Radio-Electronics

$1.25 OCT. 1981

THIS MONTH 146 PAGES

The long awaited flat-screen
POCKET TELEVISION

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NEW PRODUCT

Fresh Air Bubble

Surround your body or your work place with ion-controlled fresh air in America's first bipolar electrostatic home precipitator.

The unit measures only 2" x 4" x 7" and its black appearance will fit into most decor.

There's a danger. And this invisible menace will affect nearly everybody reading this ad.

The danger is pollution—but not the ordinary kind. In fact, ten years ago, we didn't have this new kind of pollution. Let us explain.

Ten years ago, cars didn't have catalytic converters. Today, these catalytic converters "grind up" the car exhaust into particles so small they form micron soot, and micron soot is so fine, it can be easily absorbed into your lungs. Even the EPA has stated, "Because it is so fine, such soot particles stay longer and cause more damage in the respiratory tract."

Ten years ago, homes were able to "breathe" or exchange air between the outdoors and indoors four or five times a day. Today, with our well-insulated energy-conscious buildings our homes literally create and trap pollution that we breathe unwittingly.

OTHER PROBLEMS

There are other problems too. Add the daily soot, dust, smoke and other impurities in the air and you've created pollution problems even worse than they were ten years ago—so bad in fact that environmental groups are especially concerned over this new "time bomb" lurking in our environment.

But American ingenuity hasn't been sitting still. A rash of small devices containing charcoal filters with fans and selling for around $30 have literally flooded the market. The problem is that these devices only remove particles 5 microns or larger. Today's micron soot is one micron or smaller. Cigarette smoke for example is 2 to 3 microns or smaller.

70,000 UNITS SOLD

In 1978, JS&A introduced the negative ion generator in a national advertising campaign and sold over 70,000 units. It was a device that cleaned the air by electrostatically removing particles even smaller than one micron. Hospital burn centers soon began using commercial versions of the negative ion generator.

Removing sub micron particles from the air was very important, but there was also a surprising second benefit. The unit added negatively charged ions to the air.

We've all felt the effects of negative ions after a thunderstorm. When you take a deep breath, the air smells good and you feel good.

The opposite is true of positive ions which can be found in polluted environments, air conditioned office buildings and in automobiles. Many scientists believe that positive ions make you feel moody, depressed, irritable and restless. A negative ion generator cancels out the positive ions and fills the air with negative ions.

AN EXPERIMENT

When you blow smoke into an inverted glass bowl and put it over an ion generator, the smoke immediately vanishes. Or if you place the ion generator in an odor-filled room, the room soon smells fresh.

It was these experiments that really convinced the public that the JS&A ion generator was a valuable new home appliance. Soon the market was flooded with competitive ion generators. Many were not as efficient as JS&A's first model. Some emitted very few ions and one actually emitted dangerous levels of ozone. JS&A conducted independent laboratory tests and publicized the results which showed that JS&A's unit was indeed the best.

You can easily remove and wash or simply replace the ion filter after it collects the soot. Extra filters are only $1.00 each and should be replaced or washed once every two months.

That's the history. But like any new technology, there's sure to be improvements. The first ion generator produced negatively charged ions which attached themselves to the pollutants and then fell to the ground. You ended up with clean, fresh air but also dirty rugs and walls.

In winter, the units created electrostatic discharges which can be uncomfortable when touching a door knob or someone else.

CONTROLLED ION ENVIRONMENT

So American scientists created an ion generator using a bipolar emitter which emits a balanced amount of negative ions to create a controlled ion environment. One emitter produces negative ions and the other controls and shapes those ions to create an ion bubble.

The end result is a unit which leaves just the right amount of negative ions in a large room, attracts the pollution particles and deposits them on a washable collector plate while keeping your floors and walls free of dirt. You're actually placed in a fresh air bubble while you work, sleep or relax and with no uncomfortable electrostatic charge.

I urge you to try the JS&A ion generator in your home or office for 30 days. Put one on your desk or in any smoke-filled room. Notice the refreshing difference in your work environment. Take it home and plug it in next to your bed. Chances are, you'll want to buy another one before our 30-day trial period ends.

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But if you are not pleased with your unit for any reason whatsoever, please return it within 30 days and we'll send you a prompt and courteous refund including your $4.00 postage and handling. JS&A is America's premiere electronics company—a substantial organization that guarantees your satisfaction.

To order, send your check for **$89.95** plus $4.00 postage and handling (Illinois residents please add 6% sales tax) or credit card buyers may call our toll-free service line below.

We'll send you the JS&A ion generator complete with instructions and a 90-day limited warranty. Then plug it in and leave it run all day and night. The cost to run the unit is only a few cents per day.

The era of the ion generator as a standard household appliance is here. Order the newest and best unit available at no obligation, today.

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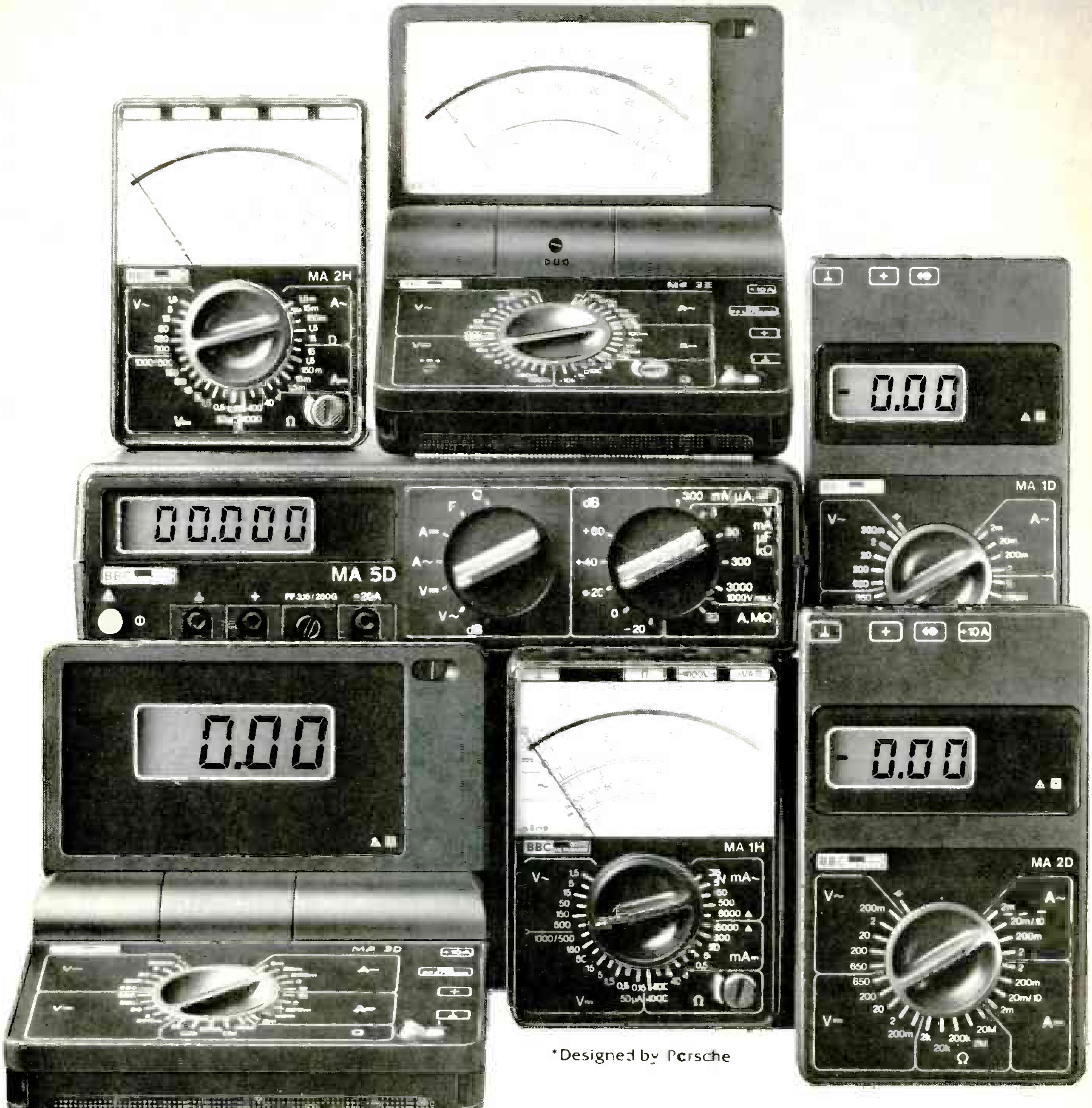

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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

OCTOBER 1981 Vol. 52 No. 10

ON THE COVER

Flat-screen displays to make truly-portable, or "skinny" large-screen, TV's have been long awaited. Now, not one, but *two*, totally different means for achieving that goal have been demonstrated in working prototypes. The story of how those displays function starts on page 39.

SPECIAL COMPUTER SECTION explains what to look for in setting up a system for home or business use. The section begins on page 51.

MANY FINE RECORDINGS have been made without using noise-reduction techniques. A dynamic noise-reduction system can improve their sound. Find out how the process works starting on page 90.

Due to lack of space in this issue, Part 3 of the Programma-2 RF generator project will appear next month. We apologize for any inconvenience that may cause.

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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

VCR SALES ZOOM

No matter what happens to videodiscs, home videcassette recorders now appear to be firmly entrenched as a major consumer electronic product. Japan's exports of VCR's now are greater than her color TV exports in dollar volume, and U.S. sales this year could reach 1,500,000, nearly double the volume of last year. Eleven Japanese VCR manufacturers produced 4,400,000 VCR's last year, and it's estimated that 8,400,000 will be made this year, perhaps 12,000,000 in 1982. In the U.S., new brand names are joining the VCR parade—including Fisher, Kenwood, Sansui, Canon and Grundig (the last with the first NTSC version of Europe's Video 2000 format).

LOOKING AT VIDEODISCS

As the dust begins to settle, it's becoming increasingly obvious that the two different videodisc systems currently on the market—LaserVision (LV) and RCA's Capacitance Electronic Disc (CED)—aren't directly competitive, and the question "Which will win?" may not be appropriate. Returns aren't yet in on the more important question of whether either or both systems will survive.

The LV optical system, with players currently being marketed by Pioneer and Magnavox, is an extremely sophisticated technological triumph which is at its best in the utilization of special interactive discs, such as the "First National Kidisc." So far, greatest successes in selling this system have been achieved by video dealers and technically proficient audio retailers. Its buyers have been largely those interested in advanced technology, plus firms and institutions seeking to harness the system's significant applications to teaching and training. Research has shown that a substantial majority of consumers who buy LV players already own videocassette recorders.

The CED system, on the other hand, hasn't exactly been a dream-come-true for video dealers, many of whom are using it to attract customers, and then selling them "up" to VCR's. Who has been successful with CED? Well, chains such as J. C. Penney, for example. And the successes have come largely in areas without cable TV, or without access to a multiplicity of TV channels—and to people who don't own VCR's.

TV STEP-UPS

Did you ever wonder what the various "step-up" features really add to the cost of a television set? Well, apparently so did the International Trade Commission, which surveyed a cross-section of dealers. In color, it found that a single-knob 12-20-channel electronic tuner increased the wholesale price (the price the dealer pays to the manufacturer) $15-$20 over that of a mechanically tuned set. Pushbutton tuning (12-20 channels) was a $20-$33 step-up, and a single-knob 82-channel tuner cost $25-$40 more than a mechanical tuner. Random-access keypad tuning added $40-$60. Remote control with 12-20-channel scan (sequential) tuning commanded a $50-$65 premium, 82-channel scanning cost $60-$70 and keypad tuning brought in an additional $80-$100. Automatic color circuitry increased the wholesale price $5-$20; the combination of automatic color and a room-light sensor cost $15-$20, and VIR added $10-$20. In both color and monochrome, woodgrain finish cost $5-$10 more than a plain cabinet, and an AC-DC monochrome set cost $2-$6 more than AC-only. R-E

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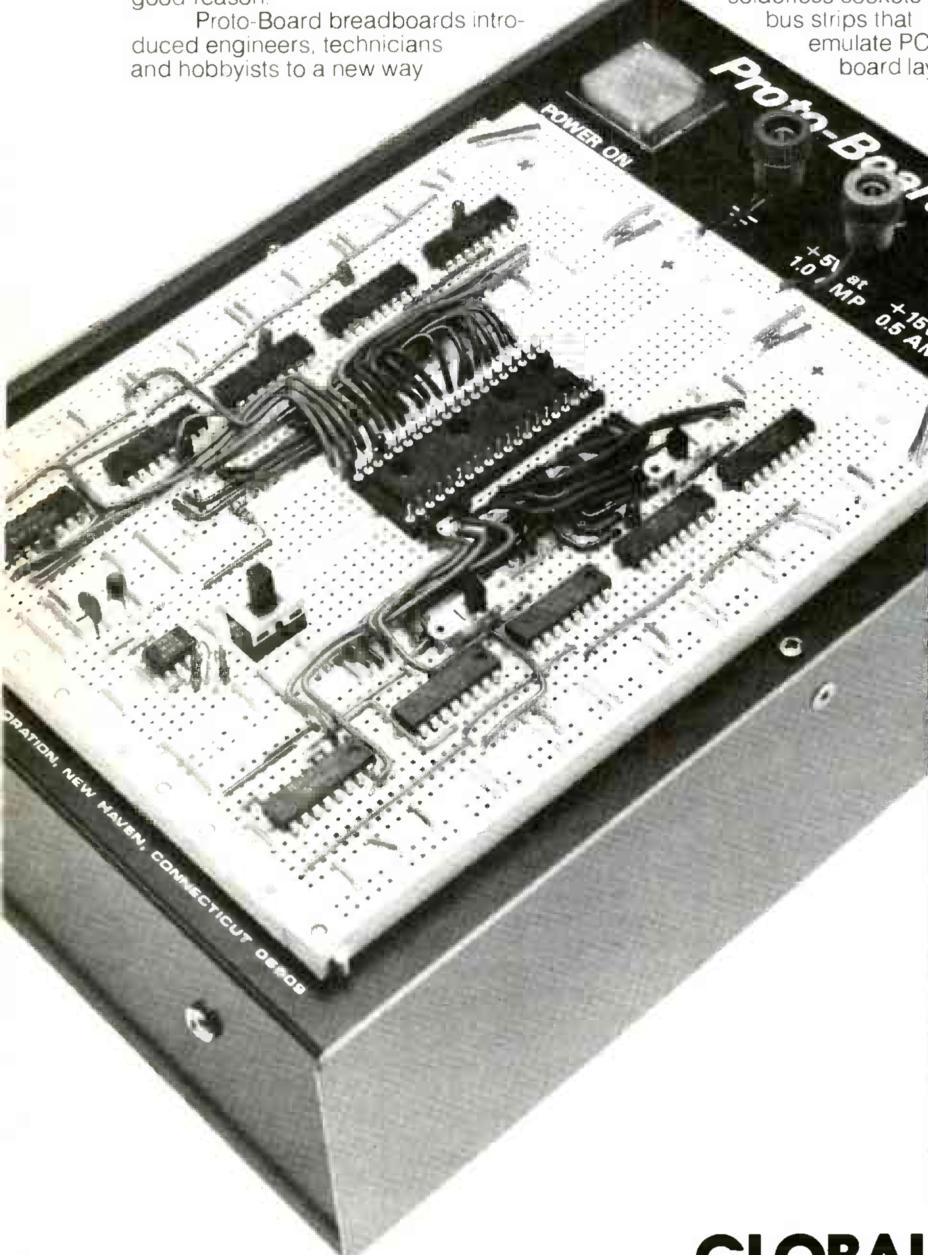

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WHAT'S NEWS

Fire alarm for the deaf uses vibrator pager unit

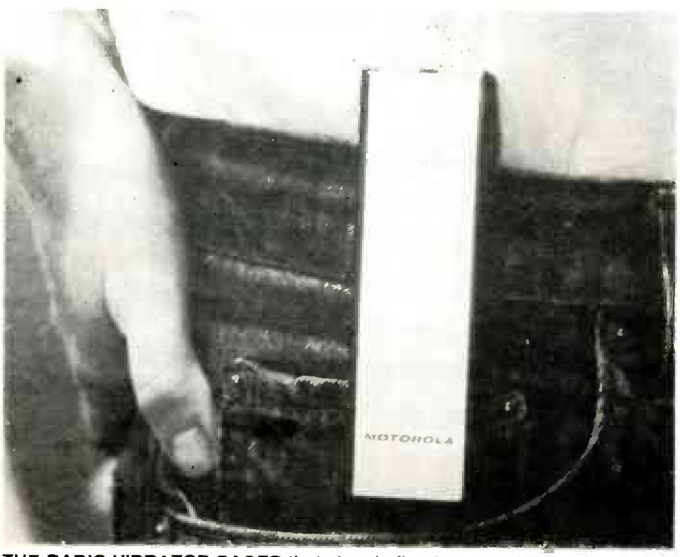
Winthrop College, of Rock Hill, SC has won a $5,000 award for innovative cost reduction with a design for a fire alarm for the deaf or the hard-of-hearing. The prize was won in a field of 160 entrants in a competition open to the nation's 3,100 institutions of higher education.

