape.

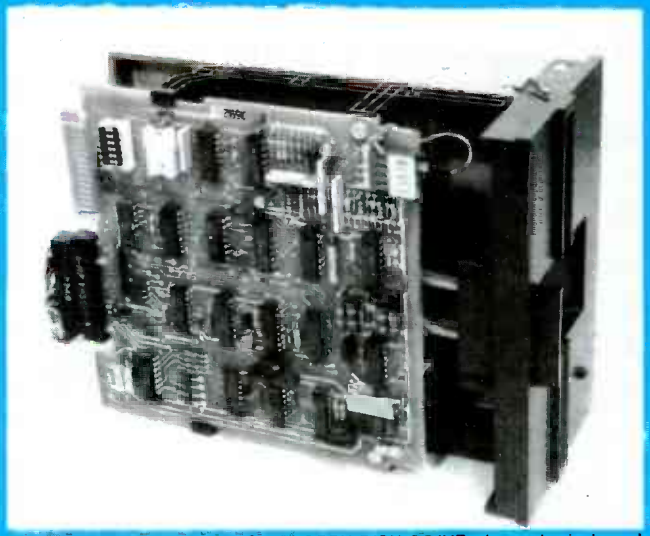
Using the address database as an example, instead of waiting half an hour to locate a particular address, the floppy can access the information in as little time as a second.

And, since the transfer rate for information is so high, instead of spending five minutes loading a program into RAM from tape, the same program can be loaded from disk in a matter of seconds.

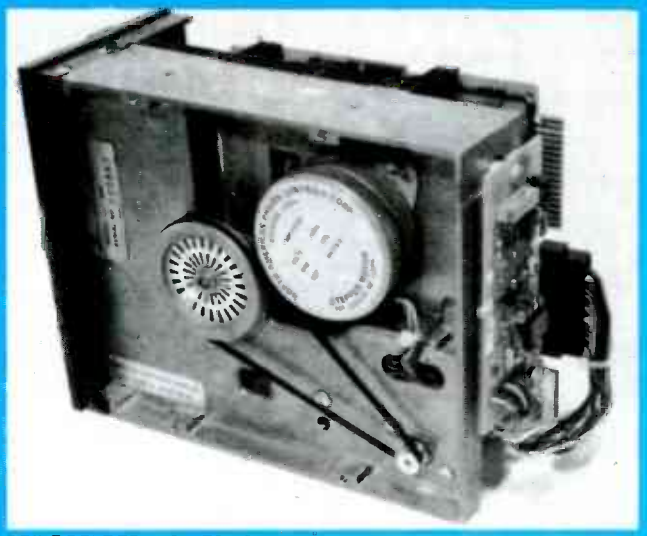
The most popular storage medium for microcomputers today is the floppy disk. Floppy disks are available in two sizes: 8-inch and 5¼-inch minifloppies.

Disk formats

Floppy disks are available in a variety of formats. Those formats include single-sided, single-density; single-sided, double-density; and double-sided, double-density. The densities refer how tightly the data is packed on a disk. You can store data on one side of a single-sided disk and on both sides of a double-sided one. Thus, a single-sided, single-density minifloppy can store about 92K of information, while a single-sided double-density one can store about twice that amount. The number doubles again for a double-sided, double-density disk. Thus a single-sided, double-density minifloppy can store about 180K of information, while that figure increases to as much as



INTERIOR VIEW OF 5¼-INCH FLOPPY-DISK DRIVE shows logic board mounted over read/write head assembly.



DRIVE BELT TRANSMITS POWER from motor to assembly that spins disk. Large round stepper motor controls motion of read/write head.

360K for a double-sided one. Because of their size, 8-inch disks have about twice the capacity of their 5¼-inch relatives.

Perhaps the limiting factor in the density situation is the way the disk is formatted (more about that later). Formatting refers to the way the tracks on the disk are set up when the disk or minifloppy disk is configured to work with a particular system. Thus, even though a diskette manufacturer may claim that his product has up to 128K of space available for storage, in reality, that space is limited to about 92K after formatting, if it is a single-sided, single-density disk. Bear that point in mind when you shop for a disk system—make sure that the storage capacity quoted you is the capacity after formatting.

Disk structure

Let's look more closely at the disk system for a clearer understanding of the way it works.

Floppy disks were an invention of the late 1960's when IBM sought to replace keypunch cards. Because they were flexible and easily bent, they were termed "floppy."

A floppy disk is a .003-inch-thick Mylar disk, covered with a coating of magnetic oxides. In that respect, it is much like an audio tape. The disk is sealed inside a protective jacket, which has several windows cut in it. The jacket also contains a lubricant so the disk rotates freely.

The disk revolves inside its protective jacket at a speed of 300 rpm for a minifloppy, and 360 rpm for an 8-incher.

The units in which the disks work—the drives—resemble file drawers with slots to insert the disks, and doors that close over the slots. Inside, along with other parts we'll discuss shortly, are the read/write heads that access and deposit the data on the disks. During recording or reading, those heads make light contact with the surface of the disk; and when they are not in use, the heads are usually lifted away from the disks to reduce wear and tear.

One of the windows in the disk jacket is a slot that allows the read/write head to make contact with the disk. There is also a large center hole that allows the drive spindles to grip the disk and it to spin. To the right of the center hole is a smaller *index hole* that provides timing information, and at the edge of the disk is a *write-protect notch*. The purpose of that notch is to allow the user to protect the information on the disk from being accidentally written over or erased. A small self-adhesive tab is used to cover the notch. In the case of 5¼-inch disks, when the notch is covered, the disk is write-protected and when it's exposed, data can be recorded on it. On 8-inch disks, the reverse is true.

A disk is covered with magnetic tracks, arranged in concentric circles. To read or write data from or to the disk, a magnetic-sensitive head is placed over a track while the disk rotates. The head senses the changing magnetic states it finds on the disk, and that information is then translated into electrical pulses representing logic-1 or logic-0 states. When it writes to the disk, the head changes the magnetic state of the disk's surface to represent the logic-level signals from the computer.

The number of tracks on a disk varies with the format the microcomputer manufacturer uses. An 8-inch disk will usually have from 77 to 80 tracks, and a 5¼-inch disk will usually have from 36 to 40 tracks.

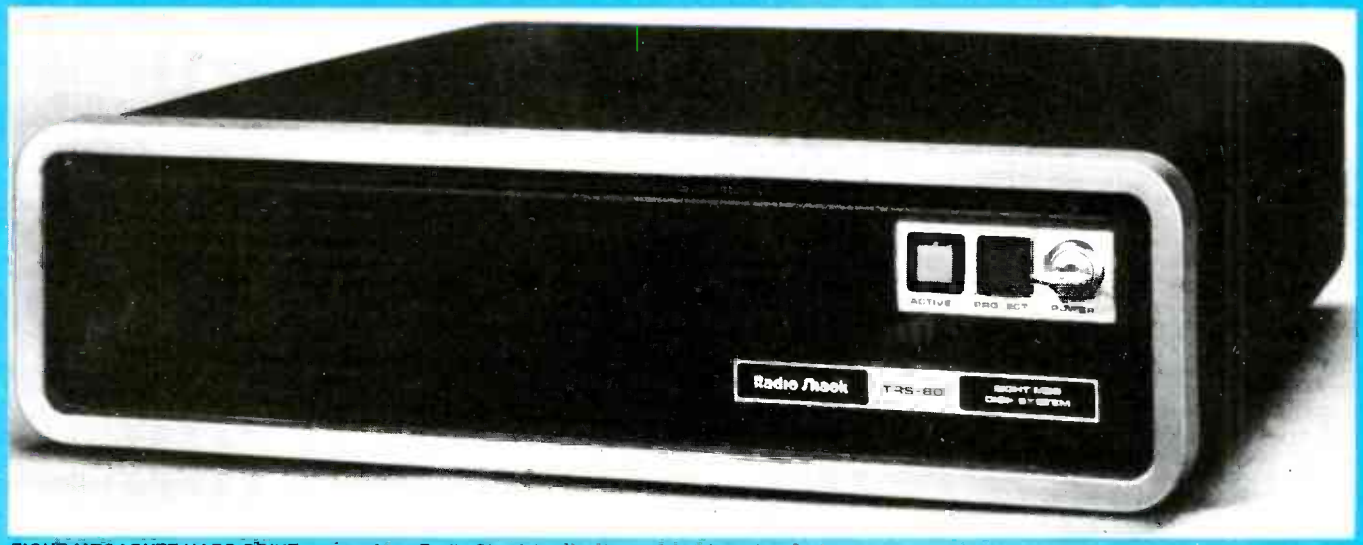
Using concentric tracks is very convenient for speedy operation, but if only one file per track were kept, it would be very inefficient. That's because, if one file were assigned per track, it would mean that a short file would leave a large amount of disk space unused. On the other hand, another file might fill up one track and still be large enough to require space on another; most of that second track could also be wasted.

To avoid that sort of problem, each track is divided into units called *sectors*, and data is written to or read from those sectors. On an 8-inch disk, there are 26 sectors per track, while on a 5¼-inch disk, there may be as few as 10 or as many as 16 or more—it depends on the manner in which the microcomputer's manufacturer chooses to handle its disk formatting. Each sector holds 128 bytes, or 1,024 bits, of information. There are, potentially, 2002 sectors available for data storage on a standard 8-inch, single-sided, single-density disk, while there are from 400 to 600 (or more) sectors available on the average single-sided, single-density 5¼-inch minifloppy.

That arrangement makes data storage and handling much easier for the microcomputer and the read/write head. A directory is automatically maintained on the disk, indicating where everything is stored, and where it is possible to place and locate data quickly and accurately.

Keeping track of the data, though, brings another element into the picture: *hard-* or *soft-sectoring*. As mentioned earlier, every disk contains an index hole. It is that hole which determines the timing for proper data access by identifying the starting spot on the disk. On a soft-sectored disk, there is one index hole, and specific sector locations are identified by information contained on the disk. As mentioned earlier, the added storage requirement for the sectoring information reduces the amount of space available for information storage.

The picture changes with a hard-sectored disk. It, too, contains a master index hole, but there are also other holes (which are also visible in the index hole cutout in the disk jacket). They are index markers, or *sector holes*, and may number from 10 to 16 (32 on an 8-inch disk). Their presence means that less timing information has to be stored on the disk, and that frees about 25 percent more space for storage. Since they are exactly spaced, the *sector holes* are able to provide the tight timing-information needed to indicate the exact start spot on the disk.



EIGHT-MEGABYTE HARD DRIVE system from Radio Shack is completely sealed and inaccessible to user.

Format compatibility

Disks made by one system will not necessarily—even if they are the same size and use the same sectoring method—work on another. There are a number of format considerations to be taken into account.

Since format compatibility is so important, let's take a closer look at it. In the 8-inch-drive world, there is at least an industry standard to which most microcomputer makers conform: the IBM 3470 standard, which calls for 77 tracks and 26 sectors, with soft sectoring. Recording density is 3408 bits-per-inch. Unfortunately, no such standard exists for 5¼-inch minifloppies.

For the moment, though, let's look at the 3470 standard. The tracks are numbered from the outer edge of the disk, beginning with 00 and ending with 76, at the innermost edge. As noted earlier, there are 2002 sectors on the disk; each of those sectors is divided into four parts. The first identifies the sector and track number, while the second contains the data. In between these two sections are two *interrecord gaps*.

The identification and data parts of the sectors are broken down even farther, and contain pulses used to synchronize the controller circuitry and to compensate for variations in the rotational speed of the disk. Also contained in them are error-checking bits to permit the controller circuitry to recognize an error, should one occur.

The sectoring information isn't usually contained on a disk when you first take it out of the box. Instead, you have a non-magnetized blank, which must be inserted into the disk drive so the tracks and sectors can be defined. That process is called *formatting* or *initializing*, and a program run by the computer initiates the process using the index hole as a marker. During the formatting process, the disk loses a considerable amount of its storage potential. Thus, a disk which may hold 400K unformatted will only hold about 256K when it's formatted.

In its formatted state, the disk is ready for use by the system. To record data on a single-density disk, frequency modulation (FM) is used. In addition, a 250-kHz clock generator produces pulses every 4 microseconds (ms) that form the data cells on the surface of the disk. If, during the interval between two pulses, data is written to disk, a logic-1 will be recorded at that spot on the disk. The magnetic state of that minute area is changed. If, however, no data appears, the disk oxide material remains unchanged and it will appear to the system as a logic-0.

When the disk is read, if a magnetic change has taken place where there was a data bit written on the disk, not only does the 250-kHz clock pulse register, but so does the data pulse, and the system sees two pulses, which it translates to a logic-1. If the system sees only the clock pulse, then it translates it to a logic-0.

Double-density recording requires another method: MFM, or *M*odified *FM* encoding. Rather than using a constant clock-pulse, many of the pulses are removed and appear only at certain intervals. That frees far more space for data, since only one pulse is used to indicate a logic-1 and none indicates a logic-0. It must be noted that the drive-controller circuitry has to become far more sophisticated to handle that type of encoding.

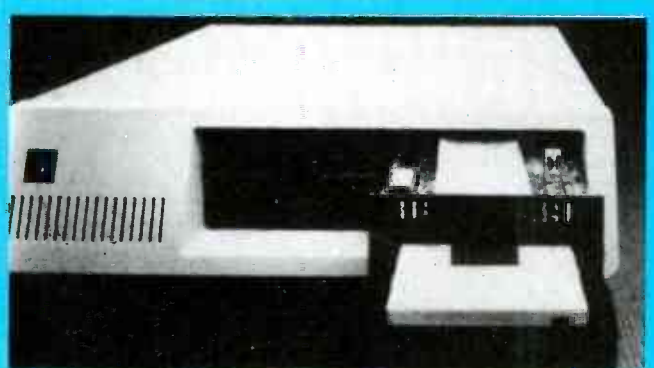
Double-sided, double-density recording uses the same type of arrangement, but adds another read/write head so the system can read and write to both sides of the disk.

Access time is defined as the time it takes the drive to access a piece of data chosen at random. (It is generally calculated as half the slowest, or worst-case, access time.) That figure, in turn, depends on how long it takes for the head to arrive at the proper track, and how long it has to wait for the proper sector to arrive beneath it. The time it takes for the drive to arrive at a track is termed the *track-to-track seek time*, and the time it takes for the proper sector to reach the head is known as the *latency time*.

Latency time is derived by measuring the interval between the time when the read/write head arrives at the proper track just as the proper sector has passed by, and the time when the beginning of the sector passes beneath the head. That, in general, requires a full disk rotation.

Generally, track-to-track seek time varies from 3 to 15 ms for an 8-inch drive, and from 6 to 30 ms for a 5¼-inch drive. Latency time is in the 85-ms range for an 8-inch drives, and is about 100 ms for a minifloppy. Total access-time ranges is about 100 ms for an 8-inch drive, and is about 300–400 ms for a 5¼-inch drive.

Also important is the *data-transfer rate*. That is the rate at which data is read or written from or to the disk. The higher the transfer rate, the quicker the data is fed into the system and the more efficient it is. That rate is on the order of 125–250



WINCHESTER DRIVE FOR IBM PC from TecMar takes the places of standard 5¼-inch minifloppy. Removable cartridge can hold five megabytes.

PARTIAL LIST OF DISK-DRIVE MANUFACTURERS AND SUPPLIERS

Amdek Corp.
2201 Lively Blvd.
Elk Grove Village, IL 60007

Apparat Inc.
4401 South Tamarak Pkwy.
Denver, CO 80237

Apple Computer Inc.
20525 Mariani Ave.
Cupertino, CA 95014

Atasi Corp.
235 Charcot Ave.
San Jose, CA 95131

Commodore Business Machines
487 Devon Park Rd.
Wayne, PA 19087

CompuPro Division
Godbout Electronics
Box 2355
Oakland Airport, CA 94614

Corvus Systems
2029 O'Toole Ave.
San Jose, CA 95131

Cybernetics Inc.
8041 Newman Ave.
Suite 208
Huntington Beach, CA 92647

Data Peripherals
965 Stewart Dr.
Sunnyvale, CA 94086

Davong Systems
1061 Terra Bella Ave.
Mountain View, CA 94043

Digital Equipment Corp.
Parker Street
Maynard, MA 01752

Evotek
1220 Page Ave.
Fremont, CA 94538

Genie Computer Corp.
31125 Via Colinas #908
Westlake Village, CA 91362

Heath Company
Benton Harbor, MI 49022

Irwin International
2000 Green Rd.
Ann Arbor, MI 48105

Laredo Systems
2264 Calle DeLuna
Santa Clara, CA 95050

Lobo Drives International
935 Camino Del Sur
Goeleta, CA 90317

Magnolia Microsystems
2812 Thorndyke Avenue West
Seattle, WA 98199

Micropolis Corp.
21329 Nordhoff St.
Chatsworth, CA 91311

Micro-Sci
2158 South Hathaway St.
Santa Ana, CA 92705

MiniScribe Corp.
410 S. Sunset
Longmont, CO 80501

Morrow Designs
600 McCormick St.
San Leandro, CA 94577

PDS Universal Inc.
2630 Walnut Ave. Suite G
Tustin, CA 92680

Percom Data Co., Inc.
11220 Pagemill Rd.
Dallas, TX 75243

Priam Corp.
3096 Orchard Dr.
San Jose, CA 95134

Quantum Corp.
448 Whitehead Rd.
Box 5141
Trenton, N.J. 08619

Qume Corp.
2350 Qume Dr.
San Jose, CA 95131

Radio Shack
One Tandy Center
Ft. Worth, TX 76102

Rana Systems
20620 Leapwood Avenue
Carson, CA 90746

Rotating Memory Systems
1701 McCarthy Blvd.
Milpitas, CA 95035

Seagate Technology
360 El Pueblo Rd.
Scotts Valley, CA 95066

Shugart Assoc.
475 Oakmead Pkwy.
Sunnyvale, CA 94086

Sony Corp.
7 Mercedes Dr.
Montvale, NJ 07645
(micro-floppy disk)

Syquist Technology
44160 Warm Springs Blvd.
Fremont, CA 94538

Tallgrass Technologies Corp.
9207 Cody
Overland Park, KA 66214

Tandon Corp.
20320 Prairie St.
Chatsworth, CA 91311

Tarbell Electronics
950 Dovlen Pl., Suite B
Carson, CA. 90746

Tecmar Personal Computer Products
23600 Mercantile Rd.
Cleveland, OH 44122

Vista Computer
1401 Borchard St.
Santa Ana, CA 92705

Xcomp
7566 Trade St.
San Diego, CA 92121

Xebec
432 Lakeside Dr.
Sunnyvale, CA 94086

Xiten Systems
16815 Hawthorne Blvd.
Lawndale, CA 90260

kilobytes-per-second for a minifloppy (depending on density) and about 250 kilobytes-per-second for an 8-inch disk (500 kilobytes-per-second, double density).

The rest of the system

There are, of course, more parts to the floppy-disk system than just the disk and drive itself. The most important of them are the disk controller and the disk operating-system, which is actually a piece of software.

The disk controller has responsibility for determining head position and sector identification, for disk-motor control, for head loading and unloading, for error detection and correction, and for controlling the data transfer to the interface circuits between the disk and the computer. The disk-controller is usually on a board separate from the computer's main board(s).

The DOS, or *D*isk *O*perating *S*ystem which, by the way, is usually loaded from the first tracks (known as the *system tracks*) of a floppy disk, is actually the manager of the microsystem. It controls data and program transfer between the computer and the disks, and also handles file management, labeling, editing, error detection, and copying.

The DOS is always the first program loaded into the computer from the disk, and its loading is handled by a ROM-based routine called the *bootstrap loader*. Actually, the short bootstrap-loader in ROM loads in a longer loader program from the disk, and *that* loads in the DOS. The process is akin to hoisting oneself by his own bootstraps, and is thus known as "booting the system" or "booting the disk."

Microfloppies

There are types of disks other than floppies. We'll look at two of them here: microfloppies and Winchesters.

One of the most recent developments in disk technology is the *microfloppy*. Microfloppies come in several sizes, ranging from a little over three- to a little under four-inches in diameter. They are basically the same as floppy or minifloppy disks, except for their small size and the fact that, instead of using a flexible protective covering, they are encased in a hard, plastic covering. That plastic shell contains what looks like a sliding door, and, indeed it is. It covers the disk-access notch through which the read/write head contacts the disk surface. When the disk is inserted into its drive, the door retracts so the head can contact the disk. It closes automatically when it is removed. That prevents the delicate disk-surface from contamination by skin oils or particulate matter in the air (like smoke or dust) that can cause the disk to "crash."

Operating at about the same speed as 5¼-inch minifloppies, microfloppies are capable of great data densities. Dense-packing techniques allow a microfloppy to store nearly 500K of data on its surface. The recording technique is similar to that used for double-sided, double-density media, except that the tracks are much closer together.

The potential for miniaturization offered by this medium is of great importance. With 3.5-inch drives occupying about half the space taken by a pair of minifloppies, it is possible to design microcomputers that are even smaller than they are now.

One disadvantage of microfloppies at present is that the drives are not yet available in great quantities. Another, and more serious problem is that the industry has yet to settle on a microfloppy standard.

Winchesters

There is a growing trend toward storage on *Winchester* drives. The concept, first developed by IBM in 1973, was originally aimed at the mainframe market. The early hard disks, code-named "Winchester," were 14 inches in diameter. But, they soon began to shrink toward 8 inches, and eventually to 5¼ inches. The 5¼-inch Winchester has become quite important in the last year or so.

The beauty of Winchester disks is the amount of data they can hold. Even the small ones are capable of storing 10 megabytes, and there is a race on now to increase that figure. In fact, in the next couple of years it is likely that disks that size will have capacities of 20, or even 30, megabytes.

That storage capacity comes at a price: Mini-Winchesters are about four to nine times more expensive than comparably sized double-sided, double-density minifloppies. Their prices range from about $1400 to $2000.

A hard disk like the Winchester differs radically from a minifloppy in the way it is constructed, although not in its basic data-storage function.

The control circuitry is much like that used for the minifloppy and, in fact, Winchester drives are usually pin-for-pin compatible with 5¼-inch minifloppies.

The hard disk is made of metal, polished to mirror brightness. Like a floppy, it is coated with a layer of oxides for recording, but it may spin at speeds of up to 3500 rpm. Dense data-packing and track-packing techniques allow the high information densities of which Winchesters are capable.

Mechanically, a Winchester is as unlike a floppy or minifloppy as day is from night. The disk and read/write head are enclosed in a rigid sealed housing; they're safe from contamination or damage by human hands. Also, the read write head never touches the surface of the disk; instead it floats on a cushion of air just microns above the surface of the disk, much like a ground-effect vehicle. That planing action is made possible by the high rotational speed of the disk. Even though it is not in contact with it, the sensitive head can still sense the changes in the magnetic state of the disk.

Because of the tight tolerances under which Winchester drives operate, the enclosure must be dirt-free. Thus, air is drawn into it by a fan through a filter and is then circulated. That also helps keep the heat level down; heat is one of the primary enemies of the hard disk.

To give an indication of the speed of the drive—data access and display seem almost instantaneous—the access time is 30 to 50 ms. (On some older models, access time is on the order of 100 ms.) That may seem slow, but it must be considered that the disks contain 800 to 900 tracks of information.

While the storage potential of hard disk drives is awesome, so are some of their inherent drawbacks. First comes the problem of backup copies. They are especially important for hard disks, where a head crash against the disk can ruin the entire data field. The most logical method for backing up data is with a floppy disk, but even with one-megabyte 8-inch disks, it can take 20 disks to backup a 20-megabyte hard-disk drive. That's not only time-consuming, but also expensive. If you use minifloppies, even more disks are needed.

An alternative is called the *streaming tape-drive*, which can copy 20 megabytes in as little as a minute. A high-speed tape unit, it is actually a huge, continuously moving data cassette. Its primary drawback is its expense.

An exciting alternative is the removable-cartridge Winchester disk. A fairly recent development, in that type of unit the disks are encased in plastic housings and can be removed and stored. It's a good idea, and makes the hard disk much like the minifloppy in flexibility.

Winchesters are also susceptible to shock and vibration. Although most companies ruggedize their units as much as possible, it is still possible for jarring or bumping to cause the head to smash into, and destroy, the disk surface. Excess vibration can also be a potential cause of data errors.

One recent development, which emphasizes the trend toward miniaturization, is the 3.9-inch hard disk. Packaged to be half the height of standard 5¼-inch units, two of those drives can fit in the space taken by one standard drive. The units contain removable disk-cartridges.

Some considerations

Whatever decisions you may make in choosing a mass storage device, there are some caveats that should be remembered. First, try to determine your future expansion requirements. Don't buy a 92K single-density drive when you know you will need far more storage space in the near future. A good starting point is a double-sided, double-density 320K 5¼-inch drive. An 8-inch drive is the choice if your data storage needs are higher. You can get nearly a megabyte of data on a double-sided, double-density 8-inch disk. If you can afford two drives, so much the better. Not only will you double your storage capacity, but you will find making backup copies much simpler and faster.

Make sure the disk-system is compatible with your computer, and can easily be interfaced with it. It makes no sense to buy an inexpensive disk only to be faced with the monumental task of interfacing it. The result will be a "kluge," and may require a great deal of original software— written either by yourself, or by someone you have to pay to write it for you.

The manufacturer should be one who has been in business for a time, and has established a good reputation. Choose a company that supports its customers and provides a good warranty.

Once you have purchased the drives, remember to back up all your key program and data disks. When you purchase a new piece of software, make a copy of it *immediately*. Use the copy, and lock up the original in a safe place.

Although the average life of a disk is about two years, it is possible for a disk or program to fail because of mishandling. It pays not only to back up your work and programs, but also to handle your disks properly. Keep them away from dirt and cigarette smoke, and keep them at a constant temperature. A separate room for your computer is advisable.

If you take those precautions, you should get long life and good reliability from whatever drives you purchase. **R-E**

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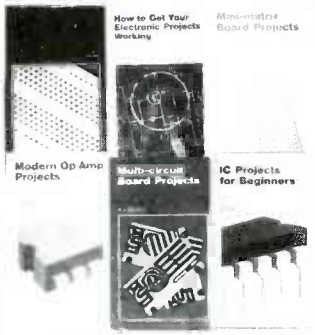

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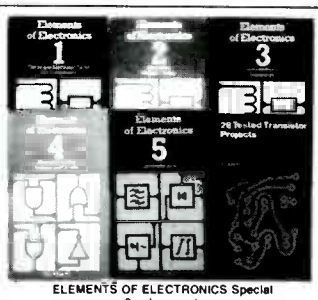

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Printers

One of the first accessories for your computer that you'll find yourself looking for is a printer. Here's some help to make knowing what to look for—and making a choice—easier.

MARC STERN

AT SOME POINT IN THE LIFE OF EVERY MICROCOMPUTER OWNER there comes a time when he needs a permanent record of what he sees on his display screen. It doesn't matter whether it's a copy of a favorite program, budget or financial data, or a letter—the printout is needed. That usually comes about the time he realizes that he's severely limiting the usefulness of his system without some sort of printing device. After all, there's just so much one can do with a CRT display as the sole output device.

Faced with this situation, there's only one thing the microcomputer owner can do; he must begin the quest for some sort of computer printer. For the veteran computerist, the task is fairly easy. He knows what he wants and sets out to get it. The novice, however, faces a bewildering array of choices—and of terminology.

Almost at once he's confronted with the need to become an expert at deciphering such terms as *bidirectional, impact, dot-matrix, pin feed, tractor feed, KSR, RO, serial, parallel, graphics, thermal,* and the like. To him, it must seem as though the list goes on forever, but it really doesn't. In fact, with a bit of study the novice can become as knowledgable as the longtime computer veteran.

Where should that study begin? Perhaps it's best to start with a simple description of the types of printers available and a glossary of terms.

Inside a printer

In general, a printer is made up of several parts: the printhead, printing mechanism, platen, and the paper-feed mechanism. Those parts are shown in Fig. 1. The **printhead** is what actually makes the impression that forms the letter that appears on the paper. It can be a typewriter-like type bar—or its functional equivalent—or it can consist of a number of wires that are electronically programmed to reproduce the letter in the form of a matrix of closely spaced dots.

The **printing mechanism** is the whole mechanical or electromechanical assembly that drives the printhead. Many print mechanisms are **bidirectional**. That is, they print from left to right *and* from right to left. The result is a greater output rate. When it reaches the end of a line, the printer "looks ahead" to see how long the next line will be. If that line is long enough, instead of performing a carriage return and starting printing from the left, the printhead will simply reverse direction and print it "backwards," from the right side of the page.

The **platen** is the roller—like the one in a typewriter—against which the printhead strikes, and which may also serve as part of the **paper feed**, the mechanism used to move the paper on which the copy is printed. The paper-feed mechanism can be either **friction feed** (like the platen); **tractor feed**, where paper with a series of holes along the sides is pulled through the printer by a sprocket arrangement; or some type of **pin feed**, where small peglike pins that are part of the platen grip and pull the paper forward, always assuring perfect alignment.

If you think that sounds like a glorified electric typewriter, you're right. It's much easier to think of a printer as a typewriter without a keyboard; generally, the microcomputer provides the keyboard.

Thinking of a printer in that way does a great deal to ease some of the confusion you may face as you go about your search. However, of even more importance is our glossary—the words presented here in bold type, along with their definitions. It will help you to make sense of the terms used by a computer-store salesman or in a printer advertisement.

Types of printers

It's quite likely that at some point or another in your search you will come across the terms KSR- and RO printers. Simply put. **KSR** means *K*eyboard *S*end/*R*eceive, while **RO** means

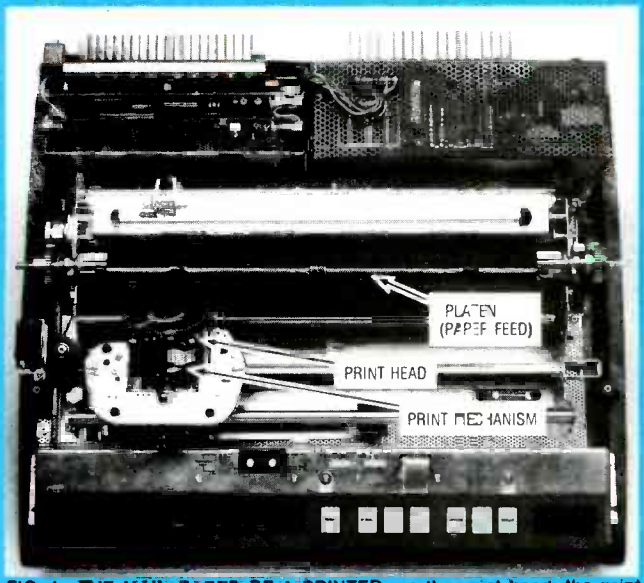

FIG. 1—THE MAIN PARTS OF A PRINTER are the print head, the print mechanism, the platen, and the paper-feed mechanism.

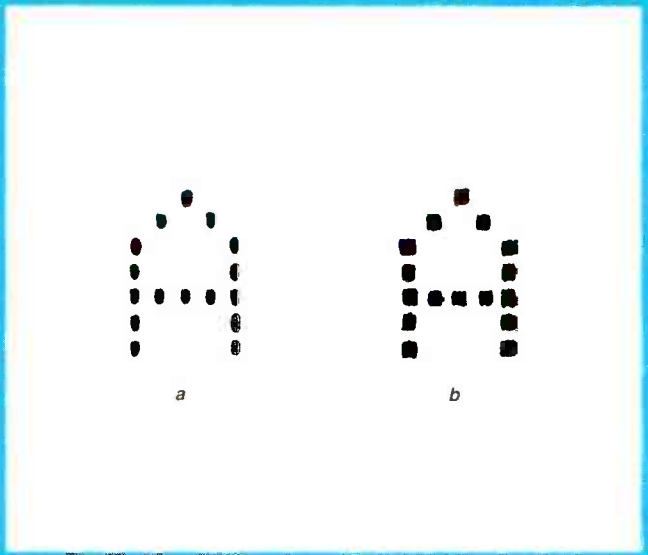

FIG. 2—DOT-MATRIX CHARACTERS (*a*) are formed by an array of pins that press against the ribbon to form an image; print offsetting can provide a much higher quality output (*b*).

*R*eceive *O*nly. If you are familiar with mainframe computers, then you probably have seen KSR's before. They are the *Teletype*-like devices used to input or request data to or from the computer. They may either be linked by a dedicated line or through a telephone modem (see the section on modems elsewhere in this supplement).

That isn't to say that's the only type of KSR device. There are compact versions available from many manufacturers that usually combine not only a printer, but also a keyboard and modem. The RO printer is like the keyboardless printer you may have seen at a friend's house. It is the printer linked to his micro and to which he sends data when he wants a printout. When he wants to send data to or through his computer, he uses the computer's keyboard.

Just as there's nothing especially mysterious about those terms, there's nothing mysterious about the terms impact and non-impact printers. Quite simply, an **impact printer** has some sort of print head that makes contact with the paper through a ribbon and forms a character. A **non-impact** printer is one that does not require the paper to be struck. It can be thermal, electrosensitive, laser, or ink jet. In that type of system, the shapes of the characters are stored in a memory, much like the one in your micro, and the characters are printed using one of the non-impact methods just mentioned.

Impact printers come in two types, dot-matrix and fully formed. A **dot-matrix** print head contains a number of pins that are driven by an electronically controlled solenoid. Those pins, in turn, are what form the actual letters by referring to character-shapes stored in the printer's memory. **Fully-formed**-character printers, on the other hand, rely on special wheels, thimbles, or balls to produce their output. The computer instructs the printer to print a letter, and the printer's control circuitry tells the print head to move that letter into position. A small hammer then strikes the letter, which contacts a ribbon, and an impression of the letter is left on the paper.

In general, non-impact printers are much quieter than their impact counterparts, although some types can be much more expensive. The reason for their quietness is that they don't use a mechanical system to form the letters on the paper. Many non-impact printers can operate at higher speeds than impact models.

The chief drawbacks of non-impact printers are that their output frequently tends to be much less legible than that of impact printers; they can only produce one copy, and they often require expensive special paper. Another drawback for the user who wants full-sized reports is the fact that many inexpensive non-impact printers are only capable of handling limited line-lengths—16 to 40 characters. Some, however, can handle 8½-inch-wide paper.

In general, non-impact printers can perform nicely for the microcomputer user who doesn't need high-quality print output. In fact, some home computer systems offer thermal or electrostatic printers as their standard printers. They are also priced relatively low. In fact, Radio Shack offers a low-cost thermal printer for as little as $129.95, although there are units that can cost upwards of $500. There are other types of non-impact printers—laser and ink-jet—but their costs are still too high for the average microcomputer user and probably will be for some time.

Dot-matrix printers

As noted, a dot-matrix printer generates patterns of dots to form a letter. The characters measure from four to seven dots horizontally by seven to nine vertically. It is that feature that defines the matrix and, in general, the greater the dot density, the better the quality of the printing. Examples of the output of a dot-matrix printer are shown in Fig. 2.

A couple of years ago, it could truthfully have been said that dot-matrix printers produced poorer-quality output than fully-formed-character ones. The situation has changed, though, with the advent of more sophisticated machines capable of print offsetting.

In normal operation a dot-matrix machine makes one pass over a line and moves on to the next. However, with **print offsetting**, the printhead makes two or more passes at each line, printing the second time in a slightly different position, and making the matrix of dots denser, as can be seen in Fig. 2-b. That feature has made the dot-matrix printer the rival of the fully-formed-character machine because it is now capable of near-letter-quality printing.

Dot-matrix characters are formed by a number of solenoid-actuated pins in the print head. The character shapes are actually stored in a character-generator ROM (*R*ead-*O*nly *M*emory) inside the printer. As the data bits arrive in the ROM, it selects the appropriate dot-pattern to create the letter, and the proper pin-solenoids are selected. The solenoids drive the printer pins forward so they make contact with a ribbon and the character is formed.

Another type of dot-matrix printer is the ribbonless printer. Instead of relying on an inked ribbon, the printer needles actually burst microdots of ink on an impregnated roll of paper. Those pin pricks produce characters directly on the paper. However, the printer paper required is much more expensive than ordinary paper.

FIG. 3—SOME DOT-MATRIX PRINTERS can produce dot-patterns exactly matching what you see on the computer's display screen. Both line graphics and more complex images can be printed.

FIG. 4—A DAISY WHEEL has one character at the end of each of its "petals." Daisy wheels commonly contain 82, 88, or 96 characters.

Graphics

As microcomputers have developed greater graphics capabilities, so have printers. It's a matter of form following function, because what good is a high-resolution graphics display on a screen if it can't be sent to a printer for output? Only a couple of years ago, the top resolution available from a personal computer was about 240 pixels (picture elements) by 240 lines. Higher resolution was reserved for scientific or engineering computers where it was felt it was needed. But the technology began to filter down to the microcomputer industry, and systems with higher-resolution graphics began to appear. Soon, resolutions approaching 400 or 500 pixels were common and now the resolution range is well over 600.

That degree of resolution means that a desktop computer can produce sophisticated graphics displays. In fact the business community is taking advantage of those graphics capabilities, and of the software that makes use of them.

The printer industry, naturally, has followed suit and the character-generator ROM has been joined by the graphics-generator ROM. That integrated circuit contains machine-language routines that control not only the printhead, but also the printing mechanism and the platen. In that manner, the printhead is moved around a sheet of paper, forming the graphics image. Further, that ROM also contains the information needed to print special character-fonts.

Further, dot-matrix printers with graphics ROM's can produce "screen dumps." Since the graphics ROM is able to use the microcomputer screen's bit-mapped memory during a graphics printing session, it is also able to print out a representation of what is shown on the computer's display screen. Many microcomputers have areas of their RAM (*R*andom-*A*ccess *M*emory) reserved to hold that display information. Thus, each area of such a computer's CRT screen will have a corresponding address in RAM. Because of that **bit-mapping**, the RAM is able to output its contents directly to the printer and a user is able to have a real-image dump or "photograph" of the screen. Figure 3 will give you an idea of what some printers are capable of.

Finally, some dot-matrix printers can now print in color. A ribbon with (usually) four horizontal color-bands can be moved up and down in front of the print head and, over multiple passes, a wide variety of colors—corresponding to those generated by the computer for its display—are produced.

So, the dot-matrix printer, because of its versatile printhead, is a far more flexible printer than the fully-formed-character type. But, even with all its capabilities, many people are still put off by dot-matrix printing. They believe it looks too "computerish," and prefer the traditional letter-quality, fully formed characters of a typewriter.

Solid-character printers

Perhaps the earliest solid-character printer was the *Telex* or *Teletype*. It used a print cylinder that rotated on a vertical axis. That printhead was transported across the page by a movable carriage. Inside the printhead is a small hammer that is the print-actuating element. The device responds to the microcomputer's request for a particular letter by raising or lowering the cylinder, and rotating it to bring the correct letter into play. When it is located, the hammer strikes the cylinder, which in turn, strikes a ribbon, and prints a character. The carriage then moves on to the next space.

Units like those—*Teletype* models *33*, *35*, and *38*—are available today for relatively little ($200 to $400), but they do have some drawbacks. They tend to be slow—about 10 characters-per-second (cps)—and they are noisy and difficult to service. Also, they can't print lower-case letters.

An alternative is the ball-type printer. The type of printhead it uses was developed by IBM for its familiar *Selectric* typewriter series and contains a set of fully-formed characters on its surface. In action, it's much like the *Teletype*. The computer requests a letter, and the printhead/carriage mechanism spins to the correct spot. The head then strikes the ribbon and a letter is printed.

There are conversion kits that can turn older *Selectrics* into computer printers. One of them consists of a device that straps to the keyboard and has a series of solenoid-actuated arms. As a letter is requested, the proper arm drops and pushes the key, causing the letter to print. However, that is only one method. There are also companies that recondition *Selectrics* and turn them into true computer printers by adding the proper electro-mechanical parts internally.

Although the ball-type unit produces good quality printing, it is still noisy and fairly slow—about 15 characters-per-second. On the positive side is the fact that it is available at a relatively low price.

The final type of solid-character printer we'll examine is the daisy-wheel type, and its variant the thimble printer. The daisy wheel was pioneered by Diablo Systems, Inc. in 1973 and offers much higher speeds than were previously possible with solid-character printers.

Running at speeds up to about 55 cps, daisy-wheel printers use a wheel-type printhead, of the sort shown in Fig. 4. Running radially from the wheel hub are flexible arms topped by embos-

sed characters. As the computer requests a letter, the wheel spins the correct character into place and that is hammered against the paper by a small striker to print the character. The print wheels are made of plastic or a metallized material, and are usually good for more than a million impressions.

The thimble printer is a variant of the daisy-wheel type. Unlike the daisy wheel, though, the thimble print-element is shaped like a thimble facing upward and the letters are on flexible steel shafts extending from the thimble base. Thimbles work on the same principle as daisy wheels.

Like the ball-type printer, those printers have an advantage in their easy interchangability of typefaces (the print elements can be changed in a matter of seconds). They are also much faster. They are somewhat noisy, though.

One alternative a computer user might want to consider is the conversion of an electronic typewriter. Since those units use daisywheels in place of normal type bars, and since many of their mechanical parts have been replaced by electronics, it makes a great deal of sense. You retain the typewriter capability for yourself...while adding, fairly inexpensively, a quality printer for your computer. There are reasonably priced interface boards available or you can purchase a converted unit such as the *Bytewriter* (based on the Olivetti *Praxis* electronic typewriter) for a reasonable price. Print speed is limited to about 10 or 15 cps and they are somewhat noisy, but, for many, they'll fill the bill.

Non-impact printers

The last category is non-impact printers, which were mentioned briefly earlier. It includes thermal printers, electrostatic matrix-printers, and ink-jet printers.

Thermal printers, which are fairly popular, use a specially manufactured paper and a heating element. Common in many calculators, they form characters using heat. The characters are formed as heating elements in the printhead discolor the sensitized paper into a dot-matrix pattern. The printers are lightweight, quiet and quick; however, the paper they use is fairly expensive.

Electrostatic printers also produce a dot-matrix pattern, but they use a special aluminum-coated paper. A voltage is applied between the printhead and a metal plate that burns off the aluminum and exposes a black layer beneath. Electrostatic printers are fairly inexpensive and their print quality is good, but the special paper they require is costly and fairly delicate. **Laser printers** work in much the same way, using a specially treated paper and a low-energy laser to form the characters.

Ink-jet printing is another non-impact process. In that system, a small jet of ink is pumped through a tiny nozzle, and the nozzle is vibrated to create a series of droplets. The resulting spray is directed to the paper, and its path controlled so it will form characters.

There are a number of methods used to determine where the jet will strike the paper, including electrostatic deflection, controlled nozzle movement, and controlled paper movement. There is also another method that uses a printhead with a matrix of nozzles that can be fired selectively; it works somewhat like a dot-matrix printer.

Print lines

Other terms that you may encounter in reference to printers include serial, character, and line. The term "serial" can be especially confusing because it refers not only to the way in which characters can be printed, but also to the way in which data can be transmitted. We'll get to the latter shortly.

In printer terms, a **serial** printer is one that prints a continuous flow of characters in a straight line across a page, one after the other. It's also known as a **character** printer. **Line** printers—which are generally large and very expensive—print an entire line all at once. That makes them much faster than serial printers, and they are used in situations where a high throughput is needed—in data-processing centers, for example, where thousands of checks or documents are printed at a time.

One of the chief advantages line printers enjoy over serial printers is speed. In fact, that's how their performance is rated. A slow line-printer will run at a speed of about 300 lines-per-minute (lpm), while a medium-speed unit will print at between 300 and 600 lpm. High-speed line printers are capable of speeds in the 600 to 1200-lpm range. Line printers are generally categorized in three groups: drum, chain, and scanning-matrix.

Serial-printer speeds contrast markedly with even the slowest of line printers. Rated in terms of characters-per-second (cps), dot-matrix printers have speeds in the 40- to 400-cps range, while fully-formed-character printers may operate between 10 and 60 cps.

Interfaces

There are two ways that a printer can be connected to a computer: through a serial interface, or through a parallel interface.

When a **serial interface** is used, data is transmitted by the computer's print routine to the printer one bit after the other. The task is handled **asynchronously**, which means that the rate at which the data is sent does not have to be constant. Instead, the timing is established by the number of start and stop bits sent at the beginning and end of each byte of data; one byte represents one character. The serial-data format is shown in Fig. 5-a. When the printer has received the correct number of start, stop, and data bits, it knows that it has received a complete byte (also sometimes called a word) and it then begins to piece together another one. Appropriately enough, that type of communication is carried out through a computer's serial port.

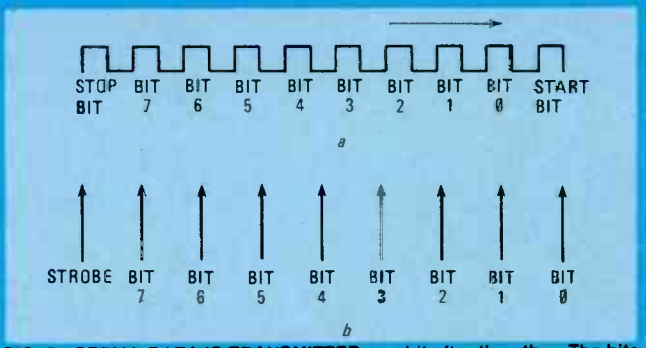

FIG. 5—SERIAL DATA IS TRANSMITTED one bit after the other. The bits indicating the character being sent are surrounded by what are known as framing bits (*a*). Parallel transmissions send all the data bits at once (*b*); a strobe pulse tells the printer when a character is to be printed.

That contrasts with a **parallel interface**, where entire bytes are sent at once, as can be seen in Fig. 5-b. That is possible because, instead of using only one input line to the printer, there are seven or eight data lines used. Thus, each of seven or eight data bits is sent down its own line. The result is a much higher transmission speed, and a corresponding increase in printer speed. A special port is needed to handle parallel communication between a printer and computer because of the number of data lines required. A **Centronics-compatible**, or **Centronics-type** interface is a particular form of parallel interface; it was originated by a printer manufacturer named *Centronics*, and was adopted by many other companies as a sort of standard. Be careful, though—not all interfaces billed as Centronics-compatible are identical; make certain before you buy that the printer will run with your computer.

Which system is better? For distances of up to ten feet, parallel transmission is better because of its greater throughput (ability to send more data in less time). However, over longer distances, the potential for errors induced by such things as vibration, electrical noise, or stray RF from the computer or printer makes parallel communication less desirable. In addition, after they travel some distance, the signals begin to weaken and must be reamplified through a repeater.

For distances of more than ten feet, the serial method is the

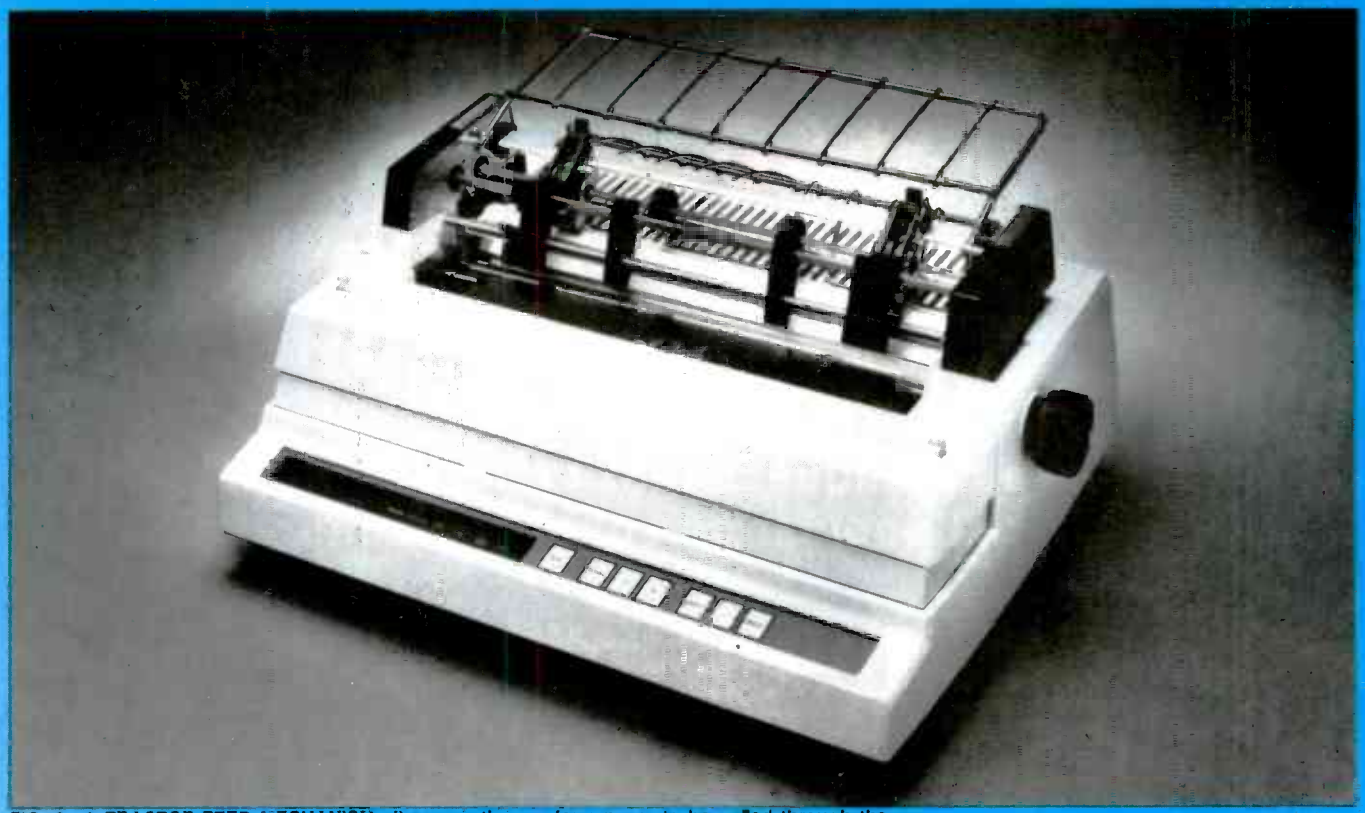

FIG. 6—A TRACTOR-FEED MECHANISM allows continuous-form paper to be pulled through the printer evenly without slipping from side to side. Thus, it allows long unattended runs.

better choice. While it is much slower than parallel data-transmission, the error rate is much lower. Furthermore, serial transmissions will carry for longer distances before needing reamplification. Transmission rates ranging from 110 to 19,200 baud (bits-per-second) are possible, but must be compatible with the capabilities of the printer, of course.

Asynchronous transmission isn't the only type of serial protocol, though; there is also **synchronous** transmission. This type of communication is far more complex than asynchronous. The system must know the exact timing of each data byte. When a synchronous protocol is used, the data flow is broken into blocks, with all the bits being sent at equal intervals.

Using oscillators as clocks, the computer initiates the timing sequence by inserting a series of synchronization signals at the start of each data block. Each block ends with an error-checking character. The clock-oscillators act to keep the timing sequence very tight. And, even if no data is transmitted, nulls (zeroes) are sent to fill each block so the timing chain never varies.

Paper-feed systems

Three different methods are used to move the paper through a printer. In the first method, known as **friction feed** the paper is pulled between the platen and a set of pressure rollers, much as in a typewriter. While it's a simple, trouble-free method most of the time, friction feed can be bothersome because of alignment problems. That is especially true when using continuous-form paper, which tends to skew (slip sidways).

With **tractor feed**, used on the printer shown in Fig. 6, a set of adjustable sprockets engages perforations at the edges of the paper. A gear train, driven by a motor, turns the sprockets which, in turn, pull the paper through the printer line by line. Usually the tractors (sprockets) are moveable, and tractor-feed printers can accommodate paper of any width. Most tractor-feed printers can also use plain paper, a sheet at a time.

Pin feed is similar to tractor feed; a set of pins set into the platen at either end fits into perforations in the paper to keep it aligned. While that system solves alignment problems, it does limit you to single paper width.

Other considerations

There are several other factors that you should take into account when looking for a printer. Consider the amount of noise the printer makes. Impact printers are generally noisier than dot-matrix printers, but the sound produced by the latter type can sometimes be very irritating. If the sound a printer makes is too obtrusive, it can make working around the printer uncomfortable, and can contribute to fatigue.

Consider, too, the speed at which the printer runs. A slow printer will tie up your microcomputer for long periods, rendering it useless for other tasks unless you add a buffering print-spooler that accepts data from the computer almost instantly, and feeds it to the printer as required, thus returning control of the computer to you. Also, remember that a bidirectional printer will operate somewhat more quickly than one that has to do a carriage return after each line.

Bear in mind the length of the lines you will be printing; don't buy a printer with too narrow a platen. For documents on standard 8½ × 11-inch paper, an 80-column printer is a necessity; some applications may require a 132-column printer. Also consider the typefaces you will need, and the graphics capabilities of the machine. And, consider the type of paper you will be using (single sheets or continuous form) and the amount of attention the printer will need while in operation.

Finally, a word about prices. Like the prices of other microcomputer peripherals, those of printers have been dropping. A couple of years ago it wasn't unusual to find a letter-quality, solid-character printer costing in excess of $3000, with the better-quality dot-matrix printers selling for over $1000. Today, it's possible to buy a letter-qualfty printer for well under $1000. Furthermore, dot-matrix printers with graphics capabilities were priced in the $1500 range only two years ago; today the same features can be found in printers costing between $300 and $1000.

If you put to use the information that's been presented here, finding the printer you need should become a much less difficult task than you may have imagined it would be. R-E

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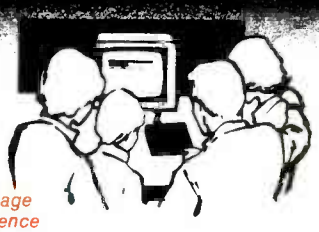

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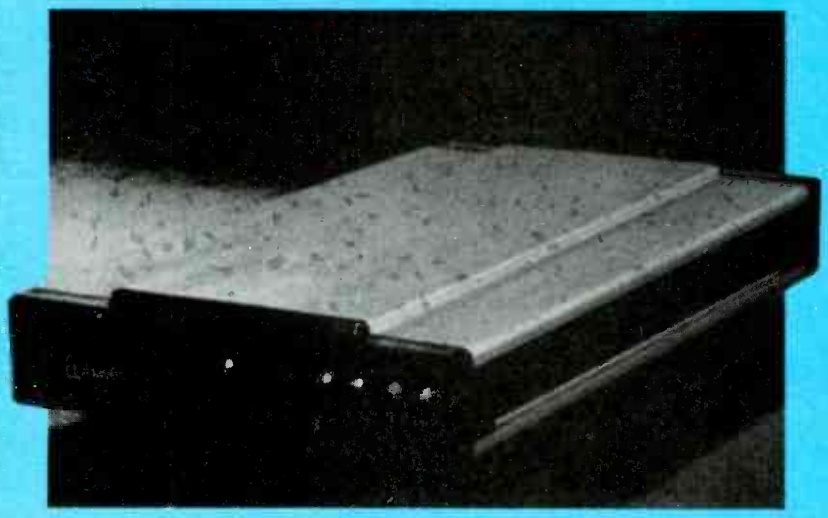


Your computer can exchange information with any other computer in the world—all you need is a telephone and a modem.