The fire-alarm system for the hard-of-hearing that is most commonly used by institutions uses flashing signal lights. The Winthrop system uses individual paging devices, which hard-of-hearing students, faculty members and staff members wear when they are on the college grounds. Radio-operated like the beeping pagers worn by doctors and other professionals, they vibrate for 30 seconds when any fire alarm on the campus sounds.

No new technology was required for the vibrator-alarm, says Winthrop's construction engineer Steve Warren. "We didn't invent anything—all the components were standard communications equipment."

Winthrop would have spent at least $147,000 for a flashing-light system. More than 1,500 lights would have been needed to cover the college's 31 buildings satisfactorily. The cost of the vibrator-pager system will be about $7,000.

The $5,000 was a third-place award in the Cost-Reduction Incentive Awards Program competition sponsored by the National Association of College and University Business Officers and the U.S. Steel Foundation. The first prize was given for a new technique for repairing shower stalls in residence halls, and the second for a chemical waste exchange and filtration system.



THE RADIO VIBRATOR-PAGER that signals fire danger to hard-of-hearing or deaf persons on the Winthrop campus.

Florida tightens up on police-radar methods

Removing automatic locking devices on police-radar units is the most important recommendation of a five-man commission set up by the Florida legislature in 1980, to develop standards for police radar.

Locking units allow a police officer to set his radar at a critical speed while he concentrates on other duties. When a vehicle exceeding that speed approaches, an alarm sounds. The officer must then determine which of the oncoming vehicles has reflected the signal. Removing the automatic lock compels the officer to identify a suspected speeder visually, rather than guessing at which car triggered the signal.

The Florida radar commission further recommends reducing the radar-beam width to 12 degrees. Since identifying the target is possibly the trickiest problem in police-radar use, reducing the area from which the radar can pick up signals reduces the number of cars that can reflect a signal to it, and thus the probability of error.

Electromagnetic interference from a number of radio or electrical devices has been found to cause erroneous radar readings. To reduce interference, Florida will convert all its radar to the higher-frequency K-band.

At the time of writing, the new standards required approval from the Florida Department of Highway Safety and from Governor Bob Graham, which was expected without delay. Once in action, Florida's new standards will not only surpass those now in process at the federal level, but will probably set the groundwork for police-radar regulations enacted by other states in the near future.

Videodisc-based memories for future computers

Describing use in mini and super-mini computer systems as the "best defined" non-consumer application for videodisc, a British research organization predicts that some 3,000 videodisc units will be tied into minicomputer systems in Europe by 1983; by the end of the '80's, videodisc memories will be found in more than 10% of all minicomputer installations.

These predictions appear in a 242-page analysis by Frost & Sullivan, a London-based market research firm. Ultimately, F & S believes, an eraseable/writable disc will become available, with units having various performance capabilities for both record and playback. Those may include multiple-disc packs and juke-box type units with extended play capabilities.

"Optical memory is not expected to undermine the magnetic disc market," according to F & S, but rather will "partially replace" magnetic tape. "As much as 40% of the information stored on magnetic tape need never be erased, and could equally as well be stored on optical disc. Moreover, the disc has a ten-to-one advantage in storage density," the report notes.

Model contract clause would limit cable TV

The National Alliance of Television and Electronic Service Associates (NATESA) warns in a recent release that the coming of the satellite/earth station concept is broadcasting will make great changes in home TV. It could eliminate network broadcasting as we now know it, and could have powerful effects on the production, distribution, and retailing, as well as the servicing of receivers.

Assumptions that cable satellite earth-station systems will confine themselves to providing cable terminations and programs and not go into sales and servicing, are time bombs in franchises, says NATESA. It reprints what it calls a "model cable-TV franchise clause," that is used in a contract in Pinellas County, FL:

"The Company, any and all of its officers, agents and employees are specifically prohibited, directly or indirectly, from engaging in the sale, repair, service or leasing of television receivers, or television or radio parts except such parts and accessories required for cable connection, such as converters and connection plugs and accessories, individually or with any person, anywhere in______, whether for a fee or charge or not and whether in the performance of duties of Company or otherwise, including fee, commission, or benefit from any other person, firm or corporation. Company, any and all of its officers, agents, and employees shall not indicate and shall not recommend in any manner a specific brand of receiver or sales and/or service company, other than the transponder supplied by Company."

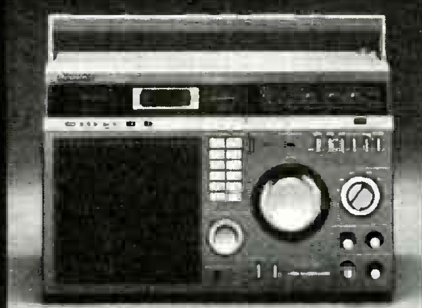
Compact disc digital audio in '82

At a recent demonstration of the new Sony-Philips Compact Disc (CD) Digital Audio System in New York City, Akio Morita, co-founder of Sony, and Frank Randall, vice chairman of North

continued on page 8

Introducing incredible tuning accuracy at an incredibly affordable price: The Command Series RF-3100 31-band AM/FM/SW receiver.* No other shortwave receiver brings in PLL quartz synthesized tuning and all-band digital readout for as low a price.† The tuner tracks and "locks" onto your signal, and the 5-digit display shows exactly what frequency you're on.

There are other ways the RF-3100 commands the airways: It can travel the full length of the shortwave band (that's 1.6 to 30 MHz). It eliminates interference when stations overlap by narrowing the broadcast band. It improves reception in strong signal areas with RF Gain Control. And the RF-3100 catches Morse communications accurately with BFO Pitch Control.



RF-6300 8-band AM/FM/SW

Want to bring in your favorite programs without lifting a finger? Then consider the Panasonic RF-6300 8-band AM/FM/SW receiver (1.6 to 30 MHz) has microcomputerized preset pushbutton tuning, for programming 12 different broadcasts, or the same broadcast 12 days in a row. Automatically. It even has a quartz alarm clock that turns the radio on and off to play your favorite broadcasts.

The Command Series RF-3100 and RF-6300. Two more ways to roam the globe at the speed of sound. Only from Panasonic.

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

†Based on a comparison of suggested retail prices.

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WHAT'S NEWS

continued from page 6

American Philips, jointly announced that they expected the CD sound-reproduction system would reach the market in the fall of 1982.

Last April, after studying the three leading systems, the Digital Audio Disc Standardization Conference recommended the CD format as the standard for aduio disc recording and reproduction.

In the Philips-Sony system, the sound from the microphone is sampled thousands of times a second, and the samples converted into binary 16-bit words by pulse-code modulation (PCM). Each word expresses the exact volume level of the sound at the instant of sampling. Those signals are recorded on the disc in the form of pits and flat places, representing binary "zeros" and "ones".

They are read in the player by a laser beam several times thinner than a human hair, at the rate of 4.3 million bits per second. A converter in the player itself changes the signals into analog form, for input into any conventional hi-fi system.

The disc is only 12 centimeters (4.7 in.) in diameter. It is made of metallized plastic, with a transparent plastic coating over the recording. This protects it from dust, scratches, accidents, and rough handling. The disc rotates counter-clockwise, and plays from the inside out. It maintains a constant velocity over its 2½ miles of track, varying from 500 rpm at the inside to 200 rpm at the outside of the disc. Tracking, rotation speeds, and decoding are all governed by information on the disc itself. That reduces wow and flutter to a point where they cannot be measured.

Right and left sound channels are encoded as separate information that cannot be mixed on the disc. Thus channel separation is 90 dB, as compared to a top of 35 dB for very good conventional equipment. The signal-to-noise ratio is also about 90 dB, considerably greater than in conventional audio equipment. The 90-dB dynamic range compares with 55 dB on the best long-playing records. Frequency response is flat from 20 to 20,000 Hz.

Each one-hour recording is made up of six billion bits. About 25% of them are used for audio; the rest contain control, error-checking, and other information. The storage capacity of a disc is over eight billion bits. That offers interesting possibilities to hi-fi designers. Already plans are under way to indicate number, length, titles, and even texts of songs with luminescent displays or TV monitors.

THE COMPACT DIGITAL DISC, as compared to a 12-inch L.P. Actual diameter of the disc is 4.7 inches (12 cm). Shown in the right foreground is the Philips player and in the left foreground is Sony's new player.

Inventor-scientist Busignies dies unexpectedly in France

Henri Busignies, chief scientist emeritus of the International Telephone and Telegraph Co. (ITT) died June 19 of a heart attack, in Antibes on the French Riviera. He was 76 years old, and had been connected with ITT since 1928, when he joined the ITT laboratory in Paris. During World War II he came to the United States, with plans of a partly developed invention that did much to end the German submarine menace.

Busignies first became interested in radio at age 14, in 1919. He obtained a degree in electrical engineering in 1926. During his senior year he obtained a patent for a radiocompass, and spent much of his later life in work on electronic navigation systems.

His high-frequency direction finder (HFDF, or "Huff-Duff") was one of the important inventions of World War II. German submarines were sweeping the seas of Allied shipping. To avoid detection, they recorded necessary communications with their base, surfaced momentarily and transmitted the compressed recordings in the form of high-speed "squirts," in which a whole message would be sent in less than a second. Existing direction finders could not detect such short transmissions. Busignies' "Huff-Duff" located the transmissions within microseconds after they started, and the Allies practically wiped out the German submarine fleet.

Work on the "Huff-Duff" was in progress when the Germans occupied Paris, and Busignies, with his plans and design data, was smuggled out of the country and to the United States, where he lived ever since. He became the leader in electronic navigation development, and was involved in such systems as VOR-DME (*V*HF *O*mnidirectional *R*ange-*D*istance *M*easuring *E*quipment), TACAN (*TAC*tical *A*ir *N*avigation) and VORTAC, a system using co-located VOR and TACAN. These systems were described in **Radio-Electronics** (February, 1951 and November, 1956) with the help of material supplied by ITT.

Dr. Busignies was the recipient of numerous international honors, including honorary degrees from the Newark College of Engineering and the Polytechnic Institute of New York; the Pioneer Award of the Aeronautical and Navigational group of the IEEE; the IEEE's David Sarnoff Award, and the Medal of the Industrial Research Institute. He was a Fellow of the IEEE and the Radio Club of America, and in 1971 received the Radio Club's highest honor, the Armstrong Medal.

New rear-projection TV works in bright light

A 50-inch Sylvania rear projection television system with improved image contrast in bright light has been introduced by North American Philips Consumer Electronics Corp. It uses the industry's first optical projection screeen based on the black matrix technology that is found in Sylvania Supersets.

THE 50-INCH SYLVANIA SUPERSCREEN television system uses a black matrix screen, which offers sharply improved contrast under bright l'ghting conditions.

The self-contained rear-screen projection system has three color-projection tubes, using new rare-earth phosphors. The black-matrix striping in the screen rejects ambient light, providing a high-contrast picture at high light levels. A 90-degree viewing range—double that of conventional projection models—permits viewing from either side.

The system also features a comb filter, infrared remote control, and favorite-station scan, which permits the viewer to scan quickly through the 20 channels programmed into the set. A microcomputer tuning system fine-tunes each channel and the receiver is cable-ready. **R-E**

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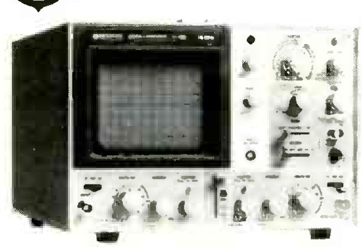

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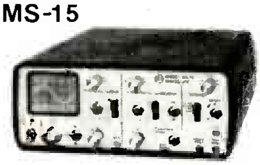
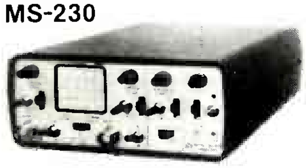


Single Trace 15MHz

MS-215

Dual Trace 15 MHz

MS-230



Dual Trace 30MHz

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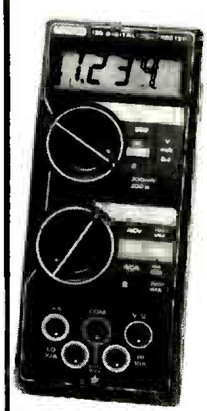

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AC VOLTAGE	200mV, 2V, 20V, 200V, 750V	1%
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AC CURRENT	2mA, 20mA, 200mA, 2000mA, 10A	3%
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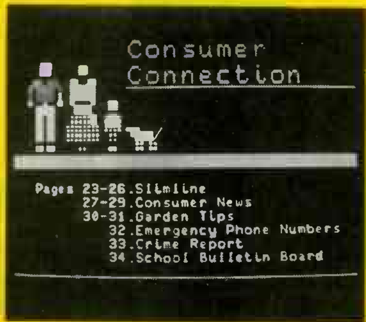
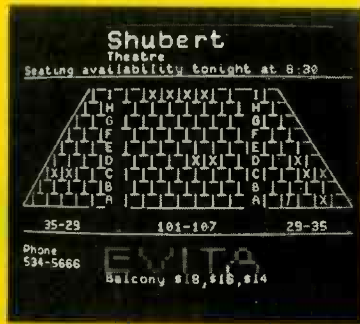
SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR





TELETEXT TESTS UNDERWAY

Teletext experiments are now in progress on TV stations in Chicago, Los Angeles, Washington, and San Francisco—and several more trials are due to get underway in the months ahead. The current market trials use each of the three major teletext technologies. And each of the tests is described as an experiment to find out what TV watchers will want to see in the way of electronic information transmitted into their homes via the vertical interval of a TV picture (left and center, above).

In Chicago, the "KeyFax" test is being transmitted on WFLD-TV Channel 32 using Britain's Teletext technology, adapted by Zenith. Field Electronic Publishing, a subsidiary of the company which publishes the Sun Times newspaper and owns WFLD, is running the test on lines 13-16 of the VBI, transmitting a magazine of about 100 pages of news, sports, and business information plus an inventive collection of puzzles and games. In Washington DC, WETA-TV Channel 26, a public-television station, is transmitting about 50 pages of news, community bulletin board, and public service information. The station is using Canadian Telidon technology, encoding data within lines 15-18 of the vertical interval. The Los Angeles test got under way last Spring aboard KNXT-TV Channel 2 (CBS-owned station) and public TV station KCET-TV Channel 28. This fall, KNBC Channel 4 is joining the test; all of the LA stations are using French Antiope technology. In addition, KPIX-TV Channel 5 in San Francisco is using Antiope for a test which is piggy-backed to the Los Angeles tests, including California news plus closed captioned programming, which is also visible at homes with the necessary decoder.

Enthusiasm about teletext and its cousin technology, videotex, got a boost recently when AT&T endorsed a Presentation Level Protocol which is akin to Telidon. AT&T hasn't yet spelled out specific plans for information-retrieval services—although it has conducted discussions with CBS and other companies for technological compatibility in developing such services. Meanwhile, the FCC is opening up a policy-making procedure to set up rules for teletext. Public comments on the FCC proposal will be accepted throughout the next few months.

CONSUMER ELECTRONICS SHOW

Nearly two dozen satellite receivers were on display at the summer Consumer Electronics show (top right)—another indicator of the avid appetite for picking up video from space. Prices remain about the same—which means it's still possible to buy reception equipment for under $3,000—but you're more likely to pay in the $5,000 to $9,000 range for a complete, installed package.

AROUND THE SATELLITE CIRCUIT

Superstation WTBS Atlanta Channel 17 is now starting all programs at five minutes past the hour and half-hour; WTBS owner Ted Turner says the variation is an aid to viewers who don't want to get wrapped up in shows starting at traditional times on the hour or 30-minute mark.

Oak Industries, which is one of the largest over-the-air pay-TV companies (operating in Los Angeles, Miami, Chicago, Detroit, and other cities), plans to go into the direct broadcast satellite business—possibly launching its own satellite eventually. Its first step, however, would be to program pay-TV services on another DBS system.

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EDITORIAL

The Computer Revolution

A little more than 12 years has passed since that fateful day in August '69. At the time no one knew how drastically that day would effect the course of modern technology. For it was on that day that the Intel Corporation was commissioned by the Busicom Corporation of Japan to design a set of calculator IC's.

On the surface it was no different a contract than any of the other million or so business ventures that were concluded on that day. But this one was different—technologically different. Busicom did not want just another standard set of calculator IC's, they wanted a set that would be versatile—that would support a whole family of calculators. The idea was to produce a single set of IC's and then customize the behavior of the IC's using ROM's to produce the particular kind of calculator desired.

Two years later, in June 1971, as a direct result of the contract with Busicom, Intel introduced the 4004 microprocessor. The 4-bit 4004 was the first microprocessor. By early 1972, Intel was shipping samples of the 8-bit 8008. The rest is history. In July 1974, **Radio-Electronics** published the first computer-construction article to use a microprocessor. It was a 8008-based computer called the Mark-8, designed and built by Jon Titus. The era of the hobby computer had begun! Shortly afterwards, a small company called MITS introduced the 8080-based Altair computer—the first computer to be offered in kit form.

Before the Mark-8 and the Altair, there was IBM, DEC, and Honeywell. Today there are names such as TRS-80, Apple, PET, Heath, Ohio Scientific, Sinclair, Microace, Netronics, and a host of others. During the interim, we have seen the birth and death of many computers, such as the SOL. But today, there is one undeniable fact: Never before in the history of mankind has a more technologically advanced piece of equipment been placed into the hands of so many people. The computer revolution is here.