HERB FRIEDMAN

MOST FAMILY AND SMALL-BUSINESS USERS OF PERSONAL COMputers eventually discover that there's a lot more to the world of computers and information-processing than software they can write or purchase. For those who need it, there are the commercial data-banks that will provide up-to-the-minute information on just about anything, as well as "community bulletin boards"—usually run by hobbyists—that will keep you up to date on the latest developments in personal computing.

Then there's customized software to share. You might have written a program (or data) you'd like to share right now with a friend on the other side of town. Or maybe he has some new software he'd like to share with you.

If you're tired of killing a lot of time at the bank every payday, waiting in line to deposit your check and pay your bills, some banks will now allow you to handle all of your banking chores from the comfort of your home using your personal computer. (And if the banks have their way, in a few years you won't have the choice: all banking will be done through some form of personal computer—but that's a whole other story.)

The key to the world of personal computer communications is a modem (*MO*dulator/*DEM*odulator)—a device that permits computer and terminal communications over a voice-grade telephone circuit. It does so by converting your computer's electrical signals to audio tones that can be efficiently handled by the telephone system. Conversely, the modem converts received audio tones back to electrical signals that are understood by your computer.

Modems

There are several kinds of modems in current use. The type generally used for communicating through the dial-up telephone system is called "Bell-System-103-compatible," which means that it uses the same protocols (standards) as the modem that was provided by the Bell System when that company had a monopoly on data exchange over most of the telephone lines in North America.

A Bell-103-compatible modem can transmit and receive data at rates of 0 to 300 bps (*B*its *P*er *S*econd), which also happens to work out to be the "baud rate," because for data transmission, the bit rate equals the baud rate: 110 bps is 110 baud, 300 bps is 300 baud, etc.

While there are modems capable of transmitting and receiving more than 300 bps, they require specially equalized telephone circuits or dedicated lines and are presently not worth the expense for personal-computer use. It often can take several years just to pay off the difference in cost between a Bell-103-compatible modem and a high-speed modem, assuming you can get convenient access to a telephone circuit that will handle more than 300 bps efficiently. Because of that, we will concentrate mainly on Bell-103 compatible modems.

The first modems were rather simple devices as they were most often used to connect terminals—usually teletypewriters such as the *Model 33*—through the dial-up telephone system to large mainframe host-computers. The most common type used was the acoustic-coupled model (we'll get to why shortly), the type with two large rubber cups into which the user places the telephone handset after dialing up another computer or terminal. That type of modem is still popular today; let's take a closer look at it.

One cup contains a small speaker; the other a microphone. When the telephone handset is seated in the device, the handset's microphone is opposite the speaker, while the receiver (earphone) is opposite the modem's microphone. The modem itself is connected to the terminal or computer through a "standard" electrical connection, called an RS-232C interface (usually shortened to simply RS-232), or a 20-mA current loop. When an RS-232 interface is used, all signals are represented as variations in voltage level. In the case of the 20-mA current loop—the original "standard" for teletypewriters—the data is represented by the make/break sequence of a reference 20-mA DC current. Many early personal computers provided a 20-mA current-loop output because almost all commonly available modems could accommodate the 20-mA connection; not all were equiped to handle an RS-232 signal.

Electrical signals from your computer or terminal are converted by the modem to audio tones that are fed to the internal speaker and passed on to the handset's transmitter (microphone). Audio tones arriving over the telephone from another computer are picked up by the modem's microphone and converted to electrical signals.

Making the connection

The usual procedure for getting your terminal or computer hooked up to the remote computer or terminal is to first use a rotary or *Touch-Tone* telephone to call the remote. When the user hears the "carrier" tone from the remote computer, he inserts the handset in the modem's cups. When the modem senses the carrier, it turns on its own carrier, thereby informing the remote computer that the communications link has been established.

To make certain that every terminal can communicate with every computer, all Bell-103-compatible modems use exactly the same protocols. In the early days, because the remote terminal usually originated the "call," its modem was called an originate modem; it transmitted data at frequencies of 1270 and 1070 Hz. Since the host computer answered the call from the

terminal, its modem was called an answer modem. The answer modem transmitted the data at frequencies of 2225 and 2025 Hz. When, as often is the case today, the communications link is computer-to-computer rather than terminal-to-computer, either one can use the answer modem unless one is specifically designated as "the host." In that case, it is the one with the answer modem.

The reason that those early modems were of the acoustic type was that, at one time, Bell would not allow anyone to connect directly to the telephone system without paying a stiff tariff for some sort of protective device; acoustic modems have no direct connection to the telephone lines. However, for those who could afford the convenience, many early acoustic modems also had provision for direct connection. For example, Fig. 1 shows an Omnitec model *701A* coupler. Many of you will recognize the Omnitec as the workhorse of the early time-share computer systems. Though the acoustic cups are plainly evident, there is also an output jack and switch for a direct connection to the telephone system, as well as a monitor output jack, a selector for half and full duplex operation, and connectors for both a 20 mA and an RS-232 input/output.

The *701A* was built like a battleship, could probably serve as a boat anchor in a howling gale, and was known for reliability. While the advertisements for many modern modems belittle acoustic coupling on the basis of noise interference or microphone distortion, bear in mind that acoustic couplers such as that one were usually bolted to the side of a teletype, which was known as a "Klunker" (because it literally "Klunked" away continuously). What's more, it was usually used in a room full of teletypes hammering away; yet it provided dependable computer communications at maximum convenience. (In case you're short of funds, those old acoustic couplers are available on the surplus market for $15 to $50, depending on the model.)

Full and half duplex

Before we go any farther, let's take time out to cover half and full duplex for those not familiar with the terms. When you use a terminal or a personal computer to communicate with a host computer, what you see on your video screen or printer is not what you sent from your keyboard. The video is an "echo" from the host computer that serves as a check on the two-way path between you and that computer. If the echo display is not what you sent you can be reasonably certain there is trouble with the telephone circuit or the host computer, not your equipment. You check that quickly by switching the modem to half duplex (if possible). In half duplex your own signal is returned by the modem to your video display; what you see is what you sent.

Unfortunately, you usually cannot use half-duplex with a host computer that is echoing for two reasons. Firstly, everything will be repeated, the video display will show your half duplex display and then the echo; the word "HELP" would be displayed as "HHEELLPP." Secondly, many terminals and computers seem to "go crazy" when they must handle both the half-duplex signal and the echo; it's sort of like trying to speak while listening through headphones to your voice being reproduced with time delay from a tape recorder.

Until recently, most modems available to personal computer users were originate-only because it was assumed the user would only want to communicate with host computers or database systems (which are provided by a host computer). When it became obvious that users of personal computers wanted to communicate with other personal computers, an instant market was created for a combination answer/originate modem because in any communications link someone has to use an answer modem—although it doesn't matter who it is.

Up until a few years ago modems were somewhat expensive, too. A cheap originate-modem could run upwards of $150, while a manually-selected combination originate/answer modem usually cost in the neighborhood of $300-$500. Through modern technology, inexpensive integrated circuits, somewhat severe competition, and Bell losing the fight over whether they can control any and all equipment that generates signals carried on the telephone circuits (the Carterfone case), the price of modems has been sharply reduced. There is now a wide assortment of modem equipment specifically designed and priced for the personal computer user, with features ranging from the most basic to the most sophisticated.

What's available

Other than using a modular connector for modems that connect directly to the telephone system, no two manufacturers seem to have the same idea as to what features should go into a modem intended for use with personal computers. Because of that, we'll take a look at the various features found in some of the most popular or generally available models. You can then select what features you need or want most for your particular computer installation.

We'll start off with one from Omnitec—the people who manufactured the *701A*. Their latest effort is the model *9123AD*. It is a direct-coupled originate/auto-answer modem with automatic telephone-silencing. The modem connects to the telephone jack through a modular connector. The telephone, which formerly connected to the modular jack, now connects to a modular receptacle on the rear of the modem. The computer connects to the modem through a "standard" DB-25S, RS-232 connector.

The unit can be switch-selected to function as an originate, manual-answer, or auto-answer modem. Auto-answer means

FIG. 1—ALTHOUGH OVERSIZED AND HEAVY, older acoustic modems such as this one did an excellent job even in teletype filled rooms.

FIG. 2—THIS OMNITEC MODEM is a direct-coupled, originate/auto-answer model. The three front-panel LED's indicate operating status.

the modem literally "answers" a telephone call. When the phone rings the modem connects to the phone line and generates an answer carrier. If it receives an answer-back carrier from an originate modem, it establishes a communications link. If it does not, the modem disconnects itself from the line after approximately 20 seconds.

In the manual-answer mode, the user selects the mode after the telephone contact has been established. For example, if your friend calls you at 3 in the morning bubbling about his latest game and insists you take a download so you can try it immediately, you simply switch your modem to answer if all he has is an originate modem. On the other hand, if you are not enthusiastic about being disturbed in the middle of the night, you can leave your modem in the automatic mode. It will answer the phone, and with the proper software take the download automatically. All around, that is a very classy personal-computer operation.

The automatic telephone-silencer works this way. You are originating a link to, say, The Source. You dial their phone circuit, and when The Source connects with its answer carrier you hear it in the phone. When the modem senses the answer carrier, which takes only a few seconds, it automatically disconnects the handset—the receiver goes "dead." The modem is now connected directly to the line and the handset is disconnected so that when it is set in its cradle it neither goes "on hook" (disconnected) nor generates a glitch in the data stream.

The unit has three front-panel LED's (see Fig. 2). One indicates when the system is in the TALK mode—regular telephone use, one indicates a modem carrier is being received, and one indicates data flow. There is no on-off switch. The disconnect can be forced by a long or short space from the terminal, but few personal computers functioning as terminals can provide the proper space. Alternately, setting the terminal to the LOCAL mode can force the disconnect, but again, few personal computers can simulate that type of disconnect. When we need a fast release of the modem from the line and can't wait the 20 seconds or so for the automatic disconnect, it's done by simply pulling the power plug from its outlet. A simple power-switch would be a lot more convenient.

A somewhat different approach to a direct-connect originate/answer modem is the model *UM1*, a special version of the *Microconnection* from the Microperipheral Corporation. The usual *Microconnection* modem has the standard RS-232 I/O; that model is made to interface directly with the data-bus connector on the back of the keyboard of the Radio Shack *TRS-80 Model I* computer as shown in Fig. 3. It eliminates the necessity of spending $100 for Radio Shack's RS-232 interface. Even if you use the expansion interface for disk drives, the modem can still be connected to the keyboard's data bus connector along with the connection between the keyboard and the expansion interface. And best of all, that modem will work even with the 4K Level I *Model I*—the necessary driver-software is provided on cassette tape.

A somewhat unusual feature is a set of jacks that allow you to connect a cassette recorder so that you can record signals for later playback directly over the telephone line.

The rest of the features are more or less standard. There is manual on-off, manual selection of the originate and answer modes, and voice/data-mode selection—the data mode seizes the telephone line so you can hang up the telephone. Power and carrier indicator-lamps are provided.

While we're talking about relatively low-cost modems, let's take a look at some that use acoustic coupling. Modern versions of the old *701A* are now available from several sources for slightly more than $100. The only substantial difference in operation is that the latest versions now provide for both originate and answer operation. One slightly different modem of that type is the model *MJF-1230* inductively coupled modem from MJF Enterprises, a company relatively unknown in computer circles but with a long track record in amateur radio. Their contribution to modern technology is to use inductive coupling to receive the incoming signal. Supposedly that reduces ambient-noise interference. However, since we've never had problems with ambient-noise interference, even with an acoustic coupler sitting on top of a teleypewriter, we can't be certain that inductive coupling is of any extra value. Essentially, the unit performs like a standard originate/answer accoustic modem. Other features include full/half-duplex selection, TTL and CMOS I/O in addition to standard RS-232 (that should appeal to computer experimenters), and cassette recorder I/O ports that let you record incoming or outgoing signals (see Fig. 4).

Moving up in price, we find some high-technology modems such as the Novation *Auto-Cat*, a miniature originate/answer, auto-answer modem that is directly hooked up to the telephone line through a modular connector. The computer I/O is through a standard RS-232 interface.

Instead of mechanical switches, that modem uses a membrane-switch front panel to select originate or answer operation; the front panel also features three LED indicators.

A RESET front-panel switch clears the unit so that you can select the operating mode. For example, to originate a transmission, first the RESET switch is depressed. Next, the remote computer is called on the regular phone, and when the answer carrier is heard the ORIG (originate) switch is depressed and the phone is hung up. The modem seizes the line when switched to ORIG. The same procedure can be used for manual answer between two personal computers, or the answer connection can be controlled by the terminal through the DTR (*D*ata *T*erminal

FIG. 3—THIS SPECIAL MODEL of the *Microconnection*, the model *UM1* from the Microperipheral Corporation, works with the Radio Shack *TRS-80 Model I* and eliminates the need for the RS-232 expansion interface.

FIG. 4—IN ADDITION TO inductive coupling, some of the extra features found on the *MFJ-1230* modem from MFJ Enterprises include TTL/CMOS and cassette-tape I/O.

Radio Electronics YOUR OWN Computer APRIL 1983

Accessory Boards

Increase RAM, add color and/or high-resolution graphics, and even add a second CPU to your system with one of these add-on accessory boards. Here's a look at what's available and what they can do.

MARC STERN

BACK AT THE DAWN OF THE PERSONAL-COMPUTER AGE, CIRCA 1975, a company named MITS introduced the first true personal computer—the *Altair 8800*. An interesting facet of that computer's design was that its circuitry was built on several boards and those boards were electrically connected to each other through a wiring structure called a *bus*.

What exactly is a bus? Simply stated, it is a group of wires that carry all of the signals from all of the boards throughout the computer. The importance of that is that all the signals from all the various parts of the computer—memory, processor, video, etc.—are available at any point along the bus; to access those signals, all you need do is tap into it. The cleanest, and most useful way to do that is to insert a card connector into the bus. Then, whatever circuitry that you want to have access to the signals on the bus is simply mounted on a PC board that slips into the connector. Often those card connectors are all mounted on a single PC board called a *motherboard*.

Using some type of bus structure allows your system maximum flexibilty because upgrading or modifying it is greatly simplified. If you want more memory, better graphics, a direct-connect modem for telecommunications, or even a second microprocessor, all you need do is slip in an add-on board into one of the connectors.

The bus developed by MITS for their *Altair 8800* is now known as the S-100 bus; it is the most widely used bus structure for microcomputers. That doesn't mean, however, that it is the only one. Another popular bus is the SS-50 used in computers from Gimix, Southwest Technical Products, and others. Several popular computers, such as the *Apple II*, Zenith *Z-89* (also known as the Heath *H-89*), Radio Shack's *TRS-80 Model II* and *Model 16*, and the IBM *PC* for instance, also are bus oriented but use their own type of bus structure. That means an accessory card for an Apple computer won't work in an IBM *PC*, and vice versa. And, not all S-100-bus boards will work on every S-100-bus machine. Although a formal standard exists, not all companies adhere to it and that can sometimes lead to problems. Thus, before you buy any accessory board, make sure that it will run in your machine.

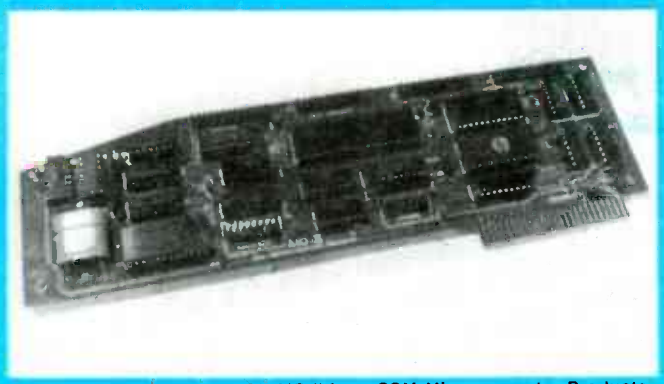
Memory boards

One of the most popular types of accessory board is the memory board. That should come as no surprise, however, since no matter how much memory your microcomputer has, it never seems to be enough. It always seems that sooner or later even 64K of RAM just isn't able to handle the tasks you want to do. The answer, of course, is to add more RAM. That's easy enough to do, particularly for users of 16-bit machines like the IBM *PC*.

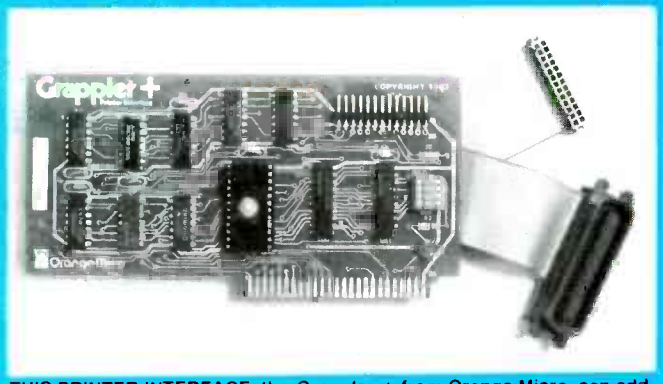
A 16-bit machine, by virtue of its having 24 address lines, can, in theory, access over 16 *megabytes*. In general, however, most memory boards feature a maximum of 256K, although we've seen a couple of boards sporting 512K and one with 576K. Thus, if you're running a 16-bit microprocessor, all you need do is select a board with as much memory as you need or can afford, and slip it into one of the edge connectors.

Actually, it's not quite that simple. If you just slipped the card in and did nothing else, the added memory would never be used simply because the microprocessor would not even know that it was there. Every byte of memory in the computer has a specific address. Before the accessory board is added, the computer is configured so that the microprocessor knows that all the RAM memory lies between two addresses. It will not attempt to store data at a memory location outside those addresses because, at least as far as the microprocessor is concerned, there is nothing there. Thus, before the memory can be accessed, a couple of DIP switches must be reset assigning the new RAM a starting address within the computer's memory.

An 8-bit microprocessor, on the other hand, has just 16 address lines, which means, at least in theory, that the most memory it can address is just a bit more than 64K. In reality, however, even 8-bit machines can access much more, but to do



INTERFACE BOARD, model *AIO-II* from SSM Microcomputer Products, provides the *Apple II* with a full function, highly flexible serial/parallel interface.



THIS PRINTER INTERFACE, the *Grappler +* from Orange Micro, can add many printing features to the Apple computers.

that you've got to play a few tricks on the system. One common trick is to use a technique known as bank select. When that is done, the memory is assigned to an I/O port and all of the data to and from that board is up- and down-loaded through that port. Hobbyists with 8-bit machines have been known to run as much as a megabyte of RAM.

Let's now take a look at some of the memory boards currently available. Turning first to a 16-bit machine, in the relatively short time since its introduction, the IBM *PC* has become one of the best supported machines in the industry. Among its nice features are provisions for easy expansion—i.e., the machine provides five card-connectors for easy installation of accessory boards. Memory boards for that machine are available from Microsoft, Microtek, Davong, Qubie Distributing, Aegis Systems, Seattle Computer, Quadram, Vista, and others. Prices vary from less than $250 to over $1700, depending on memory capacity, manufacturer, and supplier. In addition, many of the boards offer more than just memory expansion. The *Quadboard* from Quadram, for example, also offers a clock/calander, parallel-printer I/O, and an RS-232 interface.

The S-100 bus allows for up to 24 address lines, so either 16- or 8-bit computers can use that bus structure. Pick up an issue of almost any computer magazine and you'll see dozens and dozens of advertisements for S-100 boards, and prominent among them are memory boards of all capacities. Memory boards for S-100-bus machines are available from Intercontinental Micro Systems, Electronic Control Technology, Inc., Netronics, Memory Merchant, and Lomas Data Products to name just a very few. Boards for SS-50 systems are a little harder to find, but are available from several sources, including Gimix.

The *Apple II* is among the most popular 8-bit machines on the market. As it too features a user-accessible bus for easy expansion, there are a variety of accessory boards, including memory boards, available for it. Most of those are 16K boards for upgrading the 48K machine to 64K. A few boards, however, offer as much as 128K. One extremely interesting board is the *Bubble Memory Disk Emulator* from MPC. As the name indicates, it is a bubble memory (featuring 128K of storage) that attaches to a disk I/O-port and takes the place of a disk drive. Bubble technology is ideal for such an application as it is non-volatile—if power is removed from the device, the contents of the memory are not destroyed. More conventional memory boards are available from many suppliers including Advanced Logic Systems, Microtek, Wesper Micro Systems, Saturn Systems, and Davong

Microprocessor boards

One of the few serious drawbacks of the Apple *II* is that its microprocessor is a 6502. Although that is a fine microprocessor in its own right, some of the best 8-bit operating systems, and some of the best 8-bit software, are designed to be run on a Z80 microprocessor. But that doesn't mean you're out of luck. Several manufacturers, such as Microsoft and Personal Computer Products make accessory boards with that CPU for the Apple computer. Simply install one of those boards in your machine, and you can run *CP/M*, *Wordstar*, *dBASE II*, and any other Z80-based software with no difficulty. Boards with other microprocessors, such as the 16-bit 8088 (used in the IBM *PC*) are also available.

A variety of microprocessor boards are also available for S-100-based machines. Those machines are designed to run using just about any 8-bit or 16-bit microprocessor. A user needs only to select a board with the microprocessor he wants to run and install it. Also note that several manufacturers make dual microprocessor boards—most often incorporating an 8-bit and 16-bit microprocessor. Cromemco and Radio Shack, for example, make boards that contains both a MC68000 16-bit microprocessor and the 8-bit Z80. Radio Shack's board is sold as part of an upgrade kit for their *Model II*. With that upgrade, the user gains all of the advantages of the new *TRS-80 Model 16*, including the ability to run both 16-bit *Model 16* and 8-bit *Model II* software. Cromemco's board is for S-100-bus systems

Graphics boards

Another popular type of accessory board is the graphics board. Those are popular for a number of reasons, but primarily because few users are satisfied with the graphics capability of their machine as supplied. For instance, some offer only monochrome displays, others offer only a 40-column (or even smaller) display, while others lack an interface that will allow it to be used with an RGB monitor. Boards to solve each of those problems are available from a variety of sources.

Most graphics boards for the Apple *II* are intended to provide an 80-column display for that machine. As supplied, the Apple's display is just 40-columns, hardly adequate for some applications such as word processing. Most of those cards also allow the display of upper- and lower-case characters.

Although they're a little harder to find at times, there are many boards on the market designed to bring color graphics to the Zenith *Z89*; as supplied, those computers can generate 24 lines × 80 characters on a built-in monochrome display. Typically, the accessory boards provide good resolution (256 × 192 pixels) and have 15-color capability; of course, you'll need to use a separate color monitor. Some sources for boards for Heath/Zenith computers include Kres Engineering, Mako Data Products, and New Orleans General Data Services.

Turning to S-100 based systems, there are several boards on the market that allow you to generate some rather impressive graphics. One of those boards, the *Microangelo* from Scion, can produce a 512 × 480 pixel monochrome display. As to character generation, it can display 40 lines × 85 characters of text. To add color capability more boards are added, each generating its own monochrome "transparency." The output of the boards are combined by the color mixing board. If eight boards are used, the maximum that can be handled by the system, an image with 255 colors could be generated. An advantage to this type of graphics generation is that colors can be easily added or deleted without otherwise affecting the image.

ACCESSORY BOARD SUPPLIERS

Adisa Corp.
Box 1364
Palo Alto, CA 94301

Advanced Digital Corp.
12700-B Knott St.
Garden Grove, CA 92641

Advanced Logic Systems
1195 East Arques Ave.
Sunnyvale, CA 94086

Aegis Systems
202 W. Bennett St.
Saline, MI 48176

Antex Data Systems
2630 California St.
Mountain View, CA 90404

Apparat Inc.
4401 S. Tamarac Pkwy.
Denver, CO 80237

ASAP Computer Products
1198 E. Willow St.
Signal Hill, CA 90806

AST Research Inc.
2372 Morse Ave.
Irvine, CA 92714

Axlon Inc.
170 North Wolfe Rd.
Sunnyvale, CA 94086

Cactus Technology Inc.
3024 North 33rd Dr.
Phoenix, AZ 85017

California Computer Systems
250 Carribean Dr.
Sunnyvale, CA 94086

Chrislin Industries
31352 Via Colinas
Westlake Village, CA 91362

Comemco
280 Bernardo Ave.
Mountain View, CA 94040

Computer Peripherals
1117 Venice Blvd.
Los Angeles, CA 90015

Davong Systems Inc.
1061 Terra Bella Ave.
Mountain View, CA 94043

Daystar Systems Inc.
10511 Church Rd. Suite A
Dallas, TX 75238

Dual Systems
2530 San Pablo Ave.
Berkeley, CA 94702

Electronic Control Technology Inc.
763 Ramsey Ave.
Hillside, NJ 07205

Gimix
1337 W. 37th Place
Chicago, IL 60609

Godbout Electronics
Box 2355
Oakland Airport, CA 94614

GSR Computers
60-10 69th St.
Maspeth, NY 11378

Hayes Microcomputer Products
5835 Peachtree Corners East
Norcross, GA 30092

Hurricane Labs
5149 Moorpark Ave.
San Jose, CA, 95129

Independent Business Systems
5915 Graham Ct.
Livermore, CA 94550

Indigo Data Systems Inc.
100 E. NASA Rd. 1
Suite 107
Webster, TX 77598

Intercontinental Microsystems Corp.
1733 S. Douglass Rd.
Anaheim, CA 92806

Intermedia Systems
10601 South De Ansa Blvd.
Cupertino, CA 95014

Intex Micro Systems Corp.
755 West Big Beaver Rd. Suite 1717
Troy, MI 48084

JC Systems
1075 Hiawatha Ct.
Fremont, CA 94538

John Bell Engineering Inc.
1014 Center St.
San Carlos, CA 94070

Kres Engineering
PO Box 17328
Irvine, CA 92713

Legend Industries Ltd.
2220 Scott Lake Rd.
Pontiac, MI 48054

Lomas Data Products
729 Farm Road
Marlboro, MA 01752

Macrolink Inc.
1150 East Stanford Ct.
Anaheim, CA 92805

Macrotech International Corp.
22133 Cohasset St.
Canoga Park, CA 91303

Magnolia Microsystems
2264 15th Ave. W.
Seattle, WA 98119

Matco
427 Perrymont
San Jose, CA 95125

Mako Data Products
1441-B N. Red Gum
Anaheim, CA 92806

Memory Merchant
14666 Doolittle Dr.
San Leandro, CA 94577

Memory Technologies Inc.
25 Main St.
Twelve Mile, IN 46988

Memotech
7500 West Yale Ave., Suite 200
Denver, CO 80227

Microcomputer Business Industries Corp.
1019 8th St.
Golden, CO 80401

Micro Intercontinental Systems Corp.
1733 S. Douglass Rd. Suite E
Anaheim, CA 92806

Micromint Inc.
561 Willow Ave.
Cedarhurst, NY 11516

MicroSoft Corp.
10700 Northrup Way
Bellevue, WA 98004

Micro Synergy
1327 Whiteacre Dr.
Clearwater, FL 33516

Microtek
9514 Chesapeake Dr.
San Diego, CA 92123

Mosaic Electronics
Box 748
Oregon City, OR 97045

Mountain Computer
300 El Pueblo Rd.
Scotts Valley, CA 95066

MPC Peripherals Corp.
9424 Chesapeake Dr.
San Diego, CA 92123

Netronics
333 Litchfield Road
New Milford, CT 06776

N.O. General Data Services
7230 Chadbourne Dr.
New Orleans, LA 70216

Orange Micro Inc.
1400 North Lakeview
Anaheim, CA 92807

PDS Universal Inc.
2630 Walnut Ave. Suite G
Tustin, GA 92680

Personal Computer Products Inc.
16776 Bernardo Center Dr.
San Diego, CA 92128

Persyst
15801 Rockfield
Suite A
Irvine CA 92714

Precision Technology Inc.
Computer Products Div.
2970 Richards St.
Salt Lake City, UT 84115

ACCESSORY BOARD SUPPLIERS

Pure Data Ltd.
950 Denison St.
Markham, Ontario, Canada L3R 3K5

Qubie Distributing
918 Via Alondra
Camarillo, CA 93010

Quadram Corp.
4357 Park Drive
Norcross, GA. 30093

Rana Systems
20620 South Leapwood
Carson, CA 90746

Renaissance Technology Corp.
1070 A Shary Cir.
Concord, CA 94518

Saturn Systems Inc.
PO Box 8050
3990 Varsity Dr.
Ann Arbor, MI 48107

Scion
12310 Pinecrest Rd.
Reston, VA 22091

S.C. Digital
Box 906
1240 N. Highland Ave.
Suite 4
Aurora, IL 60507

Seattle Computer
1114 Industry Dr.
Seattle, WA 98188

Sierra Data Sciences
26112 Lorain Ave.
Fairview Park, OH 44126

Sigma Designes Inc.
1400 Coleman Ave. F23
Santa Clara, CA 95050

Sigma Designs, Inc.
3866 Eastwood Cir.
Santa Clara, CA 95055

Sonic Micro Systems
1500 N.W. 62nd St.
Ft. Lauderdale, FL 33309

Southwest Technical Products
219 W. Rhapsody
San Antonio, TX 78216

SSM Microcomputer Products, Inc.
2190 Paragon Dr.
San Jose, CA 95131

Static Memory Systems
401 State Bank Center
Freeport, IL 61032

Systems Group
1601 W. Orangewood Ave.
Orange, CA 92660

Tara Computer Products
3648 Southwestern Blvd.
Orchard Park, NY 14127

Tarbell Electronics
950 Dovlen Place
Suite B
Carson, CA 90746

TK Engineering
Box 1936
Corona, CA 91720

Videx Inc.
897 N.W. Grant Ave.
Corvalis, OR 97330

Vista Computer Co. Inc.
1317 E. Edinger
Santa Ana, CA 92705

Votrax Speech Synthesis
500 Stephenson Hwy.
Troy, MI 48084

VR Data
777 Henderson Blvd., N-6
Folcroft, PA 19032

Wesper Micro Systems
3188 Pullman St.
Costa Mesa, CA 92626

Finally, for best resolution, an R-G-B rather than a video output is desirable. Boards that provide R-G-B outputs for computers that lack them are available from a variety of manufacturers.

Printer interface boards

While there are a great many boards on the market whose sole purpose is to provide a serial or parallel interface for use with a printer, there are a couple of types of printer-interface boards that do quite a bit more. One type is the high-resolution graphics interface, an example of which is the *Grappler +* from Orange Micro. That board interfaces an Apple *II* (or *III* with additional software) with any one of several popular printers. Among its features is the capability of providing high-resolution screen dumps to your printer.

Another popular type of printer-interface board is the spooler or buffer. Its primary purpose is to allow the computer to perform a new task while printing is going on. If you've ever just sat around and waited during a lengthy printout, you can imagine why that type of accessory board is in demand.

FLOPPY DISK CONTROLLER, model *UFDC-1* from 3SR Computers, is capable of connecting up to four floppy-disk drives to an S-100 system.

Miscellaneous boards

We've only touched on a few types of accessory boards available. A quick look through almost any computer magazine will quickly reveal that there is a board for just about any function. Among the other popular types are modem boards, speech-synthesizer boards, sound-effects boards, PROM- and EPROM-programmer boards, and instrument-controller boards. It is also possible to combine several functions in a single board: an example is Quadram's *Quadboard*.

In addition, while we've been concentrating on boards for bus-oriented systems as those types of systems allow for the easiest expansion, boards are also available for non-bus-oriented systems. The major problems with some of those is installation—while some simply replace existing boards in a machine, others require some modifications to the computer.

All of the types of boards mentioned in this article will help a microcomputer user get the most possible computing power out of his system at a relatively low cost. Still, there are some problems of which you should be aware. First, it's necessary to check the power requirement of any board you may be considering. If your micrcomputer is already on the ragged edge of its power-providing capability then it's likely that any additional expansion boards will send it over the edge. In that event, the only alternative is to "beef-up" your computer's power supply.

Another potential problem that could be caused by adding a board is heat production. If your computer is already running hot, adding another board may just push it over the brink to self-destruction if the system is incapable of handling the heat. If your system is running hot, it is best to add a cooling fan or upgrade an existing one. In fact, if your system is running hot, it's best to do that whether or not you're adding another board.

All-in-all, however, those problems are easily corrected, as we've shown, and should not keep you from upgrading your system with one of the many types of accessory boards we've discussed. **R-E**

How to save on ZX81

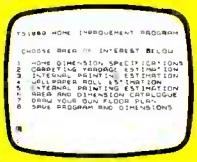
THE ORGANIZER An information storage program. Store the names, addresses, phone numbers, birthday and anniversary dates of your friends and business acquaintances.

THE STOCK OPTION ANALYZER Evaluate stock options quickly. Output includes an unexercised ROI, annual ROI, and NET worth. Last trading day calculated by computer.

VU-CALC This program constructs, generates, and calculates large tables for financial analysis, budget sheets, and projections. An immensely powerful analysis chart.

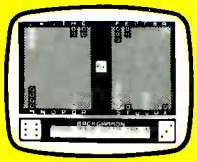
CHESS AND CHESS CLOCK Six levels. All the legal moves including castling and enpassant. Keeps a separate record of plays made for easy reference. Play another opponent or match wits with the computer

THE BUDGETER Keep track of your personal budgets and expenditures in categories such as food, clothing, rent/mortgage, medicine, education, savings, auto, and more.



THE HOME IMPROVEMENT PLANNER Store up to 20 room measurements (length, width, height), compute total area in each (wall, floor), estimate costs of painting, wall papering and carpets and draw house blueprints.

SUPER MATH Drill yourself on addition, subtraction, multiplication, and division with five levels of difficulty. Each problem graphically depicted.



BACKGAMMON AND DICE A perfect blend of chance and skill. Uses machine code to choose its moves. Full game including graphics board, rolling dice, and double cube. Play the computer or another opponent.

THE LOAN/MORTGAGE AMORTIZER Compare the cost of loans from different banks, review the details of your home mortgage. Be aware of the cost and how to minimize that cost.

THE HOME ASSET MANAGER A home inventory program that can be very valuable in case of fire or theft. Records date of purchase, place of purchase, description, price, serial # and model #.

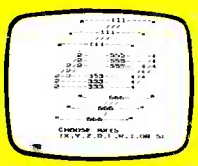
THE LIST MANAGER Mailing List—keeps track of personal or business mailing lists of up to 115 names by name, address or zip code. Phone Book—keeps track of personal or business numbers for up to 180 names.

THE GAMBLER Match your Blackjack skills with the ZX81 or TS1000. Full graphical display of cards dealt and winnings. Includes Double Down, Min-Max betting. Also a Slot Machine complete with rolling tumblers, payoff values, and coin drop.

THE COUPON MANAGER Keep track of coupons you save showing what they are for, where they are offered, starting and ending dates for validity.

REAL ESTATE INVESTMENT ANALYSIS Two different investment strategies. The first selection allows the user to choose between renting or buying. The second selection consists of a detailed analysis of the rental investment property.

STATES AND CAPITOLS Test yourself on the fifty states and their capitols. Three options of review are available. (1) States, you provide capitols. (2) Capitols, provide states. (3) A mix of states and capitols.



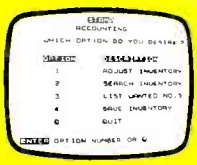
THE CUBE GAME The cube can be displayed in three views: (1) Solid; (2) Two-Dimensional (unfolded); and (3) See thru cube (3-D). You start with the cube solved, set it up any way you like, or pick up from a previous session.

THE CAR POOLER Keep track of car usage by driver, destination, and date. Rider data and time of departure is logged.

PERSONAL FINANCE PLANNER Perform calculations, finance a house, a car, keep savings accounts, repay loans and calculate an amortization schedule which can be generated for any of the financial programs.

THE FLIGHT SIMULATOR Take control of highly maneuverable light aircraft. With full controls, instrumentation and navigational aids to avoid hazards in landing.

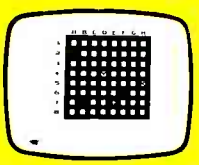
GRIMM'S FAIRY TRAILS A super game involving a young prince trapped in a maze, being chased by relentless maze dwellers. You control the prince and the chase is on. Life crystals and sacred stones are the goal.



THE STAMP COLLECTOR Inventory and store up to 600 SCOTT numbers in a single session showing quantity on hand, by major classification, and provide full want list support.

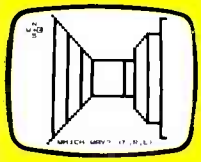
PORTFOLIO ANALYSIS Program performs minimum risk and market sensitivity calculations for a portfolio composed from a set of stocks. A portfolio is formed which gives the minimum amount of non-market risk for a given level of sensitivity.

STOCK MARKET—TECH. ANALYSIS I Program uses "technical analysis" of price and volume data to forecast the direction of the Market or of any stock. Track up to 6 stocks without reloading. You need 30 trading days of data, closing price and day's volume. Analytical summary of each stock average is computed.



THE MIXED GAME BAG I
Bowling—roll your ball down the alley controlling its flight from a keyboard.
Robot War—you are pitted against evil KORKON ROBOT in a duel of wits.
Bingo Caller—use ZX81 or TS1000 to randomly call a Bingo game.

or TS1000 software.

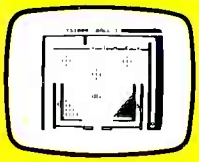


SUPERMAZE Navigate your way through a three-dimensional maze, with trapdoors, gold bars, marker stones, and compass. Ten separate mazes. Three-dimensional graphics.

THE PUZZLER Comes with two options: Inversion and Double Inversion. Inversion takes at least 250 moves to solve it. Double Inversion is twice as hard.

BIGFLAP ATTACK You're being attacked by giant birds! To defend yourself shoot the birds right between the eyes. 10 levels of play ability.

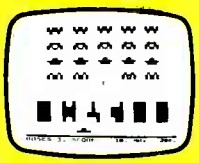
CHECKBOOK MANAGER A personal or business checking account program to store and sort banking transactions. On 90-minute tape, up to 3,600 transactions can be stored.



PINBALL Plays like real pinball complete with flippers, bumpers, "nudge," bonus points and more. Uses fast, efficient machine code to choose its moves.

INVENTORY CONTROL STOCK I —keeps track of inventory levels, suppliers, re-order levels and types for up to 400 items. STOCK II —keeps track of inventory levels for up to 2,500 items.

STOCK MARKET GAME Bull or bear? This realistic simulation lets you analyze information, buy and sell stocks, take out and pay off loans . . . and win, if you can accumulate $50,000 in "The Market."



SPACE RAIDERS, BOMBER Timex/Sinclair version of the popular arcade games full of bombs and rockets and collisions with skyscrapers.

FORTRESS OF ZORLAC A super fast game in which you are the commander of a fleet of spaceships. Your mission is to rid the galaxy of the dreaded alien, ZORLAC.

FROGGER Plays like the arcade game. Hop the frog over traffic, snakes, crocodiles, and treacherous diving turtles before time runs out.

MANUFACTURING CONTROL A comprehensive manufacturing system. Monitor cost factors, track work in progress, keep daily account on details that mean profit or loss for up to 150 products.

ATOR THE ABC GATOR Designed to teach recognition and sequence of the alphabet. Combines computer instruction, music and video games.

Sinclair,* the company that invented the world's most affordable computer, has invented a way for you to order the most affordable software—right from your home!

You've never had this wide a selection before. You can play games that challenge you, instead of bore you. You can learn new household applications and business programs that reduce work dramatically.

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The more you buy, the more you save. A serious Sinclair software offer.

The first cassette you buy, you buy at normal cost: $15.00. But every cassette thereafter, you get at a savings.

The list below explains how much you save, based on how much you buy. It couldn't be easier.

You were smart to buy the ZX81 or the TS1000. You'll be even smarter to take us up on this software offer. All cassettes listed at left work on both the ZX81 and the TS1000. All cassettes are 16K, which means you need the 16K Memory Module. (If you want more information on this component, please write Sinclair at the address listed below.)

But don't delay. This is a limited time software offer while supplies last.

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Call toll-free: 800-543-3000. Ask for operator 509. In Canada call 513-729-4300, operator 509. Have your MasterCard or VISA ready when calling. Phones open 24 hours a day, 7 days a week. These numbers are for *orders only.*

If you simply want information, please don't call, write Sinclair Research, Ltd., 2 Sinclair Plaza, Nashua, NH 03061.

(Sorry, no refunds on software. Defective cassettes will be replaced.)

Call toll free

800-543-3000

(operator 509)

Ad. code: B4RE

Mail to: Sinclair Research, Ltd.
One Sinclair Plaza, Nashua, NH 03061

Check the boxes of all cassettes you want. ☐ Check or money order enclosed.

- ☐ The Organizer #10
- ☐ The Budgeter #38
- ☐ Loan/Mortgage Amortizer #39
- ☐ Coupon Manager #12
- ☐ Car Pooler #40
- ☐ Stamp Collector #31
- ☐ Stock Option Analyzer #13
- ☐ Home Improvement Planner #29
- ☐ Home Asset Manager #47
- ☐ Real Estate Investment Analysis #30
- ☐ Personal Finance Planner #28
- ☐ Portfolio Analysis #41
- ☐ VU-CALC #11
- ☐ Super Math #14
- ☐ List Manager #45
- ☐ States and Capitols #32
- ☐ Flight Simulator #6
- ☐ Stock Market—Tech. Analysis I #46
- ☐ Chess #7
- ☐ Backgammon #8
- ☐ Gambler #43
- ☐ Cube Game #9
- ☐ Grimm's Fairy Trails #44
- ☐ Mixed Game Bag I #26
- ☐ Supermaze #34
- ☐ Bigflap Attack #42
- ☐ Pinball #35
- ☐ Stock Market Game #27
- ☐ Fortress of Zorlac #36
- ☐ Manufacturing Control #51
- ☐ The Puzzler #48
- ☐ Checkbook Manager #49
- ☐ Inventory Control #50
- ☐ Space Raiders, Bomber #5
- ☐ Frogger #37
- ☐ Ator the ABC Gator #33

Fill in the space beside total for your total payment

- ☐ 1 cassette: $15.00
- ☐ 2 cassettes: $25.00 (save $5.00)
- ☐ 3 cassettes: $35.00 (save $10.00)
- ☐ 4 cassettes: $45.00 (save $15.00)
- ☐ 5 cassettes: $50.00 (save $25.00)
- ☐ 6 cassettes or more: $10.00 each $_____

Plus Shipping/Handling **$5.00**

Total: _____ U.S. Dollars

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Street

City

State Zip

*Sinclair technology is the heart of both the ZX81 and the Timex/Sinclair 1000.

sinclair

GLOSSARY OF COMMONLY USED COMPUTER TERMS

For those readers unfamiliar with computer terminology, we have included the following glossary of some commonly used computer terms.

Address—The label or number identifying the register or memory location where a unit of information is stored.

ALU—*A*rithmetic *L*ogic *U*nit. The part of a CPU where binary data is acted upon.

ASCII—Acronym for *A*meric*a*n *S*tandard *C*ode for *I*nformation *I*nterchange. A seven-bit code used to represent alphanumeric characters. It is useful for such things as sending information from a keyboard to the computer, and from one computer to another.

Assembler—A program that translates assembly-language instructions into machine-language instructions.

Assembly language—A machine oriented language in which mnemonics are used to represent each machine-language instruction. Each CPU has its own specific assembly language. See *CPU* and *machine language*.

Baud rate—Serial-data transmission speed. Originally a telegraph term, 300 baud is approximately equal to a transmission speed of 30 bits-per-second.

Binary—Refers to the base-2 number system in which the only allowable digits are 0 and 1.

Bit—Acronym for *BI*nary digi*T*. The smallest unit of computer information, it is used to represent either a binary 0 or 1.

Bubble memory—A relatively new type of computer memory, it uses tiny magnetic "pockets" or "bubbles" to store data.

Bus—Parallel lines used to transfer signals between devices. Computers are often described by their bus structure (i.e. S-100-bus computers, etc.).

Byte—A group of eight bits.

Clock—The timing circuit for a microprocessor.

Compiler—A program that translates a high-level language, such as BASIC, into machine language.

CPU—Acronym for *C*entral *P*rocessing *U*nit. The part of the computer that contains the circuits that control and perform the execution of computer instructions.

Data base—A large amount of data stored in a well-organized manner. A data-base management system is a program that allows access to the information.

Disk operating-system—Program used to transfer information to and from a disk. Often referred to as a DOS.

EPROM—A PROM that can be erased by the user, usually by exposing it to ultraviolet light. See *PROM*.

File—A collection of data that is treated as a unit.

Firmware—Programs stored in PROM or EPROM.

Hardware—The physical components that make up a computer.

Hexadecimal—Refers to the base-sixteen number system. Machine language programs are often written in hexadecimal notation.

Interface—The connecting device between a computer and a periphiral.

K—Abbreviation for kilobyte (1024 bytes).

Machine language—Instructions, written in binary form, that a computer can execute directly. Also called machine code or object code.

Microprocessor—A one-IC CPU. One common microprocessor often used in personal computers is the Zilog Z80.

Modem—Acronym for *MO*dulator/*DEM*odulator. A device that transforms electrical signals into audio tones for transmission over telephone lines, and does the reverse for reception.

Motherboard—In a bus-oriented system, the board that contains the bus lines and edge connectors to accomodate the other boards in the system.

Port—A channel through which data is transferred to and from the CPU. An 8-bit CPU can address 256 ports.

PROM—Acronym for *P*rogrammable *R*ead *O*nly *M*emory. A semiconductor memory whose contents cannot be changed.

RAM—Acronym for *R*andom *A*ccess *M*emory. A semiconductor memory that can be both read and changed during computer operation. Unlike other semiconductor memories, this one is volatile—if power to the RAM is cut off for any reason, all data stored in the device is lost.

ROM—Acronym for *R*ead *O*nly *M*emory. A semiconductor memory containing fixed data—the computer can read the data but cannot change it in any way.

Software—Programs stored on tape or disk.

Source code—A non-executable program written in a high-level language. A compiler or assembler must translate the source code into an object code (machine language) that the computer can understand.

Word—Number of bits treated as a single unit by the CPU. In an eight-bit machine, the word length is eight bits; in a sixteen-bit machine, it is sixteen bits. R-E

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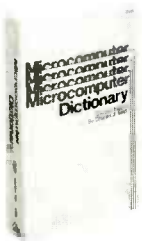

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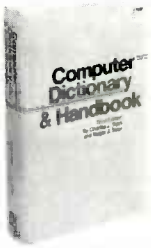

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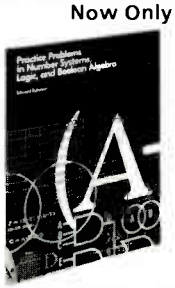

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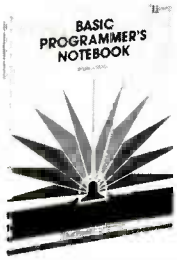

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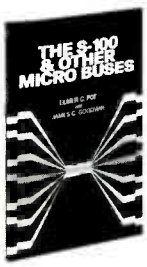

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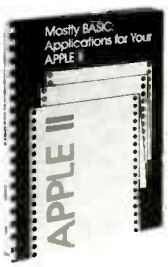

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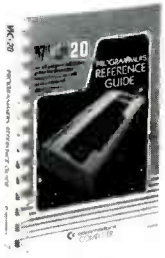

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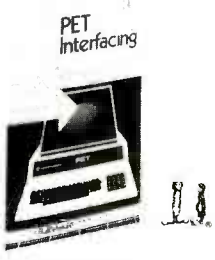

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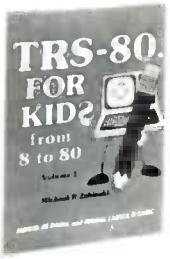

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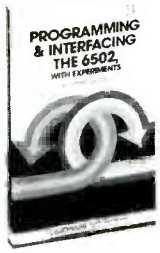

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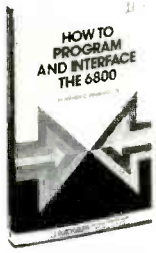

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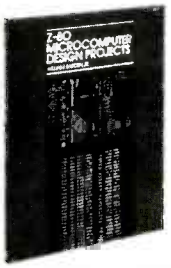

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Gadgets and Gizmos

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HERB FRIEDMAN

THE RANGE OF GADGETS AND GIZMOS THAT ARE AVAILABLE FOR personal computers is astounding. What is available includes rock-bottom-priced aids such as keyboard overlays that make software even easier to use; I/O converters that permit high-performance printers to be used with low-cost computer systems for word processing on a budget; and even disk simulators that add hundreds of thousands of bytes of RAM to a conventional 8- or 16-bit computer.

To show how an add-on can greatly increase a computer's capability or ease of use, let's start our tour through aftermarket hardware with a device that is made for Radio Shack's *Color Computer*: a serial-to-parallel printer converter.

The Radio Shack *Color Computer*—or "CoCo" as it is often called—has been a great value since its introduction. One reason is that it includes a serial output port that can be used for either a modem or a printer. Unfortunately, that port has some unusual characteristics, and until recently it could be connected only to a general-purpose printer that was really best suited for program listings. It wasn't possible to use one of the many high-performance, low-cost parallel printers on the market, such as the Epson *MX-80*.

First to rush in to change that was The Micro Works. Their *PI80C* serial-to-parallel printer adapter converts the serial output from the *Color Computer* to a parallel output. That allows the use of the Epson, or any of the other high-performance Centronics-type printers dumped on the market at rock-bottom prices—such as the Centronics *737*, and even Radio Shack's *Line Printer VII* that was sold off in some stores for the bargain price of about $300.

When the *Telewriter-64* software was introduced by Cognitec, it established the *Color Computer* as a full-featured, professional-quality word processor. The trouble was that there was no suitable low-cost daisy-wheel printer that would work with the *Color Computer* with or without the then-existing adapters. That problem was resolved by Botek Instruments' model *CCP-1* serial-to-parallel converter that works with every popular printer including the low-cost Smith-Corona *TP-1* daisy-wheel printer. With the Botek adapter, it doesn't matter whether you're using one of the old, new, or "salvage" parallel printers—they all work with the *Color Computer*.

Now that we have a picture of how drastically an add-on gadget or gizmo can affect a personal computer and its use, let's take a look at some others that are available and what they can do.

Software aids

Not all computer accessories are electronic. Some add-ons simply make a certain program easier to use. We previously mentioned keyboard overlays that can make software easier to use. They are available for *WordStar*, *dBase II*, and *SuperCalc*. *WordStar* and *dBaseII* are two of the best but most complicated programs to use because they have so many control codes and procedures. If you don't use one of those programs on a steady basis you will have to make frequent and frustrating references to the operating manual. *SuperCalc* isn't as bad—it's among the easiest of all the spreadsheet programs to use—but it also has an arm's-length list of command codes. However, with the *Kleertex* template for the Osborne (shown in Fig. 1), the operation of all three are simplified and they become almost a delight to use. I think that those *Kleertex* overlays by Creative Computer Products are possibly the best operating aids on the market. The precision die-cut keyboard overlays are made of heavy, flexible plastic. They have the commands grouped around the keys, and the grouping is better than the summary cards that the manufacturers supply with their software! The *Kleertex* aids have had test users up and running the three programs in hours rather than days or weeks. And they can quickly get you running a program that you haven't used in a while. They are supposed to

FIG. 1—KEYBOARD OVERLAYS from *Kleertex* can have you running software in hours rather than days.

be in the Xerox stores sometime in 1983. Personally, if I didn't own an Osborne I'd cut the templates down to fit my computer—which is how I'm going to fit the *Kleertext* template for *WordStar* to a Heath *H19* terminal.

Timex/Sinclair accessories

One of the great things about computer accessories is that they can increase the power of even the most inexpensive machine. One of the most popular low-cost computers is the Sinclair *ZX81* and/or the Timex/Sinclair *1000*. (The only difference between them is that the Timex, with 2K of RAM, has twice the memory of the ZX81.) That computer is used by some people as a trainer for children; by others who are on a budget as a "main" computer; and it's even used by owners of full-blown personal computers who want a portable that fits into an attache case. To say that the Timex has limitations is an understatement—but it is a remarkably powerful computer for the money. The "official" accessory is a plug-in 16K RAM module. Another Timex accessory, the printer (not yet available in the US), is tiny and uses thin rolls of thermal printer paper that are best suited for listings. But there are aftermarket outfits that turn out professional accessories for the Timex/Sinclair computers. For example, Memotech Corp. makes memory modules of 16K and 32K RAM and even 64K RAM. They also make a Centronics-type printer interface that permits the use of a standard parallel printer with the Timex and also a module for high-resolution graphics (198 × 248 pixels). As shown in Fig. 2, each module connects to the rear expansion port and has its own expansion port on the rear so that other modules can be plugged in and stacked. At the end of the line Timex's own 16K module can be installed. (For 32K total RAM you could use a Memotech 16K module and the Timex 16K RAM module.) The "award winner" of all those modules is the Centronics-type parallel printer interface. That lets the user step up to professional quality printing—no more little strips of paper.

Because the Timex/Sinclair computer is low cost and mass-merchandized it might well prove to be the most popular (at least the most widely sold) computer, so we can expect to see many more "expansion" devices offered as accessories. Already, full-sized, typewriter-like replacements for the hard-to-use membrane keyboard are hot sellers, as are keyboard "beepers" that let you know when you hit a key. We have read advertisements describing clock/calendars that plug into the expansion port, and even a communications modem and an EPROM programmer; but inquires to date have failed to turn up a production model—all appeared to be in the "final stages of production" at the time this article was prepared.

Printer accessories

Another gadget for printers—there are lots of them—is hardware generally described as a *microbuffer*. That's an 8K or 16K RAM specifically intended to connect between your computer and the printer. There are even models that provide as much as 64K or 256K of RAM. What's the advantage of one of those devices? You would know if you ever had to wait for your printer to finish printing a document before you could get back to using your computer for something else. The typical matrix printer for a personal computer runs at a top speed of approximately 80 characters-per-second. Some daisy-wheel printers are even slower, some as slow as 12 or 14 characters-per-second. If you have a long document it can take quite a while, perhaps 5 to 10 minutes to print 4000 words (24,000 characters). In "computer time," 5 minutes is a lifetime, and during that period your computer sits unused for any purpose other than to print the document. That's a most intolerable situation.

But if you connect a microbuffer RAM between the computer and the printer then the computer can dump characters into microbuffer RAM at speeds up to 120,000 characters per second, 2600 words in the blink of an eye. When enough RAM is free in the microbuffer the computer does another high-speed dump to fill the buffer RAM. While the printer extracts its data

FIG. 2—ADD-ON MODULES for the Timex/Sinclair computer from Memotech Corp. are stackable.

slowly from the microbuffer, the computer has its RAM free and can be used for other purposes.

Microbuffers are available under many different brand names for a host of computers and printers. Some get built into the printer, such as the one for the Epson printer from Practical Peripherals, Inc. Others are outboard accessories such as the *Printer Optimizer* from Applied Creative Technology, Inc.

We previously discussed a serial-to-parallel converter for the *Color Computer*, but other computers or computer users could also use such a converter. (That's not only for printers, but for any other parallel device.) Presume, for example, that you have just replaced some of your early computer equipment and discover that the new stuff is made for serial printers only. Or perhaps for some other reason you decide that serial is the way to go. But all your old printing equipment is parallel, and its trade-in value is zilch. What do you do? No, you do not mortgage the old homestead. Rather, you connect a $79.95 standard (Ho! Ho!) RS-232 serial-to-parallel interface adapter between the computer and the printer (or between the computer any other parallel accessory).

That adapter converts the computer's serial output to Centronics-type parallel, and if all goes as expected, everything should work. One standard serial-to-parallel adapter is manufactured by Engineering Specialties. Its lowest baud rate is 150 (rather than the more or less "standard" 300 baud) and the device will therefore work with Centronics-type parallel I/O, most IBM Selectric printer conversions, and the slow daisy-wheel printers such as the Smith Corona *TP-1* (which can be a real problem with serial/parallel converters because the computer is sending the second character before the first is printed). The Engineering Specialties converter has a one byte memory which allows the printer to finish before it receives the next character, and the printer will work even if the computer cannot send 110 baud. Because nothing in the world of computers is standard, I would suggest that you phone ahead and ask them if their gizmos will work with your system.

Take careful note that your printer, or the computer, must provide the 5V at 20-mA needed for the adapter. Most printers, but not all, have 5 volts on RS-232 pin 18. If not, you must provide the 5 volts from somewhere else.

When trouble comes

Having trouble interfacing your printer or your modem to your computer? Does your printer's output have no relation to the specified formatting? Surprise! Standard RS-232 doesn't turn out to be all that standard: sometimes it seems that everyone puts a zinger or two into their RS-232 connections so you have to purchase their software and hardware. (How I remember spending hours trying to get a modem working until I discovered that Heath held pin 20 of their RS-232 connection at five volts—why?)

If you like to use a lot of hardware peripherals, or if you are using several computers, a gadget that you might want is something called a *Model 50 Breakout Box* from Remark Datatcom, Inc. It has male and female RS-232 I/O connectors, and DIP switches in series with each signal line that permit you to open any of the 24 signal lines. Terminals on both sides of the switches allows the user to patch any input signal to any output terminal. It even has four common bus areas so you can connect two or more terminals together (some modem circuits need that). Six patch cords are supplied, and for those of us with poor memories, the standard RS-232 signal list is imprinted on the enclosure.

If your RS-232 hardware configuration doesn't work right then you can switch open the questionable signal lines, patch the input to what you figure is the output, and when everything works right you simply make up an ordinary patch cable with the wiring configuration that you worked out. The *Breakout Box* is shown in Fig. 3 and it can save hours of troubleshooting and calculations. While the $79 price of the device is a bit stiff for a one-time installation, its a great device for local users' groups. A slightly less sophisticated version (without the DIP switches, just patch terminals) is available for less than $40.

Male or Female?

It never fails: The connectors on your new peripherals are always the reverse of what you've been using. If all your connecting cables are male-to-male the next piece of hardware will require a female connector. Most of the gender problems with RS-232 style connecting cables are easily resolved with a *Gender Reverser* from B & B Electronics. Those are simply small printed-circuit cards with matching RS-232 connectors on each end (male to male or female to female). Attach your present RS-232 cable and *voila*, the gender on one end of the cable is reversed. The price of $19.95 is somewhat high, but that's about what it would cost you if you went out and purchased the connectors and cable from a local store, and the gender reverser is a lot smaller and more convenient. Normally, female-to-female is the most convenient reverser, so if your budget can only afford one, get the female model.

One megabyte on-line RAM.

No, you don't need a maxi-computer to get a megabyte, or even 8 megabytes of RAM on-line; all you need is lots of money and a device known as a disk simulator or semidisk. Consider your disk drive(s); if it's single density you can write about 100K. If it's double density about 180K. If it's double-sided double-density, 360K. Two drives? 740K and so on, all the way up to the megabyte range. Now imagine if you will that you replace the drive with RAM that is driven to operate as if it were a disk drive. The computer will write and read from the "disk;" but now, instead of a disk drive taking (what seems like) forever to locate the desired data, the signals zip through the RAM in microseconds.

To run a disk simulator you simply connect the device in place of a disk(s) drive and run an installation program. The computer then sees the simulator's RAM as a disk, and the data is stored in the RAM at it would be on a disk. There are two important differences: The RAM gives you virtually instant access to the data, and it is volatile. (When you turn off the computer's power, the RAM's data is lost.)

Disk simulators can be obtained as outboard add-on accessories or as cards specifically designed to plug directly into a computer in place of the disk drive. They are available for S-100 computers, the TRS-80 *Model II*, the IBM *Personal Computer*, and the Apple *II*. They are so successful that we can expect models will soon be available for every personal computer that uses a disk system.

One problem with disk simulators is that they lose their memory contents when power is shut down or interrupted. That, of course, is because of the properties of RAM. There is, however, a disk simulator that does not suffer from that shortcoming: the *Bubdisk* from MPC Peripherals Corp. That device is

FIG. 3—IF YOU HAVE TROUBLE with a "standard" RS-232 interface that is not standard, the *Breakout Box* can help you figure out what's wrong.

a bubble-memory disk simulator. Bubble memories feature the read/write abilities of RAM's along with the non-volatility of ROM's, and the mass-storage capabilites of a tape or disk.

The 128 K *Bubdisk* has an interesting feature. In the event of a power failure or brown out, the board will automatically power down to ensure the reliability of the stored data.

What happens to the disk-operating system, utilities, and the like? That's all on the first disk drive. The simulators are used in place of the second, third, or fourth drive, depending on the particular computer installation. You can use the simulator RAM for program development, or whatever, and store the end result or data on the remaining disk drive(s).

As with all new things, simulators don't come cheap. A 512K simulator goes for almost $2000—but that's today's price.

More *Color Computer* accessories

One of the major limitations of the *Color Computer* is that you can have only one ROM module plugged in at a time because there's only one ROM module port. Considering that aftermarket distributors are packaging their software in their own ROM modules, it's conceivable that there will soon be a need to run several modules at one time. For example, a disk drive (which uses the module port), a BASIC AID module, and who knows what else—the *Color Computer* is fast becoming a giant in low-cost computing. Among the leading gadgets to expand it is the Basic Technology's *BT-1000* color computer expander, which is a device that converts the single ROM module port into five ports that can handle either ROM or RAM modules. Why would you use a RAM module on a ROM port? To expand RAM. The ROM port address is located above the internal RAM, so RAM used on the ROM port will provide additional RAM at the top which can be used to store utilities, etc.

For those who want to add professional-quality time keeping to their "CoCo" programs, Basic Technology has a crystal-controlled module for a real-time clock/calendar that provides the day, date, month, year, hours, minutes and seconds. An internal NiCd battery keeps the module running when the computer is turned off.

For those owners who want to design and build their own hardware, Computer Accessories of Arizona has a breadboard that plugs into the ROM module port and brings out the data, address, and control signals. It provides 16 square inches of pre-drilled breadboarding area with plated-through holes that are compatable with wirewrap accessories.

There are probably more accessory joysticks available for the *Color Computer* than for all the video arcade games. Those "high performance" or professional (professional?) joysticks can let you zap more Klingons, protect more cities, destroy more missiles, than any other. Each claims to be a breakthrough in the state of the art of joystick technology.

Moses Engineering (PO Box 11038, Ardmore Highway Sta-

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Utica, MI 48087

Cognitec
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Del Mar, CA 92014

Computer Accessories of Arizona
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Scottsdale, AZ 85254

Engineering Specialties
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PO Box 2233
Oxnard, CA 93030

General Automation
9600 Roosevelt Blvd.
Philadelphia, PA 19115

Giltronix, Inc.
970 Sab Antonio Rd.
Palo Alto, CA 94306

Memotech Corp.
7550 West Yale Ave.
Denver CO 80227

MPC Peripherals Corp.
9424 Chesapeake Drive
San Diego, CA 92123

Practical Peripherals, Inc.
31245 La Baya Dr.
Westlake Village, CA 91362

Remark Datacom, Inc.
4 Sycamore Dr.
Woodbury, NY 11797

RKS Industries
4865 Scotts Valley Dr.
Scotts Valley, Ca 95066

The Micro Works
PO Box 1110
Del Mar, CA 92014

tion, Huntsville, AL 35805) has a light pen that plugs into one of the *Color Computer's* joystick ports. It takes some programming skill in BASIC to use the light pen, but you can write programs where the pen "selects" the correct answers from a screen full of words, patterns, or anything else. That light pen needs some better documentation if it's to be used by beginners and newcomers to BASIC, but if you know what light pens are all about you probably can make it do many tricks.

For those who need a larger computer but have so much invested in their *Color Computer* that they can't bail out for something larger, there's an expansion interface from General Automation. That gizmo—or is it a widget?—is disk compatable; it provides 64K RAM access for the 32K Revision-E model of the *Color Computer*. It provides a parallel port for a printer or I/O—leaving the RS-232 port available for simultaneous modem use, selects up to 7 more peripheral cards, and can even handle a speech synthesizer.

Expansion

If you're having trouble trying to run several peripherals on one I/O port then you should be aware that Giltronix, Inc. makes "black boxes" that eliminate plugging and unplugging equipment when you want to substitute, say, a printing terminal for a CRT terminal, or a printer for a modem, and so on. Their model *ASU-3* is an automatic port selector that will connect any one of three peripherals to a CPU or CRT by simply entering a command on the keyboard; the appropriate baud rate is set automatically when the peripheral is switched. For those of you trying to get microcomputers to run like a data-processing system, Giltronix has models that switch 5 or 7 peripherals.

Killing the killer

It takes but a single transient surge on the power line to zap hours of programming effort loaded into RAM if it rides through your computer's power supply. Now the kind of surge we're talking about isn't one that dims the lights or shrinks the video display. Rather, it is one so brief that you never know it occurred until you look up and see your screen is filled with "garbage." The fact is that even a lightning hit miles away can cause a transient that will zap your computer. There are many devices on the market designed specifically to squash that type of transient. They go under various brand names but they all accomplish the same result. One example that we will give is the *Surge Sentry* from RKS Industries. That is a protector that plugs into the powerline and the computer plugs into it. Transient surges that exceed approximately 180 volts are suppressed by the device before they even get a chance to enter the computer.

Controlling the world

In the early days of computing, no newspaper article on computers was complete without some anecdotes about computerists who "enhanced" their lives with a home controlled by a computer—or was it really a computer that controlled their lives? The computer turned the lights on and off, answered the phone when no one was home, put up the coffee in the morning, turned on the lawn sprinklers, and kicked the cat out for the night. What those articles failed to spell out was that most of the hardware was customized, very expensive, difficult for the non-engineer to install, and usually wasn't worth the effort: Do you really want coffee made from water that's been standing out all night? But, if you want your computer to control the outside world, it's now easy and relatively inexpensive. Radio Shack has a controller priced at $39.95 that works in conjunction with the BSR controller modules—the same modules that are used with the BSR *X-10* Wireless Remote Control System. As determined by your BASIC program, the controller broadcasts a BSR-type signal through the AC powerline, causing the individual modules to apply or remove AC power from an attached appliance. Though Radio Shack has been more or less the leader in utilizing the BSR-type device for control of the outside world, from time to time other control devices for other computers appear in the marketplace. As a general rule they are usually some form of parallel output port providing a TTL signal to which you must connect a lot of extra switching hardware; or they provide a low-current "dry" contact closure for eight or more circuits. Again, you provide the rest of the hardware. Except for the BSR-type controller, the other designs come and go because they are simply too much trouble for the non-technical personal-computer user. But if a BSR-type controller becomes available for your particular computer, snatch it up, even if you have no use for it at the moment. (It's amazing the uses you find for it after you own one.) They are relatively inexpensive and a delight to use—meaning they are user-friendly; they actually can switch a small room-size air conditioner directly, without any intermediate hardware.

As you have probably noticed we haven't even touched on hard disk drives, disk-storage cabinets, disk-drive cleaning kits, covers, protectors, add-on monitors, or a dozen other things. Those are all standard equipment used or desired by almost all computerists. We've concentrated on the gadgets and gizmos that are relatively unknown or unused, but that can put a lot of power and/or pleasure into your computer system. Often, a gadget you never thought you would need (or maybe that you never even thought of at all!) suddenly becomes the key to a whole new direction in personal computing. **R-E**

Radio Electronics YOUR OWN Computer APRIL 1983

Data terminals

If you want to access dial-up information networks or data bases, but don't need the power—or expense—of a home computer, then here's an attractive alternative.

MARC STERN

ONE OF THE MOST EXCITING RESULTS OF THE COMPUTER REVOlution is the ability with which we can access and use information. We now have more information we can access than ever before, such as stock reports, world news, and other data. That data is available from the wide variety of information networks that have been established in the last several years—and all of it is only a phone call away.

Those information systems (sometimes called remote databases) include The Source, CompuServe, and Dow Jones, to name just three of the major, general-interest networks. However, there are many other smaller and more specialized services available, too.

Access to those services has been somewhat limited until now. That's because if you wanted to connect to such a database, you had to have a computer and a modem with which to link the computer to the service. However, that left a wide segment of potential users out of the system, because many of them didn't have computer facilities available.

But that situation is rapidly changing as low-cost home computers are becoming more widespread. Any of those personal microcomputers, when used with the right software and a telephone modem, can connect to one of the information networks. It is necessary, of course, that you have a subscription to the service.

However, there are some people in the population who really might not care to own a microcomputer, but still want some way to access one or more of the many networks. What are those people to do? They can opt for any of the personal data terminals available on the market. Those range from keyboard-only "dumb" units to "intelligent" terminals that include their own display screen, modem, and more.

Although some terminals do offer a number of features, none can do as much as a personal computer can. What, then is the advantage of a terminal? The answer, obviously, is cost. Terminals are available as complete units in a price range from $399 to about $700. Compare that to a cost of about $1,000 for the average home computer configured with the equipment and software needed to act in a terminal role. That includes not only the software package that can run up to $150, in some cases, but also the modem, display screen, necessary memory, and possibly a printer. Yes, it is true that a top-of-the-line intelligent terminal with a printer can approach that price level, too, but for the average user who wants to save some money, a terminal is the best bet.

Dumb or intelligent?

Before we go any farther, there are several terms which have to be defined, and we'll start with "dumb" and "intelligent." A dumb terminal is just what the name implies—it cannot act for itself and must be driven by another system. It can be driven by a mainframe computer, a minicomputer, or a microcomputer. That type of terminal, available from many sources, is incapable of all but the most elementary functions, such as rudimentary screen editing and cursor movements.

An intelligent terminal, on the othr hand, is usually driven by an 8-bit microprocessor. While it is capable af acting as a dumb terminal, it can really do much more. It allows you to have a great deal more interaction with the system or network to which it is attached.

Let's now take a closer look at each of those types of terminals, and the features and capabilities that you can expect from each.

Essentially, the dumb terminal is a slave to the system to which it is connected, and the user must access the system's functions to support the terminal's actions. The terminal may include a port for connection to a modem, but it includes little else except for a keyboard processor that decodes the keyboard inputs, a ROM that contains character-generating information,

and a video driver that produces the screen display. It might also include a small amount of RAM—maybe enough to store three or four pages of information from an information network or from a mainframe system. However, it is incapable of supporting any other peripheral equipment, such as a line printer for hard copy.

If we now look at the intelligent type of terminal, we find that the motherboard not only includes an 8-bit microprocessor, but also a good bit of RAM and ROM. The intelligent terminal is also capable of driving a printer for hard copy, and it contains a line editor so you can compose and edit messages for transmission as electronic mail. It might also have some special features. For example, it might be capable of instant access to such services as The Source or CompuServe if its ROM is programmed for that.

ASCII

If you shop for a terminal, another term that you will run into is the acronym ASCII (American Standard Code for Information Interchange). Essentially, ASCII is a a binary data code that takes the information generated by your system and turns it into a binary or machine-level number or code. Its purpose is to allow for information exchange between equipment made by different manufacturers. Since the code is almost universal, the information generated by your XYZ Co. terminal will be readable either by an ABC Co. terminal, a mainframe computer, or a distant database or network. Conversely your terminal will recognize the information coming into it from any (ASCII encoded) source. If you are in the market for a terminal, be sure that it is an ASCII-capable unit. All of the terminals mentioned in this article use the ASCII code.

In most terminals, the generation of the ASCII codes is handled by an input/output (I/O) processor. The I/O processor contains the necessary code-generating information in ROM, especially if the terminal doesn't use ASCII on its own internal communications bus. The I/O processor takes the digital information it receives from the screen memory or RAM, and then performs the necessary encoding to turn it into properly-coded signals, so that the terminal can communicate with others. If the terminal uses a different internal data-encoding format, then the small I/O processor will turn the ASCII code it receives into machine-usable form. However, it should be noted that most terminals are able to use or generate ASCII directly, so the somewhat complex circuitry needed for translation and code generation isn't normally necessary.

Although ASCII is almost universal for data communication, there are some companies which still insist on using their own coding. A good example of this is IBM which still has many systems in the field using EBCDIC (*E*xtended *B*inary *C*oded *D*ecimal *I*nterchange *C*ode).

Input/output

In order for the terminal to communicate with a computer, an information network, a printer, etc., it must have some type of I/O port. There are two major kinds: parallel and serial. We'll try to explain the difference between the two without going into too much detail. A parallel port sends/receives data eight bits at a time. In contrast to that, a serial port sends/receives data serially—one bit at a time. Therefore, a parallel port can handle data much more quickly than a serial port can. However, a serial port is a more reliable method of data transmission, because it is less susceptible to noise pickup, especially over long distances. Furthermore, we should mention that serial transmission is used over the phone line. Parallel transmission, on the other hand isn't really feasible on any but a hard-wired, dedicated system. (It cannot be used with phone lines.)

On some terminal systems, you will not see a serial port. Instead, you will see a modular phone jack. However, don't be misled; inside the box there is an interface to handle the work of input and output. What the manufacturer has done is to put the modem inside the terminal. All you have to do is plug in your (modular) phone plug.

Displays

The quality of the display that you can obtain is limited by both the terminal's ability and the ability of the display screen itself. First, we'll start with the terminal.

If you look closely at the display, you'll see that the characters are actually made up of dots. The quality or clarity of the characters is determined by the size and number of the dots in the *dot matrix*. A matrix of 5 dots (width) by 9 dots (height) will yeild characters with reasonable definition. However, a 7 × 9 matrix is better because the dots are closer together and therefore the letters have more clarity.

Just because the terminal's character generator is capable of producing characters with high resolution, that doesn't assure you of having a readable display. The capability of the display screen comes into play here. The display screen is divided into a series of *pixels* (a horizontal measurement) and picture lines. It is the interaction of those two parameters that defines the sharpness or clarity with which you will see a graphic display or character. The more picture lines and the more pixels you have, the sharper will be the characters you can obtain. Thus a high-resolution screen may have a display capability of 512 × 250 (512 pixels × 250 lines) and will give a good display. Conversely, a display with a resolution of 140 × 200 will have relatively poor graphics or character-generating capability. That principle can be seen easily by comparing a magazine photo to one from a newspaper. Although both are made up of dots (look closely!), the magazine photo is sharper because its dots are smaller and closer together.

The display on an intelligent terminal is normally 24 lines × 80 columns—the commonly accepted industry standard. On most of those terminals there is a 25th line. That is the *status line*, and it gives the operator an indication of what mode the terminal is in.

The status line usually appears at the top of the screen and it is a non-changing feature of the screen. It will display the mode the terminal is in, whether it is on-line or off-line etc.

Menus

Many terminals are also user-friendly in that they display a series of *menus*. A menu gives the user a list of commands and the key to push to execute any of those commands. This prompting guides the user through the steps needed to access a function. The menu routine is usually accessed via a HELP key or keyboard routine. An example of a menu for an auto-dial function is shown in Fig. 1. Note that it tells the user exactly how to use the function. For example it says to press a letter to dial, to press F2 to change the directory, etc. If a system is menu-operated, even a first-time user should have little problem in running it.

Now we have covered some of the basics that you'll have to know when you are first in the market for a terminal. However,

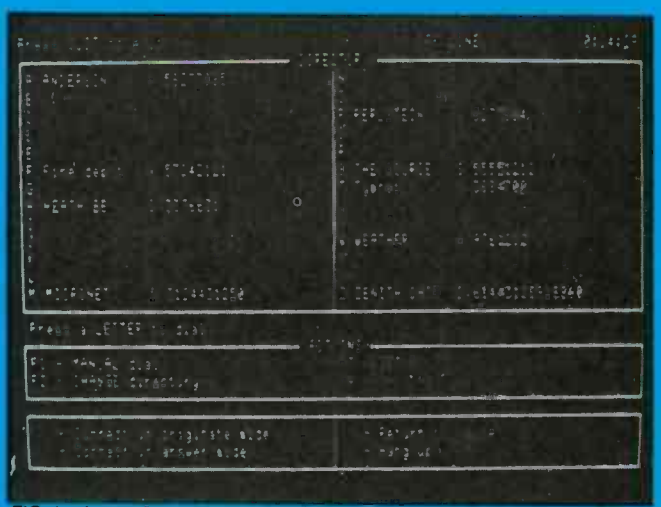

FIG. 1—A menu-operated system is easy to use even for someone with no previous experience.

FIG. 2—Radio Shack's *TRS-80 DT-1* is a high quality data terminal.

there are other things to be considered, and we'll get to those next.

Modems

Because modems are covered in detail in another article in this magazine, we will not discuss them here in great detail. We will, however, mention a couple of considerations to keep in mind. First, the modem should be Bell 103 compatible. That is a communications protocol which allows transmission at 300 bits per second or 300 baud. If it is Bell 202/212 compatible it is possible you may not be able to log onto an information network. (That type of terminal or modem runs at 1,200 baud and most information systems are geared to run at 300 baud.) If, however, the network offers a 1,200 baud option and you can use it, then do—you'll save a lot of time.

Many terminals themselves can be configured to run at many speeds up to 9,600 baud of more and can be hard-wired to a local mainframe or dedicated minicomputer. But, unless you have a dedicated phone line or circuit, then the highest speed possible for reliable communication over a phone line is 1,200 baud. After that, the bandwidth taken by the signal is too broad and there are too many chances for error.

Two more items about computer communication by phone of which you should be aware are the method of dialing and the phone-jack requirements. If your terminal is capable of auto-dialing and it uses the DTMF (*D*ual *T*one *M*ulti-*F*requency) system (commonly called *Touch-Tone*) but your phone system hasn't been computerized and still uses the older form of pulse (rotary) dialing, then it is possible that you won't be able to access the information network directly from the keyboard. Instead, you'll have to use your phone to establish communication. Further, if your terminal is equipped with a modular plug and your home has only the older-style block terminals, then you'll have to buy an inexpensive adapter.

Some examples of terminals

Now that we have looked at the different types of terminals and what they can do, let's take take a look at representatives of the types of terminals available for you. Those include the dumb terminal, the intelligent keyboard-only unit, and the all-in-one intelligent terminal.

The *TRS-80 DT-1* (from Radio Shack, One Tandy Center, Fort Worth, TX 76102) shown in Fig. 2, is a good example of a dumb terminal. Although it is best-suited for hard-wiring to a

FIG. 3—The RCA *VP3501* Videotex Data Terminal includes, among other features, a built in modem and built in tone and white-noise generators.

mainframe computer or interoffice information network, it can also be used, with a modem (not included in $699 purchase price), to access an information network. The video display is in black-and-white and it is capable of displaying the standard 80 columns by 24 lines and both upper and lower case letters. That display is housed along with a standard keyboard (with separate number keypad) in one cabinet.

Ten data transmission rates are keyboard-selectable, and range from 75 to 19,200 baud. Also included in the *DT-1* is an RS232C-compatible communications port and serial and parallel printer ports.

An interesting feature of the terminal is that it is code-compatable with four popular terminals: the TeleVideo *910*, Lear Siegler's *ADM-5* and *ADDS 25* and the Hazeltine *1410*. The particular configuration that you want to use is keyboard selectable.

The second type of terminal that we will give an example of is the keyboard-only intelligent terminal. That type is best typified by the RCA *3301* (RCA MicroComputer Products, New Holland Ave., Lancaster, PA 17604). That terminal is intelligent because it has many features including user-definable characters, full control over color graphics, tone generator, and more. It features a membrane-type keyboard, rather than a typewriter-like keyboard. However, the embossed characters are arranged in standard "QWERTY" typewriter style.

The *3301* is priced at $369. That does not include the external modem which must be used for network access. (A similar RCA terminal, the $399 *3501* is shown in Fig. 3. It *does* include an internal, direct-connect modem. It also includes a built-in printer interface, and can be hooked up to RCA accessories to make it capable of such funcions as auto-dialing to make it even more intelligent.) It offers the choice of interfacing with a standard color or black-and-white television or a computer-grade monitor (which will provide better resolution than the standard TV). However, this keyboard unit is capable of generating a display which is only 40 columns wide—that is half of the 80-column industry standard. In another mode, the characters become double-sized, cutting the display in half to 12 lines by 20 columns. The dot matrix is 5 by 6, which means, the letters do not have good definition. Besides generating 52 upper and lowercase characters, 10 numerals, 32 punctuation and math characters, and 31 control characters, there are also some user-definable characters. Also, since it is intended to be linked to a color terminal or TV, it can display eight colors in eight levels of brightness.

The unit also offers the option of setting transmission parameters. For example, six baud rates from 110 to 19,200 can be selected. Also, even or odd parity can be chosen. (Parity refers to a error-checking code where the the total number of 1's or 0's in a character code is counted. If even parity is chosen, and

an odd number is counted, then you know that an error has occured in the transmission.) If even or odd parity is not chosen, then you can select the status of the eighth bit of a character to be either a mark or a space.

Full or half duplex can also be chosen. Let's see what that means. In the full-duplex mode, when you type in a character, the terminal waits for an *echo* from the computer or network before it displays it on the screen. In the half-duplex mode, whatever you type on the keyboard is shown on the screen while it is transmitted.

Another example of a keyboard-only intelligent terminal is Radio Shack's *TRS-80* videotex terminal. That $399 terminal is shown in Fig. 4. It features a full, standard keyboard and interfaces with either a color TV or a monitor. The unit features a 6809E eight-bit microprocessor. It also has 16K of RAM so a user can store up to 32 pages of information for later viewing. One advantage of that is that in some cases it can cut down the amount of time that you are connected to the network, thus saving you money. A user also has the option of interfacing a 128K disk for mass storage.

FIG. 4—The Radio Shack *TRS-80* videotex terminal includes a built-in modem and 16K RAM.

Another type of intelligent terminal is best typified by the Zenith Data Systems *ZT-1* (1000 Milwaukee Ave., Glenview, IL 60025). That terminal, one of the best on the market, is shown in Fig. 5. The *ZT-1* is menu-driven—it displays the choices available from the moment the power is turned on. A series of menus makes it possible to use one key to perform most functions.

FIG. 5—The *ZT-1* from Zenith is one of the most intelligent terminals on the market. Its built-in prompts also make it one of the easiest to use.

One of the interesting features of the *ZT-1* is its built-in auto-dial modem, which we mentioned previously (the phone directory is shown in Fig. 1). You can store a directory of up to 26 phone numbers in battery backed-up RAM. Then, to make a call, all you need do is press the single key that the menu indicates.

A real-time 24-hour clock runs when the *ZT-1* is turned on. That can be used to keep track of on-line time, or just to keep track of the time of any telephone call.

The $699 *ZT-1* includes a 12-inch green-phosphor monitor that displays the industry-standard 24 lines of 80 characters (plus a status line). It is also capable of producing a double sized display. The character dot matrix size is 5 × 9. It will also support both RS-232C and TTL communications at rates from 110 to 4,800 baud.

FIG. 6—Its briefcase size and built-in modem and printer makes the *TRS-80 PT-210* ideal for anyone who needs a portable data terminal.

The next termal that we will look at is different from those discussed above. This terminal—Radio Shack's *PT-210* portable data terminal (shown in Fig. 6)—is not meant to be used with a display screen. Instead, it contains a built-in non-impact thermal printer. Also built in is an originate-only modem with acoustic coupler. An RS-232C interface module, which allows you to connect the *PT210* directly to a host computer, is available from Radio Shack for $70.

The unit comes with a full-sized, ASCII-encoded keyboard. It will operate at 110 or 300 baud, in duplex or half-duplex modes, and with even or odd parity. Although the keyboard does not contain a separate numeric keypad, it does include an interesting feature: a switch-selectable number-entry keypad. When that feature is chosen, thirteen of the letter keys form a calculator-style keypad so that you can easily enter numbers and signs.

The built-in printer uses a 5 × 7 dot matrix and it offers a variable contrast control. Seventy-one characters are printable, with lowercase letters printed as their uppercase equivalent. Each line can be the industry-standard 80-characters long.

So, is a personal terminal for you? Well, in short, a terminal is perfect if you want to be able to "enter the information age," but do not want (or can't afford) a microcomputer. It might also be ideal for you if you *do* have a microcomputer. For instance, you might want to quickly check the latest stock market report at the same time you are using your computer for another task. With a terminal, you can get that report while your microcomputer keeps on working. R-E

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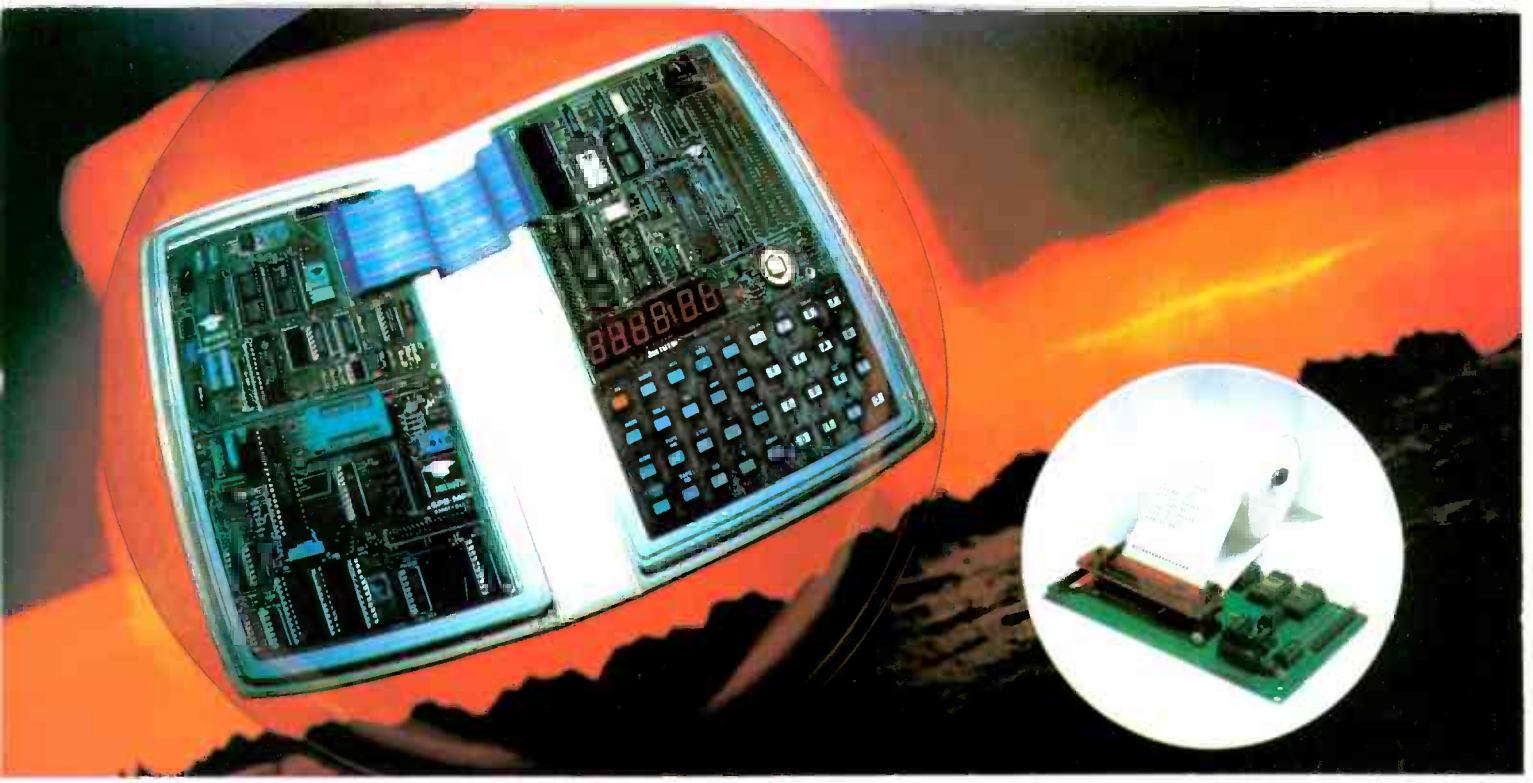

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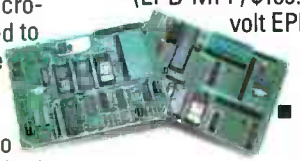

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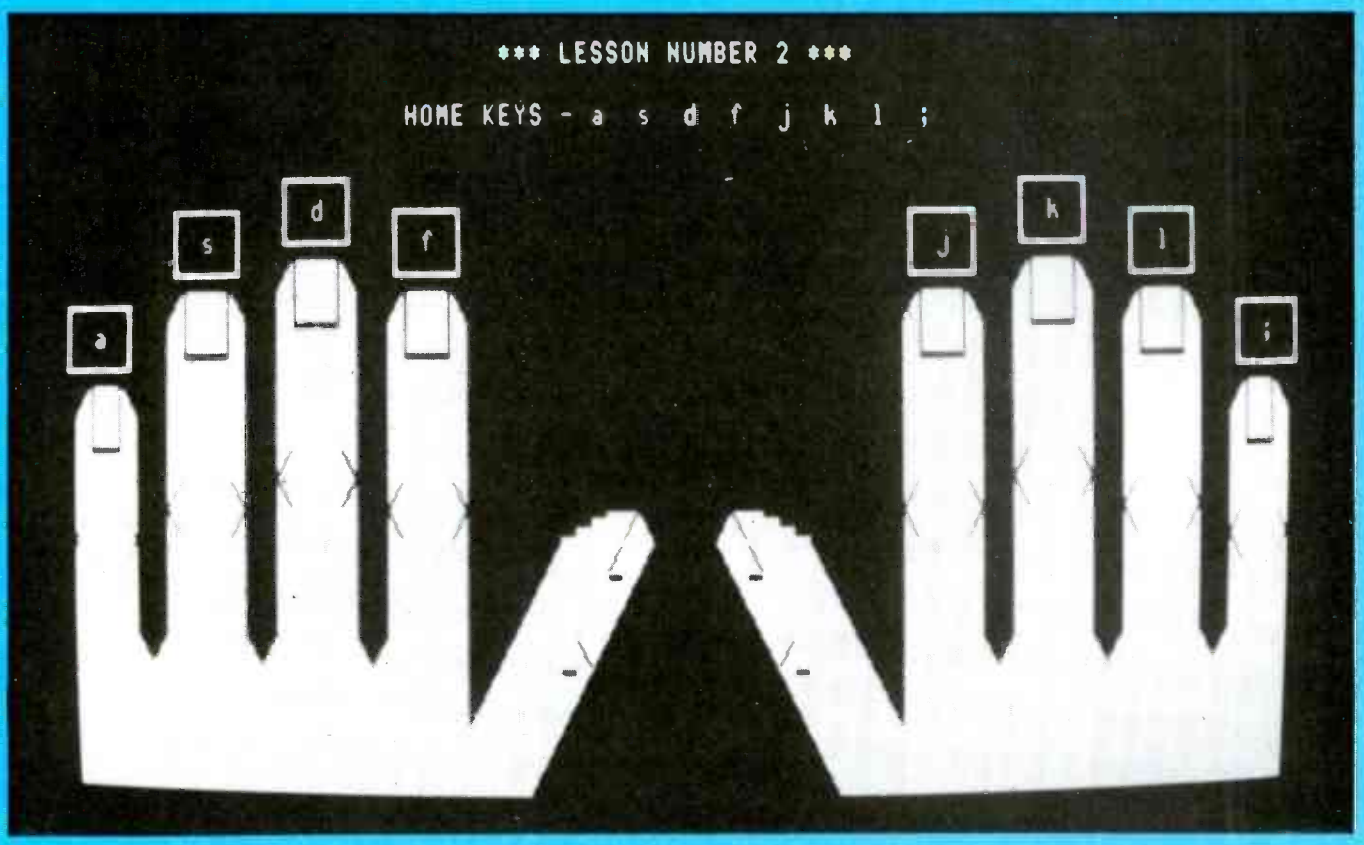
Budget Software



Need some software to perform an unusual task—or even an ordinary one—at a reasonable cost? There are quite a few low-cost, sometimes unusual, and almost always overlooked programs available that just may do the trick.

HERB FRIEDMAN

RESPONDING TO A CRITIC'S REMARK ABOUT "...A LITTLE-known work that never got the credit it deserved," the great playwright Noel Coward observed that. "Little-known works that never got the credit they deserved never deserved any."

As a general rule of thumb, Coward's observations are true, except when it comes to personal computers—where quite a bit of good, low-cost software is ignored in favor of the more expensive, more sophisticated, and more famous programs whose very names have become so well known that they have become almost synonymous with their function: *Wordstar* for word processing; *VisiCalc* and *SuperCalc* for electronic spreadsheets; *dBase II* for database management, etc. There were, of course, good reasons for the success of *VisiCalc* and the others—they stood, and in some instances still stand, head and shoulders above the competition, and their performance often exceeds what's available for mini- and mainframe computers.

But not every user of personal computers needs all of the power offered by that sophisticated software. In fact, many of you probably have no need for any of the high-priced programs. Often, all the computer functions you truly need may be available at a rock-bottom price in a small, unsophisticated program, or from the highly specialized but underadvertised software that is available from the smaller software houses (some of which are no more than someone's garage or kitchen table).

Little things can cost a lot

When looking for low-cost or unusual software that really works, keep in mind that a seemingly insignificant variation in features or function can represent a substantial increase in programming effort and a corresponding increase in price: you may have to accept a compromise to get the computing power you want at a price that fits your budget. For example, one of the largest auto-rental companies catering to driving schools keeps its records on a minimal computer system (no disk drives) using a $19.95 software package. It provides all the records needed by almost 50 schools and their students, the individual driving instructors, the State Motor Vehicle Bureau, and the tax accountant. How is all that possible for under $20? Simple—the program does not keep track of auto repairs or write the checks for those repairs. After much testing, the rental company discovered it could easily keep track of service on 3 × 5 file-cards, and the total number of checks per month for repairs never exceeded 12. A program to keep track of repairs and pay the bills would have cost several hundred dollars, required a computer

with at least two disk drives, and a fairly competent and experienced staff of CRT-terminal operators. The reason that adding repairs and repair payment to the program would sharply increase the program's complexity and cost is that software features generally interlock. If a programmer decides to provide extra function A, he may have to rewrite the code for functions B, C, D, K, L, M, and Z. And, modifying C may require new code for O, P, and Q, which in turn may affect the original work for A. That is why a so-called "simple" patch for commercial software often ends up as a series of patches.

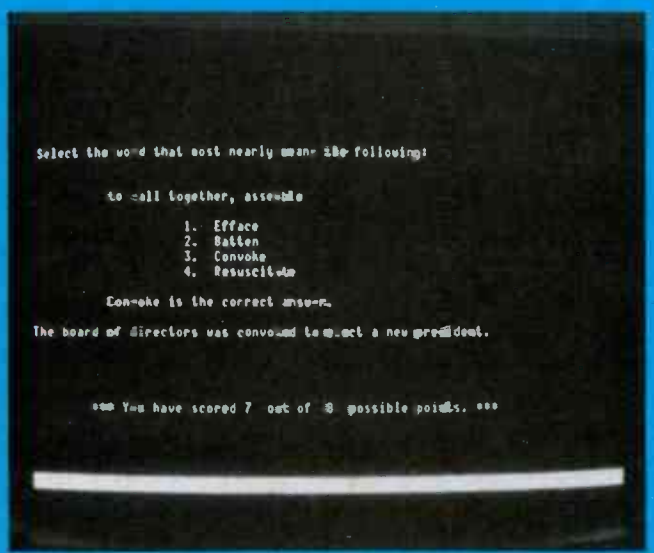
While the $19.95 software-package has none of the esoteric functions of the super-duper database systems presently being touted for even the casual personal-computer user, it nevertheless does the job—and that's the purpose of any piece of software.

Ideas to work with

Whether it's widgets, gizmos, or computer software, locating the obscure or inexpensive is usually simply a matter of knowing what you're looking for, or at least having some idea of what's available that can possibly be used as a substitute; so we'll take a look at some of the programs that have never received the attention they deserve—usually because they don't offer high-powered features. And we'll look at some highly specialized software whose value isn't apparent at first—or even second—thought. Most of it is quite decent for the money and a good idea of what's available in "far out" software. While some examples are listed specifically by name and computer type, similar software is generally available for most, if not all, of the popular computer systems.

Looking up

Heading our list of unusual software is the most expensive of all, because the package takes at least 6 disks. That gem is something called *THE WORD Processor*. No, it isn't yet another text editor or word processor, it is actually a database for the King James version of the Bible. The software allows the user to search out any information or reference in the Bible by range—such as Genesis 1:1 to Genesis 50:12—or by text, phrase, or word—like locating "Beer-sheba." Using combined search criteria (several words or phrases) it's possible to look for complex relationships of words or text. It's also possible to construct a dynamic (easily modified) index of specific words or phrases—a library of Biblical research-materials. You can merge indexes, modify indexes, delete indexes, and print just about any combination of anything. As a research tool for the home, or for the college student majoring or minoring in religious studies, the program is dynamite—it would be nice if most commerical data-bases were done as well. *THE WORD Processor* is from Bible Research Systems and was originally written for Radio Shack's *TRS-80 Model III*, Apple computers, and 8-inch *CP/M* systems. If you have a different computer write to the company. (Its address is in the list of suppliers elsewhere in this article.)



VOCABULARY BUILDERS may offer you a choice of words, one of which fits the definition supplied by the computer. Examples of usage may also be given.

While on the subject of indexes and the like, a program not to be overlooked by the serious—and involved—personal-computerist is *Index-80* by MTS, Inc., a yearly indexed disk catalog of all the articles that appeared in *80-Micro* (a publication specifically for *TRS-80* users). Simply enter the words or phrases and the software will locate the related articles and the issue they appeared in. While there have been many so-called "magazine indexes," this one offers perhaps the best implementation, and its style appears to have been copied for disk indexes for other specialized computer publications. If you're into one specific type or model of computer you cannot go wrong with a yearly index to a publication specializing in it. It's probably the only thing that will locate some obscure reference to a software patch you barely remember seeing about six months ago—the one you skipped over because you thought you would never own the software.

There are probably more label-printing programs than there are word processors, but there's only one *Lablmakr*, from ETS Center. It's specifically for use with the Radio Shack *TRS-80 Model I* and *TRS-80 Model III*, and an Epson printer. *Lablmakr* can produce twenty kinds of highly unusual "standard-size" labels using both text and graphic representations of text, and virtually every combination of character styles is provided automatically by the software. Each label type comes up on the screen as a template complete with a character count for each line, and simply touching the space bar provides automatic centering of a line. If you like, a software-constructed file will save your labels for future use. A companion program called *Casslabl* prints cassette labels. The difference between the two is that the cassette version spaces the text lines to allow for the cutout in the cassette labels. The key to the success of this software is the printer, not the computer, so it's logical to assume that similar software will become available for other computers.

Next to mailing-label programs, word-processing programs are probably the most common. Unfortunately most of the better ones are somewhat expensive, and the inexpensive ones, most designed for "entry-level" computers, usually leave a lot to be desired. The exception to both rules is something called *Telewriter-64*, by Cognitec, for the Radio Shack *Color Computer*. This piece of software far outshines anything similar on the market. Instead of 20 to 32 characters per line (and often upper case only) this word processor is able to create upper or lower case characters and line lengths of 51, 64, or 85 characters. While there is no way anyone is going to be able to display 85 characters clearly on a TV set, that feature does allow the user to see how the actual print will appear—which is something some high-priced word processors can't do. Now for the best part: the program is available in a cassette version for only $50, and will run on any version of the *Color Computer* with 16K or more of memory.

In the end you must pay

With the income-tax season in full swing, it's no wonder that "income tax" software seems to be all over the place. Actually, except for the stuff specifically intended for accountants, which is very expensive, much of what's available has little value because the really complicated parts of the tax calculations—the schedules—aren't part of the package. You generally have to do that part by hand and plug the calculated values into the software, and the whole thing ends up taking longer than doing the return by hand. Also, the tables change yearly, and updates don't come cheap. But for those of you who want the fun of being an amateur tax-accountant and don't need the absolute precision of a "professional" program, there's a very nice

package called *Tax Forecaster* by the Micromatic Programming Company. That program asks for pertinent tax information entries and then gives a very close approximation of how much you'll have to pay to—or get back from—Uncle Sam. It does not prepare the tax return itself, it just does all the hard arithmetic, and it allows you to ask the question "What if" and then instantly recalculate the results. For example, "What (happens to my taxes) if I donate $500 to charity?" It's a fun program, not expensive, and if you want to provide entertainment for friends it can be a lot of fun at parties and charity fund-raisers; but remember, it doesn't prepare the tax return and it's not a substitute for an accountant.

If you'd like to knock hours off preparing your taxes come every April 15 there's an excellent record-keeping system specifically intended for tax time. It's called *The Color Accountant*, from The Programmer's Institute and, at present, versions are available for the Atari *400* and *800* and for the *Color Computer*. In addition to the usual checkbook maintenance and summary files, you can record bills, analyze various accounts of stocks, even color-graph any of the files. The Atari versions need a little extra in the way of RAM, so make certain you have enough.

Faster BASIC

Because of the mass distribution of the Timex/Sinclair *1000* computer, many programmers, both amateur and professional, have been exposed to the advantages of single-key entry of BASIC commands. Instead of typing out every command such as GOTO, GOSUB, FOR, NEXT, PRINT, etc., a command is entered simply by touching a single key; the computer seems to know when the touch represents a command and when it's actually the key's character.

Utilities and programming aids that provide single-key entry of BASIC commands have been around for a long time, but they have usually concentrated more on adding obscure enhancements to BASIC than on making it easier to write programs. (Of course, the subject is debatable.) By not getting tangled up in yet more "new enhancements" to BASIC, Spectrum Products has produced an outstanding single-key command-entry program for the *Color Computer* called *BASIC Aid*. It is supplied as a plug-in ROM module, and a plastic overlay template for the keyboard shows every single-entry function as well as the standard key characters. There is no complex software routine for single-key entry—a touch of a key switches the single-key function on and off. Would you believe all that, including the ROM module, is only $40? It makes you wonder why some other software costs upward of $200 or $300.

Speaking of making programming easier, there is no substitute for touch-typing. Even if you don't program, with computers becoming so commonplace, you'll almost certainly eventually face the task of spending some hours entering data into a computer terminal. That job becomes a lot easier if you can touch-type. There is an almost endless list of software available for touch-typing training. In general, most work in the same manner—the computer displays several characters that the "student" must type on the keyboard. Depending on whether or not the computer has a sound output, either the screen blinks, or a tone beeps when the wrong key is struck. Sometimes there's a beep when you strike the correct key and a honk when you strike the wrong key. At the end of the lesson the computer tells you know how many errors you made and calculates your typing speed. Just about all typing programs work well, whether it's for Radio Shack, Commodore, or Heathkit/Zenith computers.

ROM CARTRIDGE CONTAINING the *BASIC Aid* program fits into Program Pak slot in *Color Computer*.

While we're on the subject of self-improvement, there are some remarkably good "vocabulary builders" floating around for all age groups. Texas Instruments has some award-winners for children, while many of the others are aimed at the high-school/adult level. Most of the programs have a basic vocabulary of approximately 200 words (that can usually be modified by the user), which can be used to "test" by definition, synonym, antonym, or a random combination of the three (those 200 words go a long way). Similar software is available for building vocabularies in a foreign language, and there is software that allows you to write your own "vocabulary exams"—you can plug in the new words learned at school and have the computer scramble them in a "test" format.

As for learning a foreign language on your own, every week or so some new brand of self-teaching language software comes into the marketplace—some of it good, some of it worthless; the problem is that you can't really know how good it is until you get it home and try it (and by then it's too late). On the other hand, the self-teaching conversational foreign-language software from Atari for their *400* and *800* computers is actually better than it appears in the TV commercials—and it comes off great on TV. If you want to learn any foreign language on your own, and you don't have an Atari computer, ask a friend who speaks the language to look over the software's documentation before you buy it. And, whatever else you do, make certain that the program comes with audio cassette-tapes that teach the proper word pronunciation. (Would you believe someone actually sold a language program for one of the most difficult languages to learn without supplying a pronunciation tape? And, would you believe people *bought* the software?)

CLEAR PLASTIC TEMPLATE with overprinting for *BASIC Aid* fits over *Color Computer*'s keyboard. Now, single-key BASIC commands are easy.

Whistles, squeaks, and other noises

While we're on the subject of education, a word or two about educational software for the younger members of the family. As a parent or relative you have their best interests in mind, and computer programs that put them one-up the rest of their nursery-school class in number and word recognition are most appealing. That's why it comes as little surprise that as soon as you see that mountain of pre-school software for sale at the local

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software shop, you're absolutely certain that your three-year-old niece or nephew is ready to learn the numbers 1 through 20 from a computer. The question remains, however: "Is the Sesame-Street style of computer software with exploding color and shrieking sound a substitute for parents or relatives?" At certain ages, and for certain subjects, the computer's capacity for untiring repitition makes for a great study or training aid, but for pre-schoolers it's better to be sure of what you're getting ahead of time; if the dealer is reluctant to demonstate the program you're interested in, it may be because he has something to hide. Sesame-Street-style effects have proven very effective on TV, but on a computer they can range from the superb efforts of Texas Instruments (with a long and excellent record with such products as their *Speak-&-Learn* machines), to junk so poor that it might actually do more harm then good. Thus, as a parent or relative, be extra careful when purchasing software for the youngsters.

A computerized paintbrush

Moving along to the fun part of computing, there's a lot of software for both computer art and graphics coming on-line all the time. One of the more typical graphic-art programs is Pioneer Software's disk-based drawing program called *Crayon*, which allows the user to draw graphic designs on the screen and then make the graphics part of a BASIC program (up to 30 separate screens depending on the available memory). The graphics screen is called through a USR function. Alternately, the program can be used just to create camera-ready computer art for photo-offset printing because the software can put both graphics elements and alphanumeric characters on the screen at the same time.

There are many different types of computerized pallets, paintbrushes, and whatever available for almost every model computer. The exact type of graphics creation and display, and whether it's in black-and-white or color, will depend on the computer and software. This is one of the few areas where just about everything is good, because everything is different.

For commercial applications, we are seeing more and more software that creates charts and graphics from either user-entered data, or using the data from another program.

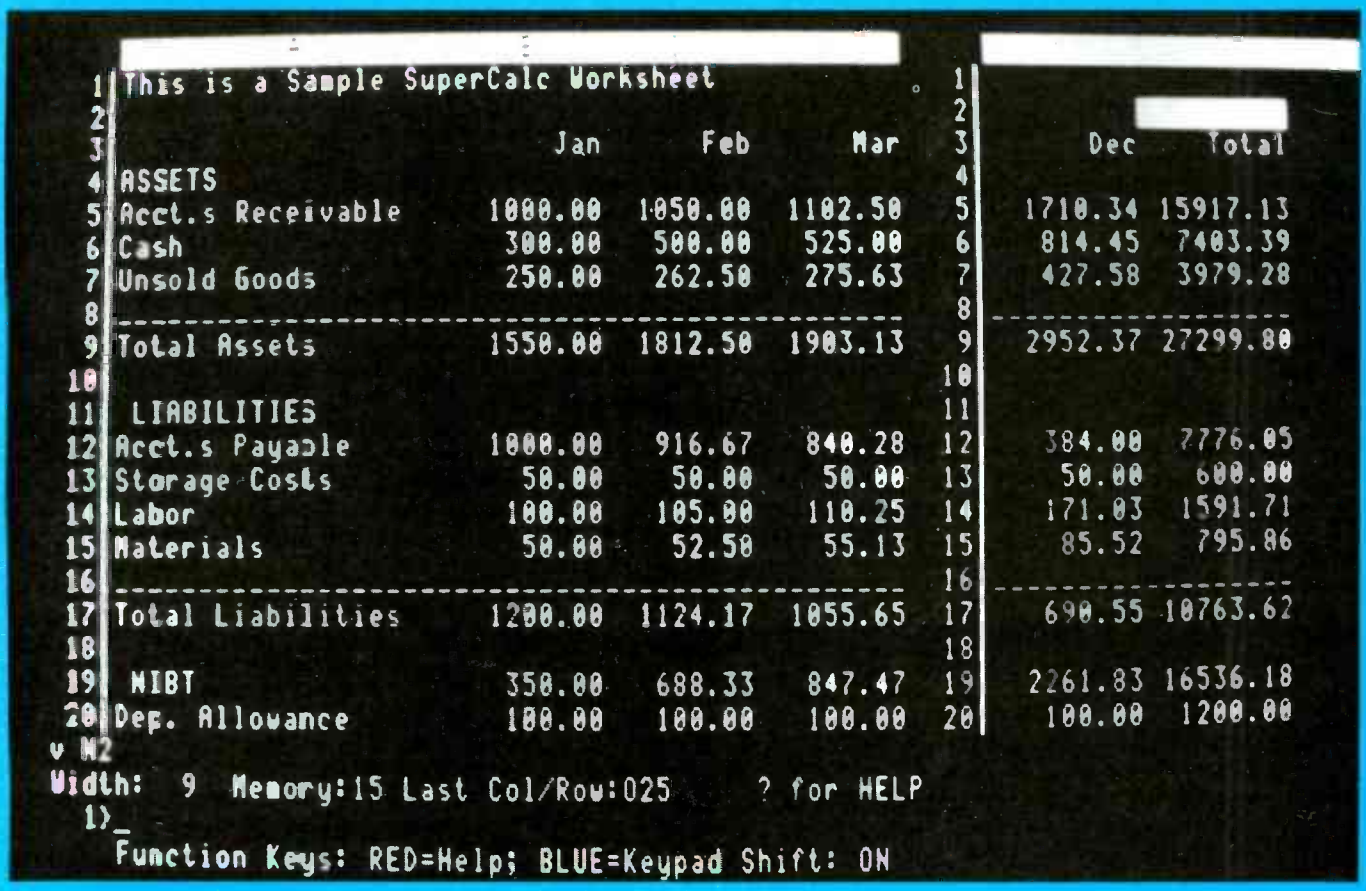
If you're just starting

With few exceptions, technicians, electronics hobbyists, and students must have a working knowledge of how to write programs in BASIC. If you are part of that group, or have just bought your first personal computer, you've probably given some thought to using one of the "computer courses" that use cassette-based instruction, a manual, and your computer. Beware—look before you buy. Many of those courses are so elementary, or so confusing for the beginner, that you'll be better off without them.