We cannot predict what the future will bring; we can only guess at it. Xerox has already announced its home computer and the industry insists that IBM's announcement will be close behind, perhaps before you get to read this. Whatever their plans, you can be sure that they, and other electronics giants, will become part of the technological tidal wave that is destined to change our life.

In keeping with the needs of our readers, we have published in this issue the fourth edition of *Your Own Computer—A Buyer's Guide to Personal Computers*. Whether you are seriously considering the purchase of a home computer or are just interested in learning what it's all about, you will find this special section must reading. Whatever the next twelve years will bring, it will be even more revolutionary then the past twelve. And that's definitely an understatement!

Art Kleiman

ART KLEIMAN
Managing Editor

Radio-Electronics is indexed in *Applied Science & Technology Index* and *Readers Guide to Periodical Literature.*

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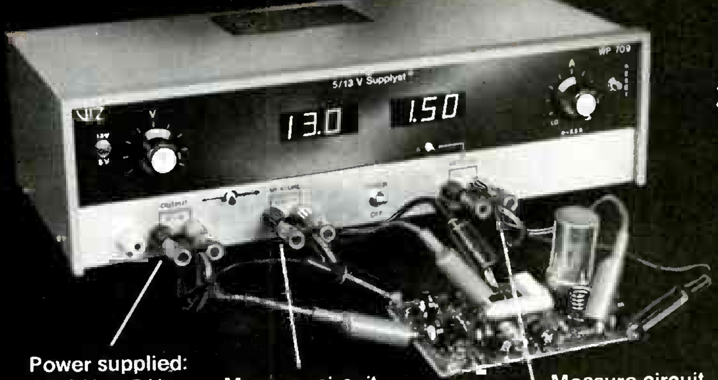

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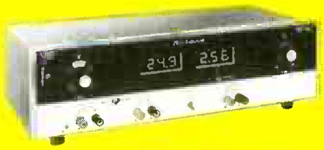

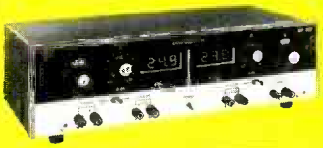

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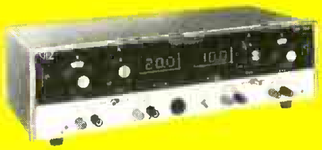

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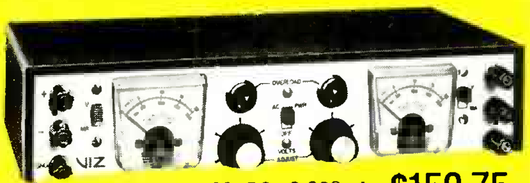

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LETTERS

UNICORN-ONE

I enjoyed your articles on the Unicorn-One project, and I thought about the closing sentence: "What will be *your* contribution to the age of robotics?"

I'm not actually into robotics, but I've come up with an idea that might be useful to those of you who are.

Do you know anything about the metal "nitinol"—the metal with a memory? On the science updates produced by CNN (Cable News Network), they demonstrated the use of that metal and its sensitivity to the heat/cold cycle.

In its normal state, it can be bent completely out of shape, but when heated it will revert back to its original shape. I found that fascinating, because it seemed to me that the metal's characteristic would make it useful to build a better robot hand.

If one could construct a subminiature device and use it for the joint connections in the robot's fingers, I think that we would then have a robotic hand that could grasp objects.

A computer would control the DC input to a thermo module via D/A conversion to either heat or cool the nitinol metal. Heating would cause it to bend in a predetermined pattern and to exert a predetermined degree of force. Rubber (or some other elastic material) would be used to provide some degree of support. One could see it for elbow joints, too.

It wouldn't take much of a temperature change to cause the metal to flex, and a computer could control the different finger movements readily by varying the DC inputs to the thermo units.

ROBERT ELMORE,
Valdez, AK

RADAR DETECTORS

One can sympathize with the sentiments expressed by Dalton T. Horn in the June 1981 "Letters" section, that radar detectors should be made illegal because they are used solely to enable motorists to break the speed-limit laws. That is true, of course; but the arguments he advances to support his indignation and his conclusions are quite wrong. Let's see why.

He starts off with his weakest argument: that a radar-detector is not a communications receiver because "it merely detects the presence or absence of a carrier signal." That is a curious argument—something like saying that a radio is not a receiver at the moment that radio stations are broadcasting dead air. The law does not specify the electrical or content nature of a received broadcast; and to suggest that the information that a radar detector conveys to a speeding motorist is not a "communication" is simple foolishness.

But, of course, the real argument goes far deeper. The primary question is whether citizens have the right to disagree with a law by breaking it. The answer should be obvious. Citizens nowadays are *obliged* to break laws with which they disagree because that is the only way that their objections can be heard. The federal bureaucracy has effectively sealed off the citizenry of the country from the majority of law-making processes. There is no

continued on page 22

cure the 10 most common nuisances in PA instantly

fact: These 10 problem solvers in your toolbox are like 10 new tricks up your sleeve. Or 10 hours of saved time. Or money in the bank. They make molehills out of troubleshooting mountains, without soldering, or splicing, or internal equipment modifications.

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Lack of Presence	**A15PA** Presence Adapter—adds intelligibility and brilliance.
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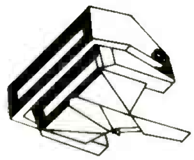
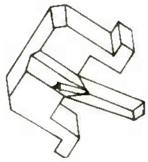
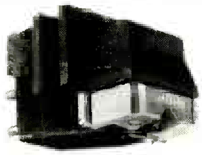
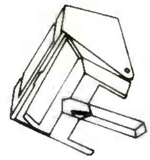
	V15 Type III SERIES	VN35HE Hyperelliptical stylus	
	M95 SERIES	N95HE* Hyperelliptical stylus	
	M70 SERIES	N72B Spherical stylus	
ANY M91, M92, M93		N91ED* stylus	
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LETTERS

continued from page 20

voting booth in the country (nor a single candidate for office anyone can vote for), whereby any change is possible in most of the regulations that are, in effect, laws—the national 55-mph speed limit included.

Not only is the 55-mph speed limit "law" one your opinion was never asked about; its proponents lie to you about why they feel it is necessary. "To save lives," they claim—as if the government has some constitutional mandate to save you from yourself. In fact, the 55-mph speed limit does little to save lives on the super highways, which are the only roadways its imposition effects. It does save *oil*, of course—but the crisis in oil is one which the federal bureaucracy's meddling with the natural dynamics of supply and demand created in the first place.

Exceeding the speed limit when it is safe to do so is no more dishonorable than avoiding the payment of a tax on tea imposed by an overseas bureaucracy. We Bostonians had as much to say about the imposition of that obnoxious "law" back in the 18th century as we have today with the 55-mph speed limit. Now, as then, it's time we did something about it in the only way that is available to us.

THOMAS MARTIN HOLZEL,
Concord, MA

In reference to Mr. Horn's letter in the June 1981 issue of **Radio-Electronics**, "Objections," I would say that he is missing a few points.

I can just imagine law enforcement attempting to identify vehicles with an automatic vehicle-identification system. The thought of that, and the attending potential problems and cost is staggering. Local law enforcement does not have the technical expertise or the equipment to enforce many of the vehicle codes that are presently on the books—for example, vehicle-noise requirements, emissions, window tinting, etc.

Radar detectors are not inexcusable, in themselves. But the way that some law-enforcement officers *use* the radar equipment is something else. It is possible to obtain erroneous indications of vehicle speeds because of reflection, and other factors. And because of their lack of technical expertise, some police officers continually take speed readings in areas with high reflectivity and vibrations—such as areas inside steel-reinforced tunnels, and in and around areas containing large stationary or moving metal objects.

Some traffic police officers like to sit around street corners and wait for unsuspecting drivers, all of whom may not be exceeding the speed limits. But when such an unsuspecting driver sees the police car, he or she is very likely to slam on the brakes abruptly because of human nature—and that could be the cause of a serious accident.

In addition, traffic police officers do not always write fair tickets; thus even innocent drivers must often look around and behind corners and bushes for lurking patrol cars, instead of watching where they are going. That, too, can cause accidents. Ask yourself: How many tickets have been written over the years to persons who were traveling four or five miles an hour above the speed limit by radar, when the limit should have been higher? In other words, they were caught in a speed trap, but probably were driving safely, and never did see personally the speed reading on the radar gun. Because of the attention that has been brought to those radar detectors, there have been some dramatic advancements in the art (in some instances it was found that the backyard technician or electronics expert was building better radar detectors than the military; not too unusual, considering the advancements).

And finally, for those people who build pay-TV decoders: If Mr. Horn checks, he will find that it is illegal to sell complete working decoders (recent federal and state court rulings). Those that are selling completed decoders have a pretty limited supply of those decoders, and those who are doing the buying usually have limited supply of cash.

Presently, the only people who should be building those decoders should be the backyard technicians or electronics experts who are attempting to improve themselves technically. Most of them have been spending around two hundred and fifty dollars for a fifty-dollar working device. (The black market, fully-working devices are going for around five hundred

continued on page 24

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- How you can knock together a simple, easy-to-use substitute instrument—from components lying around in your shop right now—instead of shelling out big money for a signal generator with metered output
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6. Each mailing also describes a number of alternate or additional selections, also available to you at the special discount price for members.

ABOUT THE AUTHOR

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

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CIRCLE 10 ON FREE INFORMATION CARD

LETTERS

continued from page 22

dollars in some cases, with not too many takers.) For the electronics buff, two hundred dollars or so can be chalked up to experience and learning; for others, the money can buy quite a bit of pay TV.

Building those decoders is time-consuming, and it's hard sometimes to get the parts. I'd say that it's time to be moving on to other things. But I doubt that the number of private decoders actually operating are making even a small dent in the pay-TV business. You might say that in the beginning, the private decoders aroused a lot of interest in pay-TV and as a result, more people found themselves subscribing to pay-TV than building decoders. And the parts houses did a lot of business in items like UHF tuners.

Unfortunately, a lot of us found out that not all UHF tuners were created equal, and that a lot of them worked poorly—if at all. But in the end, we knew a lot more about electronics than we did when we started. Personally, I laid out considerably more than two hundred dollars, but the money was spent for related experimentation and test equipment. Often new elements were discovered, or old problems with equipment reaffirmed—which, by necessity, forced improvements.

I think that the cable and pay-TV people have a lot more to worry about with their own industry than with some little guy building a decoder.

M. FOX,
Manhattan Beach, CA

UHF RECEPTION

I was very much impressed with your article, "How to Improve UHF Reception," in the July 1981 **Radio-Electronics.** Although it does contain some misleading information, it is still, for the most part, the best article on the subject that I've seen so far.

The biggest fallacy is the listing of performance characteristics using average gain, minimum gain, and average F/B and F/S ratios. Of the 22 UHF-ony antennas listed, several are made to receive channels 14 – 69 only, while others are made to receive channels 14 – 83. For those made to receive channels, 14 – 69, a sharp drop-off of gain is experienced at channel 69. Therefore, the gain on channels 70 – 89 will be low or, at least in some cases, even negative, thus lowering the average minimum-gain figures. That makes those figures very misleading.

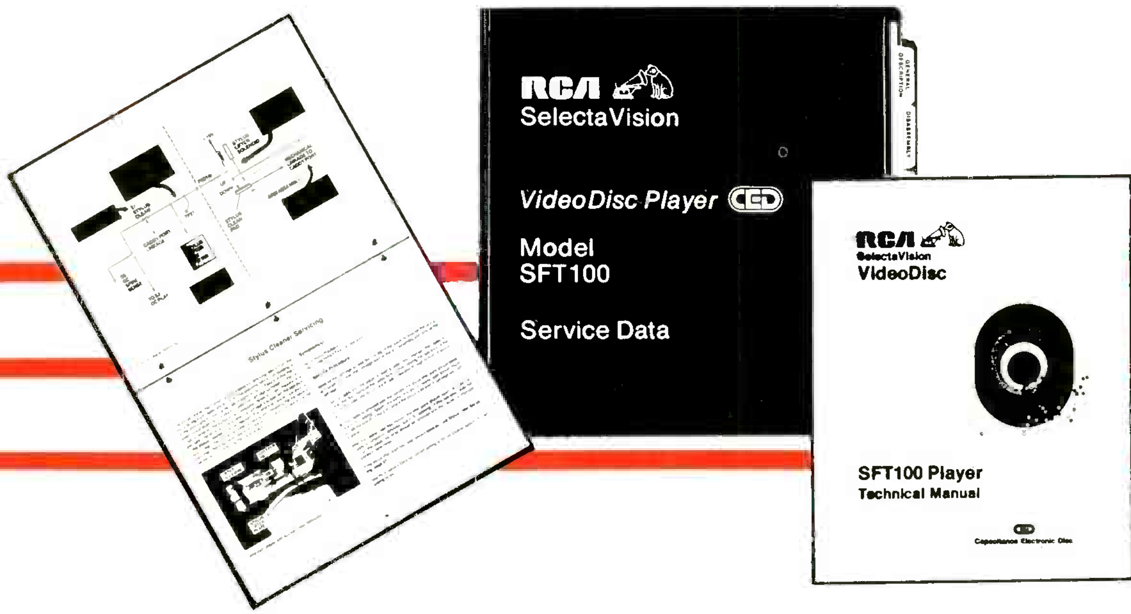
I wish that someone would do a similar test on the top VHF-UHF antennas, to compare Winegard *CH-8200*, Channel Master *1120A*, Blonder Tongue *0719*, Finco *F-89-C*, and Jerrold *VH-937S* on both VHF-lo and VHF-hi and UHF-14-69, listing such specifications as gain, F/B ratio, F/S ratio, and beam width.

It's amazing how different the study-performance figures are from those furnished by the manufacturers.

GARY J. ARNOLD,
Elk Grove, CA **R-E**

RCA SelectaVision VideoDisc

technical service information



Technical Manual

Mechanical and electronic functions of the Capacitance Electronic Disc (CED) system are discussed in detail. Numerous photographs and drawings in color are used to clarify circuit descriptions and operation theory.

Technical Service Data

Complete schematics, circuit board illustrations, chassis layout diagrams, service adjustment procedures and replacement parts lists for the RCA Model SFT100 VideoDisc Player are included in a durable three ring looseleaf binder.

Workshop Training Manual

Various Player trouble symptoms are described and step-by-step troubleshooting procedures help the service technician determine the most probable causes. Service assistance is provided with flow charts, simplified schematics and block diagrams.

Limited Time Combination Offer

These three books from RCA represent a complete library of technical information on the Model SFT100 VideoDisc Player. An overview of the CED system, mechanical and electronic theory of operation explanations, accurate service data and service troubleshooting procedures are all included in the publications.

Well over 200 8½" × 11" pages with hundreds of illustrations in color furnish electronic technicians with an understanding of the new and existing technologies employed in this new consumer product.

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EQUIPMENT REPORTS

Global Specialties *Model 4401* Frequency Standard

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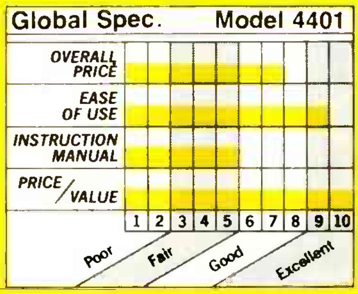


GLOBAL SPECIALTIES CORPORATION (70 Fulton Terrace, New Haven, CT 06509) has introduced its new *model 4401* frequency standard. Whether used for calibrating test equipment and communications receivers, or for testing amplifiers and transmission lines, you'll find it a valuable addition to your workshop. The compact unit offers both versatility and accuracy.

The *model 4401's* timebase boasts an accuracy of ± 0.5 parts-per-million over a temperature range of 0-40 degrees Celsius. The stability is largely due to the precision 10-MHz crystal-oscillator oven. That oscillator is factory-calibrated against the National Bureau of Standards' frequency standard, WWVB. A front-panel-mounted LED lets the user know when the oven has reached operating temperature and the unit is ready for use. The manual provided with the unit claims a 3-5-minute warm-up time. Our tests showed that the actual warm-up time was well within those limits, and that accuracy was as good as, or better than, specified in all cases.

The frequency desired is selected using the FREQUENCY SELECT pushbutton on the front panel. Eight frequencies from 0.1 Hz to 1 MHz are available—0.1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, and 1 MHz; eight corresponding LED's let you know which frequency is in use. A FREQUENCY MULTIPLIER switch lets you multiply the selected frequency by 1, 2, or 5. Also on the front panel are the POWER switch and two BNC connectors for outputting either the 10-MHz timebase or the selected frequency; the output waveform is a squarewave in either case. A trimmer that used to adjust the timebase is easily accessible through a small hole that is located in the rear panel.

The *model 4401's* TTL-compatible output is buffered to drive up to 10 TTL loads and is short-circuit protected. The output squarewave has a 20-nanosecond rise and fall time into a 50-ohm load. Power requirements are 105-135 volts AC at 5-watts maximum; a 215-230-volt version is also available. The unit measures 3 × 10 × 7 inches and weighs 2 pounds.

The instruction manual completely describes how the *model 4401* is used. The manual also covers the units theory of operation and includes a two-page fold-out schematic, and some sample applications.

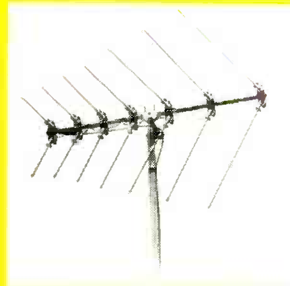
Troubleshooting microprocessors is covered quite well by the manual. In that procedure, the unit is substituted for the microprocessor's regular clock allowing a microprocessor to be stepped through a program one step at a time.

Using the *model 4401* to test audio amplifiers is covered, including test set-ups. Diagnostic charts that tell you what defects are indicated by various waveforms are also included.

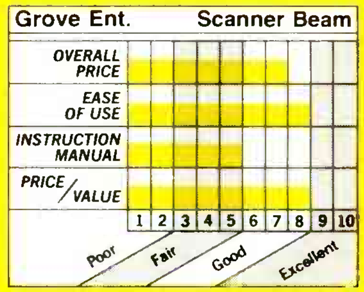
Another application described by the manual is testing transmission lines. The terminations of those lines as well as their lengths can be checked using the frequency standard. How to determine the distance from a cable-end to a defect is also described.

If you are in the market for a frequency standard, the *model 4401* deserves your consideration. We think you'll find that the unit performs as promised for all applications. In addition it is easy to operate and looks attractive on the test bench. The *model 4401* has a suggested retail price of $288.00 **R-E**

Grove Enterprises Scanner Beam Antenna



CIRCLE 102 ON FREE INFORMATION CARD



WITH THE GROWTH IN THE SALES OF scanner radios, it is not surprising that there is considerable interest in outside antennas. While the little whips supplied with the radios are adequate for local reception, it doesn't take long for the listener to develop a taste for bigger and better things.

Up to now, outside antennas have been omnidirectional. Simple ground planes, vertical dipoles, dipole clusters, and discones have dominated the marketplace.

But now that has changed. The first high-gain directional beam antenna designed specifically for wide-range scanner reception has been introduced by Grove Enterprises, manufacturer of shortwave and VHF/UHF-listening specialty products.

Grove's new *Scanner Beam* is a log-periodic dipole array, consisting of seven cross-phased dipole elements. The main boom is just four feet long, making the lightweight beam very manageable. The beam is so lightweight that it is possible to use the smallest TV-type rotators.

The antenna comes fully assembled, although it is collapsed to fit into a sturdy shipping carton. Upon installation, it is expanded like a TV antenna by pulling the elements away from the boom until they lock rigidly in place. And like a log-periodic TV antenna's, its elements are swept forward at a 60-degree angle to the boom. The purpose of that is twofold: On the half-wave fundamental dipole frequency, gain is slightly increased; on the three half-wave harmonic-frequencies, the lobes of the field pattern merge to provide better directivity and gain.

The antenna is made much like many consumer-grade TV-antennas. Insulators are unbreakable Cycolac. The boom is painted with enamel to resist corrision.

Although log-periodic dipole-arrays have a nominal 250-300 ohm feedline-impedance, a wideband 4:1 balun transformer (included) lets the user match the antenna to coaxial cable. While 75-ohm coax is best 50-ohm line may also be used with no noticeable difference; low-loss cable is recommended. Grove Enterprises also offers a 65-foot length of coax with connectors and weather boot; it is available from them for $14.95 plus $4.00 shipping.

Our lab tests

The *Scanner Beam* is designed for continuous (108-512 MHz) frequency coverage; omnidirectional low-band (30-50 MHz) reception is claimed as well.

In ou tests we found that maximum gain for the *Scanner Beam* centered in the 150-170 and 400-470 MHz range. Improvement over a dipole averaged 8 dB throughout this range. The front-to-back ratio was 15 dB.

The lowest gain, still 3 dB better than a dipole, was in the 110-140 MHz aircraft band. Even in the 225-400 MHz military aircraft band the *Scanner Beam* showed 6 to 7 dB gain over a dipole. Average VSWR over the entire range was 1.92:1. Hams can use the *Scanner Beam* on the 144, 220, and 432 MHz bands, although input power is limited to about ten watts by the small balun transformer.

At low frequencies the antenna did pick up signals quite well, probably because it represents a sizeable mass of metal. In rotating the antenna while listening to a steady low-band signal, a couple of slight nulls were detected, but the scanner beam antenna was essentially omni-directional as claimed by the manufacturer.

While the specifications looked good, how did the antenna actually

AS WE GO TO PRESS

IBM HAS FINALLY MADE ITS MOVE INTO the personal computer market. The IBM *Personal Computer*, is scheduled to go on sale in October, and will sell for as little as $1565.

Two versions will be available at that price—one aimed at home users and the other at small businesses. Both will come with 16K of user RAM and 40K of ROM (which will include a Microsoft BASIC with high-resolution color graphics and sound capabilities). A cassette interface will be included.

THE NEW IBM *Personal Computer*.

The system, which uses the 16-bit 8088 microprocessor, has three basic components—a system unit that contains the electronics, a video monitor, and a detachable 83-key keyboard. A printer is also available.

Memory can be expanded within the system unit to 256K. Optional dual 5¼-inch floppy-disk drives have a total storage capacity of 320K.

The system unit contains five expansion slots for additional memory and display, printer, communications and game adaptors.

The IBM *Personal Computer* will be sold through participating Computerland dealers and Sears, Roebuck and Co.'s new business machine stores. It will also be sold through IBM Product Centers and a special IBM sales unit.

The computer will support the CPM-86 and UCSD p-System disk operating systems, which will make a number of programming languages and applications programs available to the user.

Applications software already announced includes Visicalc, the EasyWriter word processor, business packages from Peachtree Software, Inc. and an Adventure game from Microsoft.

We'll have a lot more to tell you about the IBM *Personal Computer* shortly. **R-E** compare with competitive non-directional scanner antennas? In virtually every case, the gain advantage was quite noticeable, especially at UHF frequencies. Signals that were barely readable with a conventional scanner antenna were easily copied with the *Scanner Beam*. Even on the low band, the short-element scanner beam-antenna consistently outperformed a broadband discone.

Conclusions

Listeners must keep in mind that most scanners cannot handle excessively high signal-levels without image and intermodulation problems. Those phantoms manifest themselves as repeated signals throughout the scanner's tuning range. All scanners are somewhat susceptible, although of course, some are worse than others.

Any outside antenna may aggravate those problems. However, a directional antenna like the *Scanner Beam* may be used to advantage in some cases if it is pointed away from the offending loud signals.

We were impressed by the quality, price, and performance of the *Scanner Beam*. It has a suggested retail price of $39.95 plus $4.00 shipping and is available from Grove Enterprises, Dept. S, Brasstown, NC 28902. R-E

MACROTRONICS, INC. (1125 N. GOLDEN State Blvd., Suite G. Turlock, CA 95380), whose hardware and software products for personal computers originally served mainly the needs of the amateur radio community, now have something of interest to a much larger circle of computer users.

Their *model A4P* and *model A8P* parallel printer interfaces for the Atari *400* and *800* microcomputers fill a gap that has been quite a source of frustration to owners of those computers. Until now it has been nearly impossible for an Atari user to generate hard copy from his machine. The Macrotronics interfaces remove that obstacle.

Both interfaces are similar, differing only in the connectors supplied for the two different Atari computers, so this report will talk about them in the singular, based on our experience with the *model A8P*, for the Atari *800*. The interface itself is a deceptively simple device—a ribbon cable with a small PC board at one end that contains the actual interface circuitry, together with the connectors that plug into the computer. At the ribbon cable's other end is one of several—you indicate which when you place your order—connectors for various parallel ASCII printers. (The interface is also available without a printer-connector for specialized applications. The manual provides all the information necessary for making the proper connections.)

In use, the interface-end of the cable plugs into controller jacks 3 and 4 (intended for game-playing—but if you're interested in a printout, you're not playing games), on the front of the computer, that supply it with both the data for the printer and with its power. Those jacks differ on the two computers, hence the need for different interfaces for the model *400* and the *800*.

The PC board is so small that you don't even notice it when you're using the keyboard. The other end of the cable goes, of course, to the printer.

Two short machine-language printer-driver programs are provided on cassette. The first is intended to be used directly with cassette-based systems. The second program is for disk-based systems, and, when the instructions in the manual are followed, is integrated into the Atari DOS (*D*isk, *O*perating *S*ystem) so it will be resident in the computer's memory whenever the disk system is used.

The cassette program is only 171 bytes long and takes about 15 seconds to load. Once loaded, either program can be completely ignored during normal operation. About the only thing that will disturb them is turning the power to the computer off—they are unaffected by any of the special function keys such as SYSTEM RESET, BREAK, ESC, etc.

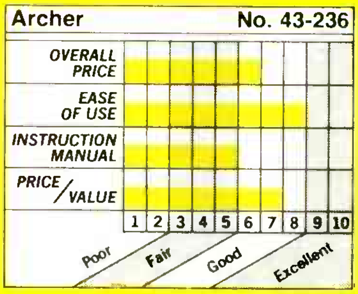
The interface, and the driver-routines supplied with it, work equally well for listings of BASIC programs, for printed output from within a BASIC program (as in printing out a mailing list or other report), or for printing source listings of machine-language programs generated using Atari's assembler/debugger software.

The commands for these are as simple as plugging in the cable: LIST "P:" for BASIC listings, LPRINT to obtain output while running a BASIC program, and LIST # P: for source listings from the assembler. In addition, the manual provides a source listing showing the user how to obtain printouts from assembly-language programs.

Perhaps the most amazing thing about this interface is that it worked perfectly the first time it was connected—not all that common an occurrence in mating one piece of computer equipment with another. The suggested list price is $69.95, including most common printer connectors.

One thing that the software provided with this interface cannot do is provide you with a "hard copy" record of what is being displayed on the screen at any given time—but Macrotronics has also provided for that situation and offers a program that allows you to perform a screen dump using a Trendcom or Paper Tiger printer, for an additional $69.95. If you want the whole package at once, the price is $139.00. **R-E**

Archer Telephone Recording Control



CIRCLE 104 ON FREE INFORMATION CARD

IN ONE SMALL, SIMPLE PACKAGE. THIS practical little box takes all the headaches out of making recordings of telephone conversations. The *Telephone Recording Control* plugs directly into a standard modular telephone jack, where it both provides a suitable audio interface to a cassette recorder's (or other) microphone input and provides the suitable switching that permits automatic starting and stopping of the cassette recorder (through its remote-control jack).

Everything is prepared for plug-in-and-use simplicity. In fact, an extra set of record/playback labels is included for the record/playback selector switch. The switch permits overriding the internal relay for listening to a recording without unplugging the remote-control connection; the extra set of labels keeps switch operation clear for those recorders where the connector polarity (versus the supply of the recorder) is the reverse of that used by Radio Shack machines.

In operation, the recorder may be left on with both RECORD and PLAYBACK buttons depressed, the *Telephone Recording Control* POWER switch on, and its MODE switch in the RECORD position. Then, assuming the *Telephone Recording Control* has been plugged into a live modular jack and into the microphone and remote-control connectors of the cassette recorder, it will automatically control the recording of all conversations any time the phone headset is lifted off the hook.

Note that you may want more intimate control of this feature, since the automatic recording of a call without the caller's knowledge may be the grounds for legal action; many telephone companies have a requirement included in their tariffs for a beeper-tone alert (1500 Hz for 1/5th of a second every 15 seconds is a typical requirement) whenever a recorder is attached. Consult your local company for its advice on the subject.

The Archer *Telephone Recording Control* is FCC-approved for direct connection to a telephone line, and the FCC Registration Number, ringer equivalence, and USOC code information provided with the unit must be reported to your local telephone company. Normally, they simply record that information on your file, but in some cases there may be a nominal charge. If you have questions, ask before you buy.

No batteries or power supplies are required for use with this device, since the operating power it needs is derived from the telephone line voltage. In fact, the impedance and level matching of the voice signals are accomplished with signal voltages alone, and line voltages are used only for remote-control switching.

Performance

Having had experience with everything from acoustic couplers to inductive couplers, we were especially interested in the *quality* of off-line recording that the *Telephone Recording Control* could provide. It is excellent. Voice, music, interviews, and commercials have been recorded during both local and long distance tests; we found extraordinary (for over-the-phone) fidelity.

Initially, there was a problem with a small amount of hum appearing on the recorded signal. That was found to be due to direct AC-line powering of the cassette machine: switching to a DC power-supply eliminated the hum problem entirely.

Attempts to play back from the cassette machine onto the phone line (by connecting the microphone plug to the recorder's earphone jack) were less successful: here, the age-old custom of putting the telephone handset near the cassette speaker is the recommended procedure.

While we have yet to try it, it's possible that a computer program or a data cassette might be successfully played back through the phone using this device. You are left to your own experiments here.

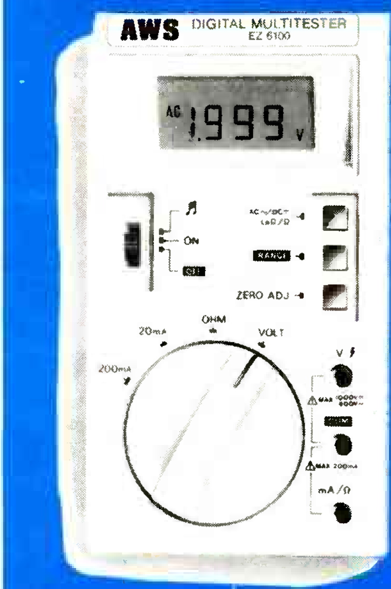
We keep the *Telephone Recording Control* and cassette recorder at hand near a typewriter, transcribing recorded material whenever convenient. The *Telephone Recording Control* has been a nerve saver and memory helper on more than one occasion, as well as a convenient time saver.

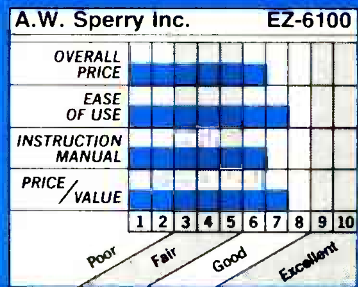
The 2½ × 2½ × 1¼ inch *Telephone Recording Control* is available at Radio Shack stores (catalog number 43-236) and sells for $24.95. **R-E**

continued on page 32

"If this works, I'll be rich—it's an attachment for a TV set that interferes with CB radios and power tools."

A. W. Sperry Inc. EZ-6100 DMM





UNTIL RECENTLY, MOST AUTORANGING digital DMM's were expensive, bulky, or both. The new *model EZ 6100* from A. W. Sperry Instruments, Inc. (245 Marcus Blvd., Hauppauge, NY 11787) has done much to change that. This unit combines a compact size (6⅛ × 3⅜ × 1⅛ inches) with many features that, as a rule, are found only on more expensive digital DMM's.

Autoranging is available on both the voltage and resistance ranges. These ranges can also be selected manually using the RANGE button; the milliampere range must be selected manually using the large FUNCTION switch that dominates the front panel. The RANGE button is also used to defeat the autorange feature. Pressing it will cause the meter to remain on the last range used.

An overrange condition is indicated by a flashing "1" on the 3 ½-digit LCD display. The display will also show which function is in use, as well as indicate polarity.

A low-power resistance function with a maximum open-circuit voltage of 0.4 volts can be selected by the AC/DC/LO-OHMS/OHMS pushbutton. In addition to determining which resistance range is used, the button is also used to choose between either AC or DC input.

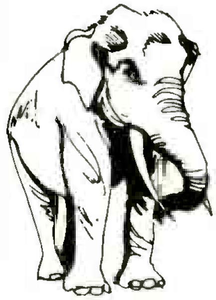
The meter can be zeroed in the OHMS ranges using the ZERO ADJUST pushbutton. All you have to do is switch to a resistance range, short the test leads together, and push the ZERO ADJUST button; the meter is automatically zeroed. Three input jacks are located to the right of the large FUNCTION switch. Those jacks are VOLTS, COMMON, and MILLI-AMPS/OHMS.

The *model EZ 6100* can also be used as an audible continuity tester in the 19-ohms-and-below area. That feature is selected by switching the ON/OFF/TONE switch to the tone position (indicated by a musical note). This function will let you check for continuity, shorts, etc. without having to look away from your work. The tone will also sound when a reading is out of range and when the meter autoranges from one range to the next. You may notice that it takes a couple of seconds before the tone sounds during autoranging. That is because of the "thinking time" that is inherent in all autoranging DMM's.

The *model EZ 6100* will read from 200-millivolts DC to 1000-volts DC with a resolution of from 100 microvolts to 1 volt depending on the range. The meter will also read AC voltages from 2-600 volts full-scale with resolu-

continued on page 110

DON'T FORGET



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John E Cunningham

Special Projects Director
Cleveland Institute of Electronics

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."

I believe he was right. Today is the age of specialization. And I think that's a very good thing.

Consider doctors. You wouldn't expect your family doctor to perform open heart surgery or your dentist to set a broken bone, either. Would you?

For these things, you'd want a specialist. And you'd trust him. Because you'd know if he weren't any good, he'd be out of business.

Why trust your education and career future to anything less than a specialist?

You shouldn't. And you certainly don't have to.