On the other hand, if you have a *Color Computer*, the best entry-to-intermediate level course you are going to find anywhere at any price, or in any format, is Radio Shack's own *Color Computer Learning Lab*. It comes on eight cassettes, has outstanding documentation at a real beginner's level that takes you through sorts, color graphics, game design, and even dynamic debugging. The course is integrated with "hands on" use of any model of the *Color Computer*, and in less than a week anyone can be a decent BASIC programmer. Considering that both college and continuing-education courses in BASIC are usually priced between $100 and 400, it's the best $49.95 investment you can make.

You're not alone

Perhaps the most important thing to keep in mind if you need something unusual is that there are probably many others with the same needs, and most likely some of them have already written the program you need and are selling it from their garages or kitchen tables. You'll more likely to find what you're looking for if you search out the little known and unusual, rather than the best known and most expensive. **R-E**



Stop wearing out those pencils and erasers. With an electronic-spreadsheet program you can see how changing one piece of data can affect hundreds, or even thousands of others—instantly!

HERB FRIEDMAN

TO MANY OF US WHO STARTED OUT AT THE BEGINNING OF personal computing, the single most important piece of software after MicroSoft BASIC was *VisiCalc*. Overnight, *VisiCalc* transformed the personal computer from a plaything for the hobbyist into a required tool for anyone engaged in planning anything: the financial structure of a school district, town, or city; how much dirt, fertilizer, and weed killer you'll need to keep your garden green, or even how much soda, pretzels, and potato chips to order for your school's homecoming-game pep rally.

VisiCalc® (from Visicorp) is an example of "What If?" software: meaning, it lets you ask the question: "If I do A, what will happen to B, C, D, and a hundred other things?"

In the not-so-good old days—before computers—to answer that required that you tape several sheets of paper together into one giant sheet, draw a grid (matrix) of many boxes called cells, and then fill in the cells with facts and figures showing how they related to each other. The information or data in the cells was interlocked with—and affected by or related to—other cells. The interrelationships of the cells meant that one change in one cell could affect several hundred cells. Changing the cells to reflect those changes wore down many erasers and pencils because every change in cell data produced by the question "What If?" resulted in yet another round of changes in the matrix.

That type of matrix or "model" has an official name when used for financial planning: it's called a spreadsheet. Depending on the size of the spreadsheet, the variations produced by changing the value of a single cell could require hours for recalculation of all the affected cells.

Now this is precisely the kind of job best done by a computer because a computer can be programmed to take the variation in cell information produced by the question "What If?", and in the blink of an eye recalculate hundreds of cell changes and instantly show the new spreadsheet on a video display, or provide a hard copy on a printer. Instead of having to scrub away

at a penciled spreadsheet to erase all the affected cells, the planner, accountant, etc., just has to key in the new information for a cell and the computer takes care of the rest. Just imagine how convenient that all is if there are two cell changes, or ten, or twenty, or fifty, or a hundred.

VisiCalc, which was initially written for the Apple computer, was the first of the electronic spreadsheets for personal computers, and many feel it is the reason for Apple's commercial success. Since its introduction, there have been numerous spinoffs, knockoffs, and customized electronic spreadsheets. Today, the "Calc" or spreadsheet program, is one of the major and most popular types of software for users of both home-and-family and business personal computers.

There are many different versions of spreadsheet software priced from less than $20 to well over $200. Each, of course, claims to be the best. Actually, though most are similar in concept, there are wide variations in features, capacity, flexibility, and, most importantly, speed. One does not expect the $17.95 *VU-Calc* program (from Timex) for the Timex/Sinclair *1000* computer to be the equal of the $200 *SuperCalc* (from Sorcim) software. though *VU-Calc* is a most surprising piece of software (more on *VU-Calc* later).

Other than the major differences determined by price, within the price range there are minor differences in features and performance that can make one brand of spreadsheet software better than the others for a particular application. In other words, one may be easier to use than the others depending on the application. As a general rule, however, spreadsheet software is being continuously upgraded—becoming more and more complex—and the latest versions are so intricate and can do so much they are often treated like a programming language.

A closer look

Figures 1 and 2 show how a spreadsheet works. The basic arrangement of a spreadsheet, the interrelationships between the cells, is called a template. The template for the spreadsheet shown in Fig. 1 does many things. After the user enters the first value at the top of the column labled 100%, the spreadsheet automatically adds "1" to the entered number, and then prints a total of all the numbers in the column at the bottom of the column. The same will occur in the other columns with the exception that 10% will be added to the value of the previous column. The columns with the automatic increase of 10% are labled 110%, 121%, 133.1%. (Read this over carefully if you don't follow it. It's important you know what's happening.)

	100%	110%	121%	133.1%
ENTER VALUE	1	1.1	1.21	1.331
add 1	2	2.2	2.42	2.662
add 1	3	3.3	3.63	3.993
add 1	4	4.4	4.84	5.324
add 1	5	5.5	6.05	6.655
TOTAL	15	16.5	18.15	19.965

FIG. 1—THE VALUES SHOWN ARE CALCULATED the instant the first value is entered in the 100% column.

	SAMPLE SPREADSHEET			
	100%	110%	121%	133.1%
ENTER VALUE	2	2.2	2.42	2.662
add 1	3	3.3	3.63	3.993
add 1	4	4.4	4.84	5.324
add 1	5	5.5	6.05	6.655
add 1	6	6.6	7.26	7.986
TOTAL	20	22	24.2	26.62

FIG. 2—WHEN THE VALUE at the top of the 100% column is changed, all the values in all of the columns are recalculated

If you imagine that Fig. 1 is a computer display, the screen would show no values until "1" was entered at the top of the column labeled 100%. The instant "1" was entered, the spreadsheet filled out with all the values shown in the figure.

Figure 2 shows what happens when we change the entry from 1 to 2. Instantly, the spreadsheet calculates the new values and enters the correct values in all the cells.

How it works

The cells of the template can be empty (waiting for user input), can contain a label that might describe anything at all, or can contain a simple or complex formula that might use data input by the user, data from other cells, data calculated by other cells, or any combination of data, computations or whatever. In short, within limits, anything goes. As a general rule, spreadsheet software can be programmed to multiply, divide, sum, average, compare relationships, etc. The precise type of calculations are determined by the specific spreadsheet program, but most are similar.

The spreadsheet exists only in a computer's memory, not on the video display. The spreadsheet itself might represent cells formed by a matrix of 60 columns by 244 rows (14,640 cells). Obviously, that much data cannot be displayed on even a 80 column by 24 row CRT. The screen serves only as a window for a small part of the total spreadsheet stored in RAM. The window can be moved around to examine any part of the spreadsheet, and the video window can even be split vertically and horizontally so data from any part(s) of the spreadsheet can be displayed side by side for comparison. (With the exception of the rock-bottom priced spreadsheet software, all can provide at least one vertical or horizontal split-screen display, or both.)

Of course, if the spreadsheet is small enough it can all fit on the video display. Figures 3 through 6 show how a small spreadsheet is created using the Heath/Zenith version of *SuperCalc*. While *SuperCalc* is similar to many other spreadssheet programs, it is the only one that simultaneously indicates all cell values and formulas directly on the video display.

Figure 3 shows how the spreadsheet's template appears on the video display. Note that each row is designated by a number while each column is designated by a letter. A similar scheme is used in all software of this type as it is the only sane way to set up the template. The junction of each column and row is a cell, and each cell is identified that way (i.e. cell B10). You can enter a label, formula, or value into a cell, or leave it blank for the entry of values when you test for "What If?".

	A	B	C
1		OUT OF POCKET CAR EXPENSE	
2			
3		1982	1983
4			
5	ESTIMATED REPAIRS		(B5*1.15)
6	MILES DRIVEN		B6
7	$ PER GALLON OF GAS		(B7*1.10)
8	$ PER QUART OF OIL		(B8*1.10)
9	INSURANCE		(B9*1.10)
10	MILES PER GALLON		B10
11	TOTAL GAS USED	(B6/B10)	(C6/C10)
12	COST OF GAS	(B11*B7)	(C11*C7)
13	OIL USED (QT./500 MI.)	(B6/500)	(C6/500)
14	COST OF OIL	(B13*B8)	(C13*C8)
15			
16	TOTAL CASH CAR COST	(B5+B9+B12+B14)	(C5+C9+C12+C14)
17			

FIG. 3—*SUPERCALC* TEMPLATE used for calculating out-of-pocket car expenses. This is what you see as you are assembling the template.

The template shown in Fig. 3 is the spreadsheet for calculating estimated out-of-pocket auto expenses based on assumed cost of insurance, repairs, gas per gallon, and oil per quart, as well as the estimated mileage, how many miles the car travels per gallon of gas, and how much oil is expected to be used. The spreadsheet takes into account assumed inflation factors and changes in individual costs. The blank (empty) cells are for the information to be filled in by the user. The other cells contain the information or the formulas to be to used to calculate the desired information.

Everything within brackets is a formula that uses information from other cells. Entries not in brackets are simply instructions to use the same information from another cell. For example, note that total gas used in 1982 is represented by the formula (B6/B10). If you look at cell B6 you'll find it represents MILES DRIVEN, while B10 is the MILES PER GALLON delivered by the car. When the B6 and B10 values are filled in by the user cell B11 will automatically calculate total gas used. On the other hand, note that for 1983 cell C7 shows we believe the price of gas will be 10% higher than the value we plug into cell B7 for 1982 (B7 × 1.10), while cell C6 will use the same information the user stores in B6. (Study the template until you get a clear understanding of how the cells can interrelate and interreact.)

Okay! That's enough theory—let's do the calculation as shown in Fig. 4. For a neat presentation, we turn off the border, and set up the display so the formulas are no longer displayed. When there are no values for a formula to work with, *SuperCalc* shows the word ERROR so you know some data hasn't been entered. In Fig. 5 we have filled in the data needed for cells B5 through B10. That is how the display would appear when all the variable data was entered if *SuperCalc* were set for manual calculation—the user must specifically press a key to force the spreadsheet calculation. (Usually, the recalculation is set to AUTO, and the recalculation is performed the instant enough information to perform the calculation(s) is entered.

OUT OF POCKET CAR EXPENSE		
	1982	1983
ESTIMATED REPAIRS		.00
MILES DRIVEN		.00
$ PER GALLON OF GAS		.00
$ PER QUART OF OIL		.00
INSURANCE		.00
MILES PER GALLON		.00
TOTAL GAS USED	ERROR	ERROR
COST OF GAS	ERROR	ERROR
OIL USED (QT./500 MI.)	.00	.00
COST OF OIL	.00	.00
TOTAL CASH CAR COST	ERROR	ERROR

FIG. 4—HOW THE SCREEN APPEARS before the required information is inserted in the 1982 column. The "errors" are caused by the template not yet having all the information needed to make the calculations.

OUT OF POCKET CAR EXPENSE		
	1982	1983
ESTIMATED REPAIRS	500.00	.00
MILES DRIVEN	10000.00	.00
$ PER GALLON OF GAS	1.39	.00
$ PER QUART OF OIL	1.45	.00
INSURANCE	450.00	.00
MILES PER GALLON	15.50	.00
TOTAL GAS USED	ERROR	ERROR
COST OF GAS	ERROR	ERROR
OIL USED (QT./500 MI.)	.00	.00
COST OF OIL	.00	.00
TOTAL CASH CAR COST	ERROR	ERROR

FIG. 5—IF SET FOR MANUAL RECALCULATION, this is how the screen will look when the required information is entered (see Fig. 6).

Figure 6 shows what happens when the last piece of data is entered if *SuperCalc* is set for automatic calculation, or if the manual-calculate key is pressed. Instantly, the spreadsheet fills with all values for the years 1982 and 1983.

Preparing the template is not all that difficult even if you're using hundreds of cells because most of the spreadsheet programs have an assortment of cell-handling functions that simplify the construction of the template; those include functions such as *replicate* and *tag*. Replicate permits you to write a few cells and then, at the touch of one or two keys, have the software automatically replicate them across hundreds of rows or columns. With tag you "stick" a cell's entry to the cursor, move the cursor directly to a desired cell or cells and "drop" the attached data into the new cell. You might also be able to instantly move or exchange columns or rows of "written" cells.

OUT OF POCKET CAR EXPENSE		
	1982	1983
ESTIMATED REPAIRS	500.00	575.00
MILES DRIVEN	10000.00	10000.00
$ PER GALLON OF GAS	1.39	1.53
$ PER QUART OF OIL	1.45	1.60
INSURANCE	450.00	495.00
MILES PER GALLON	15.50	15.50
TOTAL GAS USED	645.16	645.16
COST OF GAS	896.77	986.45
OIL USED (QT./500 MI.)	20.00	20.00
COST OF OIL	29.00	31.90
TOTAL CASH CAR COST	1875.77	2088.35

FIG. 6—AT THE TOUCH of the recalculation key the screen would blink and all the cells fill with the calculated values as shown. If the program were set up for automatic recalculation, that would happen as soon as the last required value were entered.

The exact number and degree of cell-handling procedures depend on the particular software used, but within a given price range most offer similar features.

The exception to most of our illustrations is the plug-in ROM module (not disk) version of Radio Shack's *Spectaculator* for the *Color Computer*. Though it is an electronic spreadsheet, it does not permit individual cell calculations. The calculation for each cell in a column or row is the same for every cell in the row or column. This is somewhat limiting for general use, but it's particularly useful for calculations where two out of three variables are known. For example, it is easy to use—and a decided convenience—when calculating frequency, reactance, dimensions, volume, or anything else where two values are used to calculate a third. Figure 7 is a sample of what the program can do when calculating reactance. The spreadsheet is set up to calculate the reactance of inductors at 3 MHz.

The frequency in MHz is fixed throughout column 2. The user enters the inductor values in column 1. When the command keys to calculate are pressed, the display ripples through the spreadsheet and shows the calculated reactance values in column 3.

SAMPLE SPECTACULATOR

L(UH)	3 MHZ	REACTANCE
0.15	3.00	2.83
0.25	3.00	4.71
0.50	3.00	9.42
1.00	3.00	18.84
1.50	3.00	28.26
2.00	3.00	37.68
2.25	3.00	42.39
2.50	3.00	47.10

FIG. 7—USING *SPECTACULATOR* to calculate reactance. This program is particularly useful for calculations involving three variables where one is known.

Only a little bit at a time

Since the video display is only a "window" into the spreadsheet stored in RAM, the more sophisticated spreadsheet programs such as *SuperCalc*, *VisiCalc*, and *ScratchPad* (from SuperSoft) allow you to divide the video display into two or more smaller windows so several sections of the memory can be simultaneously seen for comparison. For example, we could have had our auto-expense spreadsheet calculate expense until the year 2000, and then split the video display and show only the years 1982 and 2000 side-by-side for comparison. If we had thirty, forty, fifty, or a hundred items in each column or row, we

could still control each screen "window" independent of the other, and roll or scroll each window independent of the other. Usually, we can even treat each window as a separate spreadsheet, and ripple through one without affecting the others.

Though the more popular electronic spreadsheets can be used with several different computers, the exact nature of the implementation often depends on the available features of the computer or the associated terminal. Sometimes it works out that the same spreadsheet software is somewhat more convenient to run on one computer than another. For example, while *SuperCalc* generally uses a blinking-line cursor or created brackets to denote the cell's boundaries, the Heath/Zenith implementation uses the "smart" features of the *H89* computer and *H19* terminal, and the cell area is completely filled by a reverse video (white) rectangle, while the computer's built-in function keys are used for direct access to a HELP table and a keyboard shift. On the Osborne computer, the operating system provides a directional arrow shift specifically tailored for *SuperCalc*, while the software itself can be customized for the user's printer.

More money means more features

As with almost everything else in this world, the more you pay the more you get. In particular, the higher the price the greater the permitted mathematical operations, such as automatic summing, averaging, relational operators, sine and cosine functions, etc. The object is to decide what specific math functions you will need and then make your selection from the software that does the required calculations. In almost all instances the necessary math functions are more important than the maximum size of the available matrix (number or rows times number of columns).

The less-than-$20 cassette-tape based *VU-Calc* for the Timex/Sinclair *1000* computer is extremely powerful for the money, will probably handle most household projections, and is a superb spreadsheet trainer for schools, but it is limited to the basic arithmetic operations of addition, subtraction, multiplication, and division. However, its template of 26 rows × 36 columns (936 cells) is quite adequate for small jobs. (The program is written in BASIC and would be frustratingly slow to run if the template were larger.) The basic matrix takes almost three minutes to load, and a SAVE of even a small template using but a portion of the available matrix can take more than five minutes; but the price is a real winner.

About double the price of *VU-Calc*, the ROM module version of *Spectaculator* for the Radio Shack *Color Computer* handles a template of 99 rows × 99 columns (9801 cells). Since it's supplied in a ROM module it is up-and-running almost as soon as the power is turned on. The program is among the easiest systems to use, but it has the limitation we mentioned earlier of not permitting individual cell formulas.

Just about everything else is in the $150-and-up price range, is disk-based, and often proves to be some variation of *SuperCalc*, *VisiCalc*, or *ScratchPad*. Between discounting and special implementations, the same spreadsheet software might cost between $150 and $400.

ScratchPad, which has an unusually small number of commands, features many mathematical functions, both terminal and printer customizing, and virtual memory. Virtual memory is a means whereby the disk is used as RAM when the computer's RAM runs out. The usual matrix for a 56K RAM is 26 rows × 100 columns (2600 cells), but memory won't run out because the disk provides virtual memory when running. What is placed on the disk is transparent to the user when the session is completed so there is no loss of disk space as unusable files.

If for nothing else, *SuperCalc* stands alone because it's supplied with outstanding sample business and scientific templates (for practice and understanding) and because it allows the user to see all the cell formulas in their respective cells, not one at a time on a command line in some distant corner of the screen. Its matrix is 254 rows × 63 columns (16,002 cells). A full matrix would exceed the capacity of most personal computer RAM areas, but different portions can be used for different templates, then interrelated, interlocked, etc. It also provides the usual assortment of advanced math functions. The instruction manual is an absolute gem, easily understood by non-hardware oriented users. The problem with *SuperCalc* is that it came on the scene after *VisiCalc*, and simply never got the credit it deserved.

VisiCalc is the grandfather of all the personal computer spreadsheets. While legend has it that it got its reputation from the Apple implementation for business use, most computer hobbyists are most likely familiar with it through Radio Shack, who has always featured it as its centerpiece for both personal and business software. The original implementation for Radio Shack's *Model I* computer had a matrix of 254 rows × 63 columns (16002) cells, the same as the typical *SuperCalc* versions. It, too, provides advanced math functions, sectional interlocks and relationships, etc. The thing with *VisiCalc* is that it's dynamic; it's constantly growing, with features being added all the time to accommodate the latest computer features. Some implementations are so sophisticated, *VisiCalc* has become what is essentially an independent programming language. There are *VisiCalc* "programmers" who specialize in spreadsheets that might take weeks of preparation.

Being the most famous of the spreadsheets *VisiCalc* has the most aftermarket support, particularly in the area of pre-written templates for both home-and-family and business use. Pre-written templates are precisely what they imply; instead of you designing the template and calculating the cell structure and formulas, you simply load in from a disk a pre-written template that most approximates what you need. You can customize the pre-written template if necessary. (Most users find pre-written templates require some slight changes—but many hours, days, or weeks of programming can be saved through their use.)

SPREADSHEET SOFTWARE SUPPLIERS

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10228 North Stelling Road
Cupertino, CA 95014

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1299 4th Street, Suite 400
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Ft. Worth, TX 76102

Sorcim Corporation
405 Aldo Ave.
Santa Clara, CA 95050

SuperSoft
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Champaign, IL 61820

Timex Corporation
1579 Straits Turnpike
Middlebury, CT 06762

VisiCorp
2895 Zanker Road
San Jose, CA 95134

Something new every day

It often appears that each new issue of a computer magazine has advertisements for a new type of electronic spreadsheet. In fact, that is what's been happening because there are more and better programmers coming on-line almost daily. However, most of the latest electronic spreadsheets are essentially variations of the best known programs with some highly specialized features or implementations.

If there is perhaps one general rule of thumb for selecting an electronic spreadsheet it's to purchase one that offers easist use of the features you really need. Also be sure that it comes with an instruction manual you can understand. Some of the best software is unusable because the accompanying documentation is almost incoherent. R-E

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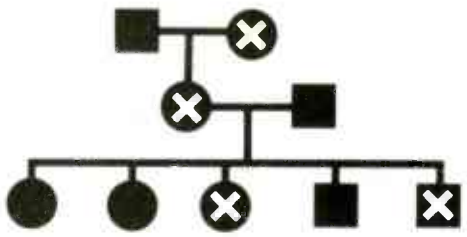

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Part 3

IN THE PREVIOUS TWO parts of this series on VLF-HF receiving techniques, we covered both the fundamentals of active receiving antennas and some practical circuits. Now we are ready to discuss the actual construction of those antennas.

The active-antenna system consists of three main parts: a whip antenna, a preamplifier, and a receiver coupler. The whip antenna is directly attached to the preamplifier, and both are remotely mounted. The receiver coupler is mounted at the receiver, and is connected to the preamplifier by a length of coaxial cable. Let's now take a look at the components of the system in more detail.

Wideband preamplifier

The wideband preamplifier circuit was discussed in the March 1983 issue of **Radio-Electronics.** Its schematic is reproduced in Fig. 1.

The wideband preamplifier is assembled on a printed-circuit board. The foil pattern of that PC board is shown in Fig. 2, and its parts-placement diagram is shown in Fig. 3. You should note that there are some "extra" pads near the input terminal. They are there to accommodate different input filter networks and/or variations in the size of the components used. The board is intended to fit snugly in a 1¼ × 2 × 1 inch drawn-steel case, although it can be used, of course, with a larger box. The only "fussy" component is the toroidal transformer.

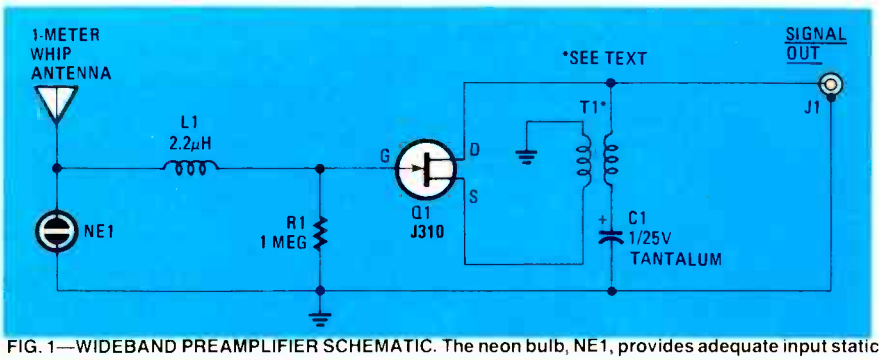

FIG. 1—WIDEBAND PREAMPLIFIER SCHEMATIC. The neon bulb, NE1, provides adequate input static charge protection.

The toroidal transformer is wound by first measuring out two 15-inch lengths of different-colored, 30 gauge, solid, insulated, wire-wrap wire. Those wires are twisted together about 8 turns-per-inch, and then that cable made up of the twisted pair of wires is wound for 17 turns on an Amidon (12033 Ostego St., North Hollywood, CA 91607) part No. FT50-75 (or similar) ferrite core. The windings should be tight, with a small gap at the start/finish point. The wire is held in place at the ends with a small drop of cement, and about 1 inch is left for connection to the circuit board. The insulation at the ends of the wires is stripped back about ½ inch for soldering to the board.

One important note is that the windings should oppose each other. What that means, is that while one wire at one end of the two-wire cable is connected to ground, the other wire at the same end is connected to the drain of the JFET. To furthur clarify that, Fig. 3 shows a dot at the one end of each winding—the dots are at a common end of the cable.

After the transformer wires are connected through the circuit-board holes, the core assembly should be cemented to the board perpendicularly. Be sure to follow Fig. 3 and make sure that the necessary jumper wires are also connected on the board for the wideband version (a version of the preamp for restricted VLF and LF use uses the same circuit board, but some different components).

The lower 3-dB point (where the response of the preamp drops 3 dB from its maximum) is at 10 kHz, where the toroidal transformer has an inductance of about 1 mH. At high frequencies, the core material effectively disappears, and the

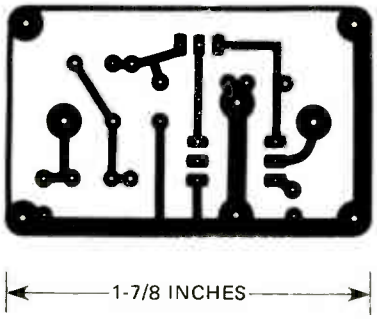

FIG. 2—FULL SIZE foil pattern for the the preamplifier circuit-board.

PARTS LIST
WIDEBAND ANTENNA PREAMP

R1—1 megohm, ¼ watt
C1—1 μF, 25 volts, tantalum
Q1—J310 FET (Siliconix or equivalent)
NE1—NE99 neon lamp
L1—2.2 μH (Mouser 43LS226 or equivalent)
T1—Bifilar wound transformer on Amidon F50-75 core or equivalent (see text)
Miscellaneous:PC board, case, coaxial connectors, hardware, etc.

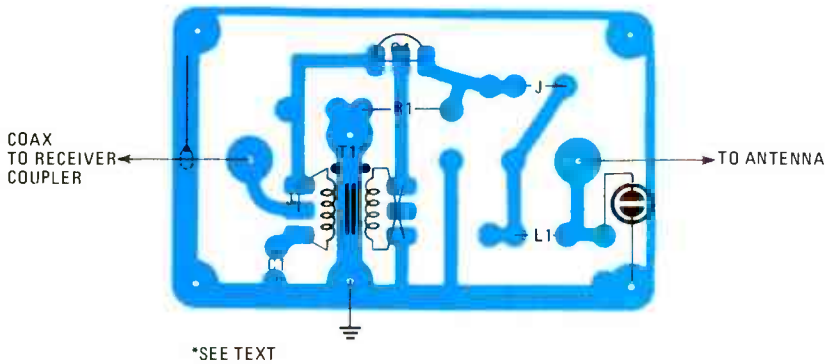

FIG. 3—PARTS-PLACEMENT DIAGRAM for the wideband version of the preamp.

response might be good to 100 MHz or so. However, the 2.2 μH input inductor (L1)—along with the board, the JFET capacitance, and the steel case—limits the preamp's upper 3-dB point to about 30 MHz. That helps to reduce interference from signals outside the desired band—say, TV and FM signals.

The receiver coupler

The foil pattern of the receiver-coupler board is shown in Fig. 4. (The receiver-coupler circuit was discussed in Part 2 of this series, in the March 1983 issue of **Radio-Electronics**. The schematic of the receiver coupler is reproduced here in Fig. 5). The board's parts placement is shown in Fig. 6. The board for the receiver coupler is the same size as that used in the preamp, and can be mounted in a similar case, if desired. In addition to the coaxial input and output terminals, a twisted pair of insulated wires are included for the power-supply leads (8–12 volts) and are fed through a small grommet or hole in the receiver-coupler case. We will not discuss the construction of a power supply.

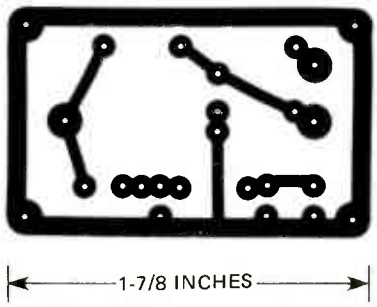

FIG. 4—FULL SIZE foil pattern for the receiver-coupler circuit-board.

Preamplifier for VLF-LF

The circuit for the VLF-LF preamplifier was discussed in Part 2 of this series, in the March 1983 issue of **Radio-Electronics.** For your convenience, we have reproduced the schematic of that circuit in Fig. 7.

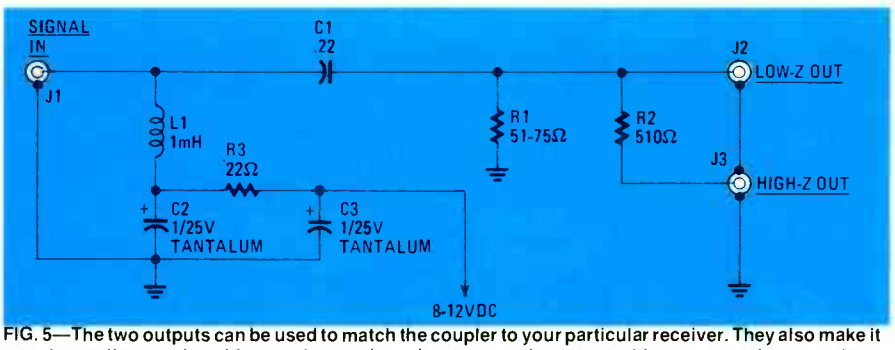

FIG. 5—The two outputs can be used to match the coupler to your particular receiver. They also make it easy to use the coupler with a receiver and monitor the coupler output with a scope at the same time.

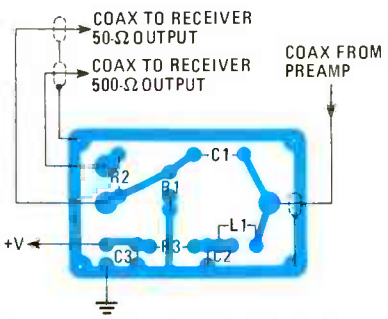

FIG. 6—PARTS-PLACEMENT DIAGRAM for the receiver-coupler board.

The circuit board for restricted VLF-LF operation is the same as the one used for the wideband preamp. (of course some components are different, and the jumpers that were used in the wideband case are not used here.) The parts-placement diagram is shown in Fig. 8. The RF chokes are short, encapasulated types that are designed for vertical PC-board mounting. The winding "polarity" or the start of the windings are indicated in Fig. 8 by black dots and on the choke package by a label dot and a longer lead.

The output transformer that we chose will fit exactly into the holes indicated, with the correct winding polarity already provided. Therefore—unlike the toroidal transfomer—it is unnecessary to cross over the transformer leads.

If you are in doubt about which side of the transformer is the primary or secondary, check with an ohmmeter. The higher resistance reading (around 20 ohms) will be the primary winding.

Preamplifier variations

In Part 2, we discussed several different resonant input circuits that could be used to provide low-frequency cutoffs, or to yield operation at a small, fixed band of frequencies. (The input networks were discussed in the "Resonant input circuits" section of Part 2.) The preamplifier can be modified with one of these input networks with relative ease. For example, a microminiature trimmer-capacitor can be soldered on the foil side of the board, directly across the 1-megohm input resistor (R1) after the board is mounted in the box. One possible source for the inductors and capacitors is Mouser Electronics (11433 Woodside

PARTS LIST
VLF–LF ANTENNA PREAMP

R1—1 megohm, ¼ watt
C1—1 μF, 25 volts, tantalum
C2—0.001 μF, ceramic
Q1—J310 FET (Siliconix or equivalent)
NE1—NE99 neon lamp
L1, L2—6.8 mH (Mouser 43LH268 or equivalent)
T1—Audio transformer (Mouser 42TL004 or equivalent)
Miscellaneous:PC board, case, coaxial connectors, hardware, etc.

TABLE 1

Frequency/Application	3-dB Bandwidth	Antenna length	C_a	L	C2	Gain
180 kHz Experimenters' Band	170–190 kHz	10 meters	120 pF	33 mH	.001	+20 dB
180 kHz Experimenters' Band	175–185 kHz	1 meter	10 pF	39 mH	.001	+15 dB
100 kHz LORAN-C	95–105 kHz	1 meter	10 pF	120 mH	.01	+6 dB
100 kHz LORAN-C	91–108 kHz	10 meters	120 pF	100 mH	.01	+12 dB
60 kHz WWVB	55–65 kHz	10 meters	120 pF	150 mH	.01	+10 dB
60 kHz WWVB	58–63 kHz	1 meter	10 pF	300 mH	.01	+6 dB

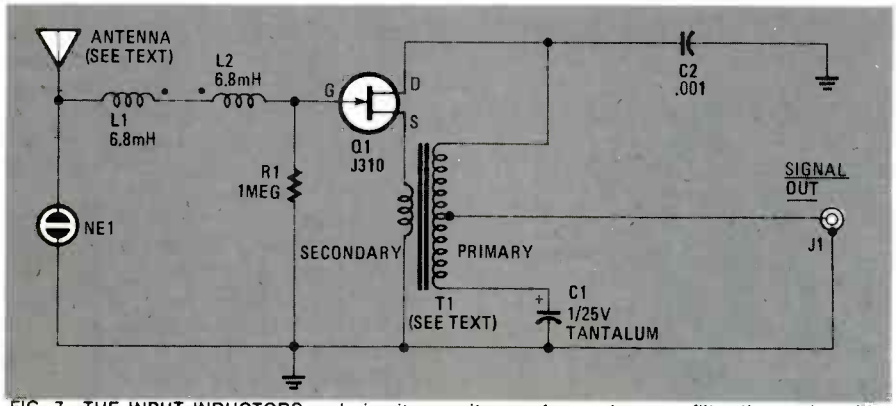

FIG. 7—THE INPUT INDUCTORS and circuit capacitances form a lowpass filter that makes this amplifier for restricted use in the VLF-LF range.

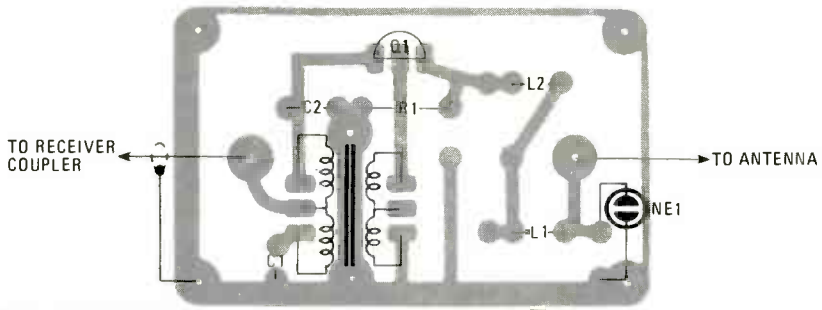

FIG. 8—PARTS-PLACEMENT DIAGRAM for the restricted-use (VLF–LF) version of the active antenna preamp.

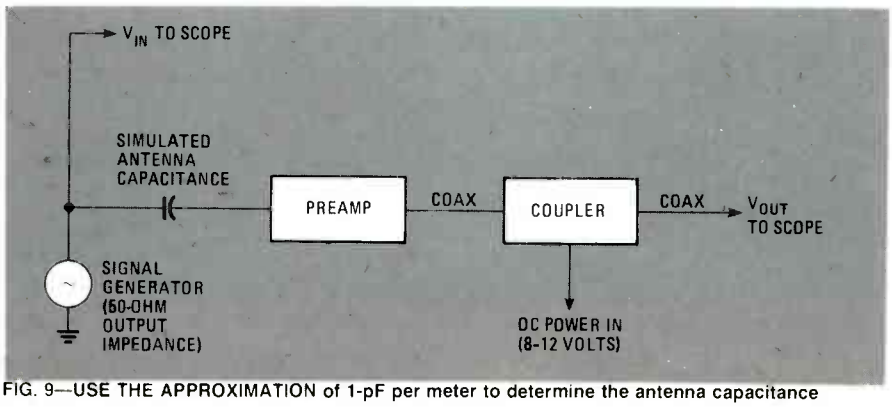

FIG. 9—USE THE APPROXIMATION of 1-pF per meter to determine the antenna capacitance

Ave., Santee, CA 92071), although other suppliers can be found by checking the ads in the back of this magazine.

You may have to bend the leads or change the part orientation if a particular component will not exactly fit the board holes. If you use 100–150-mH RF chokes (for a tuned amplifier for 60-kHz to 100-kHz operation), they will be quite close to the board edges because of their larger size. That will alter the circuit capacitance somewhat when the board is placed inside the box. The small trimmer capacitor—on the foil side of the board—can be used to compensate for that.

For wideband, lower-Q circuits with no trim capacitor, it may be necessary to check the response of the preamp after temporarily mounting it in the shield/case. The board can, of course, be used in a much larger box, with larger inductor assemblies, but keep in mind that for

For information on availability (including custom-built active-antenna preamps and coupler assemblies), send a SASE to R. W. Burhans, 161 Grosvenor St., Athens, Ohio 45701

maximum antenna sensitivity with a minimum antenna height (in other words, for maximum efficiency), the input capacitance at the antenna terminal should be as low as possible.

Table 1 shows the results of tests made with different inductor-capacitor combinations for covering different segments of the 60–200 kHz range. (See Part 2—Figs. 1, 4, and 5 for the particular circuits.) Note that in some cases the value of the preamp's output capacitor (C2) at the drain of Q1 is changed to improve the low-frequency cutoff.

Bench testing

A signal generator and suitable oscilloscope are used to observe the response of the active antenna system with a setup as shown in Fig. 9. When tuning any of the amplifier variations on the bench, or when checking the response of the amplifier, a small coupling capacitor—of a value equal to the expected antenna capacitance—is connected to the input terminal of the preamp. (A vertical or slant-wire antenna will have an approximate capacitance of about 10 pF-per-meter.) That will roughly simulate the response of the electric field at the antenna. A tuned preamp assembly can be aligned on the bench and then the antenna can be plugged in for operation. The input/output response obtained this way will fairly-well resemble the response that you will obtain in the field—except for the K factor that is dependant on the local ground-shielding effect.

PARTS LIST
RECEIVER COUPLER

All resistors are ¼ watt, 5% unless otherwise specified
R1—51 ohms
R2—510 ohms
R3—22 ohms
C1—0.22 μF, Mylar
C2, C3—1 μF, 25 volts, tantalum
L1—1 mH (Mouser 43LR103 or equivalent)

Preamp and coupler housing

The amplifier and coupler boards have been designed to fit in a small cast aluminium or drawn-steel case such as Mouser part No. 537-M12 for compact assembly. (See Fig. 10.) The circuit boards are held in place in the boxes by short, solid jumper wires that are soldered to the antenna input terminal and to the coax receptacles. The ground connections can be

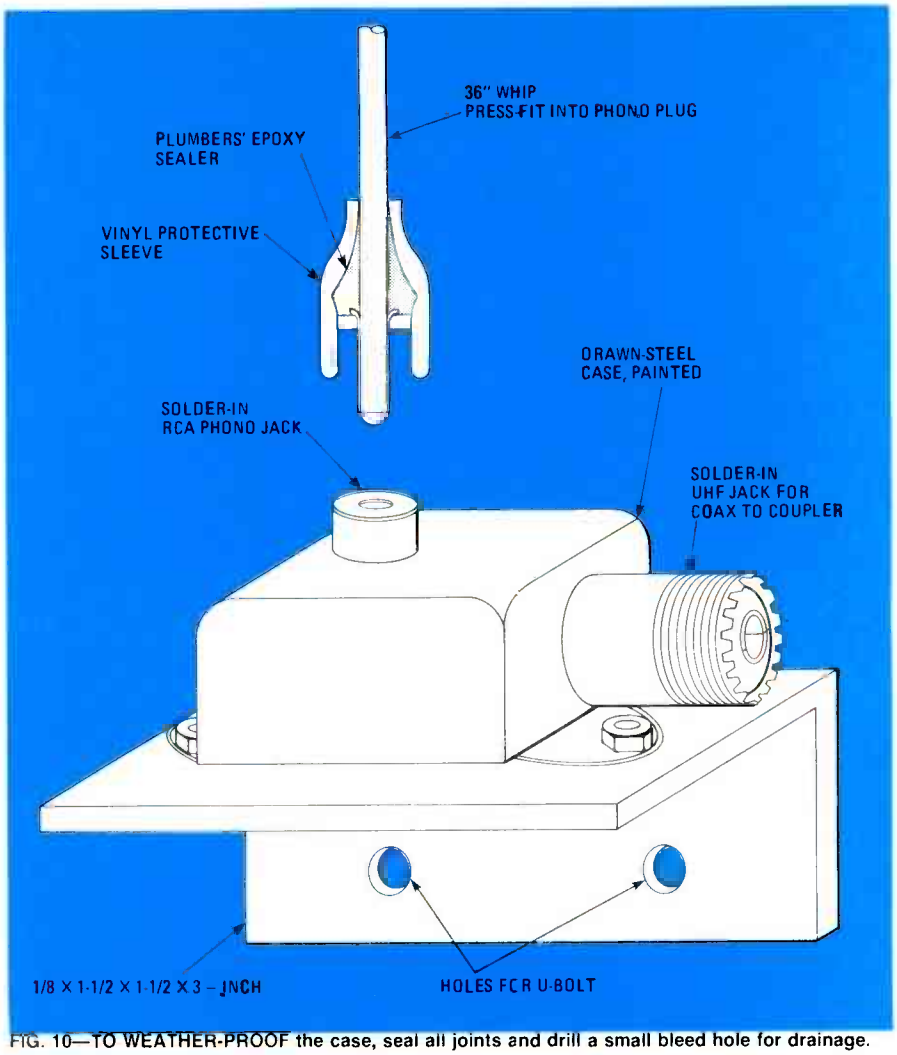

FIG. 10—TO WEATHER-PROOF the case, seal all joints and drill a small bleed hole for drainage.

either short jumper wires to the ground lug on the cable receptacle or the circuit board ground can be directly soldered to inside edges of the drawn-steel case.

The case should be mounted on an angle bracket for bolting to a short mast. A press-in or solder-in type RCA phono receptacle (Mouser part No. 16PJ051) is soldered on the inside of the box for the antenna terminal. That has a capacitance of only 5 pF at most, and it is suppled with a ceramic spacer. The output coax connector can be a UHF type. We have used SO-239 type receptacles by breaking off the flanges and pressing into a hole carefully reamed to fit. The output coax connector can be a single-hole-mounting type that uses a nut on the inside of the case. However, that takes up room inside the case and the PC board will have to be further cut and filed. Whichever type of connector you use, make sure you solder it to the inside of the case.

Prior to mounting the connectors, the box should be degreased with solvent, polished with steel wool both inside and out, and (after soldering the connectors) it should be painted *outside* with automobile primer and finally with a clear plastic spray. When painting the box, temporarily cover the connectors with masking tape to avoid getting paint on them.

To mount the circuit board in the drawn steel case, solid copper wires (22 to 20 gauge) are soldered to the center terminals of the antenna and coax connectors. Those wires are then bent to align with the holes on the circuit board. It is necessary to file the edges of the board to round the corners, in order for the board to fit inside the case. The board is then slipped down over the input/output wires so that the foil side of the board faces outside and the components inside. The board should be about 3/16 inch below the outer edge of the box for clearance. The ground of the board is then tack-soldered at a couple of points to the inside of the cleaned box. Be sure to solder the input/output wires to the terminals on the foil side and cut off all excess length from component leads.

The receiver-coupler box can be assembled in a very similar manner. Again, the fit can be compact, although it will be somewhat crowded if UHF fittings are used. It is better to use RCA phono connectors for all the coax fittings and to use shielded phono plugs with good quality RG-58U cable for interconnecting the preamp to the coupler and the coupler to the receiver. However, it is common practice to use the old-fashioned large size UHF fittings for RF, even though the metal-sleeve RCA phono types are much more compact and convenient to use. You can also use BNC type cable fittings and receptacles if desired. Some commercial systems even use type-N RF fittings for the antenna mount in place of the RCA solder-in receptacle.

Final assembly

For a short whip antenna, a mobile VHF-type stainless steel whip about 36 inches long will fit inside the typical RCA phono plug connector pin for a tight press fit. If that type of whip is not available, a copper-coated welding rod can be substituted and soldered into the phono-plug pin. After the antenna is mounted in the plug's center pin, the fitting is sealed with plumber's epoxy putty and a vinyl sleeve pushed down over the whole assembly to aid in waterproofing. A wire antenna can also be used—it is soldered to the center pin, and the phono connector is sealed similarly. For final assembly and mounting of both the antenna connector and the coax output connector at the preamplifier, we wrapped the connector with Coax-Seal, a putty-like tape, for extra waterproofing. The preamp box is bolted to the angle bracket and the joint sealed with cement or a gasket made from Coax-Seal tape. As an extra precaution against water in the box, a small bleed hole is drilled directly under the box mounting area to drain away any moisture that may enter the assembly.

Your receiver may have an auxiliary-output power source already available. For the RF input, the observer should first try the 500-ohm output from the coupler box at the VLF-LF region. More signal can sometimes be developed if the other output of the coupler is used. That indicates that the receiver is not too sensitive to antenna output-impedance. In all cases, the appropriate receiver input-terminal that is designed for the frequency range should be used. The 50-ohm coupler-output is almost always required for receivers operating in the range of 2 MHz to 30 MHz.

It may be convenient to connect a monitor oscilloscope to the 500-ohm output of the coupler and use the 50-ohm coupler terminal to drive the receiver. The scope display is useful for monitoring interference and the dominating signals in your area. By selecting various scope sweep-rates, you can get an approximate indication of the frequency of the various signals that are present. Thus, once you figure out what is causing the interference (for example, you may be able to see 60-Hz harmonics), then you can take steps to minimize it. Do not forget, however, that a wideband preamplifier is sensitive to all frequencies present at the antenna input bandwidth—not only the ones you want to amplify. **R-E**

Spot A Matic

Do you have difficulty seeing into those hard-to-reach recesses in your construction projects? Build the Spot-A-Matic and find out.

ROBERT GROSSBLATT

EVERYONE WHO BUILDS ELECTRONIC CIRcuits knows that it's hard to see the finished project inside its case. If something goes wrong and you have to look inside, it would be helpful if some gadget made it easier to inspect the circuit. Because that happened to me so many times, I stopped my other work and built the Spot-A-Matic.

I didn't want to spend a lot of time on it, so I kept the circuit as simple as possible and used things I could find around the house. As you can see in the schematic (Fig. 1), I used standard components except for the box marked "X" and, as they say, "X marks the Spot-A-Matic."

I discovered, quite accidently, that a length of transformer wire exhibits certain strange properties when massive amounts of current are passed through it. First it gets hot, then it starts to turn color, and finally it burns up. I'm just a simple electronics tinkerer—not one of your fancy nuclear physicists with a lot of initials and other junk after my name—but it seemed to me that if I could keep the wire from destroying itself there was a good chance it would keep on glowing without burning up.

X marks the spot

I'll spare you the endless agonies of my research and just share the results. I finally realized that I could keep the wire from burning up by surrounding it with a vacuum. Since oxygen was needed to support combustion, I reasoned that placing the wire in an oxygen-free enviroment would solve the problem. By experimenting, I found that my reasoning was sound.

I took a small soda bottle and, after disposing of the contents, scraped off the label and drilled three holes in the cap—two small ones and one larger one. I used a soda bottle because it was the right shape, made of durable glass and, to be honest, I like soda. I wrapped five inches of stripped transformer wire around a glass swizzle stick, and glued the assembly in position inside the bottle using two-part epoxy. The two leads were brought out through the small holes in the cap. The larger hole allowed me to insert the end of a length of plastic tubing. I used

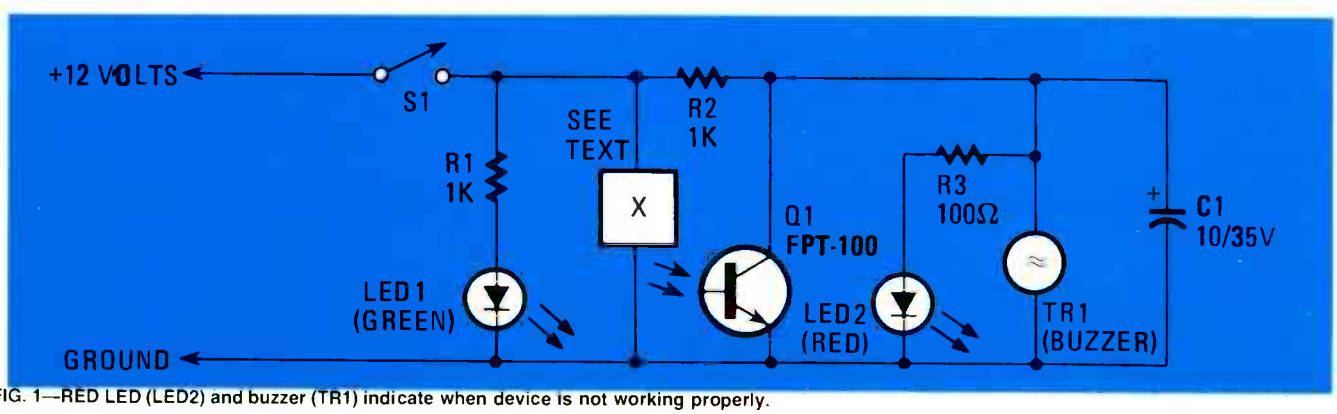

FIG. 1—RED LED (LED2) and buzzer (TR1) indicate when device is not working properly.

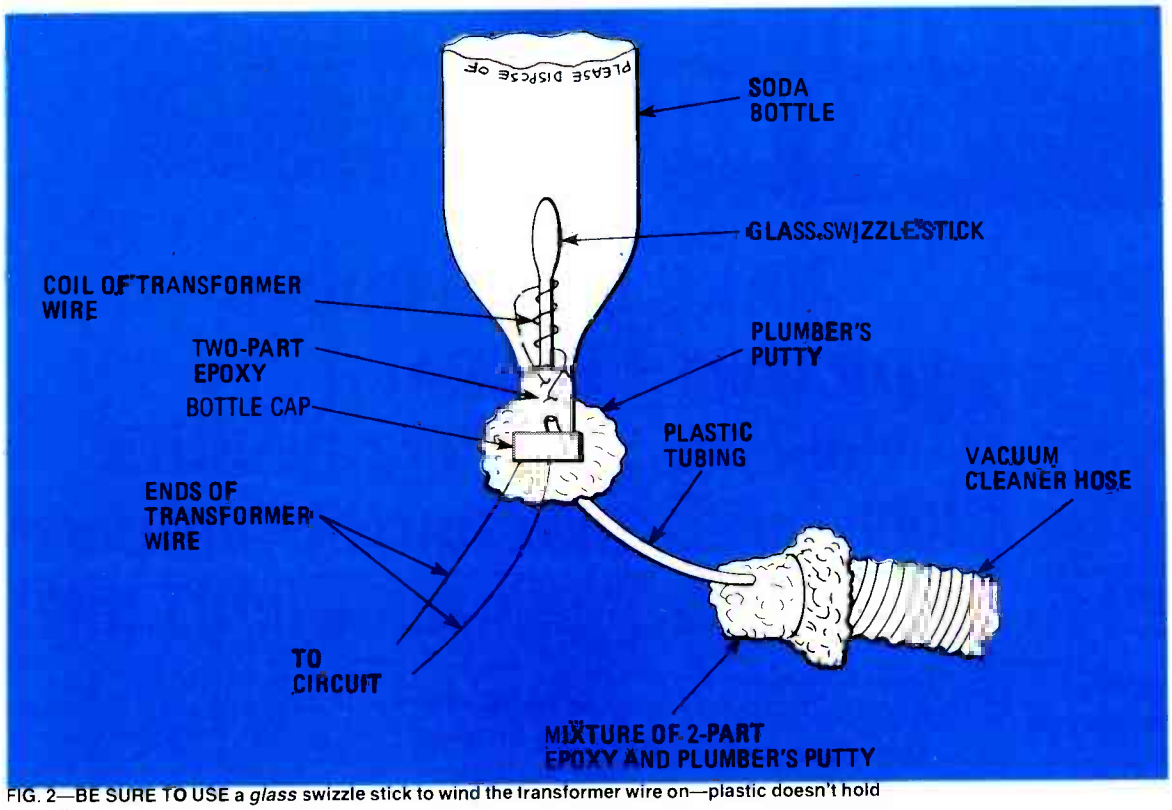

FIG. 2—BE SURE TO USE a *glass* swizzle stick to wind the transformer wire on—plastic doesn't hold up well.

PARTS LIST

All resistors 5%, ¼ watt, unless otherwise specified
R1, R2—1000 ohms
R3—100 ohms

Capacitors
C1—10 μF, 35 volts, electrolytic

Semiconductors
Q1—FPT-100 phototransistor
LED1—jumbo green LED
LED2—jumbo red LED
TR1—12-volt buzzer
S1—SPST switch

Miscellaneous: soda bottle, transformer wire, two-part epoxy, plumber's putty, glass swizzle stick, vacuum cleaner, perforated construction-board, solder, etc.

plumber's putty to seal the cap and make sure everything was airtight.

The other end of the plastic tubing was connected to the hose of my wife's vacuum cleaner. (Make sure that you ask your wife before you go ahead with the construction. If your wife is not as understanding as mine is, you might have to find an alternate means of producing a vacuum. Some friends of mine have used swimming-pool filters and have obtained excellent results.) I made up a mixture of plumber's putty and two-part epoxy to make an effective seal. The two leads of the transformer wire were connected to the points indicated in Fig. 1.

How it works

When you close S1 and apply power to the Spot-A-Matic, a green indicator, LED1, lights up as current begins to flow through the assembly in the bottle. As the wire gets hotter, a strange thing happens—it begins to glow more and more brightly. The radiant energy emitted turns on Q1, a phototransistor, which lowers the voltage across the red indicator, LED2, and TR1, a standard buzzer, disabling them. Capacitor C1 delays things until the wire is glowing brightly in the bottle. If the wire should break, Q1 will stop conducting and LED2 and TR1 will turn on; that will give you a visual and audible signal to warn you that something is wrong with the wire.

I've found that it's best to turn on the vacuum cleaner *before* closing S1: the better the vacuum, the better your Spot-A-Matic will function. Details of the construction of the box marked "X" are shown in Fig. 2. The only thing to be careful of is to make sure you have good seals at both the bottle cap and the plastic tube–vacuum hose interface. The rest of the circuit can be assembled in whatever manner you like—perforated construction-board and wire-wrap construction are fine. Figure 3 would have shown the completed unit, but it was destroyed in an unfortunate accident I'd rather not discuss.

Variations

The transformer wire is made of copper, so my Spot-A-Matic gives off a green glow. If you find that color unsuitable you can experiment with different kinds of wire—just make sure it's really thin wire because thick wire doesn't seem to work as well and keeps blowing fuses. I haven't tried bottles with different-colored glass or other shapes. My bottle was made of clear glass, but any color should work as well. Different types of bottles—e.g., ketchup, mayonnaise, and so on—may pose problems I did not encounter. The equations indicate they should work but, of course, that's only theory.

My Spot-A-Matic is a great addition to my workbench. I don't have a problem any more in seeing into the dim recesses of my projects, and the device is a great help in finding things when I drop them on the floor.