FACT: CIE is the largest independent home study school in the world that specializes exclusively in electronics.

We have to be good at it because we put all our eggs in one basket: electronics. If we hadn't done a good job, we'd have closed our doors long ago.

Specialists aren't for everyone.

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

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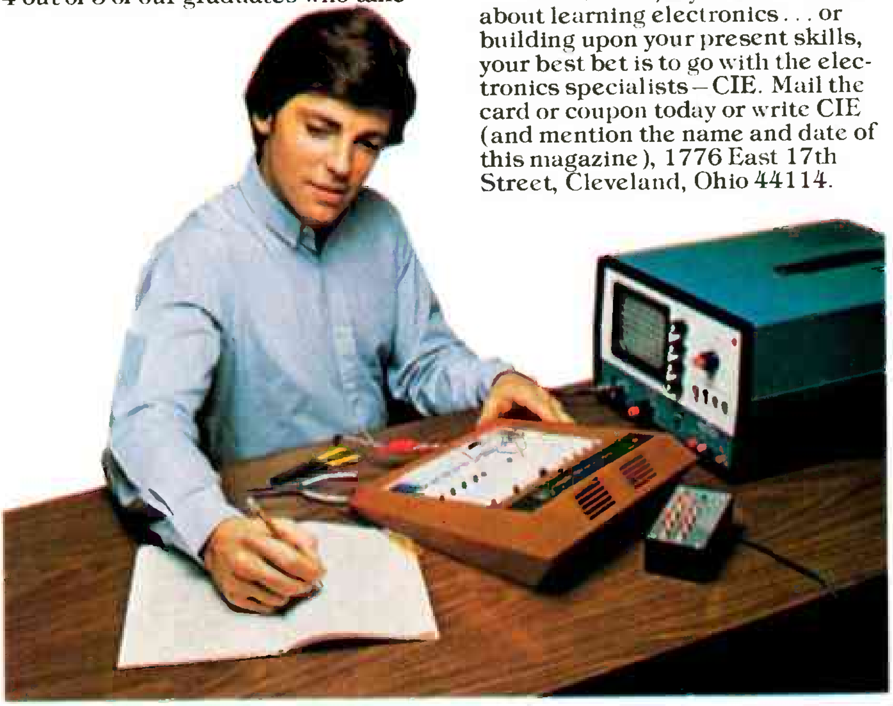

Pattern shown on oscilloscope screen is simulated.

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POCKET TV

After many years of promises and false hopes, flat-screen video displays, for TV and other purposes, are ready to make their debut. The technology that was developed to make them a reality is the subject of this article.

DANNY GOODMAN

THE TWO-WAY WRIST-TELEVISION THAT DICK TRACY wears everywhere has been quite a curiosity ever since it replaced his technologically feasible two-way wrist-radio years ago. We marvel at the TV's small screen-size, measuring, presumably, an inch or so square. What should amaze us, though, is not the screen size, but that the whole unit is wrist-watch-*thin*. Even today's two-inch (diagonal) screen "pocket" TV's, like the ones offered by Panasonic or Sanyo, need several inches behind the screen to accommodate the electron gun.

With some recent breakthroughs on several video fronts, it now seems possible that products featuring thin video-displays in sizes ranging from Detective Tracy's gadget up to panels measuring six inches on a side will be on store shelves within the next two years. One may even be ready by next year.

For many years the interest in flat video-displays had been aimed at finding a replacement for the cathode-ray tube (CRT) in television sets. In recent years, however, researchers have found new applications prospects, as microprocessor-based products at every level—factory, office, car, home—have become so

"intelligent" that they need more versatile outlets for their complex data. And while the CRT is a tried-and-true medium for alphanumerics and graphics, it is often impractical in a number of applications where space and power requirements make it impossible to use the high-voltage, long-necked tube. In those cases, a flat-panel screen is essential.

Mr. T. P. Brody, president of Panelvision (Pittsburgh, PA), notes about future applications for flat video-displays, that, just as the microprocessor gradually became more versatile and found uses never before dreamed of, so, too, will flat-panel displays find applications in products in a great many unexpected areas.

We have, of course, become accustomed to basic flat-panel non-video displays such as those found on LED calculators or LCD digital watches. Longer strings of characters, like the 26-character alphanumeric liquid-crystal display of Radio Shack's *TRS-80 Pocket Computer* (Fig. 1) are also common. More sophisticated alphanumeric displays, using less familiar technologies (which will be discussed later) are used in the orange dot-matrix displays of some supermarket check-out registers. And a new briefcase computer by Britain's Microdata Computers Ltd. offers its user a 12-line, 40 character-per line, alphanumeric flat display for better communication between computer and non-technical user.

FIG. 1—LIQUID CRYSTAL DISPLAYS for alphanumeric use, such as the one in Radio Shack's *TRS-80 Pocket Computer*, are becoming commonplace. They are not suited, however, for graphics purposes.

Even larger alphanumeric panels, with capacities in the 2000-character range of CRT monitors used in data-processing systems, are currently available. The panels still cost several times more than the CRT's they are scheduled to replace, but as more of the driving electronics become integrated into high-volume integrated circuits, that cost is likely to fall.

LCD displays used by some hand-held games are trying to simulate detailed graphics displays, providing more realism to the play action than the flashing blips of red offered by LED's. Games like the Entex *3-D Grand Prix* (Fig. 2) and Mattel Electronics' *Computer Chess* employ finely detailed

FIG. 2—LCD's CAN BE USED for graphics, as in Entex's *3-D Grand Prix* game, but the displays are "hard wired" and cannot be changed by the user.

LCD displays for added realism, but the images are "hard-wired" so that any given display element is active for specific images and those images only. Shapes of the images are predetermined at point of manufacture.

True video and graphics representations on flat panels offer special challenges, as we will see, yet there already appears to be a need for those displays in today's electronic environment. Automobile dashboards and aircraft cockpits are areas in which detailed video-displays of the vehicle's operating conditions would be useful. Portable computer-terminals could also be more valuable to their operators with high-resolution displays offering the graphics capabilities of the home or office CRT monitor.

In educational equipment, where graphics play a key role in learning reinforcement, rugged portable displays would be quite useful. Xerox Research Laboratories (Palo Alto, CA) has had a handheld electronic tutor floating around its think tank for years. Its main ingredients—as foreseen at its very inception—were high-density integrated-circuit memories containing preprogrammed coursework and a flat graphics panel. After all the years, the IC's are ready, but the video panel is lagging behind.

In the television area, flat panels of large enough size and brightness appear to be more desirable than the cumbersome projection-TV systems of today. At the other end of the size scale, portable TV is a likely target for the small size and low power-consumption of some flat-panel devices.

Some researchers have already begun to show off the feasibility of small-screen flat television-displays for the consumer marketplace. Convincing demonstrations have revealed the success of two vastly different approaches to panel-television image-creation. The first involves the application of sophisticated solid-state techniques, while the other is a novel variation on the electron-gun CRT theme.

Solid-state panels

The pace has quickened in the last two years in efforts to create a solid-state-panel video-screen, though research has been going on for at least 15 years. A solid-state panel does not use a beam scanning-system, but rather a concept known as matrix scanning. It holds great promise as a video and graphics medium not only for television receivers, but in applications where a pictorial display would be beneficial—yet where space and/or power requirements make a CRT impractical.

A matrix display, in its most basic form is an orderly mosaic, made up of closely spaced columns and rows of picture elements as shown in Fig. 3. As

FIG. 3—AN EARLY EXAMPLE of a matrix display clearly shows the mosaic elements. Also, note "contouring" at the left caused by a limited number of gray levels.

in the case with a mosaic tile mural, the more densely packed and smaller the tiles, or picture elements, the better the resolution.

The common feature of virtually all matrix displays is the basic construction of the panel. Along the back plate of the device run horizontal rows of electrodes, one for each row of picture elements. The vertical column-electrodes are usually transparent, and are fabricated on the glass faceplate of the device. Coating both row and column electrodes are insulating layers (again, transparent for the column electrodes). Sandwiched between those electrode insulators, and electrically connected to the electrodes, is a layer of material, in roughly a square shape, that is excited or altered by the application of voltage running through it when both electrodes are powered up to change its light-emitting or reflecting character-

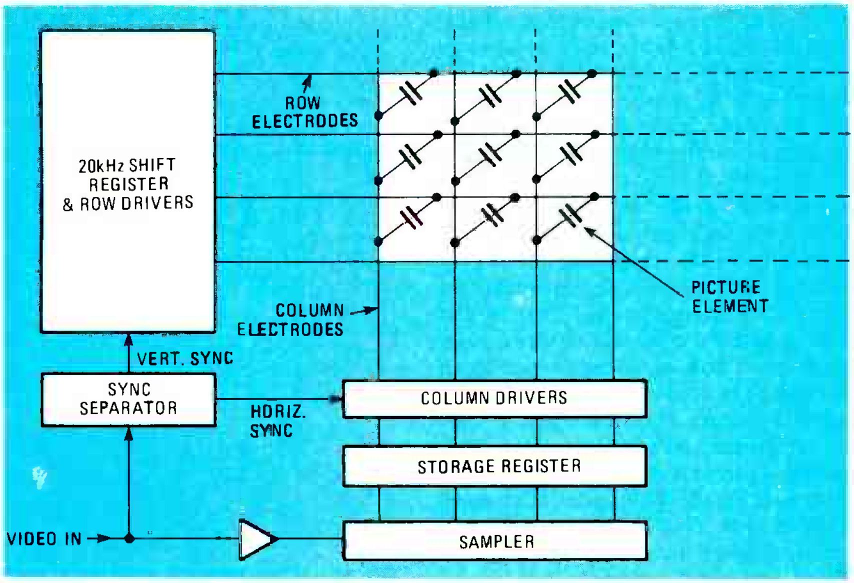

FIG. 4—SIMPLIFIED DIAGRAM of matrix display shows how each picture element (pixel) can be addressed individually.

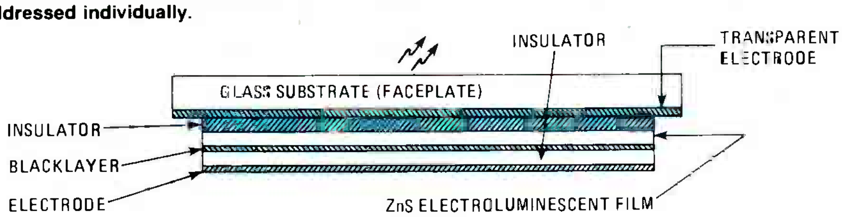

FIG. 5—THIN-FILM ELECTROLUMINESCENT elements emits light when voltage is applied to ZnS film. Black layer beneath film increases contrast.

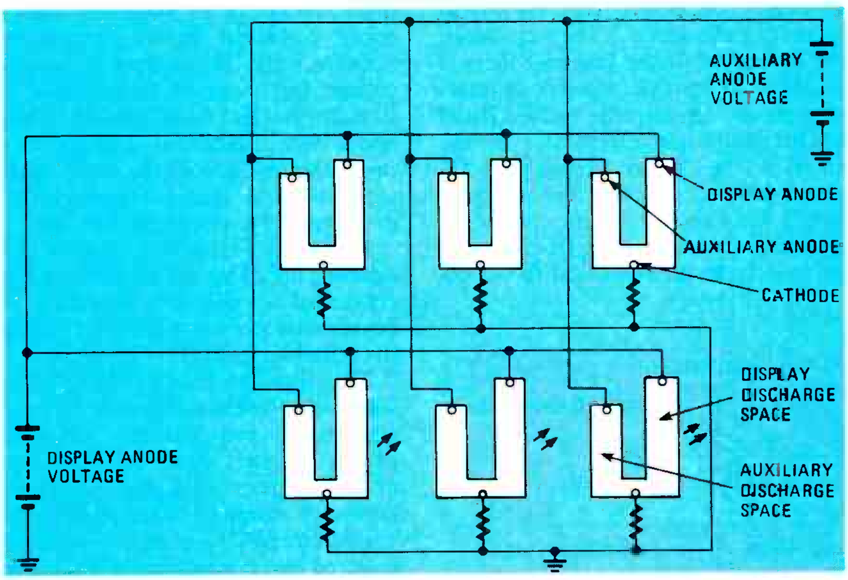

FIG. 6—ELEMENTS OF A PLASMA PANEL, with bottom row glowing. A voltage pulse to the display anode causes gas within the display discharge space to emit ultraviolet light and excite phosphor coating, which produces visible light.

istics. Any point at which a column and row electrode intersect is a picture element *(pixel)*. Figure 4 shows the elements of a matrix display.

The driving electronics of such an array must be able to send a specified voltage to any given element of the screen for each frame of the picture. In the case of television images, each element must react with a luminance proportional to the voltage applied in order to provide various shades of gray between black and white. Even when the addressing pulse is absent (as the drivers address other elements of the frame), the voltage on the element must remain constant until the next voltage pulse reaches the element. The gray shade of an element also needs to change very quickly as the image on the screen moves frame-by-frame. In other words, the element must power up quickly, maintain its charge, and then discharge before the pulse of the next picture frame.

Within the matrix-panel development arena, there are two distinct fields of research going on—each with its own challenges, and each with its own string of recent successes. The first has to do with the materials used to construct the display; the second involves the means of powering up, or addressing, the tens of thousands of elements required for an acceptable TV picture.

Panel materials

The "materials" question has been going around for some time, with each type of display system having had its popularity go through sharp peaks and deep valleys. The most popular systems are these:

Electroluminescence: As the name implies, this method uses a voltage to excite phosphor chemical-mixtures to emit visible light. The principle dates back to the 1930's, when the mixture used was in powder form. That tended to lose its luminance too soon to be considered for long-life display applications. Instead, activity has focused on what is known as thin-film electroluminescence. Here, a phosphor film —commonly zinc sulphide (ZnS) doped with manganese—is deposited on one insulating layer in a method similar to semiconductor manufacturing (see Fig. 5). The search is on for thin-film phosphor mixtures which emit light of multiple colors efficiently for full-color video.

The materials currently in use exhibit the much-desired characteristics of fast response-time and high peak-brightness. However, their high voltage-requirements (200-volts RMS) and yellowish light emission are seen as drawbacks when it comes to portable consumer-video applications.

Plasma panels: Also known as gas-discharge panels, these are based on the principle that within a vacuum chamber filled with neon or similar gases, a series of light and dark spaces of different characteristics will appear between a cathode and anode at opposite ends of the chamber. One of those light spaces, called the positive column, or display discharge-space, happens to be a highly efficient ultraviolet light source that can be used to excite phosphors to emit visible light. By way of a complex two-chamber system, and a transparent display anode on the faceplate, a phosphor-coated display chamber will emit light when power is applied (Figs. 6 and 7). By grouping three chambers side-by-side, each with a different-colored light-emitting phosphor, any color can be produced by exciting the color chambers in the proper ratios. Some outside observers have high hopes for the plasma panel becoming a replacement for the color CRT in medium sized panels, provided the brightness can be improved.

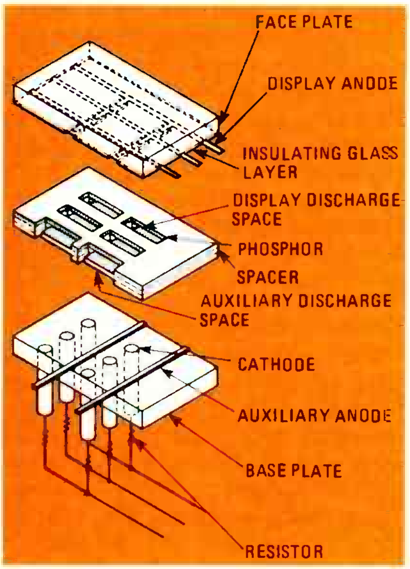

FIG. 7—EXPLODED VIEW OF PLASMA DISPLAY shows phosphor coating lining display discharge-space.

Liquid crystal displays: This is a passive medium, in that it does not emit light. It uses the same principles as the LCD digital watch or calculator displays. Ambient light normally is reflected by the rear plate of an LCD. If a voltage is applied to a specific area, the molecular structure of the material changes so that light cannot pass through it, blacking out that segment. The effect is like a louvered blind shutting out light at one window pane. Removing the voltage restores the LCD to its original structure, letting light pass freely. While the LCD is a low-voltage device, the major hurdle has been to improve its response time to better than the TV frame-rate of 33 milliseconds.

Light-emitting diodes: Currently out of favor with most researchers, the light-emitting diode matrix uses a compact arrangement of LED's fabricated directly onto a substrate, as shown in Fig. 8. All electrode rows and columns are located on the substrate, with anode connections to the tips of the LED components made with ultra-fine gold wires, in a fashion similar to that used in manufacturing integrated circuits.

Others: Several newer materials are also under investigation. Two of the more popular are passive devices, electrochromic and electrophoretic. Both represent materials that alter their light-reflecting characteristics when a voltage is applied and produce a color contrasting against a different background color (see Fig. 9). Numerous laboratory oddities have also been demonstrated, including one which conceives of microscopic magnetic spheres, one hemisphere white, the other black, encapsulated in tiny, clear cubes. The spheres would turn freely within their cubes, baring to the viewer white, black, or any proportion in between, depending on the direction and intensity of an addressing magnetic field on a picture element containing dozens of spheres.