As soon as I finish troubleshooting my computer kit I plan to spend more time investigating the basic principles of the Spot-A-Matic. As I said, I may not be a high-paid rocket scientist, but I know when I'm on to something good. **R-E**

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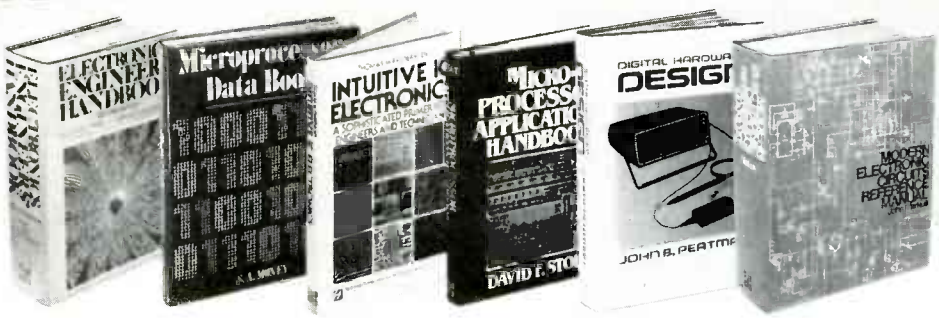

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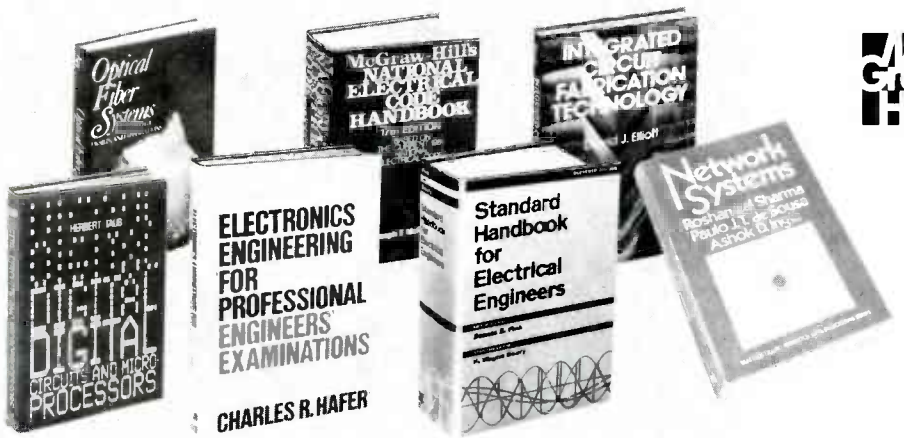

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Finishing up the keyboard encoder

ROBERT GROSSBLATT

FOR THE LAST TWO MONTHS WE'VE BEEN designing a keyboard encoder. As we left off last month, the encoder was neither easy-to-use nor useful. This month we're going to change all that. When a piece of equipment is designed and put on the market, one of the phrases that gets bandied about is "human engineering." In actual fact, that is more of an advertising phrase than a technical one and the more competitive the market, the more often you hear it. All it means is that the product was designed to make it easy to use. That, I suppose, is to set it apart from all those products that were designed to be *hard* to use. Advertisements for technical equipment with an esoteric market will stress accuracy and reliability; consumer-product advertising usually deals with color, shape, and sex appeal. Anyone who has ever tried to get detailed technical information about a consumer product knows exactly what I'm talking about.

As we finish up the design of our keyboard encoder, we're going to throw in a bit of "human engineering" in the form of—are you ready for this?—audio keyboard-feedback. How's that for a bit of psuedo-technical jargon? In any event, it's a nice convenience feature and since we get it for practically nothing we may as well throw it in. Our scan oscillator, IC2 (a 555), was set to run at a rate of about two kHz or so. That frequency was chosen for two reasons. First of all, it's highly unlikely that anyone would be able to enter data fast enough to "beat the clock" so to speak, and secondly, two kHz is a nice frequency for an audible "key-pressed" indicator. The trick is to use the oscillator without interfering with the operation of the encoder. It's clear that we will need two things: a switch to connect the 555 to the speaker, and some way of throwing the switch every time a keypad switch is closed. Let's automatically rule out double-pole double-throw switches at the keyboard and see if we can take care of business in a more elegant fashion. For us, that means using inexpensive components, and whatever unused silicon there is left in the circuit as it is so far.

Designing the beeper

Figure 1 shows a possible solution to the problem. It's not the only way to get the job done and, if you can dream up something slicker, so much the better.

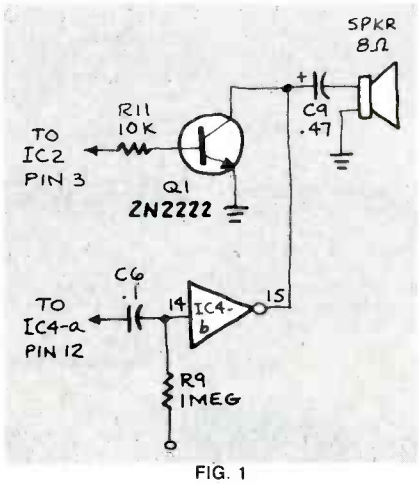

FIG. 1

Transistor Q1 is used as a switch between the 555 and the speaker, and the action of that switch is controlled indirectly by the "any-key-pressed" output of the encoder. I say "indirectly" because there's some silicon on the line. As long as we hold the collector of Q1 low the transistor is in cutoff and there's no audio. When a keypad switch is closed, the "any-key-pressed" line goes high, and that turns on the transistor and sounds the beep. As long as the keypad switch remains closed the beep will sound. That works perfectly, but we can make it slicker and use up some spare silicon at the same time.

We still have an unused inverter in IC4, so we'll build ourselves a half monostable with a period of about 100 milliseconds (0.1 second). We want it to output a positive-going pulse when a keypad entry is made; that means that using the "any-key-pressed" signal isn't possible since it's an active-high. As you now know, if you use an inverter to build a half monostable, a positive pulse at the output is produced by a positive-to-negative transition at the input. As it happens, we have such a signal available to us because we inverted the "any-key-pressed" signal to disable the 4518 BCD counter. All we have to do is pick up the trigger from the output of IC4-a, route it through our new edge-detector, and we'll get a clean beep lasting a tenth of a second whenever we enter a digit. Capacitor C9 keeps the eight-ohm impedance of the speaker from loading down the output of IC4-b, and R11 isolates that section from the rest of the circuit.

A data bus

Let's now turn our attention to the data bus—or rather the lack of one. So far, our encoder displays entered digits, but the data isn't available to us for use. That's a serious problem—since we want more out of this exercise in circuit design than an elaborate do-nothing box, a real data-bus is a must. At the moment, data from the keyboard goes directly to the display circuitry. What we have to do is change that so that the display shows whatever is on the data bus. That means we have to put some storage space between the encoder and the display. The easiest way to

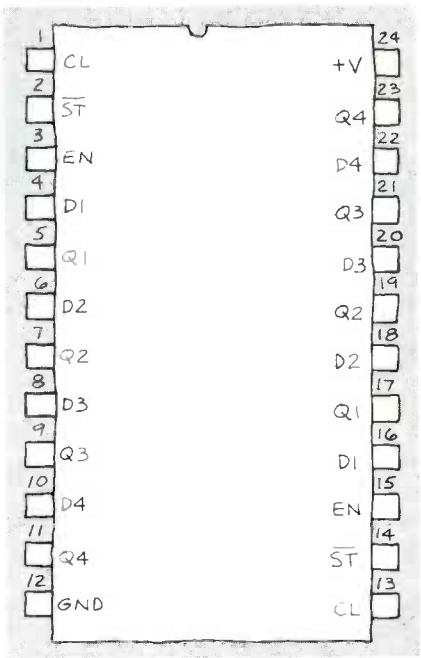

FIG. 2

do that is to put some hold-and-follow latches there and use them to remember the entered numbers.

Figure 2 shows the pinout of exactly what we need—a 4508 hold-and-follow latch that has the added bonus of Tri-State outputs. It's dual 4-bit latch, and each half of the IC can be used independently of the other. The EN (enable) pin controls the outputs, and bringing it high puts them into a high-impedance state without having any affect on the operation of the latch itself. The ST (store) pin controls the loading of the latch. If it's held high, the latch is transparent, but taking it low will

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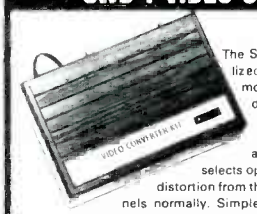

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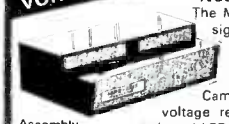

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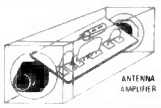

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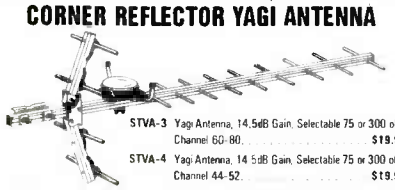

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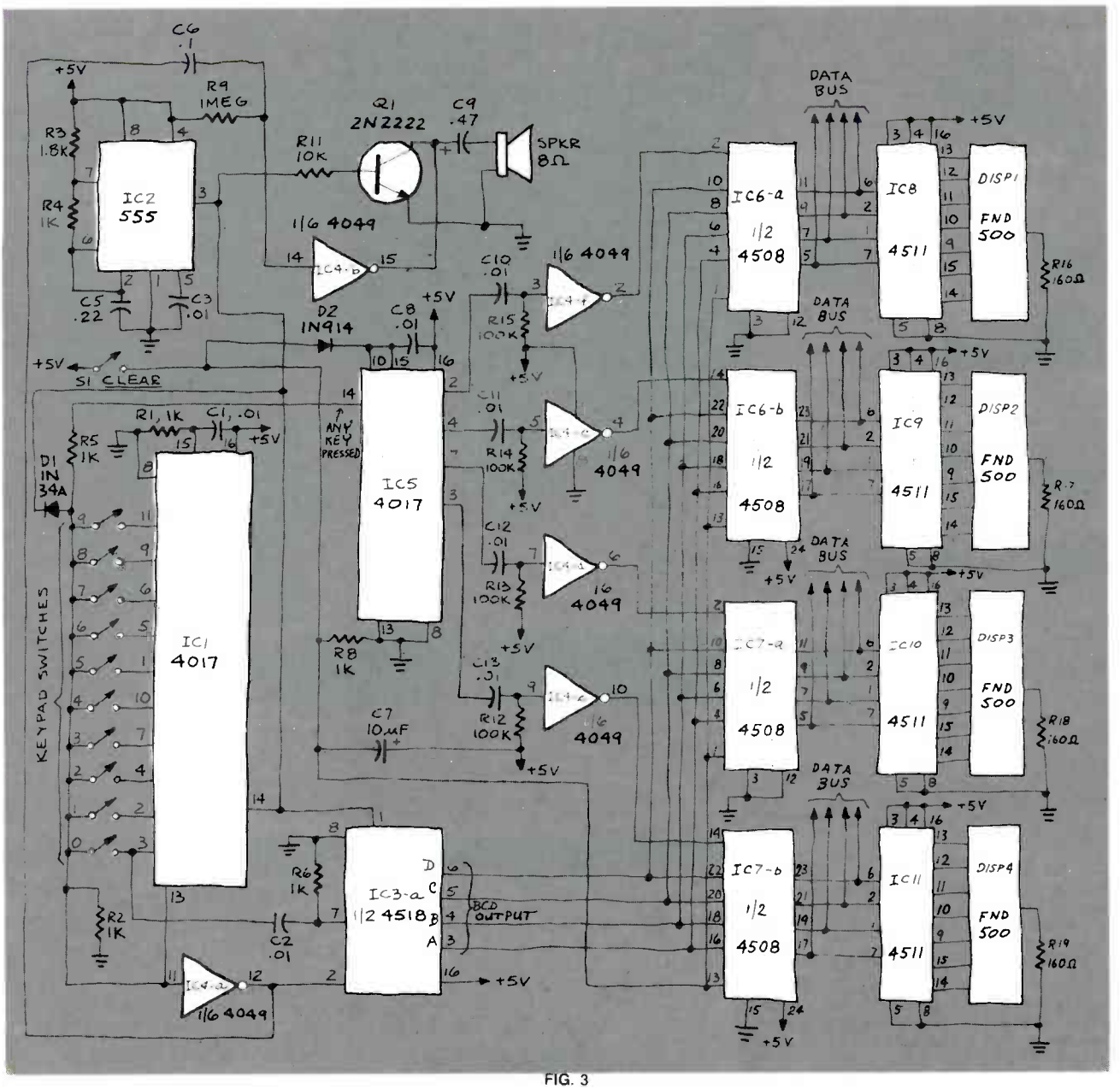

FIG. 3

close the latch and store whatever was at the inputs at that time.

On the face of it, there would seem to be a major problem in using a 4508 with the circuit we've designed so far, because the latch in the 4511 is enabled high and the 4508's latch is enabled low. A little thinking can solve that problem when we remember that the half monostables we're using to enable the latches are really edge—not level—detectors. As the circuit stands now, we're using the leading edge of the 4017 outputs to trigger the edge detectors. Well, what goes up must come down, so we can use the trailing edge instead and reconfigure our edge detectors to provide a pulse of the correct polarity. What that means in terms of circuit design is that instead of latching the first thing on the bus when a digit selector output goes high, we're grabbing the last thing on it before if goes low. Since the 4518 BCD counter is disabled while the keypad switch is thrown, the data remains unchanged.

Figure 3 is the complete schematic of our keyboard encoder. We've kept it down to four digits because the principle is the same for any amount of digits. Note that the 4508's have been put between the encoder and the display, and a true Tri-State bus now exists to display whatever data is put on it. The half monostables have been reconfigured and the digit selector, IC5, has been reconnected so that the first digit is now selected by pin 3, the zero output.

A "clear" function

The last piece of business we have to take care of to satisfy our original design criteria is to create a keyboard "clear." Now that the latches are in place, that becomes a simple problem. The CL pins of the 4508's are tied together and held at ground by R8. Throwing the CLEAR switch (S1) on the keyboard clears the latches and they output zeros. The same "clear" signal is sent on to IC5, the digit selector, to reset that to zero as well. Diode D1 prevents the normal resetting of the digit selector from clearing the latches. Capacitor C7 should be familiar by now. It provides a power-on reset pulse for the latches so they always power up with zeros. Resistor R9 forces a high on the collector of Q1 so that hitting the CLEAR switch will cause the beep to sound.

The EN pins of the 4508's have been tied to ground. If you're going to use the Tri-State feature of the data bus, some sort of selector logic will be needed to control access to the bus. It's a "one-and-only-one" sort of situation, and you should be able to do it with a few simple gates. Which ones you use will depend on the particular application, but the basic

continued on page 160

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The **Dyna-Mike Transmitter**

It's smaller than a quarter. But DYNA-MIKE will transmit every sound in the room to an FM radio tuned to the proper unused frequency, up to half a mile away.

If you're at a neighbor's home a block from your own, you can hear your baby's cry, or you can tell the instant your spouse comes home. If two of you are driving tandem in two cars, one or both of you can communicate with the other even if other cars drive between you.

DYNA-MIKE has as many uses as your imagination can think of. For a business conference, let the tiny microphone sit unobtrusively on the table or concealed on a shelf, and you'll be able to record every word. For businesses, put an FM receiver in a warehouse or remote office and "broadcast" instructions or orders to be filled.

Public speakers never had a better friend than the DYNA-MIKE. No wires or setup — just turn on one or more radios and your speech will come through with perfect fidelity. Put one on the front porch. If you hear a suspicious sound, turn on the radio and you'll hear the doorbell or even a muttered conversation.

Choose Your Model

New Horizons is introducing three models of the DYNA-MIKE supersensitive broadcast microphone. Model AR-7 is the world's smallest microphone. It's a miracle of electronic miniature power, with a range of 750 feet and a battery life of 90 hours. Introductory price is $129.95 (two for $119.95 each).

Model 9-DX is a long-range microphone, broadcasting an unbelievable half-mile distance. This miniaturized wonder is $149.95 (two for only $139.95 each). Normal battery life is 25 hours, or you can have the special Power-Pak, which operates 200 hours, for $19.95.

The AR-7 and 9-DX are sensitive. They'll pick up sounds from 40 feet away. But for super-sensitivity, nothing beats the A-5.

The A-5 will pick up a whisper from more than 60 feet away and broadcast it to a receiver 750 feet distant. The A-5 comes with a special 200-hour long-life battery and is introductory-priced at $99.95 (two for only $89.95 each).

The **Telephone Voice Changer**

It's right out of James Bond! Push a button and the VOICE CHANGER gives your voice completely different characteristics. The person on the other end of the phone won't know it's you.

The VOICE CHANGER is more than an "electronic handkerchief" — it doesn't cause your voice to sound filtered. It literally changes tone and timber.

Choose from two separate, distinct Changer Channels. If you're alone in a business office, it'll sound like an employee answering. If you live alone, you can get rid of pesky calls by pushing Channel 1 or Channel 2 and saying, "Sorry, that person isn't in."

How It Works

The VOICE CHANGER is powered by two ordinary penlight batteries. One set of lead-in wires connects to your telephone base; the other clips to the wires leading to the handset.

Pushing the button labeled "Ordinary" puts your normal voice through the line. Pushing "Channel 1" changes timber and texture. Pushing "Channel 2" creates different characteristics from Channel 1. Thus you have three voice options — your own, plus two changed voices.

MAKE NO MISTAKE! THE VOICE CHANGER DOESN'T MUFFLE YOUR VOICE OR MAKE IT UNINTELLIGIBLE. It literally changes the quality of sound — space-age electronics at work.

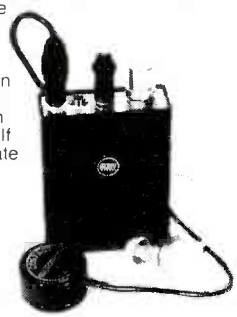
Use the VOICE CHANGER to reach that doctor, lawyer, or business executive whose secretary knows your voice and who always is "out" when you call. Use it to screen your own incoming calls. Use it for just plain fun. Any time you like, during a conversation, push the "Ordinary" button and your regular voice returns to the wire.

The VOICE CHANGER is yours for $99.95 — two for $89.95 each (plus $2.50 shipping per total order). When you consider the many uses of this brilliant electronic instrument, it's a real bargain. Of course it has the standard New Horizons guarantee.

The **Super Ear**

You'll hear it all.

Effortlessly, you can hear not just a baby's cries, but quiet breathing — through a concrete wall a foot thick. Put the earphone in your ear and place the SUPER-EAR on the wall. That's all there is to it.



SUPER-EAR hears everything — and, even more astounding, hears it clearly. It's as though the wall weren't there. If you're coming home late at night and think intruders are in your residence, let SUPER-EAR find out for you. Want to know if the meeting is over in the room with the closed door? SUPER-EAR will tell you in a second.

SUPER-EAR is undetectable from the other side of the wall. The quality of sound has amazing fidelity — good enough to record, and SUPER-EAR has its own built-in recorder jack.

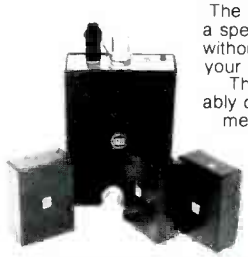
Because SUPER-EAR is the ultimate listening device, you can use it to pinpoint hidden squeaks in your car or the source of mysterious engine noises. Construction experts use it to check for flaws or cracks in buildings.

It Works Anywhere!

Ever put your ear to a railroad track to try to hear the train? Try it with SUPER-EAR. You'll hear that train many miles away. Use it as a powerful stethoscope on yourself, a friend, or a pet. You can even hear a bird's breathing.

The only source for SUPER-EAR is New Horizons. Choose from two models — Model SB-5, with ultrasensitive microphone, $139.95 (two for only $129.95 each); or Model SB-1, with suction-type microphone, $99.95 (two for only $89.95 each).

The **Private Transmitter/Receiver**



The NCZ-10 broadcasts on a special radio band. No one without equipment can hear your transmitted messages.

The reception is unbelievably clear and bright — commercial broadcast quality.

Your receiver clicks into any of three separate channels. In the suburbs the range is up to 2000 feet, and in the city 850 feet.

With your special receiver is an inconspicuous high fidelity earphone. You can put three transmitters in three locations and then switch back and forth, monitoring all three. Someone with an FM or police band receiver can tune his dial all day, but he won't pick up these signals.

With two receivers, you can have a complete two-way system without the inconvenience and annoyance of the semi-public CB channels. The NCZ-10 channels are private.

This professional-quality electronic miracle is easy to use and completely dependable. Monitor your baby's room. Leave a transmitter in an inconspicuous place in your office or your home, and you'll hear anything going on in that room.

One NCZ-10 receiver with one transmitter is $279.95; with two transmitters (two separate bands), it's $379.95; with three transmitters (three separate bands), it's $479.95.

For a complete private communications system, order two receivers, each with a transmitter (we'll send them with different bands). Special high-performance batteries enable you to operate the receiver for 40 hours continuously, the transmitter for 35 hours.

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Use any electronic instrument acquired from us for up to 30 days. If you decide for any reason you don't want to keep it, return it for a 100% refund.

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- 9-DX rechargeable power-pak, $19.95
- Dyna-Mike A-5, $99.95 (two for $89.95 each)
- Super-Ear Model SB-5 microphone, $139.95 (two for $129.95 each)
- Super-Ear Model SB-1 microphone, $99.95 (two for $89.95 each)
- Voice Changer, $99.95 (two for $89.95 each)
- NCZ-10 transmitter and receiver, $279.95 (two transmitters, one receiver, $379.95) (three transmitters, one receiver $479.95)

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NEW IDEAS

Crystal tester

IF YOU FREQUENT HAMFESTS, ELECTRONics flea markets, or any other type of surplus outlet, you know the pros and cons of buying from those sources. On the one hand, they're an excellent source of hard-to-get parts as well as a haven for bargain hunters. On the other, however, just about everything is sold "as is," with no guarantee of any kind—it's strictly "let the buyer beware." If you've ever come home with a pile of components, only to find out that half of them were useless, you know that not all bargains are what they seem.

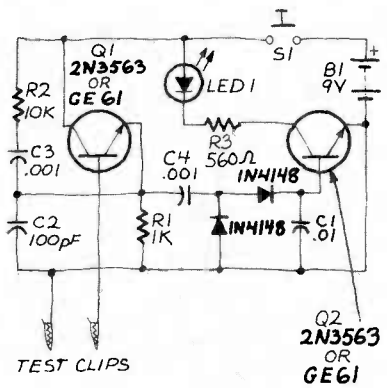


FIG. 1

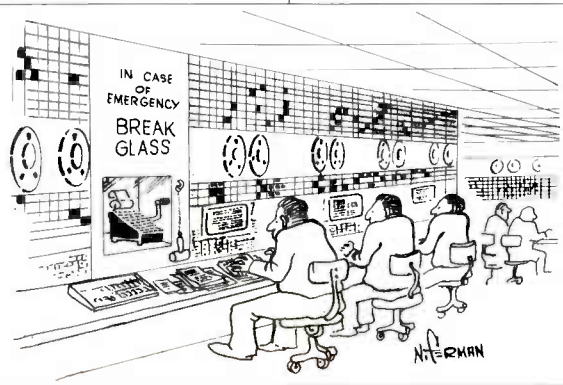
The ideal solution to that problem, of course, is to find some way to weed out the obviously bad parts before you buy them. The circuit I'll be describing here has proved useful for just that purpose when digging through stacks of crystals, as well as in troubleshooting my equipment. It is small, easy-to-build, and will, at a glance, let you know if a particular crystal will oscillate. Let's look at the circuit shown in Fig. 1.

Transistor Q1, a 2N3563, and its associated components form an oscillator circuit that will oscillate if, and only if, a good crystal is connected to the test clips. The output from the oscillator is then rectified by the two 1N4148 diodes and filtered by C1, a .01-μF capacitor. The positive voltage developed across the capacitor is applied to the base of Q2, another 2N3563, causing it to conduct. When that happens, current flows through LED1, causing it to glow. Since only a good crystal will oscillate, a glowing LED indicates that the crystal is indeed OK. The circuit is powered by a standard nine-volt transistor-radio battery and the SPST pushbutton power-switch is included to prolong battery life.

The circuit is easy to build, with size—for easy portability—the only real consideration. While just about any construction technique will work well, it's easiest to use a small piece of perforated construction-board.

To use the crystal tester, simply connect a crystal to the test leads and close the SPST pushbutton power-switch. If the crystal is OK, the LED will glow brightly. If the LED does not glow, or just glows dimly, the crystal is bad and should not be used.

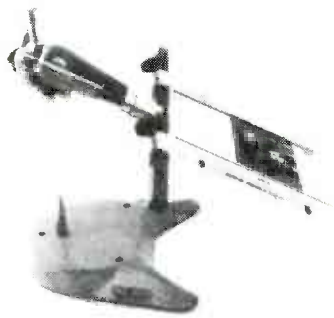
One note on the intended use for the tester is in order here, however. This tester will check any crystal for oscillation. However, it will not necessarily make the crystal oscillate at the frequency that it is supposed to; so you can't use this tester with a frequency counter to test for that. What the circuit *will* do is give you a way to quickly weed out crystals that are obviously bad, and, after all, that is half the battle.—*Jack Fernandes*



NEW IDEAS

This column is devoted to new ideas, circuits, device applications, construction techniques, helpful hints, etc.

All published entries, upon publication, will earn $25. In addition, Panavise will donate their *model 333*—The Rapid Assembly Circuit Board Holder, having a retail price of $39.95. It features an eight-position rotating adjustment, indexing at 45-degree increments, and six positive lock positions in the vertical plane, giving you a full ten-inch height adjustment for comfortable working. (See photo below.)



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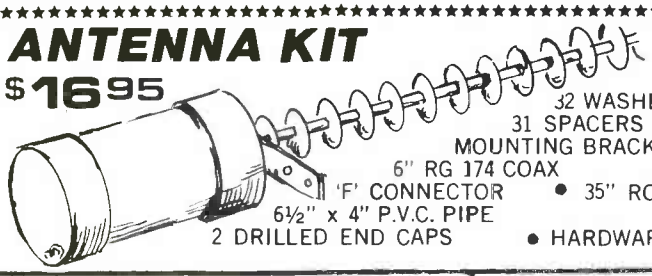

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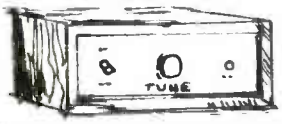

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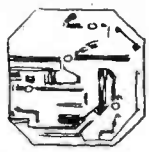

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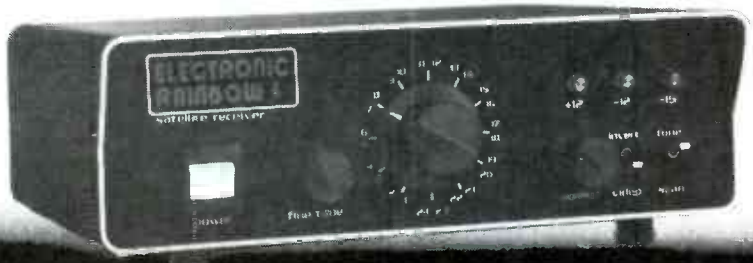

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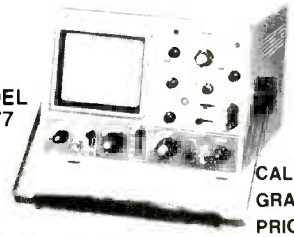

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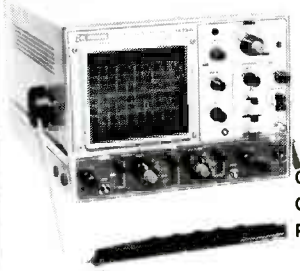

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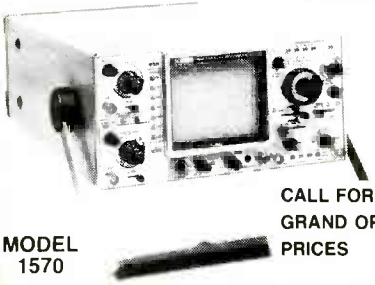

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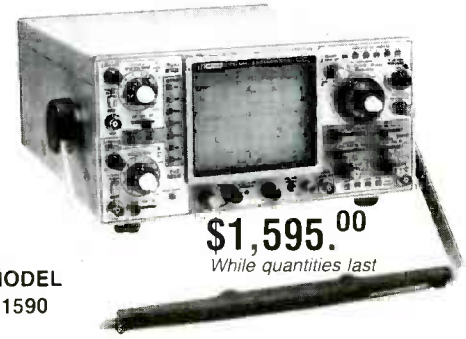

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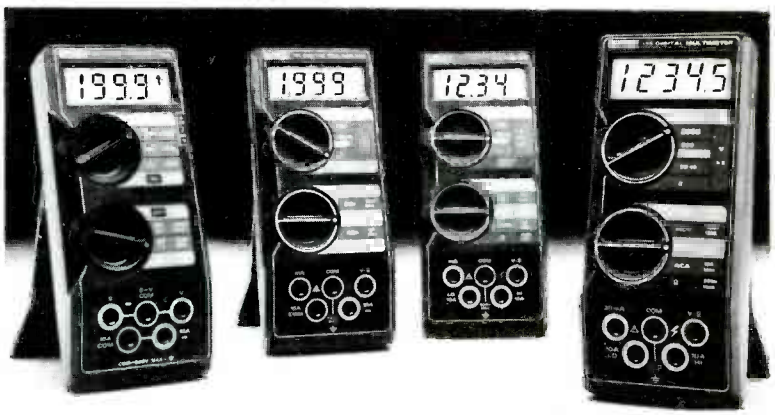

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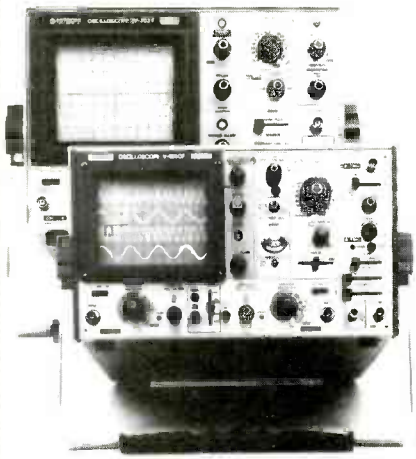

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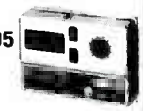

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- Automatically measures capacitance from 0.1pF to 200mF
- 0.1pF resolution
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- 3½ digit LCD display

MODEL 820

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- Fuse protected against charged capacitors
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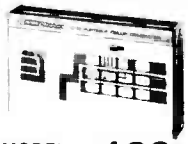

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HOBBY CORNER

Versatile timer circuit

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

LAST MONTH WE DISCUSSED A SOLUTION to Bob Allen's problem of adding timers to his "touch-plate" home-lighting-system. It involved the use of a regular mechanical timer (or clock) along with a 555-timer circuit to put out the proper type of pulse. Each timing sequence, of course, required a separate timer circuit. Now we'll look at a method that can be used for any number of timing sequences and uses just one digital clock.

A typical timer—even if it is the type that can be set to activate a device several times over 24 hours—has only one output. An alarm clock (digital or otherwise) can be used to control an external circuit also (instead of only sounding an audible alarm) but it will give only one output in each 24 hours.

There is, however, a way in which a digital clock can be modified to turn on a radio, light, *and* coffee-maker (or other devices) at three (or more) independent times. Any commercial digital clock can be modified, although it is admittedly easier to modify a clock kit as you build it.

LED readouts

To understand what we are about to do, let's take a close look at the digital readouts in the clock. Figure 1 shows the seven segments of such a readout with the labels ("a" through "g") by which they are identified. There is usually another point-segment located at the upper left or lower right that is used for decimals, colons, AM/PM and alarm-set indicators, and so on. Some clocks also have specialized readouts with dots, colons, AM, PM and other special configurations of segments.

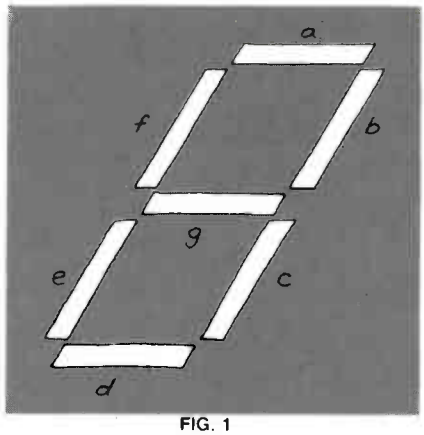

FIG. 1

In those displays, however, the digits 0 through 9 are created by lighting specific groupings of those segments. Figure 2 shows several interesting things about the way those digits are formed.

In Fig. 2, the columns are headed by the labels of the segments and the digits displayed (shown at the left) identify the rows. If there is a dot in a block, that segment (column) is on when the readout shows the digit (row). A "1," for example, has segments "b" and "c" lighted. The most significant information in the table, however, is given by the circles and squares. They indicate the segment combinations unique to each digit. (A circle means the segment is on and a square means the segment is off).

For example, when a 0 is displayed, the "f"-segment is on and the "g"-segment is off. *For no other digit is that true.* You can easily see that by glancing at the table—"f" is on and "g" is off in no other row. Thus, if we check only those two segments, we will know immediately whether the digit being displayed is a 0.

Simlilarly, checking the "c"-segment is a sure way to determine whether the display is a 2. In no other digit is that segment off. In like manner, you can check segments "a" and "b" to find out whether the digit is 5 or 6 and, if so, which it is (because while both have segment "b" off, 5 has the "a"-segment on and 6 has it off).

	a	b	c	d	e	f	g	UNIQUE
0	•	•	•	•	•	⊙	□	1 ON/1 OFF
1	□	•	•				□	2 OFF
2	•	•	□	•	•		•	1 OFF
3	•	•	•	•	□	□	⊙	1 ON/2 OFF
4	□	•	•	□		•	⊙	1 ON/2 OFF
5	⊙	□	•	•		•	•	1 ON/1 OFF
6	□	□	•	•	•	•	•	2 OFF
7	⊙	•	•	□			□	1 ON/2 OFF
8	•	⊙	⊙	•	⊙	•	⊙	4 ON
9	⊙	•	•	□		•	⊙	2 ON/1 OFF

FIG. 2

AN INVITATION

To better meet your needs, "Hobby Corner" will undergo a change in direction. It will be changed to a question-and-answer form in the near future. You are invited to send us questions about general electronics and its applications. We'll do what we can to come up with an answer or, at least, suggest where you might find one.

If you need a basic circuit for some purpose, or want to know how or why one works, let us know. We'll print those of greatest interest here in "Hobby Corner." Please keep in mind that we cannot become a circuit-design service for esoteric applications; circuits must be as general and as simple as possible. Please address your correspondence to:

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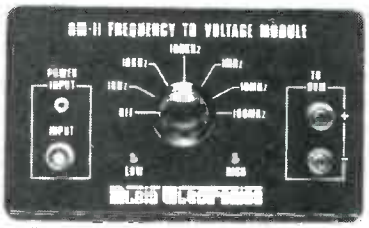

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Suppose, for example, we wanted to activate a circuit at 5:30. It could be lights, a coffee maker, the radio, or almost anything at all. You can use simple IC gates to determine when the hours digit gets to 5 and the ten-minutes digit gets to 3.

Reading the display

There are a great many ways that can be done. Fig. 3 shows just one of them. You can track through those gates and see that only when the hours display shows 5 and the ten-minute display shows 3 will the relay be actuated. Note that the relay is one of the many sensitive types made for low-power use. Normally, the contacts of those relays will not handle much current, and the control of high-current external circuits will require a change in the output. If you are operating a coffee-maker, for example, you can make one of two changes. You can use the light-duty relay to operate a relay with high current capacity or, as an alternative, have the final gate operate the heavy-duty relay through a transistor switch.

As shown in Fig. 3, the relay will be actuated at 5:30 AM and 5:30 PM. If that is not desirable, you should add another gate or two to "read" the clock's AM/PM indicator and combine it with the output from the two digits. In a 24-hour clock, you could read the tens-of-hours digit for that determination, though for the same time you would check the unit-hours digit for a "7" (as in 1730 hrs—the same as 5:30 PM) instead of "5."

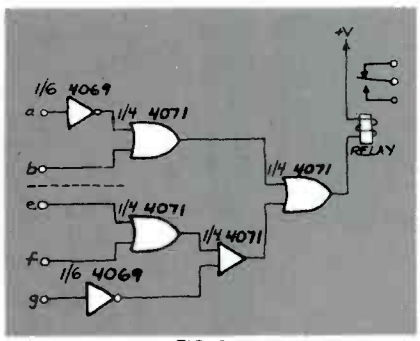


FIG. 3

If your use requires an output in the form of a pulse (as Bob Allen needs for his touch-plate lighting system), you may put one of the circuits in Fig. 4 between the final gate and the relay. For a pulse on the falling edge, use the circuit shown in 4-a. Use the one shown in 4-b for detection of the leading edge. Figure 5 shows one of many possible ways to extend the versatility of your system. The divide-by-seven counter will operate the external circuit only once a week! (Sunday morning?)

Well, so far, so good. But how are you better off than if you had used the alarm already built into the clock? As stated earlier, that will allow you only one activation each 24 hours (unless it is reset daily). In this system, however, you can

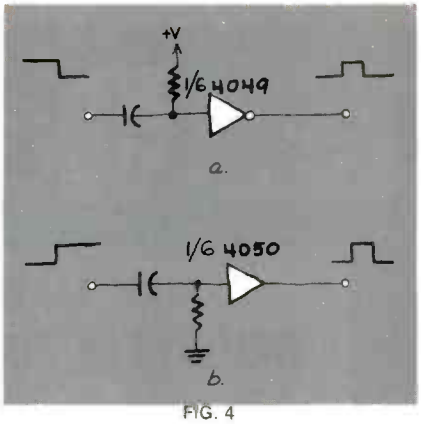


FIG. 4

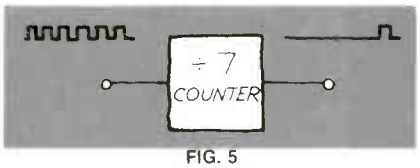


FIG. 5

connect several gates to the same segments and have any practical number of external circuits controlled by that one clock. It is unlikely, but if your need exceeds the available "fan-out" of the clock drivers, you can insert a buffer gate to increase the capacity.

The major disadvantage of the system presented here is the problem of changing the time of activation of any given circuit. The best way I have found to get around that is to install a panel of small switches by which segment combinations and/or gate configuration can be changed. It isn't entirely satisfactory, but it does work reasonably well.

Often a system like the one described here is used for a dedicated purpose—for example, only to control various groups of lights in the evening. In that case, you can adjust to daylight saving time and changing hours of sunset just by resetting the time on the clock. Then, the separate circuits will remain synchronized and, as a result, will not have to be changed individually. R-E

"Brilliant, Master but is it a marketable application of VLSI technology?"

STATE OF SOLID STATE

An interesting expander circuit for your hi-fi

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

IN THIS COLUMN, WE TRY TO BRING YOU news and details of new and interesting semiconductors and related matters without any month-to-month continuity. This month, because of long-time reader interest in volume expanders and audio noise reduction, we are deviating from the established format to show the circuit of the volume expander that complements the volume compressor discussed last month.

The hi-fi expander in Fig. 1 includes de-emphasis and attack and decay times to complement the compressor. Again, an external op-amp is substituted for the one in the Signetics NE570 compandor IC. In this case, the circuit performance demands a slew rate better than the 0.6 volts-per-microsecond provided by the NE570 op-amp. The expander, like the compressor, has a unity-gain level of 0 dBm. Adjustments are provided for harmonic distortion and DC shift.

Make the THD TRIM adjustments first using a 10-kHz 0-dBm (774.6 mV) signal. Adjust the DC SHIFT TRIM for minimum envelope bounce when tone bursts are fed through the circuit.

Performance is reported to be spectacular when the expander is applied to consumer tape recorders.

Op amp and voltage-reference IC

The National Semiconductor LM10-series comprises a group of monolithic linear IC's consisting of a precision voltage reference, an adjustable reference buffer, and an independent high-quality op-amp. The device has an absolute maximum supply-voltage rating of 45 volts for the LM10, LM10B, and LM10C; and 7 volts for the LM10BL and LM10CL. Supply voltage can be as low as 1.1 volts. Typical supply current is 270 μA.

The complementary output stage in the independent op-amp is capable of swinging to within 15 mV of the supply voltage or delivering +20-mA output current with +0.5 volt saturation. The reference output can be as low as 200 mV with 0.1% regulation.

The LM10's ability to operate from a single power supply with high output-current capabilities make it a very versatile general-purpose device. It can operate in a floating mode, independent of fixed supplies so it can be used in such applications as remote amplifiers for vibration sensors, flame detectors, resistance thermometers, optical pyrometers, and logarithmic light sensors. Its ability to operate from a wide range of voltages and currents makes the LM10 applicable in a wide range of voltage and current regulators.

The LM10 features such characteristics as 2.0 mV (max) input offset voltage, 0.7 nA (max) input offset current, 20 nA maximum input bias current, and offset-voltage drift of 2 microvolts-per-°C. The device comes in a metal can and an 8-pin dual-in-line package.

Full electrical specifications, including 33 typical-performance-characteristics charts are in the 15-page data booklet along with 33 schematics illustrating typical applications.—**National Semiconductor**, Literature Dept., M/S 16251, 1090 Kifer Rd., Sunnyvale, CA 94086

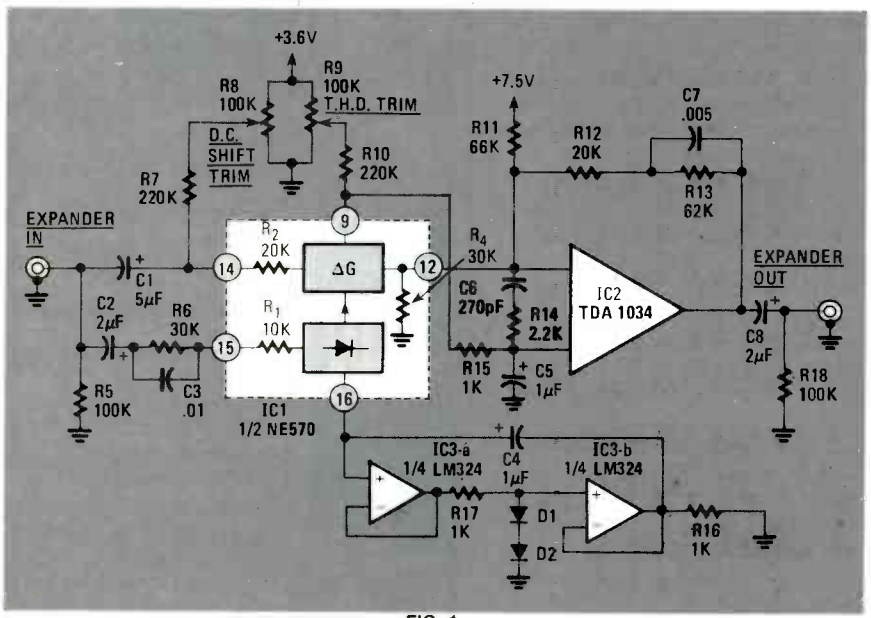


FIG. 1

SCR's go MOS

Motorola's new state-of-the-art MCR1000 series of SCR's uses MOS technology to offer the designer three devices that have the high input-impedance and fast turn-on time of a power MOSFET and the regenerative latching action of a thyristor. The new 200-ns turn-on SCR's can be driven directly from logic circuits without the need for interfacing devices.

The MCR1000 MOS SCR series has a 15-amp current rating and is designed primarily for high-speed switching and high-current pulse applications such as laser modulators, printers, fluorescent lighting, and switching power supplies. Features include: A forward voltage application rate of 1000 volts-per-microsecond at T_j = 125 °C and a fast switching (turn-on) time of 200 ns at T_j = 25 °C. (T_j is the operating temperature.)

The MCR1000-4, -6 and -8 devices are in TO-220 packages and feature peak forward blocking voltages of 200, 400, and 600 volts, respectively. Prices are $5.20, $5.70, and $6.90 in 100-999 quantities.—Contact Chris Field, **Motorola Semiconductor Products**, PO Box 20912, Phoenix, AZ 85026

1-watt power MOSFET's

International Rectifier has introduced a family of four new n-channel transistors using the company's HEXFET technology. A particular advantage of the devices is their low on-state resistance—about half that of many similar devices. Designated IRFD1Z0 through IRFD1Z3, the four devices have typical rise and fall times of 15 ns and 10 ns, respectively when I_D (continuous drain current) is 0.25 A. On-state resistance is 2.4 ohms for the IRFD1Z0 and -1Z1 and 3.2 ohms for the IRFD1Z2 and -1Z3.

Prices for those devices range from $0.89 to $1.16 in OEM quantities.—**International Rectifier**, Semiconductor Div., 233 Kansas St., El Segundo, CA 90245

Phase-locked-loop

The Exar XR-2213 is a highly stable phase-locked-loop IC designed for use in tone-detection applications and in FM detectors, tracking filters, and frequency synthesizers. Its circuit consists of a high-stability VCO, an input preamp, loop phase detector, lock phase detector, and a high-gain voltage comparator.

The XR-2213 has an operating frequency range of 0.02 Hz to 300 kHz and a preamp input voltage range of 2 mV to 3 V rms. The VCO and comparator supply TTL-compatible output signals and both Q and $\overline{Q}$ outputs. The 5-page data sheet includes design equations and examples along with circuit diagrams that illustrate various applications. Sample circuits include a tone detector, and a frequency synthesizer developing a 40-kHz output from a precision 10-kHz input signal.—**Exar Integrated Systems,** 750 Palomar Ave., Sunnyvale, CA 94088.

Semiconductor substitution guide

The Power Semiconductor Cross-Reference Guide, from Westinghouse, covers all rectifiers, transistors, SCR's and assemblies available from the company. It includes more than 10,000 JEDEC, Westinghouse, and competitive part numbers from 23 manufacturers. The guide is free.—**Westinghouse Corp.**, Semiconductor Div., Youngwood, PA 15697.

Linear-IC guide

Audio/Radio Products is a 19-page booklet prepared to introduce National Semiconductor's line of linear IC's for use in radio and audio products. Section 1 contains a 69-entry glossary of terms, definitions of maximum ratings and other IC parameters; and a check-list of do's and don't's for optimum performance from IC's. This check-list covers everything from power-supply selection and bypassing to circuit layout and heatsinking. Section 2 is the selection guide, listing devices under such application headings as tape processors, audio driver IC's, stereo decoders, audio power-amplifiers, and tone-control amplifiers. Key technical specifications are listed in tables and charts. Section 3 is a pocket containing about 2 dozen data sheets of typical devices that are covered in the previous section.

The glossary and check-list alone make this booklet a valuable addition to the libraries or technical data files of engineers, designers and others interested in IC's for radio and low-power audio applications.—**National Semiconductor Corp.**, 2900 Semiconductor Drive, Santa Clara, CA 95051. **R-E**

SERVICE CLINIC

Old sets, new sets

JACK DARR, SERVICE EDITOR

I GET A LOT OF LETTERS THAT SAY "I JUST don't understand these new TV sets! They're so complicated. Why can't they make them simpler, like the old ones?" Friends, I've had that same feeling! But I finally managed to find the best way to attack the late models. And we can use the same methods and tests that we've always used.

We do know how a TV set works—many of us have been making a living at it for a long time. And if we know how one TV set works, we know how they all work. Believe it or not, the new sets do the same things the old ones did, and in exactly the same order. But while they do do some of those things a little differently, all the old familiar stages and functions (see Fig. 1) are still there. So, if we can diagnose problems in old sets, we can do it in new ones, too.

One thing that makes some new sets different from older ones is that whole functions can be wrapped up in a single IC. For instance many new TV sets use an IC for the whole IF strip. If the complaint is "no video," you should check to make sure that the normal signal from the tuner is getting to the IC input. (The best way is to substitute a tuner.) Then (if the signal from the tuner *is* getting to the IC) see whether the video signal is coming out of it. If it isn't, and the DC supply voltages are normal, then we've got a "black box" with a normal input and normal voltage supply—but no output. Hmm. Input, but no output. The signal is lost between those two points. So, what would you do in an older tube or transistor set? You'd read the DC voltages on each amplifier stage to see if any were missing. The same test can be used with the IC. They're dandy clues to the cause of a problem. Let's say that pin 12 shows +3.6 volts, and that it should be about 12 volts. That could be a definite sign of trouble inside the IC. Usually there will be other pins that also have incorrect voltages. But before you replace the IC, be sure to check external parts, like resistors (open or changed in value), capacitors (for shorts or leakage), coils (for continuity), and so on. If you see a signal at the input but none at the output, and there's only one thing between those two points (the IC), then the chances are that it's faulty.

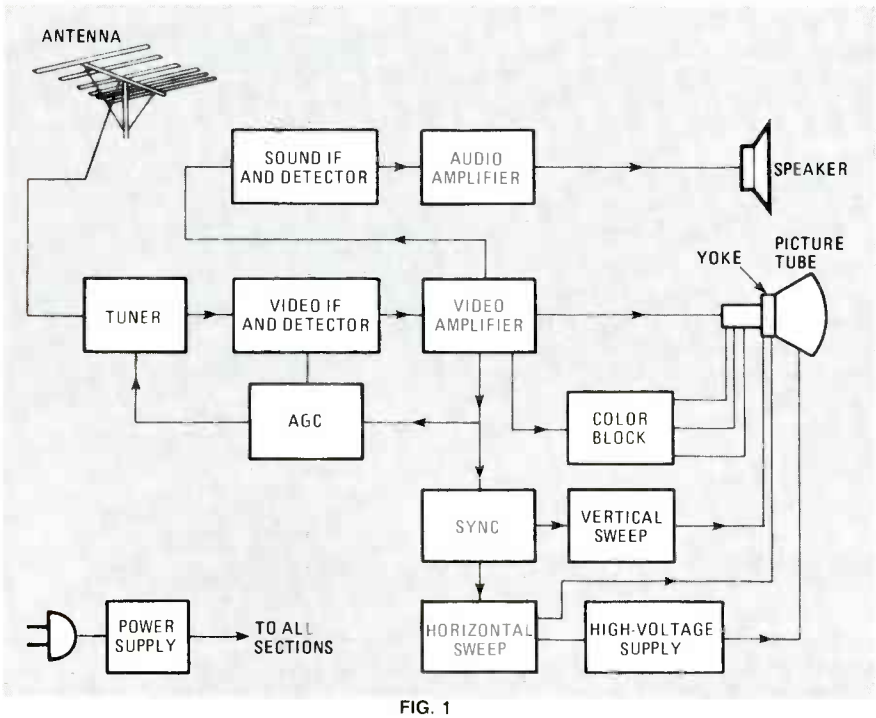


FIG. 1

Every set, old or new, has a tuner, IF amplifier, detector, video amplifier, color-amplifier stage, color detector and three color outputs. Another thing common to all the sets is that to trace trouble, you have to use the signal; follow it until you find where it is being lost, or distorted, and there you'll find the problem.

although you can't get to the individual stages.

You'll see that there are quite a few pins that have no external voltage applied, yet they show a small DC voltage. (There may be a resistor to ground, a capacitor, a coil, etc.) Those are *internal* voltages, developed inside the IC.

New circuits?

I've also heard a lot of people say, "There are so many new circuits here!" No—that's not so. Not even in the most complex all-electronic tuners. All the new tuners use VCO's (*V*oltage *C*ontrolled *O*scillators). A new circuit? Look at the horizontal-oscillator AFC circuit in almost every TV set ever made! The AFC voltage controls the frequency of the horizontal oscillator! That's a VCO, too.

The control voltages are a good way of checking those tuners. If the tuner doesn't work, it could be a fault in the tuner itself *or* it could be a fault in the stage that supplies the tuning voltages; that is usually called the "tuner control unit" or another similar name. There are two control voltages. One is the tuning voltage that determines the oscillator frequency that puts the tuner on the desired channel. That voltage often goes to only one terminal on the tuner. The DC control-voltages will change if the control unit is working. For example, the voltage might be 5–10 volts for low band VHF, 15–20 volts for high band VHF, and 25–30 volts for UHF. (Those are *not* actual figures; they're just for illustration.) The tuning voltages are applied to a varactor diode (voltage-variable capacitor) that does the actual tuning. In the service data, there will be (or at least there should be!) a table of tuning voltages for each band and channel.

Anything wrong in the control stage will throw the tuner off. For example, a missing DC voltage may keep it from going to high-band VHF, while low-band stations come in. Here's a test: look up the DC voltage for given channel, say Channel 9. Feed that voltage to the tuning-

voltage test point (from a bench DC-supply) and see whether the tuner works. If it does, the control stage is bad.

Often, the tuning-control stage is a separate unit that can be replaced without changing the tuner. That type can be repaired (if its construction permits) or it can be replaced as a unit.

Other diodes (aside from the varactors) are used in those tuners also; they are the switching diodes. Normally, there are three of them that switch the tuner from low- to high-VHF, and to UHF. The switching voltages come from the tuner control unit, just like the tuning voltages. Problems like getting only low-band VHF and the like are often the fault of the switching voltages. Always read them and compare them with the switching voltages shown in the voltage table for the tuner unit.

As we said in the beginning, there is nothing new in any of those circuits as far as function goes. They just do it in a slightly different way. (What? Show you a switching diode in a tube TV? OK: How about the B + rectifier? A 5U4 conducts or cuts off, depending on the polarity of the applied voltage. Full-wave rectification is just switching so that current can flow with only one polarity—right?)

So how do you repair a recent-model set? All you need to do is isolate the defective function, find that stage on the chassis, and then check it in the same way you've always done. **R-E**

SERVICE QUESTIONS

SOUND PROBLEM

I have a sound problem in this GE 10HE chassis. The sound-IF adjustments are all "funny." They don't react normally at all. The quad coil is very critical, and so is the sound-IF tuning. I don't get it—G.G., Murphysboro, IL

Check some components around the circuit, especially bypass capacitors such as the plate-return bypass on the IF transformer, the bypass on the low end of the quad coil, and so on. I see that there's a bypass capacitor on the sound-detector tube (17BF11). Check that too.

(Feedback: Got it! It was a bad bypass on the cathode of the 17BF11. Now, everything tunes up OK and the set sounds good. Thanks.)

HANDY HINT

Jerry Ahedo of Tampa, FL sends this tip in. When he was working on a Zenith 23HC45 with no picture (or schematic), he found a 10-watt ceramic resistor that was open. The part number and value had been completely removed by overheating. He took the resistor out and held it under an ultraviolet light. All numbers,

including the value were clearly visible! That might also work for other parts where ID numbers have disappeared.

Thanks, Jerry. Ultraviolet lamps are available from several sources (check the ads in the back pages of ***Radio Electronics****).*

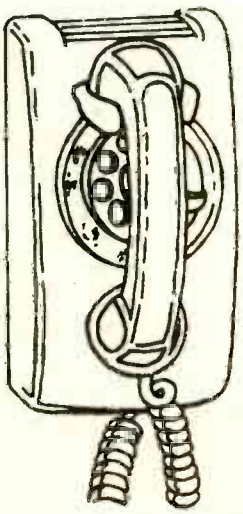
NO COLOR

I had several problems in a CTC-70AJ. Replacing the Chroma I module cleared up a short and restored the picture, but only in black and white. All voltages looked good on the IC, but checking with my scope, I found that, although there was a chroma signal at the input, there was none at the 3 color-outputs. I again installed a new Chroma I module, and the set worked beautifully. I can only assume that I managed to get a bad IC the first time around.—*J.P., Hollywood, FL.*

That happens too often, and there's not too much we can do except check and cuss.

MAN WITH A PROBLEM

Mike Shelton (Electronic Services, 2708 May Drive, Burlington, NC 27215) says that he's in desperate need of an IF module for a Heathkit GR-900 TV. The module, number 100-93502, is no longer available from Heath and no other sources have yet been found. Any help will be appreciated.



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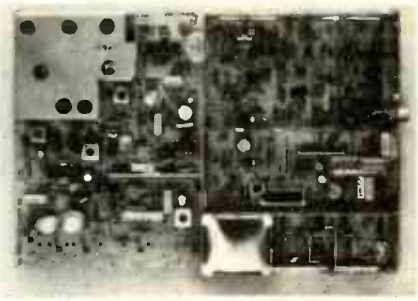

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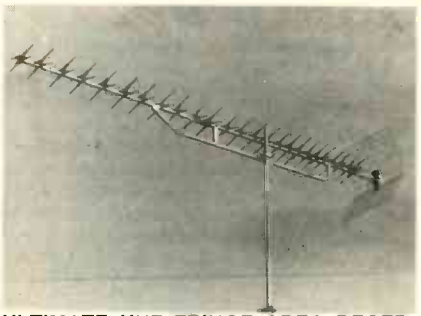

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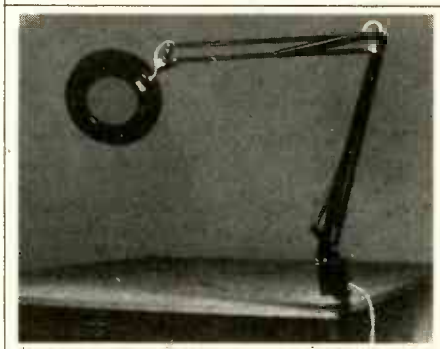

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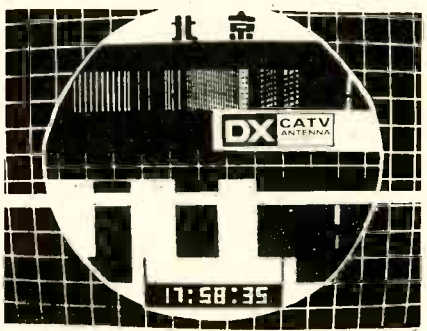

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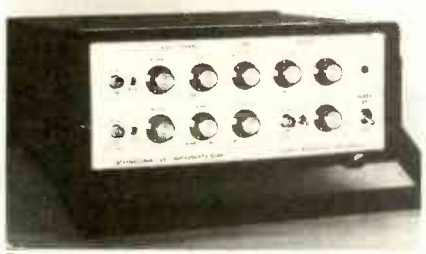

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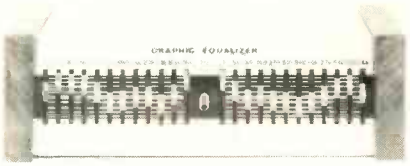

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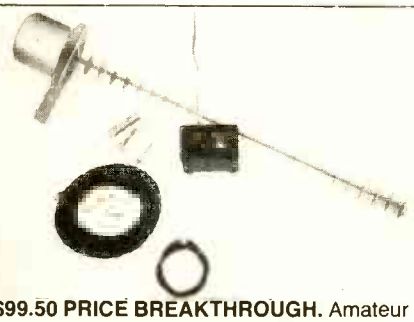

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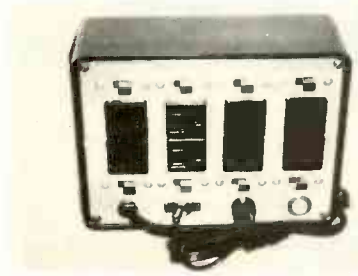

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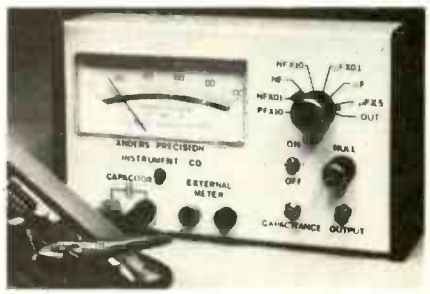

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CIRCLE 51 ON FREE INFORMATION CARD

DRAWING BOARD

continued from page 144

problem is the same. A good exercise in design is to work out a keyboard-switchable selector without using any mechanical rotary switches. Bear in mind the fact that there is still some unused silicon in the circuit—namely, the other half of the 4518. If you work out a neat way to solve the problem, let me know and I'll pass it along.

If your particular application for the encoder requires more than four digits, it would be a good idea to consider multiplexing the display. Ten digits and ten drivers mean more than seventy connections and that's a bit unreasonable, to say nothing of power hungry. Using only one driver and multiplexing the display saves a lot of trouble when you get beyond four digits. If all you're interested in is cutting back on power consumption (and don't mind adding a bit more circuitry), you have another option—you can just multiplex the LED's themselves. That's a much simpler problem, and only calls for a clock and a multiline selector that sequentially scans the digits. You can use the cathode connections of the digits but a much slicker way is to use the blanking pins of the drivers. There are lots of ways of multiplexing and I'd be interested in seeing what you can come up with. If you're thinking of trying it, remember that the 555 can deliver up to 200 milliamps and is running at a speed that's perfectly suitable for multiplexing.

Our keyboard encoder meets the criteria we set for it, and although it's more complex than using an IC that's designed especially for the purpose, it's cheaper and much more flexible. But it's certainly not the last word in keyboard encoders. There are two important rules to remember when you're doing any circuit design. The first is not to be afraid to experiment. If you find a way to do the job that looks weird on the surface and uses components in ways they were never used before—great. It's not called "weird," it's called "innovation." If your method works, don't be afraid to use it. Fresh minds bring fresh approaches, and something that seems perfectly obvious to you may never have occurred to anyone else.

Don't be afraid of blowing up your circuit. With prices as low as fifteen cents a gate, you can't do much financial damage. And when you've worked out a really slick way around a problem and figure that everything's taken care of, remember the second rule: There's always a better way. If you can do it with five packages, somebody else can do it with four.

As a matter of fact, if you think of a better way to build or improve our keyboard encoder, let me know and we'll let everybody else know. **R-E**

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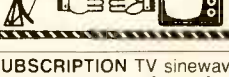

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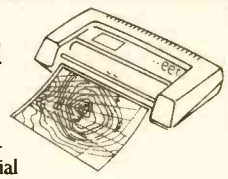

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74LS26	.35	74LS156	.80	74LS280	1.80
74LS27	.23	74LS157	.45	74LS283	.85
74LS28	.45	74LS158	.48	74LS290	.75
74LS30	.22	74LS160	.70	74LS293	.95
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74LS42	.44	74LS165	.80	74LS366	.80
74LS47	.85	74LS166	.80	74LS367	.58
74LS51	.22	74LS168	1.75	74LS368	.58
74LS54	.25	74LS170	1.50	74LS373	1.25
74LS73	.35	74LS173	.70	74LS374	1.25
74LS74	.35	74LS174	.45	74LS377	1.25
74LS75	.35	74LS175	.40	74LS386	.65
74LS76	.46	74LS181	1.95	74LS390	1.30
74LS83	.68	74LS190	.80	74LS393	1.30
74LS85	.80	74LS191	.80	74LS398	2.50
74LS86	.40	74LS192	.65	74LS670	1.80
74LS90	.39	74LS193	.65	74LS682	3.00
74LS92	.50	74LS194	.75	81LS97	1.10
74LS93	.50	74LS195	.90	81LS98	1.10
74LS96	.70	74LS196	.85		
74LS107	.36	74LS197	.85		

MULTI TURN TRIM POTS

50 OHM	5K	
100 OHM	10K	
500 OHM	50K	3/$2.00
1000 OHM	500K	

50 PIN RIBBON CONNECTORS	$3.25
40 PIN RIBBON CABLE CONN	$3.00
34 PIN RIBBON CABLE CONN	$3.00
20 PIN RIBBON CABLE CONN	$2.25
10 PIN RIBBON CABLE CONN	$1.50

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

2N3820 P FET	$ .45
2N 5457 N FET	$ .45
2N2646 UJT	$ .45
ER 900 TRIGGER DIODES	4/$1.00
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.01UF 35V	.16/$1.00	.100/$5.00

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

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106D	SPDT	1.10	
206D	DPDT	1.50	
206P	DPDT		CENTER OFF $1.75

IN4148 (IN914) 15/1.00

L1411-IR DETECTOR	3/$1.00
FP 100 PHOTO TRANS	$ .50
RED LED's .2"	8/$1.00
YEL, GREEN or AMBER LARGE LED's .2"	6/$1.00
RED-GREEN BIPOLAR LED	$ .90
RED-YELLOW BIPOLAR LED	$ .90
MLED92 IR LED	$ .75
MRD14B PHOTO DARL. XTOR	$ .50
MCT2 OPTO ISOLATORS	$ .60
4N26 OPTO ISOLATOR	$ .70
1 WATT ZENERS: 3.3, 4.7, 5.1, 5.6, 6.8, 8.2, 9.1, 10, 12, 15, 18, or 22V	6/$1.00

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GRAY
28 gauge

40 conductor .90/ft	
26 conductor .60/ft	
50 conductor 1.00	

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CTS 206- 4	4 POSITION .75
CTS 206- 7	7 POSITION .95
CTS 206- 8	8 POSITION .95
CTS 206-10	10 POSITION 1.25

DIP SOCKETS

8 PIN .10	22 PIN .25
14 PIN .12	24 PIN .25
16 PIN .15	28 PIN .35
18 PIN .20	40 PIN .40

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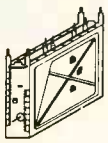

MODEL ELC 1045
FREQ. RANGE
UHF 470-889 MHZ
CHANNEL 14-83
OUTPUT CHANNEL 3
75 OHM INPUT

Comes with adapter board. You can plug Philips Tuner directly in place of a Mitsumi

Part No.	Description	Price
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90 day warranty on PS-5!!!

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- Complete system, power supply, cable, assembled reflector antenna, and downconverter.
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- Kit Form • 3½ Digits
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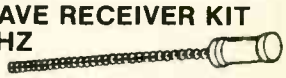

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PS-3	Complete package PS-1 & PS-2 ..	$65.00

Mounting Hardware Included

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$1.00 EA. 10 FOR $9.00

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ALL ARE 115 VAC PLUG IN

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22/44 GOLD SOLDER EYELET $2.50 EACH

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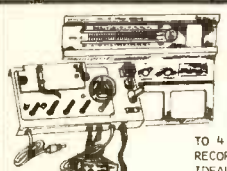

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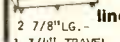

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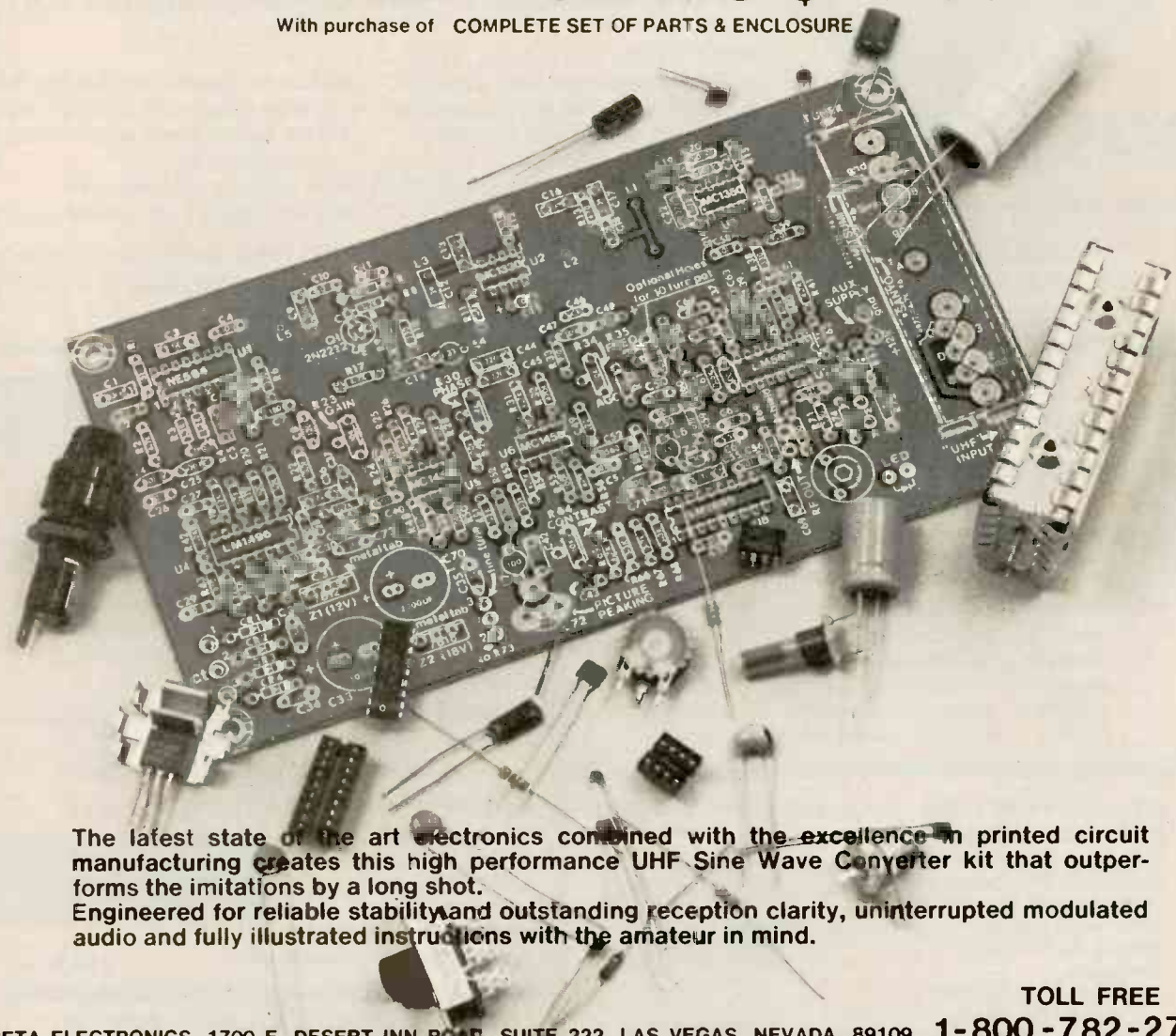

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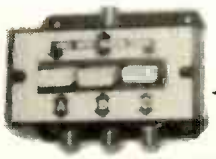

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4027	(250ns)	2.00
4116	(200ns)	1.25
4116	(150ns)	1.75
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21L02	(250ns LP)	1.55
2111	(450ns)	2.49
2114	(450ns)	1.75
2114L-3	(300ns LP)	1.85
2114L-2	(200ns LP)	1.95
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2.0	3.90	8.0	3.00
2.097152	3.90	10.0	3.00
2.4576	3.90	14.31818	3.90
3.2768	3.90	18.0	3.00
3.579545	3.00	18.432	3.00
4.0	3.00	20.0	3.00
5.0	3.00	22.1184	3.00
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74LS05	.24	74LS136	.49	74LS266	.49
74LS08	.24	74LS137	.95	74LS273	1.60
74LS10	.24	74LS138	.75	74LS275	3.25
74LS11	.30	74LS139	.75	74LS279	.49
74LS12	.30	74LS145	1.10	74LS280	1.95
74LS13	.40	74LS147	2.20	74LS283	.95
74LS14	.89	74LS148	1.20	74LS290	1.20
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74LS21	.30	74LS154	1.75	74LS298	.99
74LS22	.24	74LS155	.89	74LS324	1.75
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74LS27	.24	74LS157	.75	74LS353	1.49
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74LS48	.75	74LS169	1.69	74LS378	1.15
74LS49	.75	74LS170	1.69	74LS379	1.35
74LS51	.30	74LS173	.75	74LS385	1.89
74LS54	.35	74LS174	.89	74LS386	.59
74LS55	.35	74LS175	.89	74LS390	1.79
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74LS74	.44	74LS190	.89	74LS399	1.59
74LS75	.49	74LS191	.89	74LS424	2.89
74LS76	.39	74LS192	.89	74LS447	.75
74LS78	.49	74LS193	.89	74LS490	1.89
74LS83	.75	74LS194	.89	74LS668	1.65
74LS85	.95	74LS195	.89	74LS669	1.85
74LS86	.39	74LS196	.79	74LS670	2.10
74LS90	.65	74LS197	.79	74LS674	9.50
74LS91	.79	74LS221	1.10	74LS682	2.99
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74LS93	.59	74LS241	.95	74LS684	2.39
74LS95	.79	74LS242	1.79	74LS685	2.39
74LS96	.79	74LS243	1.79	74LS688	2.39
74LS107	.39	74LS244	.95	74LS689	2.39
74LS109	.39	74LS245	1.89		
74LS112	.39	74LS247	.79	81LS95	1.65
74LS113	.39	74LS248	1.20	81LS96	1.65
74LS114	.49	74LS249	.89	81LS97	1.65
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4009	.45	4023	.35	4502	.90
4010	.45	4024	.75	4503	.60
4011	.30	4025	.35	4508	1.90
4012	.30	4026	1.60	4510	.90
4013	.45	4027	.60	4511	.90
4014	.90	4028	.75	4512	.90
4015	.90	4029	.90	4514	1.20
4016	.45	4030	.45	4515	2.20
		4034	2.90	4516	1.50
		4035	.85	4518	1.20
		4040	.90	4519	1.20
		4041	1.20	4520	1.20
		4042	.75	4522	1.20
		4043	.75	4526	1.20
		4044	.75	4527	1.90
		4046	.90	4528	1.20
		4047	.90	4531	.90
		4049	.50	4532	1.90
		4050	.50	4538	1.90
		4015	.90	4539	1.90
		4053	.90	4543	2.70
		4060	1.39	4555	.90
		4066	.75	4556	.90
		4068	.39	4581	1.90
		4069	.30	4582	1.90
		4070	.35	4584	.90
		4071	.30	4585	.90
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		4073	.30	80C07	.90
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SN7403N	14	.25	SN7475N	16	.45	SN74161N	16	.69
SN7404N	14	.25	SN7476N	16	.35	SN74162N	16	.69
SN7405N	14	.25	SN7479N	14	4.95	SN74163N	16	69
SN7406N	14	29	SN7480N	14	.69	SN74164N	14	.69
SN7407N	14	.29	SN7482N	14	1.19	SN74165N	16	.89
SN7408N	14	.25	SN7483N	16	.59	SN74166N	16	.89
SN7409N	14	.25	SN7485N	16	.59	SN74167N	16	2.79
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SN7411N	14	.25	SN7489N	16	2.25	SN74172N	24	4.95
SN7412N	14	.35	SN7490N	14	.39	SN74173N	16	.69
SN7413N	14	.35	SN7491N	14	.59	SN74174N	16	.69
SN7414N	14	.49	SN7492N	14	.39	SN74175N	16	.69
SN7416N	14	.25	SN7493N	14	.39	SN74176N	14	69
SN7417N	14	.25	SN7494N	14	.69	SN74177N	14	69
SN7420N	14	.19	SN7495N	14	.49	SN74179N	16	1.49
SN7421N	14	.35	SN7496N	16	.49	SN74180N	14	.69
SN7422N	14	.45	SN7497N	16	2.75	SN74181N	24	1.95
SN7423N	16	.59	SN74100N	24	1.49	SN74182N	16	.89
SN7425N	14	29	SN74104N	14	.89	SN74184N	16	1.95
SN7426N	14	.29	SN74105N	14	89	SN74185N	16	1.95
SN7427N	14	.25	SN74107N	14	.29	SN74190N	16	.69
SN7428N	14	.49	SN74109N	16	.39	SN74191N	16	.69
SN7430N	14	.25	SN74116N	24	1.49	SN74192N	16	.69
SN7432N	14	.29	SN74121N	14	.39	SN74193N	16	.69
SN7437N	14	.25	SN74122N	14	.55	SN74194N	16	.69
SN7438N	14	.29	SN74123N	16	.49	SN74195N	16	.69
SN7439N	14	.59	SN74125N	14	.45	SN74196N	14	.89
SN7440N	14	.19	SN74126N	14	.45	SN74197N	14	.89
SN7441N	16	.89	SN74132N	14	.49	SN74198N	24	1.19
SN7442N	16	.45	SN74136N	14	.69	SN74199N	24	1.19
SN7443N	16	.99	SN74141N	16	.69	SN74221N	16	1.19
SN7444N	16	99	SN74142N	16	2.95	SN74251N	16	.79
SN7445N	16	.69	SN74143N	24	2.95	SN74276N	20	1.95
SN7446N	16	.69	SN74144N	24	2.95	SN74279N	16	.79
SN7447N	16	69	SN74145N	16	.59	SN74283N	16	1.49
SN7448N	16	.69	SN74147N	16	1.49	SN74284N	16	2.95
SN7450N	14	.19	SN74148N	16	1.19	SN74285N	16	2.95
SN7451N	14	.19	SN74150N	24	1.19	SN74365N	16	.55
SN7453N	14	.19	SN74151N	16	.59	SN74366N	16	.55
SN7454N	14	.19	SN74152N	14	.59	SN74367N	16	.55
SN7459A	14	.25	SN74153N	16	.59	SN74368N	16	.55
SN7460N	14	.19	SN74154N	24	1.25	SN74390N	16	1.49
SN7470N	14	.29	SN74155N	16	.59	SN74393N	14	1.49

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74LS00	14	.25				74LS192	16	.79
74LS01	14	.25				74LS193	16	.79
74LS02	14	.25	74LS92	14	.55	74LS194	16	.69
74LS03	14	25	74LS93	14	.55	74LS195	16	69
74LS04	14	.29	74LS95	14	.79	74LS197	14	79
74LS05	14	.29	74LS96	16	.89	74LS221	16	89
74LS08	14	.29	74LS107	14	.39	74LS240	20	1.09
74LS09	14	.29	74LS109	16	.39	74LS241	20	1.09
74LS10	14	.29	74LS112	16	.39	74LS242	14	1.09
74LS11	14	.35	74LS113	14	.39	74LS243	14	1.09
74LS12	14	.35	74LS114	14	.39	74LS244	20	1.09
74LS13	14	.39	74LS122	14	.49	74LS245	20	1.49
74LS14	14	.59	74LS123	16	.79	74LS247	16	1.09
74LS15	14	.35	74LS125	14	.49	74LS248	16	1.09
74LS20	14	.29	74LS126	14	.49	74LS249	16	1.09
74LS21	14	.29	74LS132	14	.59	74LS251	16	.59
74LS22	14	.29	74LS133	16	.59	74LS253	16	.59
74LS26	14	.29	74LS136	14	.39	74LS257	16	.59
74LS27	14	.29	74LS138	16	.59	74LS258	16	.59
74LS28	14	.35	74LS139	16	.59	74LS260	14	.59
74LS30	14	.29	74LS151	16	59	74LS266	14	.69
74LS32	14	.35	74LS153	16	.59	74LS273	20	1.49
74LS33	14	.55	74LS154	24	99	74LS279	16	.49
74LS37	14	.35	74LS155	16	.69	74LS283	16	.69
74LS38	14	.35	74LS156	16	.69	74LS290	14	.89
74LS40	14	.29	74LS157	16	.69	74LS293	14	.79
74LS42	16	.55	74LS158	16	.59	74LS298	16	.89
74LS47	16	.75	74LS160	16	.69	74LS352	16	1.29
74LS48	16	.75	74LS161	16	.69	74LS353	16	1.29
74LS49	16	.75	74LS162	16	.69	74LS365	16	.49
74LS51	14	.25	74LS163	16	.69	74LS366	16	.49
74LS54	14	25	74LS164	14	.69	74LS367	16	.49
74LS55	14	.29	74LS165	16	1.19	74LS368	16	.49
74LS73	14	.39	74LS168	16	1.19	74LS373	20	1.29
74LS74	14	.39	74LS169	16	1.19	74LS374	20	1.29
74LS75	16	.39	74LS170	16	1.49	74LS375	16	.69
74LS76	16	.39	74LS173	16	.69	74LS386	14	.45
74LS78	14	.39	74LS174	16	.59	74LS393	14	1.19
74LS83	16	.65	74LS175	16	.59	74LS399	16	1.49
74LS85	16	.69	74LS181	24	2.49	74LS670	16	1.49
74LS86	14	.39	74LS190	16	.89	81LS95	20	1.49
74LS90	14	.55	74LS191	16	.89	81LS97	20	1.49

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74S00	14	.35				74S243	14	2.49
74S02	14	.35				74S244	20	2.49
74S03	14	.35	74S124	16	2.95	74S251	16	1.19
74S04	14	.45	74S133	16	.45	74S253	16	1.19
74S05	14	.45	74S134	16	.50	74S257	16	1.19
74S08	14	.39	74S135	16	69	74S258	16	1.19
74S09	14	39	74S136	14	1.39	74S260	14	.79
74S10	14	.35	74S138	16	.89	74S280	14	1.95
74S11	14	.35	74S139	16	89	74S287*	16	1.95
74S15	14	.35	74S140	14	.55	74S288*	16	1.95
74S20	14	.35	74S151	16	99	74S373	20	2.49
74S22	14	.35	74S153	16	.99	74S374	20	2.49
74S30	14	.35	74S157	16	.99	74S387*	16	1.95
74S32	14	.45	74S158	16	.99	74S471*	20	5.95
74S38	14	.89	74S160	16	2.49	74S472*	20	4.95
74S40	14	.39	74S174	16	99	74S473*	20	4.95
74S51	14	.35	74S175	16	.99	74S474*	24	4.95
74S64	14	.39	74S188*	16	1.49	74S475*	24	4.95
74S65	14	.39	74S194	16	1.49	74S570*	16	2.95
74S74	14	.55	74S195	16	1.49	74S571*	16	2.95
74S86	14	.55	74S196	14	1.49	74S572*	18	4.95
74S112	16	.55	74S240	20	2.25	74S573*	18	4.95
74S113	14	.55	74S241	20	2.25	74S940	20	2.49
74S114	14	.55	74S242	14	2.49	74S941	20	2.49

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CA3013H		2.15	CA3060N	16	3.25	CA3096N	16	1.19
CA3023H		3.25	CA3080E	8	89	CA3130E	8	1.[illegible]
CA3035H		5.95	CA3081N	16	1.49	CA3140E	8	.99
CA3039H		1.35	CA3082N	16	1.49	CA3160H		1.95
CA3046N	14	.89	CA3083N	16	1.49	CA3401N	14	59
CA3059N	14	3.25	CA3086N	14	.69	CA3600N	14	3.95

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						CD4098	16	1.95
CD4000	14	.29				CD4506	16	1.19
CD4001	14	.29	CD4040	16	.79	CD4507	14	.39
CD4002	14	.29	CD4041	14	.79	CD4508	24	3.95
CD4006	14	.89	CD4042	16	.69	CD4510	16	.89
CD4007	14	.29	CD4043	16	.79	CD4511	16	.89
CD4009	16	.39	CD4044	16	.79	CD4512	16	.89
CD4010	16	.39	CD4046	16	.89	CD4514	24	1.79
CD4011	14	.29	CD4047	14	.89	CD4515	24	1.79
CD4012	14	.15	CD4048	16	.39	CD4516	16	.99
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CD4016	14	39	CD4052	16	.79	CD4526	16	1.19
CD4017	16	.75	CD4053	16	.79	CD4528	16	1.19
CD4018	16	.79	CD4056	16	2.95	CD4529	16	1.19
CD4019	16	.39	CD4059	24	7.95	CD4543	16	1.19
CD4020	16	.75	CD4060	16	.89	CD4562	14	6.95
CD4021	16	.79	CD4066	14	.39	CD4566	16	1.39
CD4022	16	.79	CD4068	14	.39	CD4583	16	2.49
CD4023	14	.29	CD4069	14	.29	CD4584	14	.59
CD4024	14	.69	CD4070	14	.39	CD4723	16	1.19
CD4025	14	.23	CD4071	14	.29	CD4724	16	1.19
CD4026	16	2.49	CD4072	14	.29	MC14409	16	13.95
CD4027	16	.45	CD4073	14	.29	MC14410	16	13.95
CD4028	16	.69	CD4075	14	.29	MC14411	24	11.95
CD4029	16	.79	CD4076	16	.79	MC14412	16	13.95
CD4030	14	.39	CD4078	14	.49	MC14419	16	7.95
CD4034	24	1.95	CD4081	14	.29	MC14433	24	13.95
CD4035	16	.89	CD4082	14	.29	MC14538	16	1.19
(More in Catalog)			CD4093	14	.49	MC14541	14	1.19

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$9.95
2650	40	MPU	14.95
IDM2901ADC	40	CPU—4-bit slice (Com. Temp. Gr.)	19.95
MCS6502	40	MPU w/Clock (65K bytes mem.)	9.95
MC6802CP	40	MPU w/Clock and RAM	7.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N-6	40	CPU-Sgl. chip 8-bit (128 bts. Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	5.95
INS8070N	40	CPU (64 bytes RAM)	11.95
INS8073N	40	CPU w/Basic Micro Interpreter	14.95
P8085A	40	CPU	5.95

Z80, Z80A, Z80B, Z8000 SERIES

Part No.	**Pins	Function	Price
Z80	40	CPU (MK3880N)(780C) 2MHz	$4.95
Z80-CTC	28	Counter Timer Circuit	5.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80-DMA	40	Direct Memory Access Circuit	15.95
Z80-P10	40	Parallel I/O Interface Controller	5.95
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	15.95
Z80-S10/1	40	Serial I/O (Lacks DTRB)	15.95
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	15.95
Z80-S10/9	40	Serial I/O	15.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	5.95
Z80A-CTC	28	Counter Timer Circuit	5.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80A-DMA	40	Direct Memory Access Circuit	17.95
Z80A-P10	40	Parallel I/O Interface Controller	5.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB bonded)	16.95
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	16.95
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	16.95
Z80A-S10/9	40	Serial I/O	16.95
Z80B	40	CPU (MK3880N-6) 6MHz	11.95
Z80B-CTC	28	Counter Timer Circuit	13.95
Z80B-P10	40	Parallel I/O Interface Controller	13.95
Z8001	48	CPU Segmented	51.95
Z8002	40	CPU Non-Segmented	55.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6800/68000 SERIES

Part No.	**Pins	Function	Price
MC6800	40	MPU	4.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6810API	24	128x8 Static RAM	3.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	4.95
MC6828	24	Priority Interrupt Controller	15.95
MC6830L8	24	1024x8-bit ROM (MC68A30-8)	10.95
MC6850	24	Asynchronous Comm. Adapter	4.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	9.95
MC6862	24	2400bps Modulator	12.95
MC6880A	16	Quad 3-state bus trans. (MC8T26)	2.25
MC68000L8	64	MPU 16-Bit (8MHz)	69.95
MC68488P	40	General Purpose Inf. Adapter	8.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	8.95

8080A SERIES

Part No.	**Pins	Function	Price
INS8080A	40	CPU	3.95
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	3.95
DP8216	16	Bi-Directional Bus Driver	2.25
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	5.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element (INS8250)	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	7.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	8.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.49
DP8307	20	8-bit Bi-Directional Receiver	2.49
DP8308	20	8-bit Bi-Directional Receiver	2.49
DP8310	20	Octal Latched Peripheral Driver	4.95
DP8311	20	Octal Latched Peripheral Driver	4.95

MICROPROCESSOR MANUALS & DATA BOOKS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00
0400	1982 Intel Data Book (1405 pg.)	14.95
30001	1981 Nat. CMOS Book (628 pg.)	6.95
30002	1980 Nat. Interface Book (640 pg.)	6.95
30003	1982 Nat. Linear Book (1952 pg.)	11.95
30005	1981 Nat. TTL Book (624 pg.)	9.95
30008	1980 Nat. Memory Data Book (464 pg.)	6.95
30011	1980 Nat. Linear Applications (736 pg.)	15.95
30013	1983 Zilog Data Book (641 pg.)	7.95
205610	1981 Intel Peripheral Design (828 pg.)	9.95

DYNAMIC RAMS

Part No.	**Pins	Description	Price
1103	18	1024x1 (300ns)	.99
4027	16	4096x1 (250ns)	2.49
4116N-2	16	16,384x1 (150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1 (200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1 (250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1 (150ns)	7.95 - 8/59.95
4164N-200	16	65,536x1 (200ns)	7.49 - 8/54.95
MM5261	18	1024x1 (300ns)	.49 - 8/1.95
MM5262	22	2048x1 (365ns)	.49 — 8/1.95
MM5270	18	4096x1 (250ns) MK4096	4.95
MM5280	22	4096x1 (200ns) 2107	3.95
MM5290-2	16	16,384x1 (150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1 (200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1 (250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1 (200ns)	1.69

STATIC RAMS

Part No.	**Pins	Description	Price
1101	16	256x1 (650ns)	1.49
2101	22	256x4 (450ns) 8101	2.49
2102	16	1024x1 (350ns)	.89
21L02	16	1024x1 (450ns) L.P.	1.49
2111	18	256x4 (450ns) 8111	2.95
2112	16	256x4 (450ns) MOS	2.95
2114	18	1024x4 (450ns)	1.95 - 8/13.95
2114L	18	1024x4 (450ns) L.P.	2.25 - 8/15.95
2114-2	18	1024x4 (200ns)	2.25 - 8/15.95
2114L-2	18	1024x4 (200ns) L.P.	2.49 - 8/17.95
2141-3	18	4096x1 (150ns)	3.95
2147	18	4096x1 (70ns)	4.95
2148	18	1024x4 (70ns)	8.95
TMS4044	18	4096x1 (450ns)	3.95
TMS4045	18	1024x4 (450ns)	3.95
5101	22	256x4 (450ns) CMOS	4.95
MM5257	18	4096x1 (450ns) 4044	4.95
HM6116P-3	24	2048x8 (150ns) CMOS	7.95
HM6116-4	24	2048x8 (200ns) CMOS	6.95
HM6116LP-4	24	2048x8 (200ns) L.P. CMOS	7.95
7489	16	16x4 (50ns) 3101	2.25
74C920	22	256x4 (250ns) CMOS (6551)	3.95
74C921	18	256x4 (250ns) CMOS	3.95
74C929	16	1024x1 (250ns) CMOS (6501)	3.95
74C930	18	1024x1 (250ns) CMOS (6518)	3.95
74S189	16	16x4 (35ns) 93405	1.95
74S200	16	256x1 (80ns) 93410	3.95
74S206	16	256x1 (60ns) 93411	3.95
74S289	16	16x4 (35ns) 3101	2.25
82S10	16	1024x1 (50ns) O.C. (93415)	3.95
82S25	16	16x4 (50ns) O.C. (74S289)	2.25

EPROMS

Part No.	**Pins	Description	Price
1702A	24	256x8 (1us)	4.95
2708	24	1024x8 (450ns)	3.95
2708-5	24	1024x8 (550ns) SM00246	2.95
TMS2516	24	2048x8 (450ns) 2716	6.95
TMS2532	24	4096x8 (450ns) NMC2532	9.95
TMS2564	28	8192x8 (450ns)	19.95
TMS2716	24	2048x8 (450ns) 3 voltage	7.95
2716	24	2048x8 (450ns)	4.95
2716-1	24	2048x8 (350ns)	6.95
2732	24	4096x8 (450ns)	9.95
27580	24	1024x8 (450ns) single +5V	2.95
MM2764	28	8192x8 (450ns)	18.95
MM2764-3	28	8192x8 (300ns)	19.95

PROMS

Part No.	**Pins	Description	Price
74S188	16	32x8 PROM O.C. (6330-1)	1.49
74S287	16	256x4 PROM T.S. (6301-1)	1.95
74S288	16	32x8 PROM T.S. (6331-1)	1.95
74S387	16	256x4 PROM O.C. (6300-1)	1.95
74S471	20	256x8 PROM T.S. (6309-1)	5.95
74S472	20	512x8 PROM T.S. (6349-1)	4.95
74S473	20	512x8 PROM O.C. (6348)	4.95
74S474	24	512x8 PROM T.S. (DM87S296N)	4.95
74S475	24	512x8 PROM O.C. (6340)	4.95
74S478	24	1024x8 PROM T.S. (TBP28S86)	8.95
74S570	16	512x4 PROM O.C. (6305)	2.95
74S571	16	512x4 PROM T.S. (6306)	2.95
74S572	18	1024x4 PROM O.C. (6352)	4.95
74S573	18	1024x4 PROM T.S. (82S137)	4.95
82S23	16	32x8 PROM O.C. (27S18)	2.95
82S115	24	512x8 PROM T.S. (27S15)	9.95
82S123	16	32x8 PROM T.S. (27S19)	2.95
82S126	16	256x4 PROM O.C. (27S20)	3.95
82S129	16	256x4 PROM T.S. (27S21)	3.95
82S130	16	512x4 PROM O.C. (27S12)	5.95
82S185	18	2048x4 PROM T.S. (TBP24S81)	9.95
DM87S180N	24	1024x8 PROM O.C. (82S180)	9.95
DM87S181N	24	1024x8 PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4 PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4 PROM T.S. (82S185)	9.95
DM87S190N	24	2048x4 PROM O.C. (82S190)	19.95
DM87S191N	24	2048x8 PROM T.S. (82S191)	19.95

DATA ACQUISITION

Part No.	**Pins	Description	Price
DC10		Mostek DC/DC Convert +5V to -9V	2.95
MC3470P	18	Floppy Disk Read AMP System	4.95
MC1408L7	16	7-bit D/A Converter (DAC0807LCN)	2.49
MC1408L8	16	8-bit D/A Converter (DAC0808LCN)	2.95
ADC0804	20	8-bit A/D Converter (1 LSB)	3.49
DAC0806	16	8-bit D/A Converter (0.78% Lin.)	1.95
ADC0809	28	8-bit A/D Converter (8-Ch. Multi.)	4.49
AY-5-1013A	40	30K Baud Uart (TR1602)	4.95

Digitalker™

DT1050 — Applications: Teaching aids, appliances, clocks, automotive, telecommunications, language translations, etc.

The DT1050 is a standard DIGITALKER kit encoded with 137 separate and useful words, 2 tones, and 5 different silence durations. The words and tones have been assigned discrete addresses, making it possible to output single words or words concatenated into phrases or even sentences. The "voice" output of the DT1050 is a highly intelligible male voice. Female and children's voices can be synthesized. The vocabulary is chosen so that it is applicable to many products and markets.

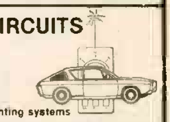
The DT1050 consists of a Speech Professor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

DT1050 Digitalker™ .... $34.95 ea.

DT1057 — Expands the DT1050 vocabulary from 137 to over 260 words. Incl. 2 ROMs and specs.

DT1057 .... $24.95 ea.

RADIO CONTROL CIRCUITS



Ideal to use for:
- **Toys, hobby crafts, robots, trains**
- **Burglar alarms • IR data link**
- **Remote slide projector control**
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A complete 6-channel digital encoder and RF transmitter, low power, at frequency of 27MHz or 49MHz, a field strength of 10,000uV meter at 3 meters. 9V operation on chip RF oscillator/transmitter, on chip 4.6 regulator. Up to 80MHz carrier frequency operation.

LM1871N RC Encoder/Transmitter Chip ... $1.95

A complete RF receiver/decoder, used at either 27MHz, 49MHz or 72MHz. It provides 4 independent channels when used with LM1871 (2 analog, 2 dig.) operates from four 1.5V cells, Crystal controlled.

LM1872N RC Receiver/Decoder Chip $2.49
SRX1504 49.435MHz Crystal (LM1872N) ... $3.95
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INTERSIL

*Evaluation Kits

Part No.	**Pins	Function	Price
7045IPI	28	CMOS Precision Timer	14.95
7045EV/Kit*	28	Stopwatch Chip, XTL	19.95
7106CPL	40	3½ Digit A/D (LCD Drive)	9.95
7106EV/Kit*	40	IC, Circuit Board, Display	34.95
7107CPL	40	3½ Digit A/D (LED Drive)	11.95
7107EV/Kit*	40	IC, Circuit Board, Display	29.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD.	16.95
7117CPL	40	3½ Digit A/D LED Dis. HLD.	15.95
7201IUS		Low Battery Volt Indicator	2.25
7205IPG	24	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	24	Stopwatch Chip, XTL	14.95
7206CJPE	16	Tone Generator	4.95
7206CEV/Kit*	16	Tone Generator Chip, XTL	7.95
7207AIPD	14	Oscillator Controller	5.95
7207AEV/Kit*	14	Freq. Counter Chip, XTL	7.95
7208IPI	28	Seven Decade Counter	15.95
7209IPA	8	Clock Generator	3.95
7215IPG	24	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	24	4 Func. Stopwatch Chip, XTL	14.95
7216AIJI	28	8 Digit Univ. Counter C.A.	29.95
7216CIJI	28	8 Digit Freq. Counter C.A.	24.95
7216DIPI	28	8 Digit Freq. Counter C.C.	19.95
7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
7224IPL	40	LCD 4½ Digit Up Counter DRI	10.95
7226AIJL	40	8 Digit Univ. Counter	29.95
7226AEV/Kit*	40	5 Function Counter Chip, XTL	74.95

— AND MORE —

30009 1983 INTERSIL Data Book (1356p.) $9.95

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Part No.	**Pins	Function	Price
PAL10H8	20	Octal 10-Input AND-OR Gate Array (High Output)	$5.95
PAL12H6	20	Hex 12-Input AND-OR Gate Array (High Output)	5.95
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PAL10L8	20	Octal 10-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL12L6	20	Hex 12-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL14L4	20	Quad 14-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL16L8	20	Octal 16-Input AND-OR-Invert Gate Array (Low Output)	9.95
PAL16R8	20	Octal 16-Input Register AND-OR Gate Array	9.95
PAL16R6	20	Hex 16-Input Register AND-OR Gate Array	9.95
PAL16R4	20	Quad 16-Input Register AND-OR Gate Array	9.95

30012 1982 NATIONAL PAL Data Book (176p.) .. $5.95

74C—C/MOS

74C00	14	.35				74C221	16	1.95
74C02	14	.35				74C240	20	1.95
74C04	14	.29	74C95	14	1.39	74C244	20	1.95
74C08	14	.35	74C107	14	.89	74C373	20	2.49
74C10	14	.35	74C151	16	2.49	74C374	20	2.49
74C14	14	59	74C154	24	3.49	74C901	14	.59
74C20	14	.35	74C157	16	2.25	74C903	14	59
74C30	14	.35	74C160	16	1.19	74C906	14	59
74C32	14	39	74C161	16	1.19	74C911	28	8.95
74C42	16	1.39	74C162	16	1.19	74C912	28	8.95
74C48	16	1.95	74C163	16	1.19	74C915	18	1.19
74C73	14	.79	74C164	14	1.49	74C917	28	8.95
74C74	14	.69	74C173	16	.79	74C922	18	4.49
74C85	16	1.95	74C174	16	1.19	74C923	20	4.95
74C86	14	.39	74C175	16	1.19	74C925	16	5.95
74C89	16	5.95	74C192	16	1.49	74C926	18	5.95
74C90	14	1.19	74C193	16	1.69	80C95	16	.39
74C93	14	1.19	74C195	16	1.39	80C97	16	.39

30001 1983 Nat. CMOS Book (628 pg.) $6.95

LINEAR

TL071CP	8	.79				NE570N	16	3.95
TL072CP	8	1.39				LM703CN	8	1.19
TL074CN	14	1.95	LM340K-15		1.35	LM709N	14	.49
TL081CP	8	.59	LM340T-5		.79	LM710N	14	.69
TL082CP	8	1.19	LM340T-12		.79	LM711N	14	.79
TL084CN	14	1.95	LM340T-15		.79	LM723N	14	.55
LM301CN	8	.35	LM348N	14	.99	LM733N	14	1.00
LM302H		1.95	LM350K		4.95	LM739N	14	1.95
LM304H		1.95	LF355N	8	1.10	LM741CN	8	.35
LM305H		.99	LF356N	8	1.10	LM747N	14	.69
LM307CN	8	.45	LM370N	14	4.49	LM748N	8	.59
LM308CN	8	.69	LM373N	14	3.95	LM1310N	14	1.49
LM309K		1.25	LM377N	14	1.95	LM1458CN	8	.59
LM310CN	8	1.75	LM380N	14	.89	LM1488N	14	.69
LM311CN	8	.69	LM381N	14	1.79	LM1489N	14	.69
LM312H		2.49	LM382N	14	1.39	LM1496N	14	1.95
LM317T		1.19	LM384N	14	1.79	LM1800N	16	1.49
LM317K		3.95	LM386N-3	8	.89	LM1889N	18	1.95
LM318CN	8	1.95	TL494CN	16	2.95	LM1896N	14	2.95
LM319N	14	1.95	TL496CP	8	1.19	LM2002T		1.49
LM320K-5		1.35	NE510A	14	4.95	LM3189N	16	1.59
LM320K-12		1.35	NE529A	14	2.95	LM3900N	14	.59
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LM320T-5		.89	NE536H		8.95	LM3909N	8	99
LM320T-12		.89	NE540H		4.95	LM3914N	18	3.49
LM320T-15		.89	NE544N	14	2.95	LM3915N	18	3.49
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LM324N	14	.59	NE555V	8	.35	RC4136N	14	1.25
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LM338K		6.95	NE564N	16	2.95	ICL8038B	14	3.95
LM339N	14	.69	LM565N	14	1.19	LM13080N	8	1.19
LM340K-5		1.35	LM566CN	8	1.49	LM13600N	16	1.19
LM340K-12		1.35	LM567V	8	.89	MORE AVAILABLE		

30003 1982 Nat. Linear Data Book (1952 pgs.) . $11.95

CONNECTORS

DB25 — D Subminiature (meets RS232)

Part No.	Description	Price
DE9P	9 Pin Plug	$1.79
DE9S	9 Pin Socket	1.95
DA15P	15 Pin Plug	1.95
DA15S	15 Pin Socket	2.95
DB25P	**25 Pin Plug (Meets RS232)**	**2.49**
DB25S	**25 Pin Socket (Meets RS232)**	**3.25**
DB25P-831	25 Pin Right Angle Plug	4.95
DB25S-831	25 Pin Right Angle Socket	5.25
DC37P	37 Pin Plug	4.95
DC37S	37 Pin Socket	5.95
DD50P	50 Pin Plug	5.95
DD50S	50 Pin Socket	6.95

Accessories

DE-9H	Hood for DE-9 Series Connectors	$1.19
DA-15H	Hood for DA-15 Series Connectors	1.29
DB25H	Hood for DB25 Series Connectors	1.25
DC37H	Hood for DC37 Series Connectors	1.39
DD50H	Hood for DD50 Series Connectors	1.49
D20418-2	2 screws for mtg. connectors to a panel	.79

Solder Eyelet/Wire Wrap Edge Card

Part No.	Cnts.	Sp.	Description	Price
15/30SE	15/30	.156	Solder Eyelet	$1.79
18/36SE	18/36	.156	Solder Eyelet	1.95
22/44SE	22/44	.156	Solder Eyelet	2.49
22/44PC	22/44	.156	PC type (no mtg. ears)	.99
50/100SE	50/100	.125	Solder Eyelet	9.95
22/44WW	22/44	.156	Wire Wrap - Level 3	4.95
67031-5	22/44	.156	WW (Pins .0625x.03x.75)	3.95
R-681-1	50/100	.125	Wire Wrap - Level 3	7.95
R-681-2	50/100	.125	Wire Wrap - Level 1	6.95

RF Coaxial Connectors

Part No.	Description	Price
PL259	UHF Plug	$ .89
SO239	UHF Panel Receptacle	.69
PL258	UHF Straight Adaptar	.89
UG175/U	UHF Reducing Adapter	.49
UG88/U	BNC Plug	1.49
UG89/U	BNC Jack	1.69
UG306/U	BNC Angle Adapter	2.49
UG260/U	BNC Plug	1.49
UG1094/U	BNC Bulkhead Receptacle	.89

IC SOCKETS

For Socket Required, See Column After The IC Part No.

LOW PROFILE (TIN) SOCKETS

	1-9	10-99	100-999
8 pin LP	.16	.14	.13
14 pin LP	.17	.15	.14
16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.26
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
36 pin LP	.46	.42	.39
40 pin LP	.49	.46	.43

— Soldertail Standard Tin & Gold Also Available —

WIRE WRAP (GOLD) SOCKETS LEVEL #3

	1-9	10-99	100-999
8 pin WW	.49	.45	.42
10 pin WW	.65	.62	.59
14 pin WW	.65	.62	.59
16 pin WW	.69	.65	.61
18 pin WW	.89	.85	.79
20 pin WW	1.09	1.05	.99
22 pin WW	1.25	1.19	1.15
24 pin WW	1.29	1.23	1.18
28 pin WW	1.59	1.50	1.45
36 pin WW	1.85	1.75	1.69
40 pin WW	1.99	1.89	1.79

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6½% Sales Tax
Shipping — Add 5% plus $1.50 Insurance
Send S.A.S.E. for Monthly Sales Flyer!

Spec Sheets — 30¢ each
Send $1.00 Postage for your
FREE 1983 JAMECO CATALOG
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4/83 ***PHONE ORDERS WELCOME — (415) 592-8097 Telex: 176043***

CIRCLE 64 ON FREE INFORMATION CARD

Portable Speakers For "Walkman" Style Stereos

Portable Stereo Speakers with Carrying Case

After skating, skiing, jogging or any other outside activity, just plug these portable stereo speakers into your stereo and you and your friends can enjoy your favorite tapes reproduced by these full range speakers. Great for motel rooms, the beach, or in your car. They weigh just 3 lbs. and measure 5⅞"H x 4⅛"W x 2⅞"D. This unit uses 3" x 5" 8ohm speakers with a 3 oz. magnet. Speaker system includes two speakers, a carrying case, auxiliary speaker connector cable, and signal connector cable. Uses 8 "AA" batteries. Can be used with both portable stereos shown below, and is compatible with most mini-portable stereo cassettes and FM stereo units.

Part No. TSU-012 ..... **$29.95**
AM3-8 8 AA Alkaline Batteries ..... 8 for $7.90

Stereo Cassette Player with FM Stereo Tuner Pack

- Lightweight Headphones
- Cr02/Metal/Normal Tape Selector
- Anti-Rolling Mechanism

FEATURES: • Blue carrying case, shoulder strap, belt strap, lightweight headphones, FM stereo tuner pack & instruction manual • Talkline • Tone selector • Cr02/Metal/Normal tape selector • LED operation indicator •Built-in microphone • Stop/eject, play, rewind/review, fast forward/cue, tape/radio selector functions • Vol. control • Ext. power input jack • Headphone jack • Auto-stop mechanism (shuts off player when tape ends) • Anti-roiling mechanism (prevents sound from quivering when walking, jogging, etc.) • Weighs 13 oz. • Requires 4 AA batteries (not included) • Size: 6"L x 4"W x 1-1/8"H

Model TWF-802 ..... **$69.95**
AM3-4 AA Alkaline Batteries ..... 4/$3.95

CREDIT CARD AM/FM RADIO

World's Thinnest Stereo Hi-Fi

This is a pocketable AM/FM stereo radio with a folding stereo headphone. It weighs just 5 oz. and measures 4¼"L x 2⅝"W x ⅞"Thk. Comes complete with radio, headphones and headphone case. Uses two AAA batteries (not included).

Part No. TCR-809 ..... **$29.95 each**

JOYSTICKS

JS-5K (Pictured)

JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JS-150K	150K Linear Taper Pots	$4.75
JVC-40	40K (2) Video Controller in Case	$4.95

JS KNOB Knob for JS5K,100K,150K ..... $.99 ea.
JVC KNOB Knob for JVC-40 ..... $.99 ea.

Jameco ELECTRONICS Digital Thermometer Kit

Dual sensors — switch controls for indoor/outdoor or dual monitoring — can be extended to 500 feet. Continuous LED .8" ht. display. Range -40°F to 199°F, -40°C to 100°C. Accuracy ±1° nominal. Calibrate for Fahrenheit/Celsius. Simulated walnut case. AC wall adapter included. Size: 6¾"L x 3¼"H x 1⅞"D.

JE300 ..... **$39.95**

BOOKS

NATIONAL SEMICONDUCTOR — INTERSIL — INTEL

30001	**National CMOS Data Book (1981)** (640 pages) 74C, CD4000, and A/D Converters	$6.95
30002	**National Interface Data Book (1980)** (704 pages) DP, DS8000, DS3600, DS5700, etc.	$6.95
30003	**National Linear Data Book (1982)** (1376 pages) LM, LF, ADC, DAC, LH Series	$11.95
30004	**National Series 80 — Board Level Computer (1980)** (224 pages)	$4.95
30005	**National TTL Logic Data Book (1981)** (624 pages) 7400,LS,L,H,S, and DM8000 Series	$9.95
	30006 Above (3) 30001,3,5 as set	**$24.95**
30008	**National Memory Data Book (1980)** (464 pages) RAMs, ROMs, PROMs, EPROMs Series	$6.95
30009	**Intersil Data Book (1983)** (1356 pages) Complete line.	$9.95
30010	**National Audio/Radio Handbook (1980)** (240 pages) Pre-Amps, AM, FM & FM Stereo, Power Amps	$5.95
30011	**National Linear Application Handbook (1980)** (736 pages) Application Notes, Linear Briefs, etc.	$15.95
30012	**National PAL Data Book (1982)** (178 pages) Data Sheet, PAL Design	$5.95
30013	**Zilog Data Book (1983)** (641 pages) Microprocessors and Support Chips	$7.95
010400	**Intel Component Data Book (1982)** (1405 pg.) Full data sheets for Intel's products Incl. mem. devices, microproc., periph. & ind./mil. products	$14.95
205610	**Intel Peripheral Design Handbook (1981)** (828 pages) Full data sheets, application notes for intel peripheral device components	$9.95

Universal Computer Keyboard Enclosures

"DTE" Blank Desk-Top Enclosures are designed for easy modification. High strength epoxy molded end pieces in mocha brown finish. Sliding rear/bottom panel for service/component access. Top/bott. panels .080" thick alum. alodine type 1200 finish (gold tint color) for best paint adhesion after modification. Vented top & bottom panels for cooling efficiency. Rigid construction provides unlimited applications. Assembly instructions included.