Matrix addressing

Following a different line of research are those concerned with matrix-addressing techniques. The challenge here is twofold: In the first case there is the desire to limit the number of interconnections between the picture panel and the television electronics to the minimum. On a matrix screen with 220 row-electrodes and 240 column-electrodes, for example, there can be as many as 460 wires coming from the display matrix to be interfaced to the receiver. In terms of reliability, this means too many points that can fail. In manufacturing terms, it is a nightmare of expensive assembly.

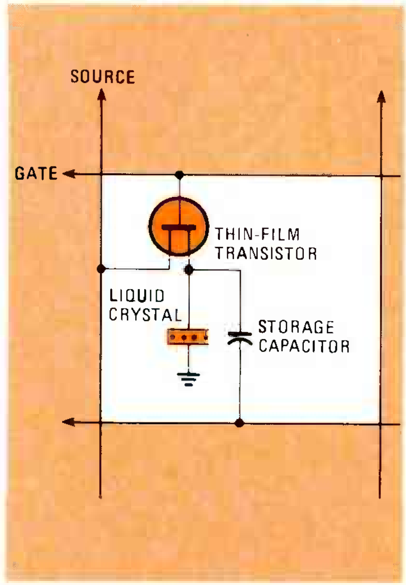

FIG. 10—ACTIVE MATRIX PICTURE ELEMENT. Switching transistor and storage capacitor are integrated into panel construction, then concealed by a square display element (liquid crystal in this example).

The second part of the addressing challenge involves energizing each element. While it is relatively easy to apply a voltage to any element, it is necessary for that element to retain the charge for a period longer than it is initially driven. Some storage device, and a switch to keep that device turned on in the absence of the main voltage, are needed at each element. Such an arrangement is shown in Fig. 10.

It appears that both problems of addressing are being solved with the application of solid-state fabrication processes directly on—or rather inside—the panel screen.

Thin-film transistors (TFT's) and supportive components are being deposited on the substrate of display panels at each element. Photomicrographs of the panels show the familiar layers of materials often used in integrated circuits. Most of the circuitry is covered by an insulating layer, separating electronics from the display material, with the exception of a tiny "through-hole" for electrical contact.

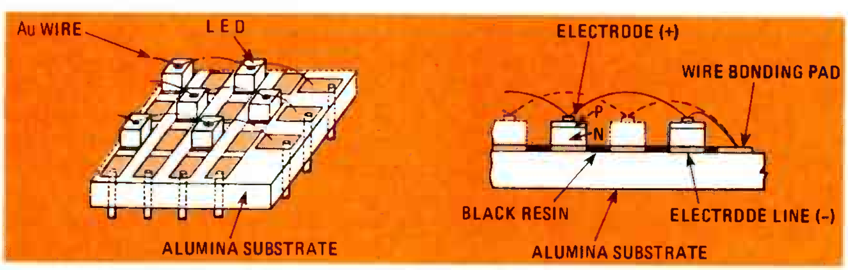

FIG. 8—LED MATRIX DISPLAY is made up of an array of discrete LED's fabricated on the same substrate and connected by extremely fine-gold wire.

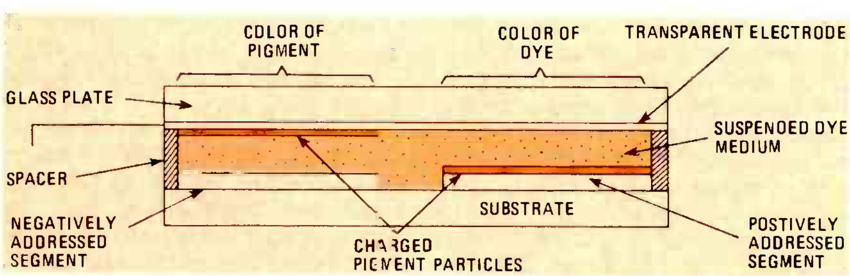

FIG. 9—COLOR OF ELECTROPHORETIC display depends on whether pigment particles in dye solution are in suspension or concentrated against transparent faceplate electrode.

Pocket LCD television

A close examination of one matrix display demonstrated in a prototype consumer product will help explain the construction of a matrix video display. The construction details outlined in Figs. 11 and 12 are for a pocket-TV prototype by Toshiba.

The screen is made up of 220 horizontal rows and 240 vertical columns of tiny liquid-crystal squares: 52,800 pic-

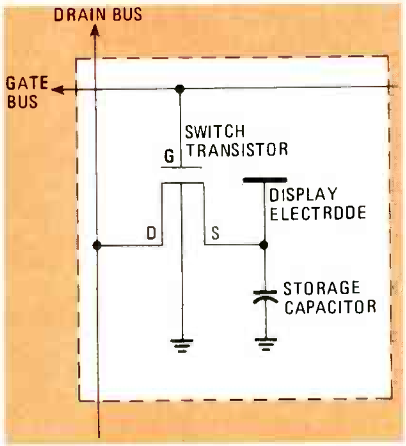

FIG. 11—PICTURE ELEMENT CIRCUIT used by Toshiba. Storage capacitor keeps element "alive" between address pulses.

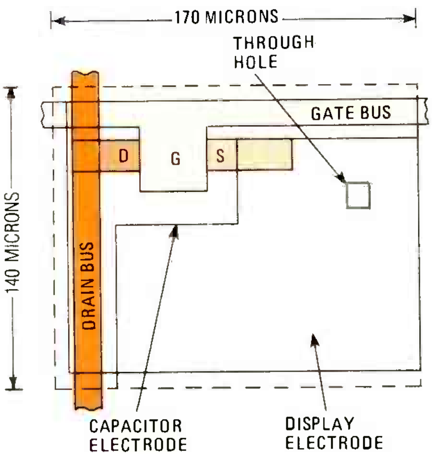

FIG. 12—CONFIGURATION of picture element. Through-hole for display electrode is not visible in finished panel.

ture elements in all. All are crammed onto an area measuring 30.8 mm × 40.8 mm, producing a two-inch diagonal black and white picture. Each picture element has an active display area of 132 × 162 microns, with a center-to-center spacing (also known as "pitch") of 140 × 170 microns.

Toshiba claims to have solved the slow-response problem of LCD materials with a proprietary formulation. The response times reported are on the order of 30 milliseconds. Actual broadcast reception in the demonstration units does not indicate any smearing of the picture when the images move.

Toshiba attacked the problem of the enormous number of interconnections between the LCD matrix and the receiver electronics by incorporating the driving electronics for the row electrodes (gate-bus) directly on the same substrate as the picture elements. Only six connections are made to the gate-bus drivers, which, in turn, drive the 220 rows of elements. In future generations of the device, the drain-bus driving circuits will also be constructed on the matrix chip.

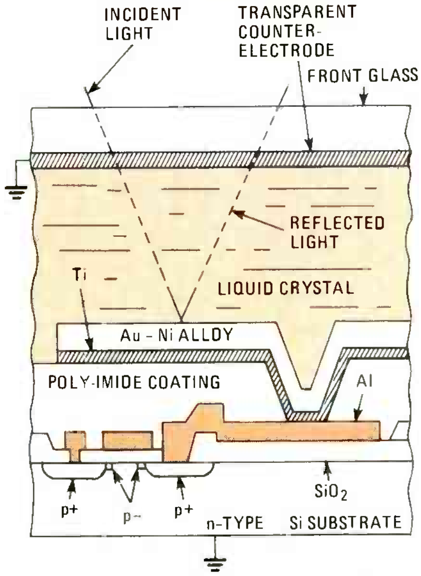

FIG. 13—CROSS SECTION of Toshiba LCD display element. Titanium layer provides extra-smooth base for highly reflective gold-nickel electrode. Liquid-crystal material is approximately 10 microns thick.

Toshiba screen construction is that the electronic circuitry on the substrate is covered by two layers, as shown in Fig. 13. The first is a poly-imide coating which provides an especially smooth base for the second, a highly reflective display-electrode layer made of a gold-nickel alloy. The combination of smoothness and high reflectivity sets the contrast ratio at a respectable 20:1. Five gray levels have been attained through voltage variations at each display element and integral storage capacitors.

Three prototype matrix-display sets have been demonstrated at consumer electronics trade shows in Japan and the U.S. The smallest set, measuring 6.8 × 3.2 × 0.7 inches thick, is a TV only, with slide-rule tuning of all VHF and UHF channels. Another sample incorporates an AM radio, while the third includes an LCD digital clock in a slightly taller package. The present power-consumption level of 2.2 watts is higher than Toshiba's production-TV goal of about 1 watt. At 2.2 watts, the

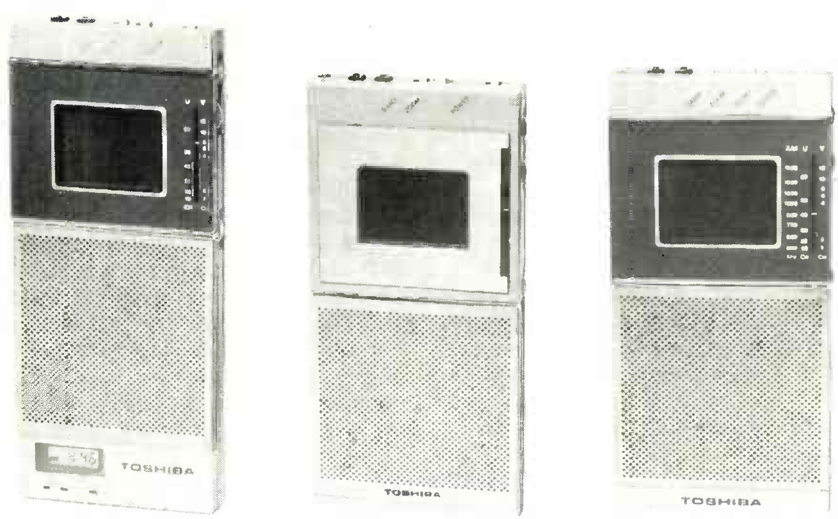

FIG. 14—TOSHIBA'S LCD TV PROTOTYPES. Smallest unit measures 6.8 × 3.2 × 0.7 inches.

Manufacturing yield is an important factor in making this LCD screen, because the gate-bus drivers and 52,800 picture elements' electronics are all fabricated on a single 3-inch wafer. A hairbreadth misalignment can affect one element, or part of a row of elements, destroying an otherwise flawless mini-image. Anyone with knowledge or experience in the field of semiconductor manufacture knows that yields of 60–70% are common in today's simple circuits, with that number decreasing rapidly as the size of each circuit increases.

As the search for larger and larger matrix-panels goes on, and the use of thin-film transistor circuitry expands, high yields will be quite important, if not crucial, to the success of those panels.

Another important feature of the sets, shown in Fig. 14, are reported to run for three to four hours using a pair of lithium cells.

All three sets have a zoom feature that doubles the size of the image at the center of the screen at the touch of a button.

Toshiba is not the only company in the LCD TV race. Hitachi, Ltd. is also demonstrating their version of a palm-sized television set with a screen measuring almost three inches diagonally. Hitachi claims to be using a different matrix-addressing technique which they call a quad-matrix. The prototype is said to have a current drain of only 1.3 watts, and can play for four hours on four "AA" cells.

It may be a couple of years before any of those, or comparable sets, reach the stores. And, their prices will be high—around $400 for the first-generation models. As with all heavily semiconductor-based products, the price should drop rapidly as production volumes and yields increase. Industrial video applications may help to stimulate the jump in volume.

Flat CRT

The other flat-screen TV system demonstrated employs the traditional raster scan technique, where a television picture is "painted" on a picture-tube phosphor, 525 lines (in the U.S.) per frame, 30 frames per second. The difference for flat video is that the electron gun is placed parallel to the screen, instead of perpendicular to it.

The idea of having the electron beam spew out from the side of the screen is an old one; the first demonstrations were made more than 25 years ago. All along, there were numerous problems which proved difficult to conquer.

The biggest challenge was to overcome the distortion of the picture as the electron-beam hit the phosphor surface. A spot would appear elliptical instead of circular, like the effect of a spotlight hitting a stage from any angle except directly overhead, and an out-of-focus picture would result.

Difficulties also arose in making the picture fill the entire screen—including the corners and edges—with uniform clarity and brightness.

Recently, word came from Britain's Sinclair Research Ltd. that the problems had been overcome, and that a flat-picture tube for a battery-operated, portable television was ready for mass production. A prototype of the unit shown in Fig. 15, and measuring 6 × 4 × 1 inches thin was demonstrated. Pricing, when available in the U.S. in 1982, will be in the astonishingly-low $100 range.

FIG. 15—SINCLAIR RESEARCH'S FLAT-CRT TV. The 6 × 4 × 1-inch unit is expected to sell in the $100 range when it is introduced in 1982.

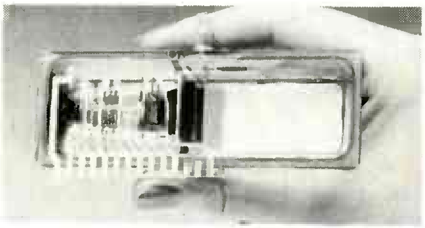

FIG. 16—FLAT CRT has phosphor coating on rear instead of front. Picture is viewed *through* the tube.

The key to this paperback-sized TV is the flat tube (Fig. 16) which uses some unique methods to achieve the sidelong raster scan.

The tube itself measures approximately 4 × 2 × ¾ inches. Its most unusual construction feature is that the phosphor screen is located on the inside of the tube, on the *rear* plate. You see the image, on the inside of the phosphor, *through* the vacuum and through the invisible scanning electron beams, instead of on the outside of the phosphor. One major benefit from this system is that the picture can achieve greater brightness with less power consumption than traditionally-designed tubes of the same size.

As the electron beam, made to scan by a series of electrostatic deflection-plates, speeds out of the gun, it traverses a focusing field created by a transparent electrode on the front face. It is this field that corrects the angle of beam-incidence for uniformity across the phosphor field, rounding the potentially-elliptical beam spot.

Special optics are also used to bring a normal-appearing video picture to the viewer's eye. The screen height of the Sinclair tube is only one-half of what you'd expect it to be. The smaller scanning area that results reduces both power consumption and the potential for distortion involved in sending the electron beam far off the axis of the gun. Proper proportion of the picture is restored by way of a Fresnel lens incorporated into the plastic faceplate of the exterior case.

Another unusual technique used to reduce the number of wire interconnections, which would otherwise slow manufacture and lessen reliability is screen-printing all connections to the gun and deflection/focusing electrodes onto the glass front-plate of the tube.

Sinclair speculates that the concept of this pocket-sized tube can be upgraded in scale to the point where a 50-inch wall-mounted TV will be possible, with all the electronics concealed in a "shoe-box-sized unit" at its side. Color TV, using a 3-gun array, is also considered possible.

Now, though, we have to wonder: Since the small flat TV panel is just about upon us, what new gadget will Dick Tracy get for his wrist? **R-E**

What's News

Exposure to microwaves

The New York State Worker's Compensation board recently upheld a decision that the death of Samuel Yannon, telephone technician, was caused by prolonged exposure to microwaves. Mr. Yannon tuned and maintained microwave equipment that is located on the 87th floor of the Empire State Building from 1957 through 1968.

This appears to be the first case in which the dangers of microwaves have been accepted in a United States court; the decision is being appealed. One expert who testified against the Yannon claim went so far as to state: "There is no evidence of human hazards other than superficial burning at such frequencies..."

In Europe, microwaves are taken much more seriously, and hundreds of cases of microwave sickness have already been reported. The permitted level of microwave exposure in the Soviet Union, for example, is only one thousandth of that which is currently permitted in the United States under Federal guidelines.

The case is attracting a great deal of attention both among manufacturers of electronic equipment, who might be faced with large claims for damages, and environmental workers, who have been pointing out the hazards of electronic radiation for some years. "The Yannon case is the most important piece of litigation since the Borel case in 1973 exposed the dangers of asbestos," says Paul Brodeur, author of *The Zapping of America*, a 1977 book on the growing exposure of Americans to electromagnetic radiation.

RCA large-screen projection TV

An early entry into the projection-TV business was forecast at a meeting of RCA distributors in Dallas late last year. RCA's plans include a 50-inch diagonal screen model—which will have about four times more screen area than the 25-inch picture of RCA's largest direct-view receiver. The size of the new projection-set picture is 1,176 square inches as compared to the 315 square inches of the present 25-inch receiver.

RCA is not really a newcomer in the projection-set field. Following the introduction of the company's first mass-production set in 1946—a 10-inch model that sold for $375—it brought out a series of projection receivers. The first of those—made in 1947—had a 300 square-inch picture and sold for $1200.

CBS high-resolution TV prototype

Columbia Broadcasting System recently demonstrated a new high-resolution television system with a 1,125-line signal. Transmission was in the 12-GHz band, with a bandwidth of 30 MHz. CBS was quick to point out that the system, which was largely developed by NHK, the Japan Broadcasting Corp., is in the early experimental stage and that all details are subject to change at any time.

CBS has requested that the FCC consider the feasibility of a service based on the system when planning spectrum space in the forthcoming allocations slated for 1983. **R-E**

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Part 2 IN SEPTEMBER WE described an analog reverberation unit that adds realism to recorded music. Have that issue handy as we continue by showing you how to build your own.