DTE-8	Panel Width 7.5"	$24.95
DTE-11	Panel Width 10.13"	$27.95
DTE-14	Panel Width 13.5"	$29.95
DTE-20	Panel Width 19.25"	$34.95

KEYBOARDS — POWER SUPPLIES

DATANETICS 73-KEY KEYBOARD (ASCII) *Apple Compatible*
Data Entry Keyboard uses MM5740 BEE/N encoder chip (included). 73-Key Keyboard features 11-key numeric keypad, SPST switching, 24-pin edge card connection. Includes pin-out.
17⅝"L x 6"W x 1⅞"H
Part No. KB261 (Fits DTE-20 Enclosure) ..... $49.95 each

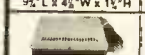
MICRO SWITCH 69-KEY KEYBOARD
Data Entry Keyboard, Encoded Output: 8-bit Parallel EBC DIC. Switching: Hall Effect, 24-pin Edge Card Connection. Complete w/Pin Connection. Can easily be modified to ASCII code.
16⅜"L x 5¼"W x 1⅞"H
Part No. KB69SD12-2 (Fits into DTE-20 Enclosure) ..... $19.95 each

MICRO SWITCH 85-KEY KEYBOARD
Word Processing Keyboard, 26 Pin Edge Card Connection, Supply Voltage +5VDC. Main Keyboard is DWERTY. Additional Key Pads for Cursor and word processing functions.
23"Lx5¼"Wx1-3/8"H
Part No. 85S018-1 ..... $29.95 each

HI-TEK 58-KEY KEYBOARD
SPST switching, mechanical, monolithic housing, charcoal grey keycaps. Keyboard is not mounted on circuit board (each key is individually accessible).
11⅞"L x 3¾"W x 1⅞"H
Part No. K-58 (Fits DTE-14 Enclosure) ..... $19.95 each

HI-TEK 14-KEY NUMERIC KEYPAD
SPST switching. Charcoal grey keycaps, matches HI-TEK K-58 Keyboard (above). Mounted on printed circuit board.
3"L x 3"W x 1½"H
Part No. K-14 ..... $9.95 each

ALPS 29-KEY CALCULATOR KEYBOARD
Features one 8-position decimal select switch, one 3-position switch, and two 2-position switches, mechanical SPST switching, 22-pin edge card connection. Pin-out included.
9¾"L x 4¾"W x 1⅞"H
Part No. KB297040 (Fits DTE-11 Enclosure) ..... $4.95 each



POWER SUPPLY +5VDC @ 1 AMP REGULATED *Transaction Tech*
Output +5VDC @ 1A (also +30VDC) reg. Input 115VAC 60Hz, 2-tone (black/beige) self-enclosed case, 6 ft., 3 cond. black power cord, 6½"W x 7"D x 2¾"H. Wt. 3 lbs. Data sheet incl.
Part No. PS51194 ..... $19.95 each

POWER SUPPLY +5VDC @ 3 AMP REGULATED *Deltron*
Input: 115VAC, 47-440Hz. Output: 5VDC Adjustable @ 3 amp, 5VDC @ 2.5 amp. Adjustable current limit, Ripple & Noise: 1MV rms, 5MV p-p — 2 mounting surfaces, UL recognized. Size: 4"W x 4¼"L x 2-7/16"H - wt. 2 lbs. Data sheet included.
Part No. QPS-1 ..... $29.95 each

POWER SUPPLY +5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING
Input: 115VAC, 50-60Hz @ 3 amp/230VAC, 50Hz @ 1.6 amp. Fan volt./power supply select switches (115/230VAC). Output: 5VDC @ 7.6 amp, 12VDC @ 1.6 amp. 8 ft. blk. pow. cord, 11½"W x 13¼"D x 3¾"H. Wt. 6 lbs.
Part No. PS94V0 ..... $49.95 each

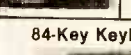
POWER SUPPLY 4-Channel Switching Power Supply
Microprocessor, mini-computer, terminal, medical equipment and process control applications. Input: 90-130VAC 47-440Hz. Output: +5VDC @ 5A, -5VDC @ 1A; +12VDC @ 1A, -12VDC @ 1A. Line reg.: ±0.2%. Ripple: 30mV p-p. Load reg.: ±1%. Overcurrent protection. Adj: 5V main output ± 10%. 8-3/8"L x 1-7/8"W x 4-15/16"H. Wt. 1½ lbs.
Part No. FCS-604A ..... $69.95 each

POWER SUPPLY Adjustable Switching 4-24VDC to 5 Amps
Adj. 4-24VDC; 5VDC @ 5A, 6VDC @ 4.8A, 9VDC @ 4.1A, 12VDC @ 3.3A, 18VDC @ 1.9A, 24VDC @ .5A. Overvoltage Protection. Input: 115VAC 50/60Hz. Output variations within 20mV. 8.25"L x 4.25"W x 2.25"H. Wt. 3.25 lbs.
JE224 Kit ..... $79.95 each
JE224A Assembled & Tested ..... $99.95 each

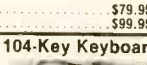
84-Key Keyboard
CA153A $69.95

CONTROL DATA
Data Entry Keyboards
Parallel Output
FTZ Shielded Base
SPST Switching
ASCII OUTPUT
30" Interface Cable
Attractive Case

104-Key Keyboard
CA148 ..... $99.95



95-Key Keyboard
CA154A $79.95



80-Key Keyboard
CA150C $89.95

Color; keycaps: black, blue, red - cover: black w/beige base. 21½"x9"x3½". 6lbs.

BUG BOX™ — 30 individual compartments • Stores 60 8-pin or 30 14- or 16-pin DIPs • Bug rugs not included • Clear plastic cover slides & locks • Cover marked w/numbers 1-30 • Compartment size: 1" x 3.75" x .5" deep • Box size: 4.9" x 3.3" x .6" • Weight: 1.75 oz.

BUG BOX™
Please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

Part No./Color Code		QTY	PRICE
BGX-001-( )		1	$ 2.29
BGX-010-( )		10	19.99
	ANTI-STATIC		
BGX-001-( )AS		1	$ 3.29
BGX-010-( )AS		10	28.89

BUG CAGE™ — 12 locations store Bug Boxes, Big Bug Boxes or Bug Trays • Modular and interlocking • Heavy duty injection molded plastic • Each cage has 6 slip-on locations • 2 cages per pkg. • Cage size: 5-1/8" x 5" x 3-7/8" • 4 colors available — please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

Part No./Color Code		Price
BGC-001-( )	2 Cages (6 loc. ea.)	$11.95/pkg.

BUG TRAY™ — Stores in Bug Cage • Molded plastic • Three styles: Open (1 compartment 3.05" x 4.8" x .6"); Vertical (5 compartments .5" x 4.6" x .6"); and Horizontal (6 compartments .4" x 3.95" x .6") • Ideal for tools, hardware, components, etc. • Tray size: 3.55" x 5.05" x .6" • Black color only

PART NO.	DESCRIPTION	PRICE
BTH-001	Horizontal Bug Tray	$1.95
BTV-001	Vertical Bug Tray	1.95
BTO-001	Open Bug Tray	1.95
BTX-003	1 of each Bug Tray (3)	4.98

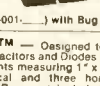
BUG RUG™ — Static discharge protection for CMOS and MOSFET devices • Pre-cut to dimensions of BUG BOX (1" x .35")

Part No.	Description	Price
BRG-030	30 foam rectangles for Bug Box	$1.98
BBR-036	6 foam rec. for LSI Big Bug Box	1.98

CAGE KEEPER™ — Pins column of Bug Boxes in Bug Cage

		Price
CKP-005	5 Inch	$4.98/pkg.
CKP-010	10 Inch	6.98/pkg.

BUG CAGE™ STORAGE SYSTEMS



BUG CAGE™ (BGC-001-____) with Bug Boxes

LSI BIG BUG BOX™ — Designed to store large IC's, Resistors, Capacitors and Diodes • Divided into three compartments measuring 1" x 4.15" x 5" deep • Three vertical and three horizontal dividers included • Bug Rugs not included • Box size: 4.9" x 3.3" x .6" • Weight: 1.75 oz.

LSI BIG BUG BOX™
Please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

PART NO./COLOR CODE		QTY	PRICE
BLX-001-( )		1	$ 3.29
BLX-010-( )		10	28.79
	ANTI-STATIC		
BLX-001-( )AS		1	$ 4.29
BLX-010-( )AS		10	37.89

BACK PACK™ — Self-adhesive labels for the back of ICs • Shows exact internal logic in relation to IC pins • 532 labels in each package (including several blank labels) • Each package for 8, 14, 16, 24, 28 and 40-pin ICs • Combo package includes 1,068 labels for TTL and CMOS ICs • Microprocessor package contains 744 labels.

Part No.	Description	Price
BPT-012	TTL	$7.95
BPC-012	CMOS	8.95
BPM-012	Combo	14.95
BPU-012	Microprocessor	9.95

BUG TAGS™ — Self-adhesive, easy-to-read labels for marking Bug Box and LSI Big Bug Box • Most popular components

PART NO.	DESCRIPTION	QTY.	PRICE
BTT-200	TTL	200	$4.98
BTC-200	CMOS	200	4.98
BTK-200	LS Schottky	200	4.98
BTS-200	Special	200	4.98
BTM-600	Mixer	800	13.95

MORE BUG TAGS AVAILABLE!

★ ★ ★ **BUG BOX SYSTEMS INTRODUCTORY SPECIAL** ★ ★ ★

Your choice: regular or anti-static. Includes 2-Bug Cages (12 locations); 6-Bug Boxes; 3-LSI Big Bug Boxes; 1-horizontal Bug Tray; 1-open Bug Tray; 1-vertical Bug Tray; 1 package Bug Rug for regular Bug Boxes; 1 package Bug Rug for LSI Big Bug Boxes; 1 package Mixer Labels (800 each). Color: Bug Boxes and Cages - Blue, Bug Trays - Black.

SP-BUG Regular (Retail value $59.45) ..... *Sale Price $49.95*
SP-BUG-AS Anti-Static (Retail value $67.45) ..... *Sale Price $59.95*

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6½% Sales Tax
Shipping — Add 5% plus $1.50 Insurance
Send S.A.S.E. for Monthly Sales Flyer!

Spec Sheets — 30¢ each
Send $1.00 Postage for your *FREE 1983 JAMECO CATALOG*
Prices Subject to Change

Call for Quantity Discounts

Mail Order Electronics - Worldwide
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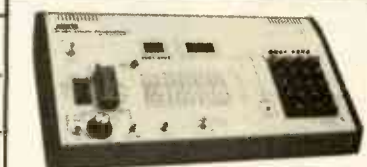
NEW! Telex Number Telex 176043

1355 SHOREWAY ROAD, BELMONT, CA 94002
4/83 *PHONE ORDERS WELCOME — (415) 592-8097 Telex: 176043*

8K, 16K, 32K, 64K EPROM Programmer



2708,2716,2732 & 2764 EPROM Programmer

JE664 EPROM PROGRAMMER

8K TO 64K EPROMS — 24 AND 28 PIN PACKAGES
Self-Contained — Requires No Additional Systems for Operation

• Programs, validates, and checks for properly erased EPROMs • Emulates PROMs or EPROMs • RS232C Computer Interface for editing/program loading • Loads data into RAM by keyboard • Changes data in RAM by keyboard • Loads RAM from an EPROM • Compares EPROMs for content differences • Copies EPROMs • Power Input: 115VAC, 50Hz, .4A 10W power consumption • Enclosure: Color-coordinated, light tan panels w/molded mocha brown end pieces • Size: 15-5/8"L x 8⅜"D x 3½"H • Wt.: 5¾ lbs.

JE664-A EPROM Programmer **$995.00**
Assembled & Tested (Includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The JE665 RS232C Interface Option implements computer access to the JE664's RAM. Sample software written in BASIC provided for TRS-80® Model I, Level II Computer. Baud rate: 9600. Word Lgth: 8 bits - odd parity. Stop bits: 2. Option may be adapted to other computers.

JE664-ARS EPROM Prog. w/JE665 Option **$1195.00**
Assembled and Tested (Includes JM16A Module)

EPROM JUMPER MODULES — The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets JE664 for proper programming pulses to the EPROM & configures EPROM socket connections for that particular EPROM.

Part No.	EPROM	EPROM MANUFACTURER	PRICE
JM08A	2708	AMD, Motorola, National, Intel, TI	$14.95
JM16A	2716,TMS2516	Intel, Motorola, National, NEC, TI	$14.95
JM16B	TMS2716	Motorola, TI (+5,-12, +12)	$14.95
JM32A	TMS2532	Motorola, TI	$14.95
JM32B	2732	AMD, Fujitsu, NEC, Hitachi, Intel	$14.95
JM64A	MCM68764, MCM68L764	Motorola	$14.95
JM64B	2764	Intel	$14.95
JM64C	TMS2564	TI	$14.95

Siemens 8" Floppy Disk Drive

- Shugart 801R compatible
- Single-Sided
- 77 Tracks
- 400/800K Bytes Capacity
- Industry Standard

The FDD100-8 8" Floppy Disk Drive (Industry Standard) features single or double density. Recording mode: FM single, MFM double density. Transfer rate: 250K bits/sec. single density, 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette I, or eq. disk cartridge. Power: 115VAC @ 50-60Hz, +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs. Incl. 96-pg. manual.

Part No.		Price
FDD100-8	Buy 1 for	$269.95 each
FDD100-8	Buy 2 for	$259.95 each
FDD100-8	*Buy 10 for*	*$249.95 each*

5¼" Mini-Floppy Disk Drive

Pertec Computer Corp.

FOR TRS-80 MODEL I (Industry Standard)
Features single or double density. Recording mode: FM single, MFM double density. Power: +12VDC (±0.6V) 1.8A max., +5VDC (±0.25V) 0.8A max. Unit as pic. at left (does not incl. case, power supply, cables) 30-pg. data book incl. Wt. 3½ lbs. Size: 5¾"W x 8"D x 3¼"H.

Part No.	*Limited Quantity!*	Price
FD200		$179.95
Single-sided, 40 tracks, 250K bytes capacity		
FD250		$199.95
Double-sided, 35 tracks, 438K bytes capacity		

EXPAND YOUR MEMORY

TRS-80 to 16K, 32K, or 48K

**Model 1 = From 4K to 16K Requires (1) One Kit
Model 3 = From 4K to 48K Requires (3) Three Kits
Color = From 4K to 16K Requires (1) One Kit

**Model 1 equipped with Expansion Board up to 48K Two Kits Required — One Kit Required for each 16K of Expansion —

TRS-16K3 *200ns for Color & Model III $12.95
TRS-16K4 *250ns for Model I $10.95

TRS-80 Color 32K or 64K Conversion Kit

Kit comes complete with 8 each 4164-2 (200ns) 64K dynamic RAMs and conversion documentation. Converts TRS-80 color computers with D and E circuit boards, and all new color computers to 32K. Minor modifications of 32K memory will allow the use of all 64K of the dynamic RAM.

TRS-64K2 ..... **$54.95**

Sprite-style Fan

- 36cfm free air delivery
- 3.125" sq. x 1.665" depth
- 10 yrs. cont. duty at 20°C
- 115V 50/60Hz

Metal Frame

PWS2107U Cleaned & tested (used) ..... $ 9.95 ea.
*PWS2107F New ..... $14.95 ea.

Muffin-style Fan

- 105cfm free air delivery
- 4.68" sq. x 1.50" depth
- 10 yrs. cont. duty at 20°C
- Impedance protected, ambients to 70°C
- 115V 50/60Hz 14W Wt. 17 oz.

Metal Frame

MU2A1-U Cleaned & tested (used) ..... $9.95 ea.
*MU2A-1N New ..... $14.95 ea.

Mostek DC/DC Converter +5 VOLTS TO -9 VOLTS

Input: +5V. Output: -9V (regulated) @ 30mA. Printed circuit mounting. Specifications incl.
DC10 ..... $2.95 ea. or 2/$4.95

APRIL 1983

CIRCLE 64 ON FREE INFORMATION CARD

MICRO MART

508 Central Ave.
Westfield, N.J. 07090
(201) 654-6008

SANYO
AFFORDABLE, HIGH PERFORMANCE COMPUTER

MBC 1000

Special Software Package Included

- Z-80 CPU
- 64 KB RAM
- 328 KB FLOPPY
- 12" GREEN SCREEN (80x25)
- CENTRONICS/ EPSON PORT
- RS 232C PORT
- CP/M
- S BASIC
- WORDSTAR
- CALCSTAR
- MAILMERGE
- SPELLSTAR
- INFOSTAR

SPECIAL **$1,995**

PRINTERS

EPSON MX-80+ III w/Graftrax $579
EPSON MX-80FT+ III w/Graftrax $629
EPSON MX-100+w/Graftrax $849

OKIDATA dual mode printer (near letter quality) #92A $625
OKIDATA #82A (8½") $419
OKIDATA#83A (15") $699
OKIDATA #84P $1,039

CENTRONICS 122 Parallel $869
CENTRONICS 352 S/P 200CPS $1,699

Signalman Mark I Modem-$99
Direct connect modem/RS-232C; Built in interface cable and connector; Light, compact, Bell 103 compatible Data/voice switch

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PERIPHERAL DRIVER IC's
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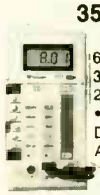

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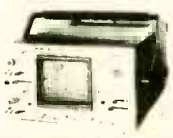

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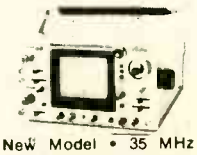

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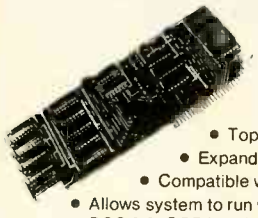

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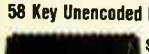

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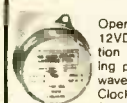

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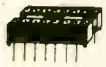

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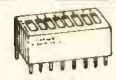

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7408	.26	7489	1.75	74172	4.75
7409	.23	7490	.39	74173	.79
7410	.22	7491	.57	74174	.89
7411	.29	7492	.45	74175	.85
7412	.29	7493	.45	74176	.75
7413	.39	7494	.69	74177	.75
7414	.59	7495	.65	74179	1.34
7416	.29	7496	.69	74180	.75
7417	.29	7497	2.90	74181	1.75
7420	.22	74100	2.90	74182	.75
7421	.35	74107	.32	74184	2.25
7422	.29	74109	.37	74185	2.25
7423	.29	74116	1.95	74188	9.95
7425	.29	74121	.29	74188	3.90
7426	.29	74122	.39	74190	1.15
7427	.25	74123	.59	74191	1.15
7429	.45	74125	.39	74192	.85
7430	.23	74126	.44	74193	.85
7432	.29	74128	.59	74194	.85
7437	.25	74132	.69	74195	.68
7438	.29	74136	.75	74196	.85
7439	.29	74139	.95	74197	.85
7440	.19	74141	.79	74198	1.39
7441	.79	74142	2.95	74199	1.39
7442	.57	74143	2.95	74221	1.19
7443	.95	74144	2.95	74251	.95
7444	.95	74145	.62	74273	1.05
7445	.79	74147	1.95	74276	1.89
7446	.79	74148	1.20	74279	.75
7447	.65	74150	1.09	74283	1.40
7448	.79	74151	.67	74284	3.90
7450	.19	74152	.67	74285	3.90
7451	.19	74153	.67	74290	1.25
7453	.19	74154	1.19	74298	.95
7454	.19	74155	.78	74365	.68
7459	.25	74156	.78	74366	.68
7460	.23	74157	.69	74367	.68
7470	.29	74158	1.65	74368	.68
7472	.29	74159	2.49	74390	1.45
7473	.34	74160	.88	74393	1.90
7474	.34			74490	1.90

74LS00

74LS00	$ .26	74LS113	$ .43	74LS245	$2.20
74LS01	.28	74LS114	.43	74LS247	1.10
74LS02	.28	74LS122	.55	74LS248	1.10
74LS03	.28	74LS123	1.19	74LS249	1.19
74LS04	.35	74LS124	1.35	74LS251	1.40
74LS05	.28	74LS125	.89	74LS253	1.40
74LS08	.28	74LS126	.52	74LS257	.85
74LS09	.35	74LS132	.79	74LS258	.98
74LS10	.28	74LS136	.49	74LS259	2.95
74LS11	.39	74LS138	.85	74LS260	.65
74LS12	.33	74LS139	.85	74LS261	2.49
74LS13	.47	74LS145	1.25	74LS266	.59
74LS14	.95	74LS148	1.49	74LS273	1.75
74LS15	.33	74LS151	.79	74LS275	4.40
74LS20	.26	74LS153	.79	74LS279	.59
74LS21	.33	74LS154	1.70	74LS283	.99
74LS22	.33	74LS155	1.19	74LS290	.99
74LS26	.33	74LS156	.99	74LS293	.99
74LS27	.33	74LS157	.85	74LS295	1.10
74LS28	.33	74LS158	.75	74LS298	1.19
74LS30	.26	74LS160	1.05	74LS324	1.75
74LS32	.33	74LS161	1.15	74LS347	1.95
74LS33	.55	74LS162	1.05	74LS348	1.95
74LS37	.45	74LS163	1.05	74LS352	1.19
74LS38	.39	74LS164	1.19	74LS353	1.19
74LS40	.26	74LS165	.89	74LS363	1.49
74LS42	.79	74LS166	2.48	74LS365	.69
74LS47	.79	74LS168	1.15	74LS366	.69
74LS48	.95	74LS169	1.15	74LS367	.69
74LS51	.26	74LS170	1.99	74LS368	.69
74LS54	.29	74LS173	.89	74LS373	1.89
74LS55	.29	74LS174	.89	74LS374	1.89
74LS73	.45	74LS175	.89	74LS375	.69
74LS74	.42	74LS181	2.20	74LS377	1.95
74LS75	.59	74LS190	1.15	74LS385	1.95
74LS76	.45	74LS191	1.15	74LS386	.65
74LS78	.45	74LS192	.98	74LS390	1.95
74LS83A	.79	74LS193	.98	74LS393	1.95
74LS85	1.19	74LS194	1.15	74LS395	1.70
74LS86	.45	74LS195	.95	74LS399	2.35
74LS90	.57	74LS196	.89	74LS424	2.95
74LS92	.75	74LS197	.89	74LS668	1.75
74LS93	.75	74LS221	1.15	74LS670	2.29
74LS95	.88	74LS240	1.69	81LS95	1.69
74LS96	.98	74LS242	1.69	81LS98	1.69
74LS107	.45	74LS243	1.69	81LS97	1.69
74LS109	.45	74LS244	1.49	81LS98	1.69
74LS112	.43				

VOLUME PRICING CALL TOLL FREE

CMOS

4000	$ .35	4037	$1.95	4089	$2.95
4001	.35	4040	1.29	4093	.99
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4006	1.05	4042	.95	4098	2.29
4007	.25	4043	.85	4099	1.25
4008	1.39	4044	.85	14408	12.95
4009	.45	4046	1.75	14409	12.95
4010	.45	4047	1.25	14410	12.95
4011	.35	4048	.99	14412	12.95
4012	.25	4049	.45	14415	8.95
4013	.45	4050	.69	14419	4.95
4014	1.39	4051	1.10	4501	.39
4015	1.15	4052	1.10	4502	1.65
4016	.59	4053	1.10	4503	.69
4017	1.19	4055	3.95	4505	8.95
4018	.89	4056	2.95	4506	.75
4019	.45	4059	9.25	4507	.95
4020	1.10	4060	1.39	4508	3.75
4021	1.19	4066	.75	4510	1.19
4022	1.15	4069	.35	4511	1.19
4023	.29	4070	.49	4512	1.39
4024	.75	4071	.35	4515	2.75
4025	.25	4072	.35	4516	1.45
4027	.65	4073	.35	4518	1.39
4028	.85	4075	.35	4520	1.25
4029	1.29	4076	1.29	4555	4.95
4030	.45	4077	.35	4556	.99
4031	3.25	4078	.35	4566	2.25
4032	2.15	4081	.35	80C95	1.50
4034	3.25	4082	.35	80C97	1.25
4035	.95	4085	1.95		

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74LS241	2/1.99	2758 EPROM	2.95	2732	6.95	MM5320	5.99
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6561 RAM	2.95	Z80A CPU	4.95	UPD411	2.98	EMM4402	1.99
LM733CN	3/1.99	6522	6.95	2708 EPROM	8/29.95	10415	4.95
LM323K	3.95	6502 CPU	5.95	2114	8/14.50	8700 A/D	2/16.95

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The Big DIGI-KEY Discount makes a Big Price Difference (SEE BELOW)

ITT SILICON RECTIFIERS ZENER DIODES

3 AMP SILICON RECTIFIER

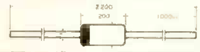
IF	PIV	I Surge (10ms)	VF
3A	50V	100A	1.1V

Part No.	1	10	100	1000
PR5400	.35	3.00	27.50	250.00

ITT RECTIFIERS

Cat. No.	Description	Pkg	10	100	1000	10,000
1N4001	1 Amp 50 PIV	DO 41	.80	7.00	60.00	540.00
1N4002	1 Amp 100 PIV	DO 41	.80	7.00	60.00	540.00
1N4003	1 Amp 200 PIV	DO 41	.80	7.50	64.00	576.00
1N4004	1 Amp 400 PIV	DO 41	.80	7.80	68.00	612.00
1N4005	1 Amp 600 PIV	DO 41	1.00	8.00	74.00	666.00
1N4006	1 Amp 800 PIV	DO 41	1.00	9.00	80.00	720.00
1N4007	1 Amp 1000 PIV	DO 41	1.50	12.00	100.00	900.00
1N4148	Ultra Fast Switching Diode (1N914 equiv.)	DO 41	.60	5.00	32.00	276.60

ITT SILICON ZENER DIODES



Catalog Number	Description	Unit Price	10
1N5226B	3.3 V 5% 500mW Zener (1N746A equiv.)	.24	1.80
1N5227B	3.6 V 5% 500mW Zener (1N747A equiv.)	.24	1.80
1N5228B	3.9 V 5% 500mW Zener (1N748A equiv.)	.24	1.80
1N5229B	4.3 V 5% 500mW Zener (1N749A equiv.)	.24	1.80
1N5230B	4.7 V 5% 500mW Zener (1N750A equiv.)	.24	1.80
1N5231B	5.1 V 5% 500mW Zener (1N751A equiv.)	.24	1.80
1N5232B	5.6 V 5% 500mW Zener (1N752A equiv.)	.24	1.80
1N5233B	6.0 V 5% 500mW Zener	.24	1.80
1N5234B	6.2 V 5% 500mW Zener (1N753A equiv.)	.24	1.80
1N5235B	6.8 V 5% 500mW Zener (1N957B equiv.)	.24	1.80
1N5236B	7.5 V 5% 500mW Zener (1N958B equiv.)	.24	1.80
1N5237B	8.2 V 5% 500mW Zener (1N959B equiv.)	.24	1.80
1N5238B	8.7 V 5% 500mW Zener	.24	1.80
1N5239B	9.1 V 5% 500mW Zener (1N960B equiv.)	.24	1.80
1N5240B	10 V 5% 500mW Zener (1N961B equiv.)	.24	1.80
1N5241B	11 V 5% 500mW Zener (1N962B equiv.)	.24	1.80
1N5242B	12 V 5% 500mW Zener (1N963B equiv.)	.24	1.80
1N5243B	13 V 5% 500mW Zener (1N964B equiv.)	.24	1.80
1N5244B	14 V 5% 500mW Zener	.24	1.80
1N5245B	15 V 5% 500mW Zener (1N965B equiv.)	.24	1.80
1N5246B	16 V 5% 500mW Zener (1N966B equiv.)	.24	1.80
1N5247B	17 V 5% 500mW Zener	.24	1.80
1N5248B	18 V 5% 500mW Zener (1N967B equiv.)	.24	1.80
1N5249B	19 V 5% 500mW Zener	.24	1.80
1N5250B	20 V 5% 500mW Zener (1N968B equiv.)	.24	1.80
1N5251B	22 V 5% 500mW Zener (1N969B equiv.)	.24	1.80
1N5252B	24 V 5% 500mW Zener (1N970B equiv.)	.24	1.80
1N5253B	25 V 5% 500mW Zener	.24	1.80
1N5254B	27 V 5% 500mW Zener (1N971B equiv.)	.24	1.80
1N5255B	28 V 5% 500mW Zener	.24	1.80
1N5256B	30 V 5% 500mW Zener (1N972B equiv.)	.24	1.80
1N5257B	33 V 5% 500mW Zener (1N973B equiv.)	.24	1.80

Littelfuse Fuses

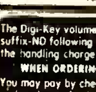
3AG "NORMAL-BLO" FUSES

DIGI-KEY Part No.	Amp. Rtg	5	100	1,000
F100-ND	.010	13.70	206.00	926.00/M
F101-ND	.031	11.00	165.00	741.00/M
F102-ND	.062	4.00	60.00	270.00/M
F103-ND	.100	4.00	60.00	270.00/M
F104-ND	.125	4.00	60.00	270.00/M
F105-ND	.150	4.00	60.00	270.00/M
F106-ND	.175	4.00	60.00	270.00/M
F107-ND	.187	4.00	60.00	270.00/M
F108-ND	.200	4.00	60.00	270.00/M
F109-ND	.250	2.42	36.30	163.00/M
F110-ND	.300	2.42	36.30	163.00/M
F111-ND	.375	2.42	36.30	163.00/M
F112-ND	.500	2.42	36.30	163.00/M
F113-ND	.600	2.42	36.30	163.00/M
F114-ND	.750	2.42	36.30	163.00/M
F115-ND	1	1.24	18.60	84.00/M
F116-ND	1.250	1.24	18.60	84.00/M
F117-ND	1.500	1.24	18.60	84.00/M
F118-ND	1.600	1.24	18.60	84.00/M
F119-ND	2	1.24	18.60	84.00/M
F120-ND	2.500	1.24	18.60	84.00/M
F121-ND	3	1.24	18.60	84.00/M
F122-ND	4	1.98	29.70	134.00/M
F123-ND	5	1.98	29.70	134.00/M
F124-ND	6	1.98	29.70	134.00/M
F125-ND	7	2.14	42.80	321.00/M
F126-ND	8	2.74	41.10	185.00/M
F127-ND	10	2.74	41.10	185.00/M

3AG SLO-BLO" FUSES

DIGI-KEY Part No.	Amp. Rtg.	5	100	1,000
F300-ND	.010	6.90	104.00	467.00/M
F301-ND	.031	6.90	104.00	467.00/M
F302-ND	.040	6.90	104.00	467.00/M
F303-ND	.062	4.86	72.90	328.00/M
F304-ND	.100	4.86	72.90	328.00/M
F305-ND	.125	4.86	72.90	328.00/M
F306-ND	.150	4.86	72.90	328.00/M
F307-ND	.175	4.86	72.90	328.00/M
F308-ND	.187	4.86	72.90	328.00/M
F309-ND	.200	4.86	72.90	328.00/M
F310-ND	.250	4.86	72.90	328.00/M
F311-ND	.300	4.86	72.90	328.00/M
F312-ND	.375	4.86	72.90	328.00/M
F313-ND	.400	4.86	72.90	328.00/M
F314-ND	.500	4.86	72.90	328.00/M
F315-ND	.600	4.86	72.90	328.00/M
F316-ND	.700	4.86	72.90	328.00/M
F317-ND	.750	4.86	72.90	328.00/M
F318-ND	.800	4.86	72.90	328.00/M
F319-ND	1	4.86	72.90	328.00/M
F320-ND	1.200	4.42	66.30	298.00/M
F321-ND	1.250	4.42	66.30	298.00/M
F322-ND	1.500	4.42	66.30	298.00/M
F323-ND	1.600	4.42	66.30	298.00/M
F324-ND	1.800	4.42	66.30	298.00/M
F325-ND	2	4.42	66.30	298.00/M
F326-ND	2.250	4.42	66.30	298.00/M
F327-ND	2.500	4.42	66.30	298.00/M
F328-ND	2.800	4.42	66.30	298.00/M
F329-ND	3	4.42	66.30	298.00/M
F330-ND	3.200	4.42	66.30	298.00/M
F331-ND	4	4.42	66.30	298.00/M
F332-ND	5	4.42	66.30	298.00/M
F333-ND	6.250	3.54	7.08	53.10/M
F334-ND	7	3.54	53.10	239.00/M
F335-ND	8	3.54	53.10	239.00/M
F336-ND	10	3.54	53.10	239.00/M
F337-ND	12	3.54	53.10	239.00/M
F338-ND	15	3.54	53.10	239.00/M
F339-ND	20	3.54	53.10	239.00/M
F340-ND	25	3.54	53.10	239.00/M
F341-ND	30	3.54	53.10	239.00/M

3AG PANEL FUSEHOLDER



Black phenolic conforming to MIL-M-14, type CFG. Rated at 20 amps for any voltage to 250. Includes neoprene washer, hex nut, and lock washer.

Part No.	1	10	100
F004-ND	1.89	15.00	94.50

National Semiconductor

MA1026 Time-Temp Clock Module

Giant .7 Inch 4-Digit LED Display

- F° and or C° and virtually any number of sensors
- 50/60Hz line frequency operation
- 12 or 24 Hour Display

Instruction included with all orders

Typical Applications Include: Clock Radio Timers, Alarm Clock, Desk Clock, TV and Stereo Timer, Instrument Panel Clock, Digital Thermometer and much more.

Part No.	Description	Price
MA1026M	MA1026 clock module only	$18.95
MA1026P	Digi-Key switch panel kit (P.C. Board, 12 switches, two LM334Z temp sensors, two KOA32 potentiometers, instructions)	11.95
MA1026T	110 VAC transformer for MA1026M	3.95
MA1026B	Alarm buzzer for MA1026M	3.36
MA1026K	MA1026M, P, T, B	34.95

For additional sensor units, you will need:

LM334Z	Temperature Sensor	1.51
K4A32	300 ohm Potentiometer	.32
802PB	Normally open SPST Switch	.56

"Programmable" Clock Modules

0.7" or 0.84" Red 4-Digit LED Display

User Programmable For:
- 12 or 24 hour display
- 50/60 Hz line frequency
- Fixed or flashing dot (colon indicator)
- Display, hours and minutes, minute and seconds, alarm time, and sleep time
- Battery back up in case of power failure
- Typical applications include clock radio timer, alarm clock, desk clock, instrument panel clock, and many more

MA1020 — 0.84 INCH HIGH DIGITS

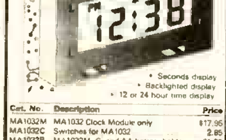
Cat. No.	Description	Price
MA1020M	MA1020 Clock Module only	$15.95
MA1020P	Digi-Key switching panel (includes P.C. board, switches, hardware and instructions.)	7.96
MA1020T	110 VAC Transformer for MA1020M	3.95
MA1020B	Buzzer for MA1020M alarm output	3.36
MA1020K	MA1020M, P, B and T	29.95

MA1023 — 0.7 INCH HIGH DIGITS

Cat. No.	Description	Price
MA1023M	MA1023 Clock Module only	$8.95
MA1023P	Digi-Key switching panel (includes P.C. board, switches, hardware and instructions.)	6.95
MA1023T	110 VAC Transformer for MA1023M	3.95
MA1023B	Buzzer for MA1023 alarm output	3.36
MA1023K	MA1023M, P, B and T	21.30

.5" 4-Digit LCD Clock

National Semiconductor MA1032 Clock Module
- One year use on a 90mA hour battery (typ.)
- Buffered alarm and sleep outputs
- AC or DC alarm output
- Hold function

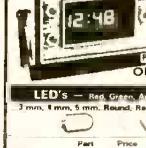


- Seconds display
- Backlighted display
- 12 or 24 hour time display

Cat. No.	Description	Price
MA1032M	MA1032 Clock Module only	$17.95
MA1032C	Switches for MA1032	2.85
MA1032B	MA1032M, C, and AA battery holder	21.20

DIGI-CLOCK KIT

12 VDC — Ideal for Car, Van or Boat!

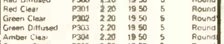


- Quick and easy to install

Part No. 5001K ONLY $17.95

LED's — Red, Green, Amber, Orange

3 mm, 4 mm, 5 mm, Round, Rectangular Arrow



Color	Part No.	Price 10	100	Size MM	Shape
Red Diffused	P300	2.20	19.50	5	Round
Red Clear	P301	2.20	19.50	5	Round
Green Clear	P302	2.20	19.50	5	Round
Green Diffused	P303	2.20	19.50	5	Round
Amber Clear	P304	2.20	19.50	5	Round
Orange Clear	P305	2.20	19.50	5	Round
Amber Diffused	P306	2.20	19.50	5	Round
Orange Diffused	P307	2.20	19.50	5	Round
Red Clear	P308	2.20	19.50	3	Round
Green Clear	P309	2.20	19.50	3	Round
Amber Clear	P310	2.20	19.50	3	Round
Red Clear	P311	2.20	19.50	4	Round
Green Clear	P312	2.20	19.50	4	Round
Amber Diffused	P314	2.20	19.50	4	Round
Red Diffused	P315	2.20	19.50	3x5	Rectangle
Green Diffused	P316	3.12	26.00	3x5	Rectangle
Amber Diffused	P317	3.12	26.00	3x5	Rectangle
Red Diffused	P318	2.20	19.50	4x4.5	Arrow
Green Diffused	P319	3.12	26.00	4x4.5	Arrow
[illegible] Diffused	P320	3.12	26.00	4x4.5	Arrow

Panasonic LED Numeric Display

Red, Green, Amber and Orange Colors — Direct Drive

Part No Comm Anode	Comm Cath.	Digits	Color	Size In.	Price 1	10	100
P322	P343	8	Red	.3	1.25	11.60	105.00
P323	P344		Green	.3	1.58	14.60	132.00
P324	P345		Amber	.3	1.93	17.70	162.00
P325	P346		Orange	.3	1.93	17.70	162.00
P326	P347		Red	.43	1.45	13.30	122.00
P327	P348		Green	.43	1.78	16.30	149.00
P328	P349		Amber	.43	1.93	17.70	162.00
P329	P350		Orange	.43	2.10	19.32	176.00
P330	P351	8	Red	.57	1.58	14.50	132.00
P331	P352		Green	.57	1.90	17.50	159.00
P332	P353		Amber	.57	1.93	17.70	162.00
P333	P354		Orange	.57	2.25	20.70	188.00
P334	P355	88	Red	.43	2.10	19.30	175.00
P335	P356		Green	.43	2.45	22.50	205.00
P336	P357		Amber	.43	3.08	28.30	257.00
P337	P358		Red	.57	2.10	19.30	175.00
P338	P359		Green	.57	2.45	22.50	205.00
P339	P360		Amber	.57	3.58	32.90	299.00
P340*	P361*	8888	Red	.28	5.35	49.20	448.00
P341*	P362*		Green	.28	6.15	56.60	515.00

* Multiplexed Display

Silicon Transistors

DIGI-KEY Part No.	1	10	100	1,000
2N3055	1.44	12.00	108.00	960.00
2N3904	.20	1.79	16.25	146.25
2N3906	.20	1.79	16.25	146.25
2N4124	.21	1.93	17.50	157.50
2N4126	.22	2.01	18.25	164.25
2N4401	.21	1.93	17.50	157.50
2N4403	.21	1.93	17.50	157.50
2N4410	.30	2.70	24.38	219.38
2N5087	.24	2.20	20.00	180.00
2N5089	.24	2.20	20.00	180.00
2N5210	.27	2.48	22.50	202.50
2N5457	.54	4.86	43.88	394.88
92PU01A	.38	3.42	30.88	277.88
92PU10	.38	3.42	30.88	277.88
92PU45A	.41	3.69	33.32	299.82
92PU51A	.38	3.42	30.88	277.88
MJ2955	1.47	13.48	122.50	1102.25
MJE172	.74	6.66	60.13	541.13
MJE182	.65	5.55	46.25	416.25
MJE3439	.56	4.80	40.00	360.00
MJE344	.68	6.12	55.25	497.25
MJE370	.89	8.01	72.32	650.82
MJE371	1.10	9.90	89.38	804.38
MJE520	.86	7.74	69.88	628.88
MJE521	.86	7.74	69.88	628.88
MJE703	1.13	10.17	91.82	826.31
MJE712	.74	6.66	60.13	541.13
MJE722	.74	6.66	60.13	541.13
MJE803	1.01	9.09	82.07	738.57
MPF102	.54	4.95	45.00	405.00
MPS2222A	.21	1.93	17.50	157.50
MPS2369A	.24	2.20	20.00	180.00
MPS2907A	.24	2.20	20.00	180.00
MPS3392	.23	2.07	18.75	169.00
MPS3393	.21	1.93	17.50	157.50
MPS3394	.24	2.20	20.00	180.00
MPS3395	.24	2.20	20.00	180.00
MPS3563	.21	1.93	17.50	157.50
MPS3565	.21	1.93	17.50	157.50
MPS3638A	.21	1.93	17.50	157.50
MPS3641	.21	1.93	17.50	157.50
MPS3643	.21	1.93	17.50	157.50
MPS918	.22	1.98	17.88	160.88
MPS930	.21	1.93	17.50	157.50
MPSA13	.27	2.48	22.50	202.50
TIP112	.98	8.40	70.00	630.00
TIP117	1.12	10.08	91.00	819.00
TIP120	1.17	10.73	97.50	877.50
TIP122	1.54	13.20	110.00	990.00
TIP127	1.54	13.20	110.00	990.00
TIP132	2.32	20.88	188.50	1696.50
TIP136	2.32	20.88	188.50	1696.50
TIP29C	.81	6.90	57.50	517.50
TIP30C	.81	6.90	57.50	517.50
TIP31C	.98	8.40	70.00	630.00
TIP32C	1.02	8.70	72.50	652.50
TIP61C	.81	6.90	57.50	517.50
TIP62C	.81	6.90	57.50	517.50

PCB Transformers

Ratings Based on 20% Regulation

DIGI-KEY Part No.	Output Series VCT@MA	Price 1	10	25	50
T100-ND	18 @ 440	7.00	56.00	118.75	200.00
T101-ND	12.5 @ 350	7.00	55.00	118.75	200.00
T102-ND	16 @ 280	7.00	56.00	118.75	200.00
T103-ND	20 @ 220	7.00	56.00	118.75	200.00
T104-ND	24 @ 180	7.00	56.00	118.75	200.00
T105-ND	28 @ 160	7.00	56.00	118.75	200.00
T106-ND	34 @ 125	7.00	56.00	118.75	200.00
T107-ND	40 @ 110	7.00	55.00	118.75	200.00
T110-ND	10 @ 1000	8.37	62.80	134.50	239.00
T111-ND	12.6 @ 800	8.37	62.80	134.50	239.00
T112-ND	16 @ 640	8.37	62.80	134.50	239.00
T113-ND	20 @ 500	8.37	62.80	134.50	239.00
T114-ND	24 @ 450	8.37	62.80	134.50	239.00
T115-ND	28 @ 360	8.37	62.80	134.50	239.00
T116-ND	34 @ 300	8.37	62.80	134.50	239.00
T117-ND	40 @ 250	8.37	62.80	134.50	239.00
T120-ND	10 @ 2400	11.45	85.90	186.00	326.50
T121-ND	12.6 @ 2000	11.45	85.90	186.00	326.50
T122-ND	16 @ 1500	11.45	85.90	186.00	326.50
T123-ND	20 @ 1200	11.45	85.90	186.00	326.50
T124-ND	24 @ 1000	11.45	85.90	186.00	326.50
T125-ND	28 @ 800	11.45	85.90	186.00	326.50
T126-ND	34 @ 700	11.45	85.90	186.00	326.50
T127-ND	40 @ 600	11.45	85.90	186.00	573.00

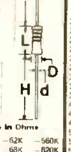
5% Carbon Film Resistors

Specifications

	¼ W	½ W
Rating Wattage	¼ W	½ W
Max. Working Voltage	250V	350V
Rated Ambient Temp.	70°C	
Operating Temp. Range	-55°C to +155°C	
Resistance Range	22Ω to 5.1MΩ	
Resistance Tolerance	±5%	
Series	E24	

Dimensions

	Style	¼ W	½ W
Body	Length (L)	6.5 ± 0.4	9.5 ± .75
	Diameter (D)	2.3 ± .10	3.7 ± 0.2
Lead Wire	Length (H)	28 ± 1.0	28 ± 1.0
	Diameter (d)	0.6	0.7



5% Carbon Film Resistor Values in Ohms

-1.0	-9.1	-82	-750	-6.8K	-62K	-560K
-1.1	-10	-91	-820	-7.5K	-68K	-620K
-1.2	-11	-100	-910	-8.2K	-75K	-680K
-1.3	-12	-110	-1.0K	-9.1K	-82K	-750K
-1.5	-13	-120	-1.1K	-10K	-91K	-820K
-1.6	-15	-130	-1.2K	-11K	-100K	-910K
-1.8	-16	-150	-1.3K	-12K	-110K	-1.0M
-2.0	-18	-160	-1.5K	-13K	-120K	-1.1M
-2.2	-20	-180	-1.6K	-15K	-130K	-1.2M
-2.4	-22	-200	-1.8K	-16K	-150K	-1.3M
-2.7	-24	-220	-2.0K	-18K	-160K	-1.5M
-3.0	-27	-240	-2.2K	-20K	-180K	-1.6M
-3.3	-30	-270	-2.4K	-22K	-200K	-1.8M
-3.6	-33	-300	-2.7K	-24K	-220K	-2.0M
-3.9	-36	-330	-3.0K	-27K	-240K	-2.2M
-4.3	-39	-360	-3.3K	-30K	-270K	-2.4M
-4.7	-43	-390	-3.6K	-33K	-300K	-2.7M
-5.1	-47	-430	-3.9K	-36K	-330K	-3.0M
-5.6	-51	-470	-4.3K	-39K	-360K	-3.3M
-6.2	-56	-510	-4.7K	-43K	-390K	-3.6M
-6.8	-62	-560	-5.1K	-47K	-430K	-3.9M
-7.5	-68	-620	-5.6K	-51K	-470K	-4.3M
-8.2	-75	-680	-6.2K	-56K	-510K	-4.7M

When ordering individual resistors, place a "Q" after the ohms value for ¼ W and an "H" for ½ W resistors.

¼ WATT 5% CARBON FILM RESISTOR ASSORTMENT

RS125	5 each of 73 values in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc. to 1M ohm of the ¼ W 5% resistor for a total of 365 pieces	$9.90
RS225	5 each of 72 values in the series 1.1, 1.3, 1.6, 2.0, 2.4 etc. to 910K ohm of the ¼ W 5% resistor for a total of 360 pieces	$9.90

½ WATT 5% CARBON FILM RESISTOR ASSORTMENT

RS150	5 each of 73 values in the series 1.0, 1.2, 1.5, 1.8, 2.2 etc. to 1M ohm of the ½ W 5% resistor for a total of 365 pieces	$9.90
RS250	5 each of 72 values in the series 1.1, 1.3, 1.6, 2.0, 2.4 etc. to 910K ohm of the ½ W 5% resistor for a total of 380 pieces.	$9.90

Remember a "Q" after the resistance value indicates a ¼ watt, an "H" indicates a ½ watt (i.e., 10KQ or 10KH). Prices are for single values.

¼ Watt ... for 25¢, 200 for $3.40, 1000 for $13.00
½ Watt ... for 25¢, 200 for $3.60, 1000 for $16.00

In order to receive the pricing below, the resistor part number must be followed by a "-ND" (i.e., 10KQ-ND) and ordered in multiples of 1,000 only.