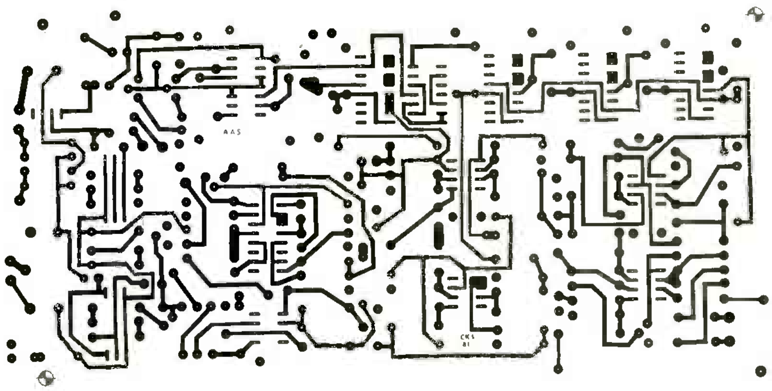
Construction

Foil patterns for the double-sided PC board are shown in Figs. 8 and 9. Note that the component-side of the board is laid out so that, when trimmed, it will be divided into two electrically-isolated sections. Almost all of the reverberation unit's components are mounted on the PC board (refer to Fig. 10). The board is double-sided, so unless it is plated-through, care must be taken to connect the two sides using jumpers where the foil patterns on both sides of the board coincide. Generally, components (including integrated circuits) that connect to the ground plane should be inserted first and soldered to minimize static-electricity problems—especially if you are not using sockets. Do not install LED 1—you'll need it to check out the unit. Note that connections to the off-board components (front panel controls, input jacks, etc.) are made to the pads labeled "A" through "U," corresponding to similarly labeled points in the schematic.

The front-panel controls should be connected to the board before they are mounted mechanically. The AC ground (point "E") is common to the INPUT LEVEL, OUTPUT LEVEL, and REVERB controls; wiring one end of each of those pots together and then wiring to point "E" on the PC board is the simplest way to make that connection. The wires from the controls to the PC board should be about 8 inches long.

Care must be taken to isolate the output jack from the chassis (AC ground). The easiest way to do that is to put an insulating layer of electrical tape or Mylar film over the chassis hole (from the inside), and cut a similar, but slightly smaller, hole through the tape or film. If that is done, the jack will not come in electrical contact with the chassis when it is installed.

*Signetics Corp., Sunnyvale, CA

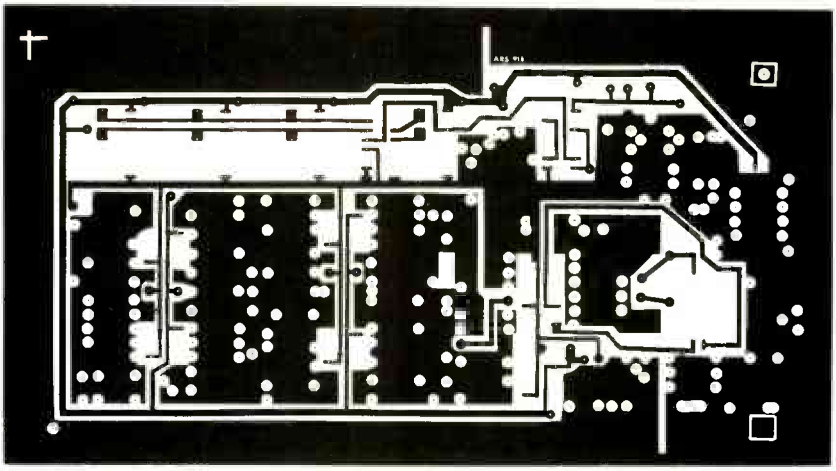


8–1/2 INCHES

FIG 8—FOIL PATTERN for the bottom side of the PC board. Note that the PC board is double sided (see Fig. 9).

The jumper from "T" to "U" *must be left disconnected* during checkout to reduce the chance of damaging the output stage. Also, R57, which sets the bias current in the output stage, should be set at its minimum value (i.e., D8 shorted to the base of Q5). The checkout procedure is as follows:

1. Using an ohmmeter, make sure that all sections of the ground plane (on the component side of the board), *except for the one that runs to the right-hand edge of the board,* are connected together. (That section is V_{EE}; the others are AC ground).
2. Plug the unit in, and turn it on. Using a voltmeter, read the voltages between the transformer's center tap (V_{EE}) and the cathode of D1 and the cathode of D3. In both cases the voltage should be 25-volts DC.
3. Referring to voltmeter readings to V_{EE}, check the positive voltage on pin 8 of each op-amp (IC1, IC2, IC6, IC7, and IC9). It should be about 18 volts. The voltage at the ground plane on the left-hand side of the board should be about 10 volts.
4. With the LEVEL and OUTPUT LEVEL controls set at their minimum values, and the DELAY and FEEDBACK DELAY controls set at 50% of full scale, the output (pins 1 and 7) of all op-amps should be about 10 volts.
5. Check the clock pulses at the outputs of the CMOS D flip-flops (IC11-a and IC11-b). The DC reading should be about 9 volts at those points; the AC reading should be 5-10 volts, depending on the type of meter used.
6. To adjust the bias current in the output stage, temporarily connect LED 1 from point "T" to V_{CC}. Current flowing through Q1 and Q2 (also Q3 and Q4) will now flow through the LED. (If you wish, an ammeter can be connected between point "T" and V_{CC} and used in place of the LED for this checkout procedure.) Adjusting R3 will cause Q1 and Q2 to conduct and LED1 to glow. Since distortion is reduced with increasing current level, it is desirable to keep the bias current reasonably high; however, if the current is too high, reliability will be reduced. Carefully touch the power FET's (Q1-Q4) and adjust R57 until LED1 glows brightly but the FET's do not get hot. You should read about 15 mA if you're using an ammeter. After the bias current has been set, LED1 should be installed between R77 and point V and a jumper placed between points "T" and "U."



8-1/2 INCHES

FIG. 9—COMPONENT (TOP) SIDE of the double-sided PC board. This pattern is NOT a negative—there is no foil around many of the holes so the component leads can pass through the board without contacting the ground plane.

Once you've completed the checkout procedure and are sure that everything is correct, the PC board, potentiometers, transformer, and jacks should be mounted securely in the case. The PC board should be mounted on standoffs. The case used, and its layout, are not critical as long as everything fits comfortably (the case shown in Fig. 11 is included with the kit available from the supplier listed in the Parts List).

Setup

The reverberation system is connected to your stereo system using the stereo's tape-monitor output. The output of the delay unit can be connected to a high-efficiency speaker. That speaker is generally placed at the rear of the listening room. Set up that way, the analog reverberation system can simulate the sound reflected from the rear of a concert hall.

Use of the controls on the front panel is reasonably straightforward. The INPUT LEVEL control adjusts the sensitivity of the unit for maximum dynamic range. With the OUTPUT LEVEL control set so that the output level is low (to avoid overloading the amplifier), the INPUT LEVEL control is set so that the level is as high as possible without overloading on loud passages. Initially, the REVERB control should be kept at its minimum position. The DELAY control is adjusted for the desired (first-arrival) delay; this is best done with your system playing at a low level so that both outputs can be heard at the same time. The FEEDBACK DELAY control is not likely to have a dramatic effect on the sound quality. While that control's presence in the circuit breaks up the "standing-wave" effect, its precise setting is unimportant. Adjust the FEEDBACK DELAY control for minimum noise. (The presence of two clock-signals causes a limited amount of intermodulation, heard as whistles and tweets. They are eliminated by adjusting the FEEDBACK DELAY control).

The degree of reverberation is adjusted with the REVERB control. There is a definite threshold where audible reverberation begins. Beyond that point, the reverberation becomes both more pronounced and more artificial; the system will actually oscillate if the REVERB control is turned up too high. Even before oscillation occurs, there is an increase in the peak signal-level that may force you to turn down the INPUT LEVEL control.

The most difficult adjustment to make is setting the OUTPUT LEVEL control. There is a strong temptation to make the delayed signal too loud. Bear in mind that the more subtle the effect of the reverb, the more impressive it will be! That seeming contradiction is something one usually learns the hard way; perhaps this advice will help.

Speaker selection

The choice of a rear speaker is important if the system is to work properly. The delayed channel does not have as wide a bandwidth as the front channel, so a wide, flat, powerful high-frequency driver is unnecessary. With about one watt of power available, efficiency is far more important than power-handling capability.

Looking at some of the "mini-speakers" that are currently on the market can help us understand the reverberation system's speaker requirements. Those small, acoustic-suspension, two-way systems have two notable features: most have excellent high-frequency response, and all are inefficient. Their lack of efficiency prevents them from playing loudly, but their output is more than adequate for most purposes. The high-frequency response is, if anything, a point against that type of unit. The high frequencies do not help the reverberation system

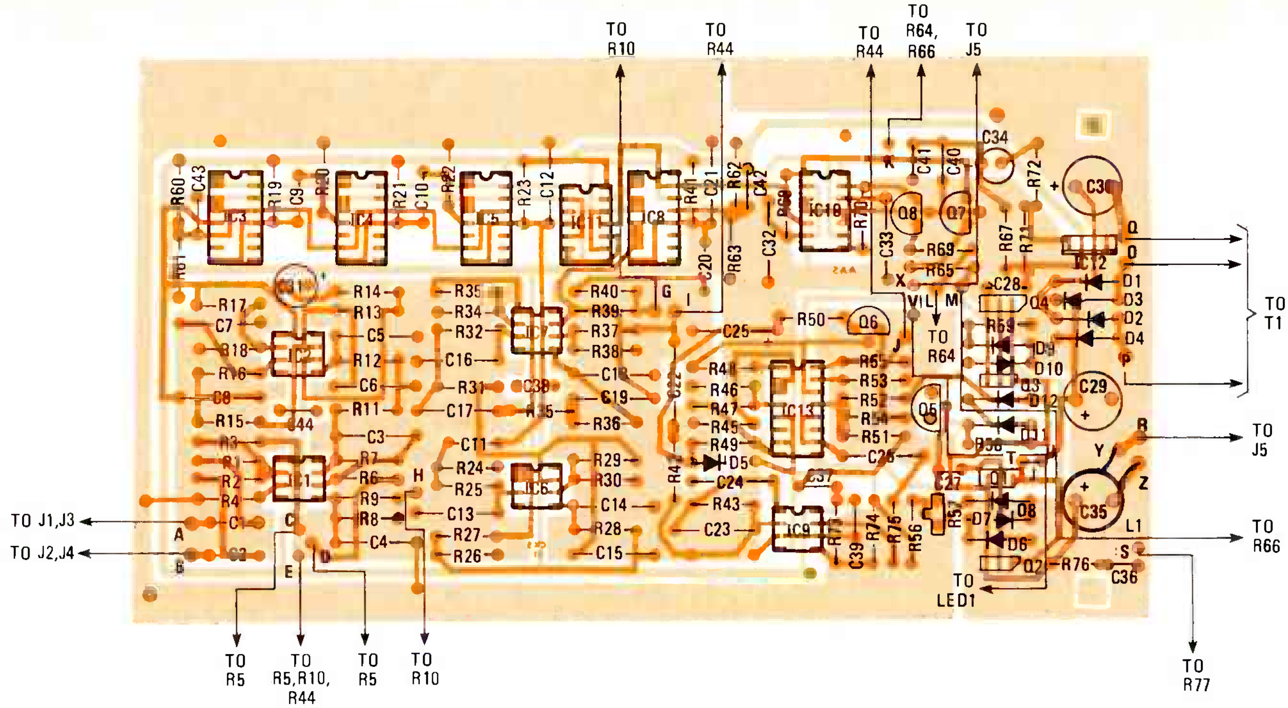


FIG. 10—DOUBLE-SIDED BOARD should be trimmed so that foil on component side is split into two areas to separate areas of differing potential. Also, be sure transistors Q1-Q4 are positioned with beveled edges at lower right.

PARTS LIST

Resistors ¼ watt, 5%, unless otherwise noted

R1, R2, R8, R20, R22, R24, R39, R40, R47, R73, R74—100,000 ohms
R3, R45—200,000 ohms
R4—39,000 ohms
R5, R44—5000 ohms, potentiometer, audio taper
R6, R7, R11, R12, R14-R16, R18, R25, R31-R36, R38—18,000 ohms
R9, R17, R30, R43—30,000 ohms
R10—100,000 ohms, potentiometer, linear taper
R13—5600 ohms
R19, R21, R23, R41, R48—47,000 ohms
R26—24,000 ohms
R27—75,000 ohms
R28—27,000 ohms
R29, R60, R62—15,000 ohms
R37—22,000 ohms
R42, R58, R65, R69, R72, R77—3000 ohms
R46—2000 ohms
R49—100 ohms
R50—43,000 ohms
R51—620,000 ohms
R52—180,000 ohms
R53—360,000 ohms
R54—62,000 ohms
R55—470,000 ohms
R56—5000 ohms
R57—5000 ohms, trimmer potentiometer
R59—20,000 ohms
R61, R63—910 ohms
R64, R66—20,000 ohms, potentiometer, linear taper
R67, R75—200 ohms
R68, R70—300 ohms
R71—7500 ohms
R76—10 ohms

Capacitors

C1, C2, C9-C11, C20—.22 μF, 100 VDC, Mylar
C3-C8, C12-C19, C21, C23, C24, C26—.001 μF, polystyrene
C22—.01 μF, polystyrene
C25, C27, C31, C34—4.7 μF, 16 VDC, electrolytic
C28, C37-C44—.1 μF, ceramic disc
C29, C35—2,200 μF, 25 VDC, electrolytic
C30—1000 μF, 25 VDC, electrolytic
C32, C33—510 pF, ceramic disc
C36—.01 μF, 400 VDC, electrolytic

Semiconductors

D1-D4—1N4002, 100 PIV, 1 amp
D5-D12—1N914
LED1—jumbo red LED
Q1-Q4—VN46QF VMOS transistor (Siliconix)
Q5-Q8—2N4403 PNP transistor
IC1, IC2, IC6, IC7—NE5512 low-noise dual op-amp (Signetics)
IC3-IC5, IC8—TDA1022, 512-stage bucket-brigade device (Philips)
IC9—NE5532 low-noise dual op-amp (Signetics)
IC10—NE556-1 dual timer (Signetics)
IC11—CD4013 dual D flip-flop (RCA)
IC12—μA78MG adjustable voltage regulator (Fairchild)
IC13—NE5517 TCA (Signetics)
L1—10 turns of No. 22 wire wound around C35
T1—36 VCT, 300 mA

Miscellaneous: PC board (double-sided with plated-through holes), case, hardware, etc.

NOTE: The following are available from Advanced Analog Systems, Inc., 790 Lucerne Dr., Sunnyvale, CA 94086 (Tel. 408-730-9786): ARS-911—complete kit including case, $149.95; PC-911—PC board only, $24.00; IC-911—IC1-IC13 and Q1-Q8 only $49.95. Visa and Mastercard welcome. California residents please add sales tax. Prices include shipping (within continental U.S. only).

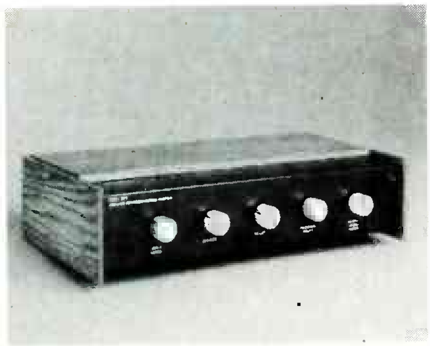


FIG. 11—THE COMPLETED REVERB unit. Enclosure shown is included with kit available from supplier listed in Parts List.

recreate the feeling of a large hall, but instead make any system-noise or distortion much more obvious. We found that disconnecting the tweeter and operating the woofer over the full range gave impressive performance.