Price /1000	1M	10M	50M	100M	500M	1000M
¼ W	8.10/M	7.20/M	5.80/M	5.40/M	4.50/M	4.00/M
½ W	12.25/M	10.25/M	9.50/M	8.90/M	7.40/M	6.65/M

ROBINSON NUGENT INC. — TERMINATION JUMPERS

S = SOCKET CONNECTOR TERMINATION

P = PCB CONNECTOR TERMINATION

K = CARD EDGE CONNECTOR TERMINATION

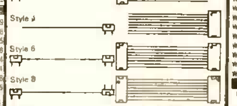
Number After Dash is Cable Length in Inches

Contacts	Style	DIGI-KEY Part No.	1	10	100	1,000
10	S	R300-ND	1.15	10.26	84.90	872.10
14	S	R301-ND	1.40	12.52	115.81	1064.20
16	S	R302-ND	1.61	14.32	132.46	1217.20
20	S	R303-ND	1.86	16.56	153.18	1407.60
26	S	R304-ND	2.43	21.60	199.80	1836.00
34	S	R305-ND	3.15	28.00	259.00	2380.00
40	S	R306-ND	3.73	33.20	307.10	2822.00
50	S	R307-ND	4.65	41.40	382.95	3519.00
10	P	R400-ND	1.01	9.00	83.25	765.00
20	P	R401-ND	1.21	10.84	100.27	921.40
26	P	R402-ND	1.52	13.52	125.06	1149.20
34	P	R403-ND	1.86	16.56	153.18	1407.60
40	P	R404-ND	2.11	18.82	174.08	1599.70
50	P	R405-ND	2.65	23.60	218.30	2006.00
20	X	R500-ND	2.38	21.00	194.25	1785.00
26	X	R501-ND	2.65	23.60	218.30	2006.00
34	X	R502-ND	3.26	29.00	268.25	2465.00
40	X	R503-ND	3.80	33.80	312.65	2873.00
50	X	R504-ND	4.74	42.20	390.35	3587.00
1A	SOCKET CONNECTOR					
10	1A	R309-36-ND	2.13	19.01	175.87	1616.19
14	1A	R310-36-ND	2.78	24.73	228.80	2102.66
16	1A	R311-36-ND	3.18	28.33	262.05	2408.05
20	1A	R312-36-ND	3.83	34.06	315.12	2895.76
26	1A	R313-36-ND	4.99	44.36	410.36	3770.84
34	1A	R314-36-ND	6.49	57.70	534.33	4910.11
40	1A	R316-36-ND	7.67	68.21	630.99	5794.36
50	1A	R317-36-ND	9.58	85.17	787.87	7239.45
2A	PCB CONNECTOR					
10	2A	R406-36-ND	1.98	17.75	164.22	1509.09
20	2A	R407-36-ND	3.18	28.34	262.21	2409.58
26	2A	R408-36-ND	4.08	36.28	335.62	3084.14
34	2A	R409-36-ND	5.21	46.32	428.51	3937.71
40	2A	R410-36-ND	6.05	53.83	497.98	4576.06
50	2A	R411-36-ND	7.57	67.31	623.17	5726.45
3A	CARD EDGE CONNECTOR					
20	3A	R505-36-ND	4.33	38.50	356.19	3273.16
26	3A	R506-36-ND	5.21	46.36	428.86	3940.94
34	3A	R507-36-ND	6.81	58.76	543.56	4994.94
40	3A	R509-36-ND	7.74	68.81	636.54	5849.36
50	3A	R510-36-ND	9.67	85.97	795.22	7307.45
1B	SOCKET CONNECTOR — SOCKET CONNECTOR					
10	1B	R318-6-ND	2.47	21.97	203.29	1868.13
10	1B	R319-18-ND	2.80	24.89	230.29	2116.24
10	1B	R319-36-ND	3.29	29.27	270.78	2488.29
14	1B	R320-6-ND	3.04	27.08	250.50	2301.97
14	1B	R320-18-ND	3.50	31.16	288.28	2649.11
14	1B	R320-36-ND	4.19	37.25	344.61	3166.76
16	1B	R321-6-ND	3.48	30.97	286.51	2632.87
16	1B	R321-18-ND	4.01	35.64	329.71	3029.82
16	1B	R321-36-ND	4.79	42.65	394.51	3625.25
20	1B	R322-6-ND	4.05	36.03	333.36	3063.23
20	1B	R322-18-ND	4.71	41.87	387.33	3559.29
20	1B	R322-36-ND	5.69	50.62	468.30	4303.38
26	1B	R323-6-ND	5.28	46.99	434.69	3994.49
26	1B	R323-18-ND	6.14	54.58	504.86	4639.47
26	1B	R323-36-ND	7.42	65.96	610.16	5606.84
34	1B	R324-6-ND	6.85	60.96	563.88	5181.68
34	1B	R324-18-ND	7.97	70.88	655.66	6025.05
34	1B	R324-36-ND	7.39	65.76	608.33	5590.11
40	1B	R325-6-ND	8.12	72.23	668.18	6140.06
40	1B	R325-18-ND	9.43	83.90	776.14	7132.18
40	1B	R325-36-ND	11.40	101.41	938.09	8620.36
50	1B	R326-6-ND	10.13	90.09	833.37	7656.07
50	1B	R326-18-ND	11.77	104.68	968.33	8898.22
50	1B	R326-36-ND	14.23	126.57	1170.77	10758.45
2B	PCB CONNECTOR — PCB CONNECTOR					
10	2B	R412-6-ND	2.18	19.45	179.99	1654.01
10	2B	R412-18-ND	2.51	22.37	206.96	1902.04
10	2B	R412-36-ND	3.00	26.75	247.47	2274.09
20	2B	R413-6-ND	2.76	24.59	227.53	2090.83
20	2B	R413-18-ND	3.42	30.43	281.51	2586.89
20	2B	R413-36-ND	4.40	39.18	362.48	3330.98
26	2B	R414-6-ND	3.46	30.83	285.21	2620.89
26	2B	R414-18-ND	4.32	38.42	355.40	3265.87
26	2B	R414-36-ND	5.60	49.80	460.68	4233.34
34	2B	R415-6-ND	4.28	38.08	352.24	3236.88
34	2B	R415-18-ND	5.40	43.00	444.07	4080.25
34	2B	R415-36-ND	7.07	62.88	581.69	5345.31
40	2B	R416-6-ND	4.89	43.47	402.16	3695.46
40	2B	R416-18-ND	6.20	55.14	510.11	4687.58
40	2B	R416-36-ND	8.17	72.66	672.06	6175.76
50	2B	R417-6-ND	6.13	54.49	504.07	4632.07
50	2B	R417-18-ND	7.77	69.08	639.03	5872.22
50	2B	R417-36-ND	10.23	90.97	841.47	7732.45
3B	CARD EDGE CONNECTOR — CARD EDGE CONNECTOR					
20	3B	R511-6-ND	5.05	44.91	415.49	3818.03
20	3B	R511-18-ND	5.70	50.75	469.47	4314.09
20	3B	R511-36-ND	6.69	59.50	550.44	5058.18
26	3B	R512-6-ND	5.73	50.99	471.69	4334.49
26	3B	R512-18-ND	6.58	58.58	541.88	4979.47
26	3B	R512-36-ND	7.87	69.96	647.18	5946.94
34	3B	R513-6-ND	7.08	62.96	582.38	5351.68
34	3B	R513-18-ND	8.19	72.88	674.16	6195.05
34	3B	R513-36-ND	9.87	87.76	811.81	7459.94
40	3B	R514-6-ND	8.26	73.43	679.28	6242.06
40	3B	R514-18-ND	9.57	85.10	787.24	7234.18
40	3B	R514-36-ND	11.54	102.61	949.19	8722.36
50	3B	R515-6-ND	10.31	91.69	848.17	7794.07
50	3B	R515-18-ND	11.95	106.28	983.13	9034.22
50	3B	R515-36-ND	14.41	128.17	1185.57	10894.45
C	SOCKET CONNECTOR — PCB CONNECTOR					
10	C	R328-6-ND	2.33	20.71	191.65	1761.11
10	C	R328-18-ND	2.65	23.63	218.64	2009.14
10	C	R328-36-ND	3.15	28.01	259.12	2381.19
20	C	R329-6-ND	3.41	30.31	280.44	2577.03
20	C	R329-18-ND	4.06	36.15	334.42	3073.09
20	C	R329-36-ND	5.05	44.90	415.39	3817.18
26	C	R330-6-ND	4.37	38.91	359.95	3307.69
26	C	R330-18-ND	5.23	46.50	430.14	3952.67
26	C	R330-36-ND	6.51	57.88	535.42	4920.14
34	C	R331-6-ND	5.57	49.52	458.08	4209.28
34	C	R331-18-ND	6.68	59.44	549.84	5052.65
34	C	R331-36-ND	8.36	74.32	687.51	6317.71
40	C	R332-6-ND	6.50	57.85	535.16	4917.76
40	C	R332-18-ND	7.82	69.52	643.13	5909.88
40	C	R332-36-ND	9.79	87.03	805.08	7398.06
50	C	R333-6-ND	8.13	72.29	668.72	6145.07
50	C	R333-18-ND	9.77	86.86	803.68	7385.22
50	C	R333-36-ND	12.23	108.77	1006.12	9245.45
E	PCB CONNECTOR — CARD EDGE CONNECTOR					
20	E	R418-6-ND	3.91	34.75	321.51	2954.43
20	E	R418-18-ND	4.58	40.59	375.49	3450.49
20	E	R418-36-ND	5.55	49.34	456.46	4194.58
26	E	R419-6-ND	4.60	40.91	378.45	3477.69
26	E	R419-18-ND	5.45	48.50	448.64	4122.67
26	E	R419-36-ND	6.73	59.88	553.92	5090.14
34	E	R420-6-ND	5.68	50.52	467.31	4294.28
34	E	R420-18-ND	6.79	60.44	559.09	5137.65
34	E	R420-36-ND	8.47	75.32	696.76	6402.71
40	E	R421-6-ND	6.57	58.45	540.71	4968.76
40	E	R421-18-ND	7.88	70.12	648.68	5960.86
40	E	R421-36-ND	9.85	87.63	810.63	7449.06
50	E	R422-6-ND	8.22	73.08	676.12	6213.07
50	E	R422-18-ND	9.86	87.68	811.08	7453.22
50	E	R422-36-ND	12.32	109.57	1013.52	9313.45
D	SOCKET CONNECTOR — CARD EDGE CONNECTOR					
20	D	R516-6-ND	4.55	40.47	374.42	3440.63
20	D	R516-18-ND	5.21	46.31	428.40	3936.69
20	D	R516-36-ND	6.19	55.06	509.37	4680.78
26	D	R517-6-ND	5.51	48.99	453.19	4164.49
26	D	R517-18-ND	6.36	56.58	523.38	4809.47
26	D	R517-36-ND	7.64	67.96	628.66	5776.94
34	D	R518-6-ND	6.97	61.96	573.13	5268.68
34	D	R518-18-ND	8.08	71.88	664.91	6110.05
34	D	R518-36-ND	9.76	86.76	802.58	7375.11
40	D	R519-6-ND	8.19	72.83	673.73	6191.06
40	D	R519-18-ND	9.50	84.50	781.69	7183.18
40	D	R519-36-ND	11.47	102.01	943.64	8671.36
50	D	R520-6-ND	10.22	90.89	840.77	7726.07
50	D	R520-18-ND	11.86	105.48	975.73	8966.22
50	D	R520-36-ND	14.32	127.37	1178.12	10828.45
1H	SOCKET CONNECTOR — SOCKET CONNECTOR — SOCKET CONNECTOR					
10	1H	R334-6-ND	3.62	32.23	298.20	2740.23
14	1H	R335-6-ND	4.45	39.60	366.31	3366.17
16	1H	R336-6-ND	5.09	45.29	418.97	3850.07
20	1H	R337-6-ND	5.91	52.58	486.53	4470.83
26	1H	R338-6-ND	7.71	68.59	634.49	5830.49
34	1H	R339-6-ND	10.00	88.96	822.86	7561.68
40	1H	R340-6-ND	11.86	105.43	975.28	8962.08
50	1H	R341-6-ND	14.79	131.49	1216.32	11177.07
2H	PCB CONNECTOR — PCB CONNECTOR — PCB CONNECTOR					
10	2H	R423-6-ND	3.20	28.45	263.24	2419.01
20	2H	R424-6-ND	3.98	35.43	327.80	3012.23
26	2H	R425-6-ND	4.98	44.35	410.27	3770.09
34	2H	R426-6-ND	6.14	54.64	505.42	4644.48
40	2H	R427-6-ND	7.00	62.28	576.23	5295.16
50	2H	R428-6-ND	8.78	78.09	722.37	6638.07
3H	CARD EDGE — CARD EDGE — CARD EDGE					
20	3H	R521-6-ND	7.41	65.91	609.74	5603.03
26	3H	R522-6-ND	8.39	74.59	689.99	6340.49
34	3H	R523-6-ND	10.34	91.96	850.63	7816.68
40	3H	R524-6-ND	12.06	107.23	991.93	9115.06
50	3H	R525-6-ND	15.06	133.89	1238.52	11381.07

DIP Jumper Cable Assembly

Standard Assembly Styles

Style 2, Style 4, Style 6, Style 8, Style 0



Dot Indicates Pin 1

Number After Dash is Cable Length in Inches

Contacts	Style	DIGI-KEY Part No.	1	10	100	1,000
14	2	R102-6-ND	1.58	14.08	130.25	1196.97
14	2	R102-12-ND	1.81	16.12	149.14	1370.54
14	2	R102-18-ND	2.04	18.16	168.03	1544.11
14	2	R102-24-ND	2.27	20.20	186.92	1717.68
14	2	R102-36-ND	2.73	24.28	224.70	2064.82
14	4	R104-6-ND	1.58	14.08	130.25	1196.97
14	4	R104-12-ND	1.81	16.12	149.14	1370.54
14	4	R104-18-ND	2.04	18.16	168.03	1544.11
14	4	R104-24-ND	2.27	20.20	186.92	1717.68
14	4	R104-36-ND	2.73	24.28	224.70	2064.82
14	6	R106-6-ND	2.93	26.12	241.62	2220.37
14	6	R106-12-ND	3.16	28.16	260.51	2393.94
14	6	R106-18-ND	3.39	30.20	279.40	2567.51
14	6	R106-24-ND	3.62	32.24	298.29	2741.08
14	6	R106-36-ND	4.08	36.33	336.07	3088.22
14	8	R108-6-ND	2.93	26.12	241.62	2220.37
14	8	R108-12-ND	3.16	28.16	260.51	2393.94
14	8	R108-18-ND	3.39	30.20	279.40	2567.51
14	8	R108-24-ND	3.62	32.24	298.29	2741.08
14	8	R108-36-ND	4.08	36.33	336.07	3088.22
14	0	R110-6-ND	2.93	26.12	241.62	2220.37
14	0	R110-12-ND	3.16	28.16	260.51	2393.94
14	0	R110-18-ND	3.39	30.20	279.40	2567.51
14	0	R110-24-ND	3.62	32.24	298.29	2741.08
14	0	R110-36-ND	4.08	36.33	336.07	3088.22
16	2	R112-6-ND	1.67	14.87	137.60	1264.46
16	2	R112-12-ND	1.93	17.21	159.19	1462.85
16	2	R112-18-ND	2.19	19.54	180.80	1661.41
16	2	R112-24-ND	2.46	21.88	202.39	1859.80
16	2	R112-36-ND	2.98	26.55	245.58	2256.75
16	4	R114-6-ND	1.67	14.87	137.60	1264.46
16	4	R114-12-ND	1.93	17.21	159.19	1462.85
16	4	R114-18-ND	2.19	19.54	180.80	1661.41
16	4	R114-24-ND	2.46	21.88	202.39	1859.80
16	4	R114-36-ND	2.98	26.55	245.58	2256.75
16	6	R116-6-ND	3.30	29.41	272.09	2500.36
16	6	R116-12-ND	3.57	31.75	293.68	2698.75
16	6	R116-18-ND	3.83	34.08	315.29	2897.31
16	6	R116-24-ND	4.09	36.42	336.88	3095.70
16	6	R116-36-ND	4.62	41.09	380.08	3492.65
16	8	R118-6-ND	3.30	29.41	272.09	2500.36
16	8	R118-12-ND	3.57	31.75	293.68	2698.75
16	8	R118-18-ND	3.83	34.08	315.29	2897.31
16	8	R118-24-ND	4.09	36.42	336.88	3095.70
16	8	R118-36-ND	4.62	41.09	380.08	3492.65
16	0	R120-6-ND	3.30	29.41	272.09	2500.36
16	0	R120-12-ND	3.57	31.75	293.68	2698.75
16	0	R120-18-ND	3.83	34.08	315.29	2897.31
16	0	R120-24-ND	4.09	36.42	336.88	3095.70
16	0	R120-36-ND	4.62	41.09	380.08	3492.65
24	2	R122-6-ND	2.63	23.38	216.28	1987.47
24	2	R122-12-ND	3.02	26.88	248.67	2285.14
24	2	R122-18-ND	3.41	30.38	281.07	2582.81
24	2	R122-24-ND	3.81	33.88	313.46	2880.48
24	2	R122-36-ND	4.60	40.89	378.25	3475.82
24	4	R124-6-ND	2.63	23.38	216.28	1987.47
24	4	R124-12-ND	3.02	26.88	248.67	2285.14
24	4	R124-18-ND	3.41	30.38	281.07	2582.81
24	4	R124-24-ND	3.81	33.88	313.46	2880.48
24	4	R124-36-ND	4.60	40.89	378.25	3475.82
24	6	R126-6-ND	4.86	43.26	400.17	3677.27
24	6	R126-12-ND	5.26	46.76	432.56	3974.94
24	6	R126-18-ND	5.65	50.26	464.96	4272.61
24	6	R126-24-ND	6.04	53.76	497.35	4570.28
24	6	R126-36-ND	6.83	60.77	562.14	5165.62
24	8	R128-6-ND	4.86	43.26	400.17	3677.27
24	8	R128-12-ND	5.26	46.76	432.56	3974.94
24	8	R128-18-ND	5.65	50.26	464.96	4272.61
24	8	R128-24-ND	6.04	53.76	497.35	4570.28
24	8	R128-36-ND	6.83	60.77	562.14	5165.62
24	0	R130-6-ND	4.86	43.26	400.17	3677.27
24	0	R130-12-ND	5.26	46.76	432.56	3974.94
24	0	R130-18-ND	5.65	50.26	464.96	4272.61
24	0	R130-24-ND	6.04	53.76	497.35	4570.28
24	0	R130-36-ND	6.83	60.77	562.14	5165.62
40	2	R132-6-ND	3.26	29.03	268.58	2468.06
40	2	R132-12-ND	3.92	34.87	322.56	2964.12
40	2	R132-18-ND	4.57	40.70	376.54	3460.18
40	2	R132-24-ND	5.23	46.54	430.53	3956.24
40	2	R132-36-ND	6.54	58.21	538.49	4948.36
40	4	R134-6-ND	3.26	29.03	268.58	2468.06
40	4	R134-12-ND	3.92	34.87	322.56	2964.12
40	4	R134-18-ND	4.57	40.70	376.54	3460.18
40	4	R134-24-ND	5.23	46.54	430.53	3956.24
40	4	R134-36-ND	6.54	58.21	538.49	4948.36
40	6	R136-6-ND	5.87	52.23	483.18	4440.06
40	6	R136-12-ND	6.53	58.07	537.16	4936.12
40	6	R136-18-ND	7.18	63.90	591.14	5432.18
40	6	R136-24-ND	7.84	69.74	645.13	5928.24
40	6	R136-36-ND	9.15	81.41	753.09	6920.36
40	8	R138-6-ND	5.87	52.23	483.18	4440.06
40	8	R138-12-ND	6.53	58.07	537.16	4936.12
40	8	R138-18-ND	7.18	63.90	591.14	5432.18
40	8	R138-24-ND	7.84	69.74	645.13	5928.24
40	8	R138-36-ND	9.15	81.41	753.09	6920.36
40	0	R140-6-ND	5.87	52.23	483.18	4440.06
40	0	R140-12-ND	6.53	58.07	537.16	4936.12
40	0	R140-18-ND	7.18	63.90	591.14	5432.18
40	0	R140-24-ND	7.84	69.74	645.13	5928.24
40	0	R140-36-ND	9.15	81.41	753.09	6920.36

alpha wire cable tubing

Hookup Wire, Stranded, PVC Insulated

4 Color MIL W 16878D Type B · 600 Volt · -55° to +105°C

White	Black	Green	Red	Price 100 Ft	AWG
W100W-ND	W100B-ND	W100G-ND	W100R-ND	7.32	32
W101W-ND	W101B-ND	W101G-ND	W101R-ND	6.01	30
W102W-ND	W102B-ND	W102G-ND	W102R-ND	5.71	28
W103W-ND	W103B-ND	W103G-ND	W103R-ND	5.90	26
W104W-ND	W104B-ND	W104G-ND	W104R-ND	5.82	24
W105W-ND	W105B-ND	W105G-ND	W105R-ND	6.37	22
W106W-ND	W106B-ND	W106G-ND	W106R-ND	8.03	20
W107W-ND	W107B-ND	W107G-ND	W107R-ND	8.35	18
W108W-ND	W108B-ND	W108G-ND	W108R-ND	10.90	16
W109W-ND	W109B-ND	W109G-ND	W109R-ND	24.52	14

Hookup Wire, Solid, PVC Insulated

4 Color MIL W 76B Type MW · 1,000 Volt · -40° to +80°C

White	Black	Green	Red	Price 100 Ft	AWG
W110W-ND	W110B-ND	W110G-ND	W110R-ND	5.48	24
W111W-ND	W111B-ND	W111G-ND	W111R-ND	5.31	22
W112W-ND	W112B-ND	W112G-ND	W112R-ND	8.32	20
W113W-ND	W113B-ND	W113G-ND	W113R-ND	8.41	18

Multiconductor, Solid, PVC Insulated Cable

Color Coded · Gray Jacket · Tinned Copper Conductors

DIGI-KEY Part No.	Price Per Roll 100 Ft.	500 Ft.	1,000 Ft.	No. Of Cond.	Conductor AWG	Strand	Voltage Rating
W140-X-ND	15.27	54.18	106.65	2	22	1	150V
W141-X-ND	35.04	121.94	231.00	2	18	1	300V
W142-X-ND	37.58	145.83	306.89	3	18	1	300V
W143-X-ND	50.67	190.79	363.15	4	18	1	300V

Multipair Individually Foil Shielded Cable

UL2464 CSA Certified · Drain Wire · 20° to +80°C · 300 Volts · 22 AWG 7/30 · X = Number of Feet Per Roll

DIGI-KEY Part No.	Price Per Roll 100 Ft.	500 Ft.	1,000 Ft.	No. of Pairs	Nom. O.D. Inches	mm
W170-X-ND	39.44	139.84	279.87	2	.316	8.03
W171-X-ND	52.03	185.63	371.27	3	.331	8.41
W172-X-ND	64.43	240.30	480.57	4	.360	9.14
W173-X-ND	103.86	388.14	776.27	6	.431	10.95
W174-X-ND	121.85	526.50	1053.00	9	.500	12.70
W175-X-ND	145.50	626.25	1252.50	11	.551	14.00
W176-X-ND	192.39	831.00	1660.50	15	.606	15.39
W177-X-ND	251.03	1080.00	2160.00	19	.646	16.41
W178-X-ND	362.79	1549.42	3299.19	27	.776	19.71
W179-X-ND	704.25	3202.35	6406.49	51	.970	24.64

Multiconductor, Stranded, PVC Insulated Cable

UL2576 Color Coded · Gray Jacket · 150 Volts · -20° to +80°C · Conductor 22 AWG 7/30 · X = Number of Feet Per Roll

DIGI-KEY Part No.	Price Per Roll 100 Ft.	500 Ft.	1,000 Ft.	No. Cond.	Nominal O.D. Inches	mm
W120-X-ND	8.70	34.40	58.78	2	.164	4.17
W121-X-ND	11.47	42.22	89.60	3	.169	4.29
W122-X-ND	15.31	57.89	101.00	4	.194	4.93
W123-X-ND	18.11	68.80	113.40	5	.199	5.05
W124-X-ND	27.57	108.70	174.24	6	.209	5.31
W125-X-ND	28.37	102.03	177.75	7	.214	5.44
W126-X-ND	34.58	103.28	206.55	8	.224	5.69
W127-X-ND	38.31	125.03	250.05	9	.249	6.32
W128-X-ND	42.88	145.50	291.00	10	.259	6.58
W129-X-ND	48.41	165.38	330.75	12	.279	7.09
W130-X-ND	76.00	254.48	508.95	15	.304	7.72
W131-X-ND	96.28	328.80	657.60	20	.324	8.23
W132-X-ND	106.84	411.75	823.50	25	.364	9.25
W133-X-ND	113.06	472.50	945.00	30	.379	9.63
W134-X-ND	150.08	625.50	1251.00	40	.439	11.15
W135-X-ND	176.63	783.00	1566.00	50	.500	12.70
W136-X-ND	286.12	1217.24	2386.94	60	.530	13.46

See Your FREE DIGI-KEY Catalog For Color Codes

Twisted Pair, Solid, Comm. and Control Cable

22 AWG Color Coded · Gray Jacket · UL2578 · 150 Volt · X = Number of Feet Per Roll

DIGI-KEY Part No.	Price Per Roll 100 Ft.	500 Ft.	1,000 Ft.	No. of Pairs	No. of Cond.
W150-X-ND	9.14	30.30	60.61	1	2
W151-X-ND	16.47	58.51	88.00	2	4
W152-X-ND	21.35	81.54	134.40	3	6
W153-X-ND	28.17	101.01	177.90	4	8
W154-X-ND	31.23	106.85	213.90	5	10
W155-X-ND	35.04	118.28	236.55	6	12
W156-X-ND	50.89	176.93	353.85	9	18
W157-X-ND	63.85	228.00	456.00	11	22
W158-X-ND	71.98	257.33	514.65	13	26
W159-X-ND	86.67	304.73	609.45	15	30
W160-X-ND	109.70	481.58	834.80	16	32
W161-X-ND	109.70	381.00	762.00	19	38
W162-X-ND	111.98	482.75	825.50	23	46
W163-X-ND	123.20	528.00	1056.00	27	54

See Your FREE DIGI-KEY Catalog For Color Codes

Shrinkable Tubing, Polyolefin: Black

UL and CSA Accepted · Flame Retarded · Self Extinguishing · Non Dripping

DIGI-KEY Part No.	Price Per Roll 5 Ft.	10 Ft.	50 Ft.	100 Ft.	Minimum Supplied I.D. Inches	Maximum Recovered I.D. Inches
W180-ND	2.51	4.18	18.83	33.48	.046	.023
W181-ND	2.87	4.45	20.05	35.65	.063	.031
W182-ND	3.03	5.05	22.75	40.40	.093	.046
W183-ND	3.20	5.35	24.07	42.78	.125	.062
W184-ND	3.90	6.50	29.22	51.94	.187	.093
W185-ND	4.93	8.22	36.89	65.75	.250	.125
W186-ND	5.50	9.16	41.21	73.28	.375	.187
W187-ND	6.20	10.33	46.48	82.65	.500	.250
W188-ND	8.28	13.80	62.10	110.40	.750	.375
W189-ND	11.61	19.35	87.09	154.82	1.000	.500
W190-ND	20.83	34.72	156.22	277.73	1.500	.750
W191-ND	28.74	47.90	215.58	383.25	2.000	1.000
W192-ND	45.54	75.90	341.54	607.18	3.000	1.5000
W193-ND	66.35	110.59	497.66		4.000	2.000

Adhesive Wall Shrinkable Tubing: Black

MIL I-23053/4B Class 2 - Flame-Retarded
Self-Extinguishing - Waterproof

DIGI-KEY Part No.	Price 4 Ft.	Pak/Ft.	Minimum Supplied I.D. Inches	Maximum Recovered I.D. Inches
W200-ND	9.29	185.16/100	.250	.125
W201-ND	10.34	206.86/100	.375	.187
W202-ND	12.20	48.78/20	.500	.250
W203-ND	18.84	73.52/20	.750	.375
W204-ND	23.29	93.16/20	1.000	.500
W205-ND	33.18	132.70/20	1.500	.750

Self-Encapsulating Caps: Black

Inexpensive Method of Encapsulating Electrical Connections or Sensors

DIGI-KEY Part No.	Price/Pak Of 10	100	1,000	Minimum Supplied I.D. Inches	Maximum Recovered I.D. Inches
W210-ND	.91	7.58	45.47	.125	.023
W211-ND	1.22	10.21	61.26	.187	.080
W212-ND	2.11	17.60	105.60	.250	.080
W213-ND	3.80	31.65	190.00	.375	.090
W214-ND	6.38	53.18	319.10	.500	.080

D-Subminiature Connectors

9, 15, 25, 37, and 50 contact solder pot contacts. Accommodates up to 20 AWG standard wire. Current Rating of 5 Amps. Contacts: Pin, copper, alloy, gold over nickel plate. Socket, phosphore bronze, gold over nickel plate. Temperature Range: -55° to +120°C

DIGI-KEY Part No.	Style	1	10	100	1,000
1S9P-ND	9 Pin Male	1.65	13.50	120.00	900.00
1S9S-ND	9 Pin Female	2.18	17.78	158.00	1185.00
1S15P-ND	15 Pin Male	2.20	18.00	160.00	1200.00
1S15S-ND	15 Pin Female	3.03	24.75	220.00	1650.00
1S25P-ND	25 Pin Male	3.00	24.53	218.00	1635.00
1S25S-ND	25 Pin Female	4.42	36.23	322.00	2415.00
1S37P-ND	37 Pin Male	4.13	33.75	300.00	2250.00
1S37S-ND	37 Pin Female	6.19	50.63	450.00	3375.00
1S50P-ND	50 Pin Male	5.25	42.98	382.00	2865.00
1S50S-ND	50 Pin Female	8.20	67.06	596.00	4470.00
HD9-ND	9 Pin Hood	1.62	13.50	108.00	810.00
HD15-ND	15 Pin Hood	1.62	13.50	108.00	810.00
HD25-ND	25 Pin Hood	1.62	13.50	108.00	810.00
HD37-ND	37 Pin Hood	1.80	15.00	120.00	900.00
HD50-ND	50 Pin Hood	2.01	16.75	134.00	1005.00

The Digi-Key volume discount and handling charges are simple to apply. Most items sold by Digi-Key may be combined for a volume discount. Items that are not discountable are identified by the suffix-ND following the part number. After writing your order, total all of the discountable items and apply the appropriate discount. To this subtotal, add the non-discountable items. Then add the handling charge. We pay all shipping and insurance to addresses in the U.S.A., Canada and Mexico when check or money order accompanies order.

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IMPEDANCE PROTECTED

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Remote Control Amplifier w/Infrared Pre Amp **9.95/Set**

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Miniature-500 OHMS to 8 OHMS. P.C. leads **.29¢ ea.**

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2304 MHZ DOWN CONVERTERS. TUNES IN ON CHANNELS 2 TO 7 ON YOUR OWN HOME T.V. HAS FREQUENCY RANGE FROM 2000 MHZ TO 2500 MHZ. EASY TO CONSTRUCT AND COMES COMPLETE WITH ALL PARTS INCLUDING A DIE-CAST ALUM CASE AND COAX FITTINGS, REQUIRE A VARIABLE POWER SUPLY AND ANTENNA (Antenna can be a dish type or coffee can type depending on the signal strength in your area.)

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2304 MOD 2 (Basic/Pre-amp) (less case & fittings) $29.95

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POWER SUPPLY FOR EITHER MODEL ABOVE IS AVAILABLE. COMES COMPLETE WITH ALL PARTS, CASE, TRANSFORMER, ANTENNA SWITCH AND CONNECTORS (Kit) $24.95

Assembled..... $34.95

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PREAMPLIFIERS

HAL PA-19—1.5 mhz to 150 mhz, 19db gain operates on 8 to 18 volts at 10ma. Complete unit $8.95.

HAL PA-1.4—3 mhz to 1.4 ghz. 10 to 12 db gain operates on 8 to 18 volts at 10 ma. Complete unit $12.95.

(The above units are ideal for receivers, counters, etc.)

16 LINE TOUCH TONE DECODE KIT WITH P.C. BOARD AND PARTS $69.95

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16 LINE ENCODER KIT, COMPLETE WITH CASE, PAD AND COMPONENTS..... $39.95

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PRINTED CIRCUIT BOARD PRINTED CIRCUIT BOARD PRINTED CIRCUIT BOARD
SINGLE SIDED SINGLE SIDED SINGLE SIDED SINGLE SIDED

WGE= WHITE GLASS EPOXY BGE=BLUE GLASS EPOXY P=PHENOLIC

ALL DIMENSIONS ARE IN INCHES

Printed Circuit Boards

JAVAN ORDER #	DESC.	DIMENSIONS	PRICE
PCB-1001	P	12 x 18	$4.00
PCB-1002	WGE	36½ x 2½	$1.40
PCB-1003	WGE	12 3/8 x 4 5/8	$ .90
PCB-1004	BGE	3 7/8 x 17½	$1.00
PCB-1005	P	24½ x 3 3/8	$1.40
PCB-1006	P	6 x 24½	$2.80
PCB-1007	P	6 x 7½	$ .80
PCB-1008	P	20 x 9	$3.50
PCB-1009	P	4 x 7 3/16	$ .50
PCB-1010	P	16½ x 6 3/16	$1.90
PCB-1011	P	18½ x 3	$1.00
PCB-1012	WGE	13 x 18	$4.60
PCB-1013	WGE	20 x 2½	$ .80
PCB-1014	BGE	18½ x 4 7/8	$1.40
PCB-1015	WGE	2 5/8 x 18 5/16	$ .70
PCB-1016	BGE	2 5/8 x 9	$ .30
PCB-1017	BGE	12 x 5	$1.20
PCB-1018	P	9 x 10½	$1.80
PCB-1019	WGE	2½ x 12	$ .40
PCB-1020	BGE	12 x 12	$2.80
PCB-1021	WGE	4 1/16 x 36½	$2.80
PCB-1022	BGE	7½ x 24	$3.30
PCB-1023	P	18 x 24	$8.60

MICK-180 $32.50
TRIMMER POTENTIOMETERS (10) EA. 18 TYPES miniature controls,both vert and horiz mounts (OUR NEWEST ASSORTMENT) 180 PCS. TRIMMER CONTROLS

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90 radial printed circuit bypass and coupling mylar type capacitors.mave have some polyester etc. ALL GOOD FOR EVERY DAY PROJECTS. !!EXACT FOR THE POCKETBOOK!! packed in a plastic,clear tray with hinged lid.
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TR-54 $6.50 (3) FOR $15.00
THIS VERSATILE TRANSFORMER CAN PRODUCE 6v,12v,18v,24v 30v,36v,42v.JUST BY COMBINING THE WINDINGS YOU CAN MAKE JUST ABOUT ANY TRANSISTOR POWER SUPPLY YOU WANT TO FIGURE THE D.C. OUTPUT UNDER LOAD, USING A BRIDGE RECTIFIER, MULTIPLY AC VOLTAGE BY 1.1 LESS ABOUT 1½ VOLTS FOR RECTIFIER DROP.

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72 SLIDE SWITCHES
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120 PCS.EA.(18)values LEADS CUT AND READY FOR INSERTION

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ELECTROLYTIC CAPACITORS
(4)EA 18 TYPES ECKA-72

TN. RES. ADD 6.75% TAX

FCKR-72 MINI-LYTIC KIT $6.85
72 radial electrolytics. price includes handy re-useable 18 section container with hinged lid. 4 ea. 18 types. NO LIMIT PER ORDER WHILE THEY LAST.(BUY SEVERAL)
ECKR-72

FUSES ORDER #	FUSES AMPS	FUSES VOLTS	FUSES BODY	FUSES REMARKS
FU-1	1½	125	3AG	SLO-BLO PIGTAIL
FU-10	2½	125	3AG	SLO-BLO PIGTAIL
FU-15	3½	125	3AG	SLO-BLO PIGTAIL
FU-2	3	250	3AG	SLO-BLO REG
FU-3	5	250	3AG	SLO-BLO REG
FU-24	7	125	3AG	SLO-BLO REG
FU-14	7½	250	3AG	SLO-BLO PIGTAIL
FU-17	7½	250	3AG	FAST BLO REG
FU-7	10	250	3AG	SLO-BLO REG
FU-27	12½	125	3AG	SLO BLO REG
FU-19	15	250	3AG	FAST BLO REG
FU-28	17	125	3AG	FAST BLO
FU-20001	25	250	3AG	FAST BLO
FU-11	7	125	3AG	FAST BLO
FU-26	20	125	3AG	FAST BLOW

SMALL CASE 1 x 20 MM FUSES
YOUR CHOICE (3) PER TYPE FOR $1.40
YOUR CHOICE (100) PER TYPE FOR$19.00
YOUR CHOICE 100 ASSORTED FOR$23.00

INDEX #	AMPS	BODY
FU-9	1A	SFZ20MM
FU-18	2½	
FU-42	3½	TIME LAG
FU-12	7½	SFZ20 MM
FU-5		SFZ20 MM
FU-29	25	SFZ20 MM
FU-23	1A	SFZ20 MM
FU-30	2½	SFZ20 MM
FU-33	6½	TIME LAG
FU-44	4	SFZ20 MM

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180

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ramsey the first name in Counters !

9 DIGITS 600 MHz $129.95 WIRED

PRICES

CT-90 wired, 1 year warranty	$129.95
CT-90 Kit, 90 day parts warranty	109.95
AC-1 AC adapter	3.95
BP-1 Nicad pack +AC Adapter/Charger	12.95
OV-1, Micro-power Oven time base	49.95
External time base input	14.95

The CT-90 is the most versatile, feature packed counter available for less than $300.00! Advanced design features include; three selectable gate times, nine digits, gate indicator and a unique display hold function which holds the displayed count after the input signal is removed! Also, a 10mHz TCXO time base is used which enables easy zero beat calibration checks against WWV. Optionally; an internal nicad battery pack, external time base input and Micro-power high stability crystal oven time base are available. The CT-90, performance you can count on!

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 10 MV to 150 MHz Less than 50 MV to 500 MHz
Resolution:	0.1 Hz (10 MHz range) 1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	9 digits 0.4" LED
Time base:	Standard-10.000 mHz, 1.0 ppm 20-40°C. Optional Micro-power oven-0.1 ppm 20-40°C
Power:	8-15 VAC @ 250 ma

7 DIGITS 525 MHz $99.95 WIRED

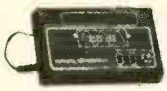
SPECIFICATIONS:

Range:	20 Hz to 525 MHz
Sensitivity:	Less than 50 MV to 150 MHz Less than 150 MV to 500 MHz
Resolution:	1.0 Hz (5 MHz range) 10.0 Hz (50 MHz range) 100.0 Hz (500 MHz range)
Display:	7 digits 0.4" LED
Time base:	1.0 ppm TCXO 20-40°C
Power:	12 VAC @ 250 ma

The CT-70 breaks the price barrier on lab quality frequency counters. Deluxe features such as; three frequency ranges - each with pre-amplification, dual selectable gate times, and gate activity indication make measurements a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1.0 ppm accuracy - that's .0001%! The CT-70 is the answer to all your measurement needs, in the field, lab or ham shack.

PRICES:

CT-70 wired, 1 year warranty	$99.95
CT-70 Kit, 90 day parts warranty	84.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC adapter/charger	12.95



7 DIGITS 500 MHz $79.95 WIRED

PRICES:

MINI-100 wired, 1 year warranty	$79.95
AC-Z Ac adapter for MINI-100	3.95
BP-Z Nicad pack and AC adapter/charger	12.95

Here's a handy, general purpose counter that provides most counter functions at an unbelievable price. The MINI-100 doesn't have the full frequency range or input impedance qualities found in higher price units, but for basic RF signal measurements, it can't be beat! Accurate measurements can be made from 1 MHz all the way up to 500 MHz with excellent sensitivity throughout the range, and the two gate times let you select the resolution desired. Add the nicad pack option and the MINI-100 makes an ideal addition to your tool box for "in-the-field" frequency checks and repairs.

SPECIFICATIONS:

Range:	1 MHz to 500 MHz
Sensitivity:	Less than 25 MV
Resolution:	100 Hz (slow gate) 1.0 KHz (fast gate)
Display:	7 digits, 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	5 VDC @ 200 ma

8 DIGITS 600 MHz $159.95 WIRED

NEW READ RECEIVER FREQUENCY

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double-duty!

PRICES:

CT-50 wired, 1 year warranty	$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95

DIGITAL MULTIMETER $99.95 WIRED

PRICES:

DM-700 wired, 1 year warranty	$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack +AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include; 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts:	100 uV to 1 KV, 5 ranges
DC/AC current	0.1 uA to 2.0 Amps, 5 ranges
Resistance:	0.1 ohms to 20 Megohms, 6 ranges
Input impedance:	10 Megohms, DC/AC volts
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells

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For high resolution audio measurements, multiplies UP in frequency.

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

$29.95 Kit $39.95 Wired

ACCESSORIES

Telescopic whip antenna - BNC plug	$ 7.95
High impedance probe, light loading	15.95
Low pass probe, for audio measurements	15.95
Direct probe, general purpose usage	12.95
Tilt bail, for CT 70, 90, MINI-100	3.95
Color burst calibration unit, calibrates counter against color TV signal	14.95

COUNTER PREAMP

For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer-included.

- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop

$34.95 Kit $44.95 Wired

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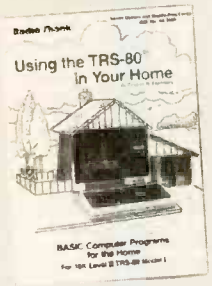

A B

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14.95

Indicates "opens", "shorts" and current gain in small-signal and power types, PNP and NPN. In or out of circuit. Requires "AA" battery.
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Computer Connectors

F G H

Solder 25 D-Submini Peripheral Connectors. Use optional hood when less than 25 conductors are required.
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G Female. 276-1548 . . . . . 3.99
H Hood. 276-1549 . . . . . 2.19

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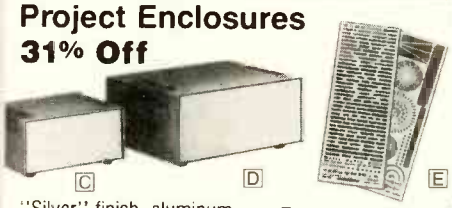
31% Off



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"Silver" finish, aluminum chassis, vented steel top.

Panel Lettering

C 2 1/2 x 5 1/16 x 4 5/16". Reg. 6.95.
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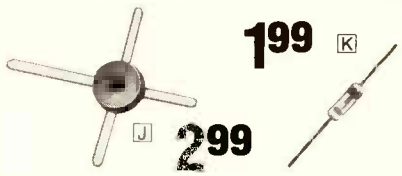
Quality Microwave Devices



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1.99

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J MRF-901. Low-noise NPN for small-signal RF use to beyond 2 GHz. Manufacturer's prime. 300 mW. **276-2044 . . . 2.99**

K H-P 5082-2835. Schottky barrier diodes. Ideal for UHF and SHF mixers. 1pF max. **276-1124 . . . . . Pkg. of 2/1.99**

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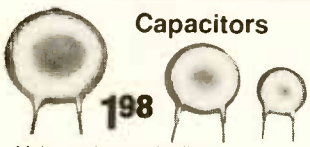

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Mylar and ceramic discs. Includes NPOs, Hi-Qs, N-750s.
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3.99

"C" frame. For robotics, model trains, opening valves, more. 31-ohm, 430 mA coil.
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Miniature 4PDT Relays For PC or Socket Mounts

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12VDC. Switches up to 4 circuits. Rated 3A at 125 VAC. 75 mA, 160-ohm coil.
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Relay Socket. Rated 3A. For above.
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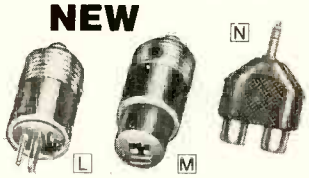
Audio Connectors For Stereo Hookup

NEW



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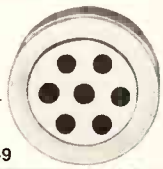
N Stereo Playback Y-Adapter. Adapts phono plugs to 1/8" mike jack. **274-369 . . . . . 1.99**

Crystal Mike Element

1.69



For projects that call for sound. High impedance. Perfect for replacement.
270-088 . . . . . 1.69

Axial-Lead RF Chokes

Low As **79¢**

For RF bypass, filtering and peaking.
10 µH. 1.5 amps. 1/4" dia. x 7/8" long.
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30-Gauge Kynar® Wire

50 Feet 2.39

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Blue	278-503	2.39
Yellow	278-504	2.39

Solid Buss Wire

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50 Feet

Makes ground wiring easy. For Perf-Board and PC projects. Pretinned 24-ga. copper. **278-1341 . . . . . 1.49**

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Just 11/32 x 3/8 x 1/4". Contacts: 1 amp at 125VAC. 55-ohm, 90-mA coil. .100" centers. **275-240 . . . . . 2.49**

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For digital or low-current use. Mounts in 16-pin DIP socket or on PC board.
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40 ft. of 22-ga., 75 ft. of 26-ga., 200 ft. of 30 ga. Ideal for winding coils.
278-1345 . . . . 3 Spools/Sale 3.99

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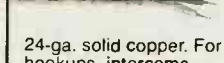

2.39 Each

24-ga. solid copper. For low-voltage hookups, intercoms.
2-Conductor. 35' 278-755 . . . 2.39
4-Conductor. 25' 278-757 . . . 2.39

Fast PIN Photodiode

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TIL413. High linearity. PRV: 30. Diss: 150 mW. Perfect for IR communications, even music. **276-144 . . 99¢**

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2102-1	1024 x 1	(450ns)	.89
2102L-4	1024 x 1	(450ns) (LP)	1.29
2102L-2	1024 x 1	(250ns) (LP)	1.69
2111	256 x 4	(450ns)	2.99
2112	256 x 4	(450ns)	2.99
2114	1024 x 4	(450ns)	8/14.95
2114L-4	1024 x 4	(450ns) (LP)	8/15.25
2114L-3	1024 x 4	(300ns) (LP)	8/15.45
2114L-2	1024 x 4	(200ns) (LP)	8/15.95
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TMS4044-3	4096 x 1	(300ns)	3.99
TMS4044-2	4096 x 1	(200ns)	4.49
MK4118	1024 x 8	(250ns)	9.95
TMM2016-200	2048 x 8	(200ns)	4.15
TMM2016-150	2048 x 8	(150ns)	4.95
TMM2016-100	2048 x 8	(100ns)	6.15
HM6116-4	2048 x 8	(200ns) (cmos)	4.95
HM6116-3	2048 x 8	(150ns) (cmos)	5.95
HM6116-2	2048 x 8	(120ns) (cmos)	8.95
HM6116LP-4	2048 x 8	(200ns) (cmos)(LP)	6.95
HM6116LP-3	2048 x 8	(150ns) (cmos)(LP)	8.95
HM6116LP-2	2048 x 8	(120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8	(300ns) (Qstat)	34.95

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1	(250ns)	1.99
UPD411	4096 x 1	(300ns)	3.00
MM5280	4096 x 1	(300ns)	3.00
MK4108	8192 x 1	(200ns)	1.95
MM5298	8192 x 1	(250ns)	1.85
4116-300	16384 x 1	(300ns)	8/11.75
4116-250	16384 x 1	(250ns)	8/11.95
4116-200	16384 x 1	(200ns)	8/13.95
4116-150	16384 x 1	(150ns)	8/15.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
4164-200	65536 x 1	(200ns) (5v)	6.25
4164-150	65536 x 1	(150ns) (5v)	7.25

5V = single 5 volt supply

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1702	256 x 8	(1us)	4.50
2708	1024 x 8	(450ns)	3.95
2758	1024 x 8	(450ns)(5v)	5.95
2716	2048 x 8	(450ns)(5v)	3.95
2716-1	2048 x 8	(350ns)(5v)	6.25
TMS2516	2048 x 8	(450ns)(5v)	5.50
TMS2716	2048 x 8	(450ns)	7.95
TMS2532	4096 x 8	(450ns)(5v)	7.95
2732	4096 x 8	(450ns)(5v)	4.95
2732-250	4096 x 8	(250ns)(5v)	12.95
2732-200	4096 x 8	(200ns)(5v)	16.95
2764	8192 x 8	(450ns)(5v)	16.95
2764-250	8192 x 8	(250ns)(5v)	18.95
2764-200	8192 x 8	(200ns)(5v)	24.95
TMS2564	8192 x 8	(450ns)(5v)	24.95
MC68764	8192 x 8	(450ns)(5v)(24 pin)	39.95

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320	X	32	15,000	595.00

DISC CONTROLLERS

1771	16.95
1791	29.95
1793	38.95
1795	54.95
1797	54.95
6843	34.95
8272	39.95
UPD765	39.95
1691	18.95
2143	18.95

INTERFACE

8T26	1.69
8T28	2.49
8T95	.99
8T96	.99
8T97	.99
8T98	.99
DM8131	2.95
DP8304	2.29
DS8835	1.99
DS8836	.99

MISC.

3242	7.95
3341	4.95
MC3470	4.95
MC3480	9.00
11C90	13.95
95H90	7.95
2513-001 UP	9.95
2513-002 LOW	9.95

SOUND CHIPS

76477	3.95
76489	8.95
AY3-8910	12.95
MC3340	1.49

CRT CONTROLLERS

6845	14.95
68B45	35.95
HD46505SP	15.95
6847	12.25
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	39.95
CRT5037	49.95
TMS9918A	39.95
DP8350	49.95

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MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
AY3-1015	6.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
TMS6011	5.95
IM6402	7.95
IM6403	8.95
INS8250	14.95

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AY5-2376	11.95
AY5-3600	11.95

CLOCK CIRCUITS

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MM5369	3.95
MM5375	4.95
MM58167	8.95
MM58174	11.95
MSM5832	6.95

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2.5 Mhz

Z80-CPU	3.95
Z80-CTC	5.95
Z80-DART	15.25
Z80-DMA	17.50
Z80-PIO	5.75
Z80-SIO/0	18.50
Z80-SIO/1	18.50
Z80-SIO/2	18.50
Z80-SIO/9	16.95

4.0 Mhz

Z80A-CPU	6.00
Z80A-CTC	8.65
Z80A-DART	18.75
Z80A-DMA	27.50
Z80A-PIO	6.00
Z80A-SIO/0	22.50
Z80A-SIO/1	22.50
Z80A-SIO/2	22.50
Z80A-SIO/9	19.95

6.0 Mhz

Z80B-CPU	17.95
Z80B-CTC	15.50
Z80B-PIO	15.50

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Z6132	34.95
Z8671	39.95

CRYSTALS

32.768 khz	1.95
1.0 mhz	4.95
1.8432	4.95
2.0	3.95
2.097152	3.95
2.4576	3.95
3.2768	3.95
3.579535	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.738635	3.95
14.31818	3.95
15.0	3.95
16.0	3.95
17.430	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

DATA ACQUISITION

ADC0800	15.55
ADC0804	3.49
ADC0809	4.49
ADC0817	9.95
DAC0800	4.95
DAC0806	1.95
DAC0808	2.95
DAC1020	8.25
DAC1022	5.95
MC1408L6	1.95
MC1408L8	2.95

8000

8035	5.95
8039	6.95
INS-8060	17.95
INS-8073	24.95
8080	3.95
8085	5.95
8085A-2	11.95
8086	29.95
8087	CALL
8088	39.95
8089	89.95
8155	7.95
8156	8.95
8185	29.95
8185-2	39.95
8741	39.95
8748	29.95
8755	32.00

8200

8202	29.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	39.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

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MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

INTERSIL

ICL7103	9.50
ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

6800

68000	59.95
6800	4.95
6802	7.95
6808	13.90
6809E	19.95
6809	12.95
6810	2.95
6820	4.95
6821	3.25
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	12.25
6850	3.45
6852	5.75
6860	9.95
6862	11.95
6875	6.95
6880	2.25
6883	24.95
68047	24.95
68488	19.95
6800 = 1MHZ	
68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	7.95
68B21	12.95
68B45	35.95
68B50	12.95
68B00 = 2 MHZ	

6500

1 MHZ	
6502	5.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	8.75
6532	11.25
6545	22.50
6551	11.85
2 MHZ	
6502A	9.95
6522A	11.70
6532A	12.40
6545A	28.50
6551A	12.95
3 MHZ	
6502B	14.95

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XR 2206	3.75
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9334	2.50
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74LS00	.24	74LS86	.39	74LS169	1.75	74LS323	3.50
74LS01	.25	74LS90	.55	74LS170	1.49	74LS324	1.75
74LS02	.25	74LS91	.89	74LS173	.69	74LS352	1.29
74LS03	.25	74LS92	.55	74LS174	.55	74LS353	1.29
74LS04	.24	74LS93	.55	74LS175	.55	74LS363	1.35
74LS05	.25	74LS95	.75	74LS181	2.15	74LS364	1.95
74LS08	.28	74LS96	.89	74LS189	8.95	74LS365	.49
74LS09	.29	74LS107	.39	74LS190	.89	74LS366	.49
74LS10	.25	74LS109	.39	74LS191	.89	74LS367	.45
74LS11	.35	74LS112	.39	74LS192	.79	74LS368	.45
74LS12	.35	74LS113	.39	74LS193	.79	74LS373	.99
74LS13	.45	74LS114	.39	74LS194	.69	74LS374	.99
74LS14	.59	74LS122	.45	74LS195	.69	74LS377	1.39
74LS15	.35	74LS123	.79	74LS196	.79	74LS378	1.18
74LS20	.25	74LS124	2.90	74LS197	.79	74LS379	1.35
74LS21	.29	74LS125	.49	74LS221	.89	74LS385	1.90
74LS22	.25	74LS126	.49	74LS240	.95	74LS386	.45
74LS26	.29	74LS132	.59	74LS241	.99	74LS390	1.19
74LS27	.29	74LS133	.59	74LS242	.99	74LS393	1.19
74LS28	.35	74LS136	.39	74LS243	.99	74LS395	1.19
74LS30	.25	74LS137	.99	74LS244	.99	74LS399	1.49
74LS32	.29	74LS138	.55	74LS245	1.49	74LS424	2.95
74LS33	.55	74LS139	.55	74LS247	.75	74LS447	.37
74LS37	.35	74LS145	1.20	74LS248	.99	74LS490	1.95
74LS38	.35	74LS147	2.49	74LS249	.99	74LS624	3.99
74LS40	.25	74LS148	1.35	74LS251	.59	74LS668	1.69
74LS42	.49	74LS151	.55	74LS253	.59	74LS669	1.89
74LS47	.75	74LS153	.55	74LS257	.59	74LS670	1.49
74LS48	.75	74LS154	1.90	74LS258	.59	74LS674	3.65
74LS49	.75	74LS155	.69	74LS259	2.75	74LS682	3.20
74LS51	.25	74LS156	.69	74LS260	.59	74LS683	3.20
74LS54	.29	74LS157	.65	74LS266	.55	74LS684	3.20
74LS55	.29	74LS158	.59	74LS273	1.49	74LS685	3.20
74LS63	1.25	74LS160	.69	74LS275	3.35	74LS688	2.40
74LS73	.39	74LS161	.65	74LS279	.49	74LS689	3.20
74LS74	.35	74LS162	.69	74LS280	1.98	74LS783	24.95
74LS75	.39	74LS163	.65	74LS283	.69	81LS95	1.49
74LS76	.39	74LS164	.69	74LS290	.89	81LS96	1.49
74LS78	.49	74LS165	.95	74LS293	.89	81LS97	1.49
74LS83	.60	74LS166	1.95	74LS295	.99	81LS98	1.49
74LS85	.69	74LS168	1.75	74LS298	.89	25LS2521	2.80
				74LS299	1.75	25LS2569	3.25

IC SOCKETS

	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
28 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
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		
16 pin ZIF	6.75	call
24 pin ZIF	9.95	call
28 pin ZIF	10.95	call
ZIF = TEXTOOL (Zero Insertion Force)		

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RS232 MALE	2.95
RS232 FEMALE	3.50
RS232 FEMALE RIGHT ANGLE	5.25
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S-100 ST	3.95
S-100 WW	4.95

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4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

7400

7400	.19	74132	.45
7401	.19	74136	.50
7402	.19	74141	.65
7403	.19	74142	2.95
7404	.19	74143	2.95
7405	.25	74145	.60
7406	.29	74147	1.75
7407	.29	74148	1.20
7408	.24	74150	1.35
7409	.19	74151	.55
7410	.19	74152	.65
7411	.25	74153	.55
7412	.30	74154	1.25
7413	.35	74155	.75
7414	.49	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7422	.35	74162	.85
7423	.29	74163	.69
7425	.29	74164	.85
7426	.29	74165	.85
7427	.29	74166	1.00
7428	.45	74167	2.95
7430	.19	74170	1.65
7432	.29	74172	5.95
7433	.45	74173	.75
7437	.29	74174	.89
7438	.29	74175	.89
7440	.19	74176	.89
7442	.49	74177	.75
7443	.65	74178	1.15
7444	.69	74179	1.75
7445	.69	74180	.75
7446	.69	74181	2.25
7447	.69	74182	.75
7448	.69	74184	2.00
7450	.19	74185	2.00
7451	.23	74186	18.50
7453	.23	74190	1.15
7454	.23	74191	1.15
7460	.23	74192	.79
7470	.35	74193	.79
7472	.29	74194	.85
7473	.34	74195	.85
7474	.33	74196	.79
7475	.45	74197	.75
7476	.35	74198	1.35
7480	.59	74199	1.35
7481	1.10	74221	1.35
7482	.95	74246	1.35
7483	.50	74247	1.25
7485	.59	74248	1.85
7486	.35	74249	1.95
7489	2.15	74251	.75
7490	.35	74259	2.25
7491	.40	74265	1.35
7492	.50	74273	1.95
7493	.35	74276	1.25
7494	.65	74279	.75
7495	.55	74283	2.00
7496	.70	74284	3.75
7497	2.75	74285	3.75
74100	1.75	74290	.95
74107	.30	74293	.75
74109	.45	74298	.85
74110	.45	74351	2.25
74111	.55	74365	.65
74116	1.55	74366	.65
74120	1.20	74367	.65
74121	.29	74368	.65
74122	.45	74376	2.20
74123	.49	74390	1.75
74125	.45	74393	1.35
74126	.45	74425	3.15
74128	.55	74426	.85
		74490	2.55

CMOS

4000	.29	4527	1.95
4001	.25	4528	1.19
4002	.25	4531	.95
4006	.89	4532	1.95
4007	.29	4538	1.95
4008	.95	4539	1.95
4009	.39	4541	2.64
4010	.45	4543	1.19
4011	.25	4553	5.79
4012	.25	4555	.95
4013	.38	4556	.95
4014	.79	4581	1.95
4015	.39	4582	1.95
4016	.39	4584	.75
4017	.69	4585	.75
4018	.79	4702	12.95
4019	.39	74C00	.35
4020	.75	74C02	.35
4021	.79	74C04	.35
4022	.79	74C08	.35
4023	.29	74C10	.35
4024	.65	74C14	.59
4025	.29	74C20	.35
4026	1.65	74C30	.35
4027	.45	74C32	.39
4028	.69	74C42	1.29
4029	.79	74C48	1.99
4030	.39	74C73	.65
4034	1.95	74C74	.65
4035	.85	74C76	.80
4040	.75	74C83	1.95
4041	.75	74C85	1.95
4042	.69	74C86	.39
4043	.85	74C89	4.50
4044	.79	74C90	1.19
4046	.85	74C93	1.75
4047	.95	74C95	.99
4049	.35	74C107	.89
4050	.35	74C150	5.75
4051	.79	74C151	2.25
4053	.79	74C154	3.25
4060	.89	74C157	1.75
4066	.39	74C160	1.19
4068	.39	74C161	1.19
4069	.29	74C162	1.19
4070	.35	74C163	1.19
4071	.29	74C164	1.39
4072	.29	74C165	2.00
4073	.29	74C173	.79
4075	.29	74C174	1.19
4076	.79	74C175	1.19
4078	.29	74C192	1.49
4081	.29	74C193	1.49
4082	.29	74C195	1.39
4085	.95	74C200	5.75
4086	.95	74C221	1.75
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
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74S65	.40	74S253	.95
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2N2907	PNP SWITCH	TO-18	.25	50/10.99
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3055T	NPN POWER	TO-220	.69	10/5.99
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LM337T	1.95	NE555	.34	LM1414	1.59	LM13080	1.29
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LM339	.99	NE558	1.50	LM1488	.69	LM13700	1.49
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H = TO-5 CAN T = TO-220 K = TO-3

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75189	1.25	75493	.89
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TL083	1.19	LF356	1.10
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78L15	.69	79L15	.79
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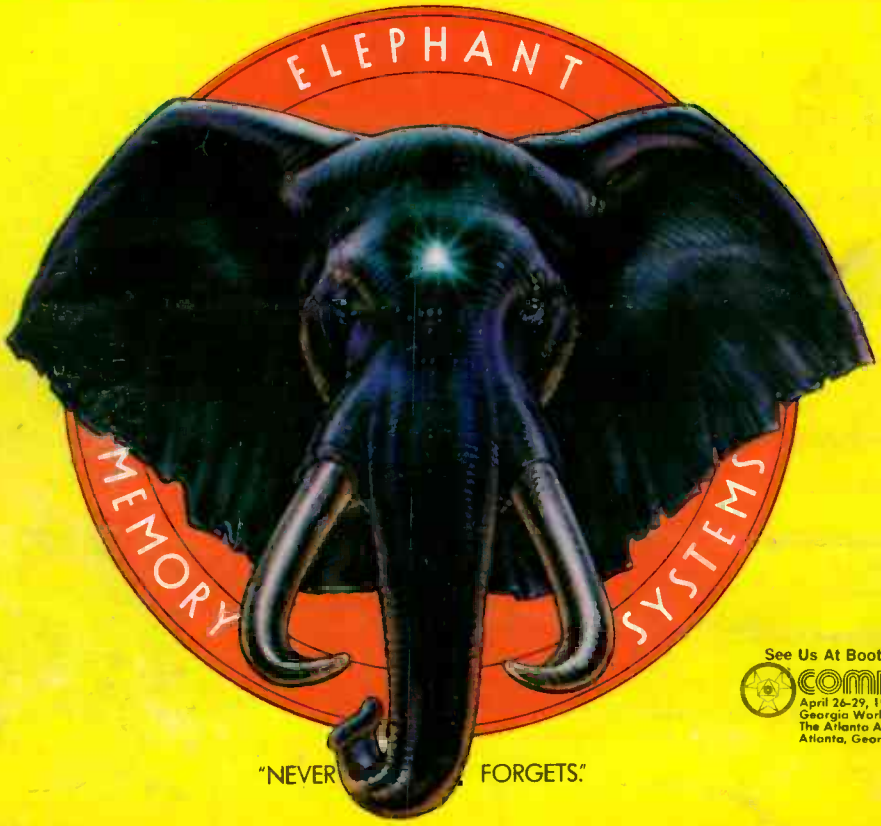

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