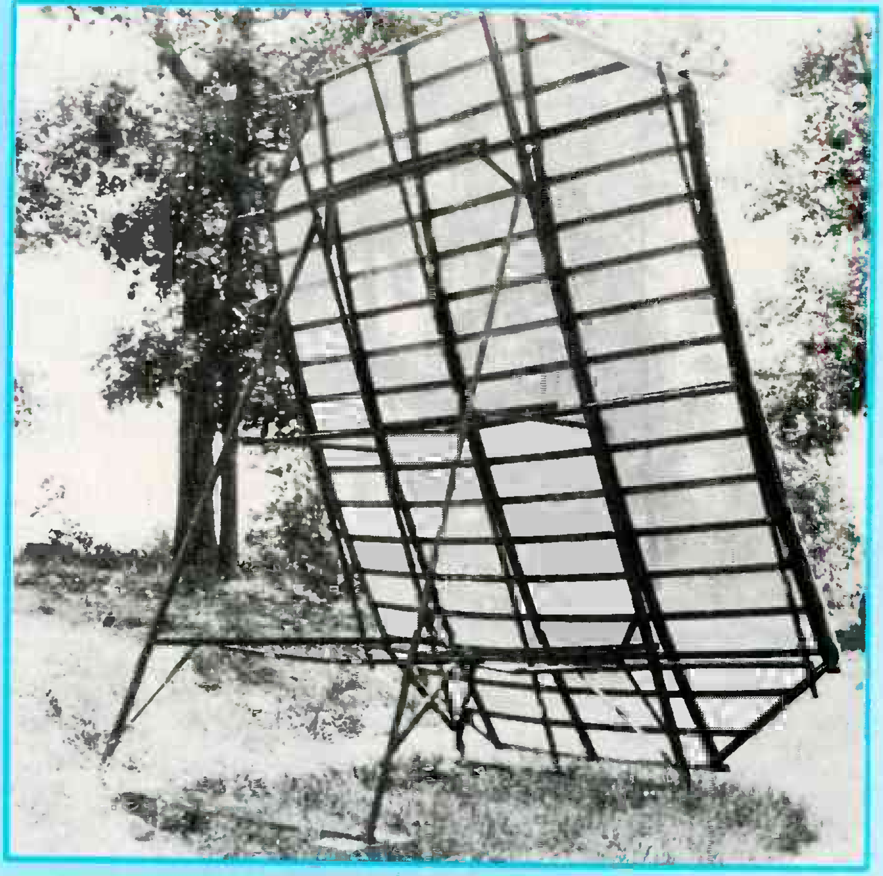
Generally, a single full-range speaker is adequate for the reverberation system. Better still, an array of speakers will help improve the "spaciousness" of the reverberation. As long as there are no gross frequency-response irregularities, the characteristics of most speakers are generally no worse than the frequency-response variations found in actual concert halls. Those variations are caused by the resonances of the reflecting walls and ceilings in the hall, and the frequency-dependent sound-absorption properties of those walls and ceilings.

One major problem that you may have initially is amplifier-overload. It's rather obvious that you won't get rock-

continued on page 95

BUILD THIS

SATELLITE TV ANTENNA



Now that you've built the antenna, you have to set it up and aim it in the right direction. This month we'll show you everything you need to know to complete the project.

BY H. D. McCULLOUGH

Part 3 BEFORE INSTALLING the 8-Ball, you need to know where the satellites that you're interested in are located relative to where you live. That information is needed to position the antenna properly.

Positioning the antenna

Using the graphs in Figs. 23 and 24, and Table 2, you can determine the elevation and azimuth from any location to any satellite. To use the graphs, you must know your longitude and latitude, and the longitude of the satellite. Table 2 shows the positions of the satellites in the Clark belt.

After determining the look-angles (elevation and azimuth) to the satellite(s) desired, you must set the base pads for the necessary azimuth heading. Figure 25 shows how the pads are positioned, and Table 1 (p. 62. Sept. issue) gives the front-to-back and side-to-side dimensions. Pour concrete piers or pads 1 foot square and 2 feet deep (more in loose soil). Set 10-inch long, ½-inch anchor bolts to project 2-3 inches above the surface. (Note that the rear pads are spread farther apart than the front ones. The front pads are 5 feet, 8 inches apart; the rear ones from 7 feet, 4 inches to 8 feet, 2 inches.) Figure 26 shows how the antenna is anchored on the pads.

If you are primarily interested in receiving signals from one satellite, then face the antenna toward the azimuth heading of that "bird" and, for elevation look-angles of 30 degrees or less, tilt the antenna back from the vertical an amount equal to *half* the elevation look-angle of that satellite. The focal point (and the horn/LNA location) will be 6-feet high and directly in front of the dish. (Refer to Fig. 4-a in "How the 8-Ball Got Its Shape", P. 61 in the September issue)

For elevation look-angles greater than 30 degrees, tilt the antenna back 15 degrees *less than the look-angle*. (See Figs. 4-b and 4-c of "How the 8-Ball Got Its Shape" as mentioned above.) Figure 27 shows how the antenna's tilt angle can be checked using an inclinometer. The inclinometer is made using a protractor, string, and plumb-bob.

Once the reflector is positioned fairly close to the desired azimuth and elevation settings, find the satellite by pointing the feed horn directly toward the center of the dish, and then moving the horn up and down and side-to-side around the point where the focal point should be. The best focus (and best picture) will be about 15 feet from the center of the dish. That assumes that you have an LNA, receiver (down-converter), and TV set all properly connected. Place the TV set where you can see it while positioning the antenna feed horn.

If you want to receive more than one satellite, position the reflector midway between the azimuth headings and elevation look-angles of the two satellites that are farthest apart. Just be sure to be within 15 degrees of the bore-sight direction of the satellite you are primarily interested in.

See Fig. 28 for the focus-point locations for seven satellites. The heading

TABLE 2

Satellite	Location (Degrees West) Longitude
Comstar III	87
Westar III	91
Comstar II	95
Westar I	99
Anik I	104
Anik B	109
Anik III	114
Satcom II	119
Westar II	123.5
Comstar I	128
Satcom I	135

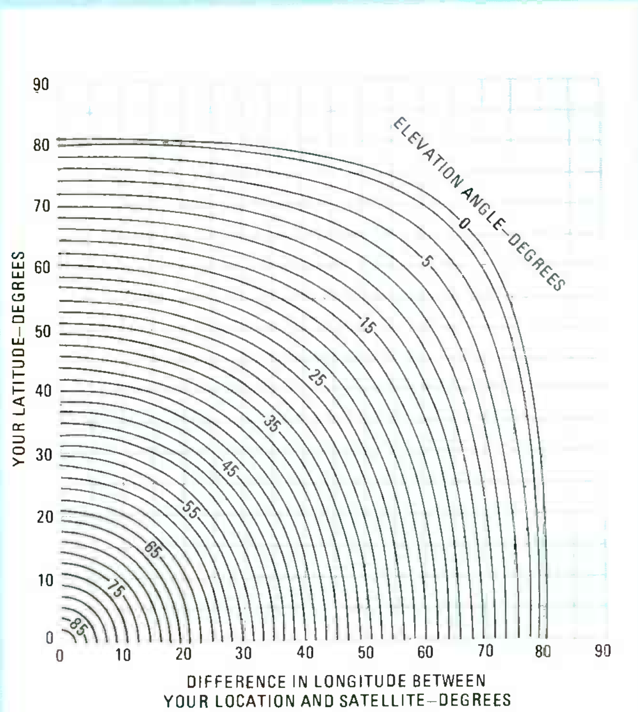


FIG. 23—ELEVATION ANGLE of the satellite can be determined easily by using this chart. Find the difference in longitude between the satellite and your location on one axis, and your location's latitude on the other. The point of intersection falls on a curve showing elevation angle.*

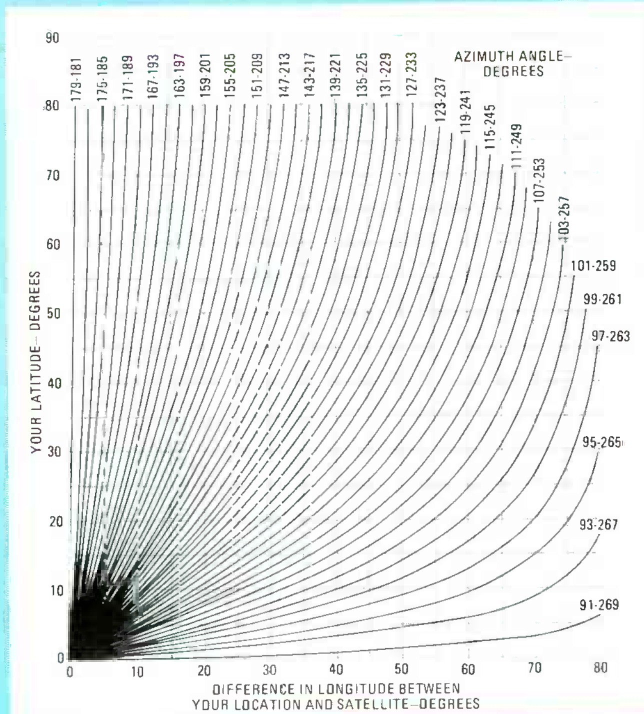


FIG. 24—AZIMUTH ANGLE is determined from this chart. The azimuth angles of 179 degrees and less are for satellites east of your location; angles of 181 degrees and up are for satellites west of you.*

(azimuth) given (220 degrees) is only accurate for one location—northern Arkansas—but the relative positions of the focus points (Fig. 28-a) will be the same anywhere.

The elevation look-angle will be largest for a satellite that is due south of your location. Notice that the greater the elevation angle, the lower the focus point will be for any specific angle you have tilted back the dish. The satellites used in the example in Fig. 28 are all west of due south and the most westerly satellite (Satcom 1) gives the highest focus point. Notice also that to receive all seven satellites with maximum efficiency, the dish has to be tilted back enough to accommodate the satellite with the highest look-angle (30-degree tilt in this example to match Anik I which has a look-angle of 45 degrees). That results in the focus point for Satcom I (the lowest look-angle) being rather high off the ground.

For that reason, and the fact that our experiments required moving the LNA/feed horn around, the test antenna was oriented more toward Satcom I, with signals still received with good efficiency from Comstar I, Westar II and Satcom II. The signals from the Anik were

*Figures 23 and 24 are reprinted through the courtesy of CATJ. They originally appeared in the November 1978 issue of that publication.

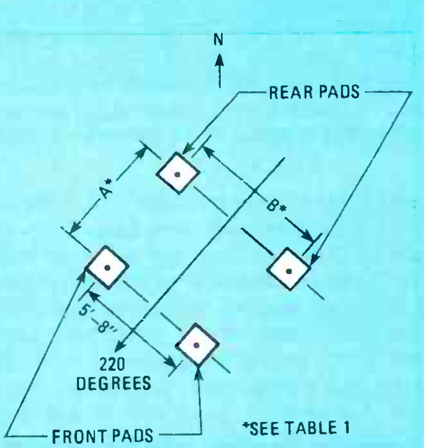


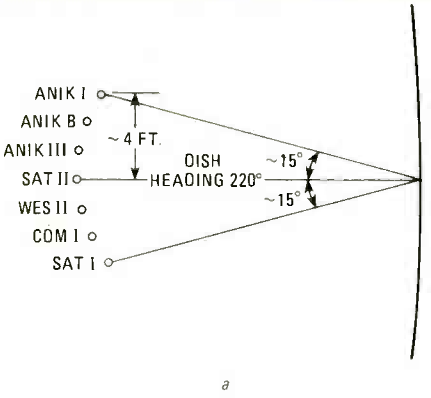
FIG. 25—MOUNTING PADS ARE POSITIONED according to the azimuth heading of the satellite you want. Here, the azimuth is 220 degrees, suitable for receiving satellites with azimuths from 205 to 235 degrees.

FIG. 26—CONCRETE BASE PADS support and anchor the four corners of the antenna. Anchor bolts and "J" clips secure the antenna to the pads.

FIG. 27—A SIMPLE INCLINOMETER (a protractor, string, and plumb-bob) used to check the tilt angle of the antenna. With the protractor against a vertical rib, read the angle where the string crosses the scale.

watchable, but not "clean." The problem of high off-the-ground focus points does not exist in the far Northern latitudes, where elevation look-angles are low for ALL satellites.

A feed horn is available from the supplier listed. If you decide to build your own, see Fig. 29 for the dimensions of the horn that gives the best results of all that we've tried. Ordinary galvanized sheet metal seems to work fine. Brass or silver may be better, but probably not much.



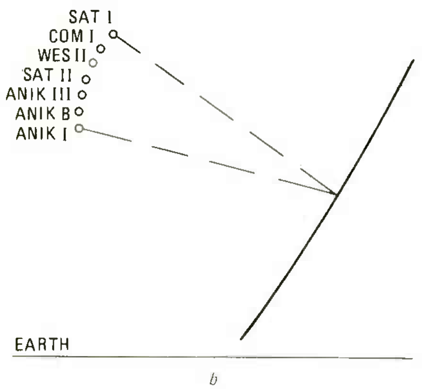


FIG. 28—HOW FOCUS POINTS ARE LOCATED: A top view of the antenna (*a*) shows the relative locations of the focus points for seven satellites. The side-view (*b*) shows the vertical position of the LNA horn for satellites.

FIG. 30—THE LNA/FEED-HORN ASSEMBLY can be mounted inside a length of PVC pipe as shown here.

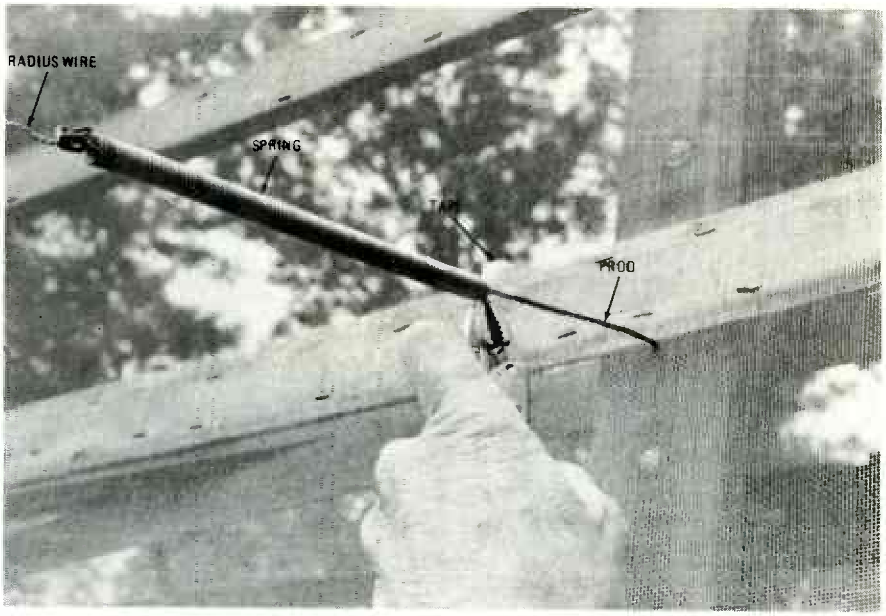


FIG. 31—RADIUS WIRE, 30 feet long, is used to check the reflector's curvature. Adjustment bolts are set so that all points on the surface are exactly the same distance from the radius point.

A simple and inexpensive way to mount the LNA/feed horn is shown in Fig. 30. Attach the horn to the LNA and slip it inside a piece of 5-inch plastic pipe, 10 inches long. Secure it with any small brackets and spacers. Slip the 5-inch pipe inside a piece of 6-inch pipe, 12 inches long. Place soft spacers or pads between the pipes so that the inside pipe will rotate, but with enough friction to hold it in place. The assembly can be mounted on a board, with a motor attached to rotate the LNA for polarity selection.

Final alignment

After the antenna is in place on the base pads, you should adjust it for a precise curve. A simple way to do that is to tie a radius wire to a point 30 feet directly in front of the center of the dish, then check the antenna surface near each adjustment bolt and adjust so that every part of the dish is 30 feet from the radius point.

A radius wire with a spring-loaded end is best for this. The spring-loaded end is fairly easy to make. The prod is simply a piece of coat-hanger wire, about 15 inches long, with a loop at one end. The actual length of the prod is not critical as long as you remember that the total length of the radius wire and the prod should be approximately 30 feet. Slip a moderately-stiff spring over the hanger-wire prod and attach the spring and the radius wire to the loop as shown in Fig. 31. The spring makes it easier to hold a constant tension on the wire throughout the adjustment procedure; simply stretch the spring the same amount for each adjustment. A piece of tape can be stuck to the prod and used as a reference point as shown in Fig. 31.

To keep the spot where the radius point is tied from being too high off the ground, it may be necessary to tilt the antenna forward. If you do that, be sure to raise the two rear legs by the *exact* same amount so you don't warp the antenna. Also, if you tilt the antenna to a near-vertical position, tie it down temporarily to prevent it from being blown over during the adjustment.

The radius point can be located by trial and error. First attach one end of the radius wire to a point about 30 feet (the exact distance is not critical as long as it is close) directly in front of the center of the dish—or as near the center as you can tell by looking. Then with the spring end, check across the middle of the dish surface left to right to see if one side is closer to the radius point than the other. Move the radius point to the left or right as necessary to get the best "fit" across the dish. Repeat that procedure going from top to bottom, adjusting the radius point up or down for the best "fit."

Once the radius point is set, move each adjustment bolt in or out where the bolt goes through the frame so that the prod on the end of the radius wire just touches the screen when the spring is stretched to where it just touches the piece of tape on the prod.

It is important to take your time and do this right. With two people, you should be able to set the surface to within 1/16-inch in 30 minutes or so. If you have the dish tilted forward when you complete the adjustments, carefully lower it back in place and sight across the edge of the dish to make sure there is no twist in the surface. If necessary, put a shim under a rear leg.

Probably the easiest way to get the reflector surface out of "true" and lose the effectiveness of the antenna is to

continued on page 110

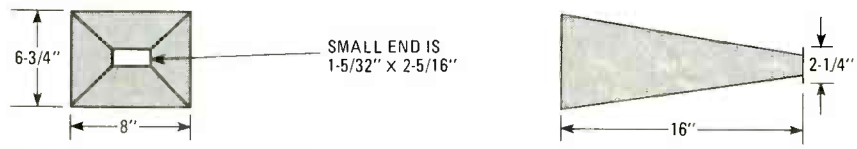


FIG. 29—FEED-HORN DIMENSIONS. Use these to build your own horn from sheet metal or a simlar material.

Radio-Electronics®

OCTOBER 1981

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- Setting up a system

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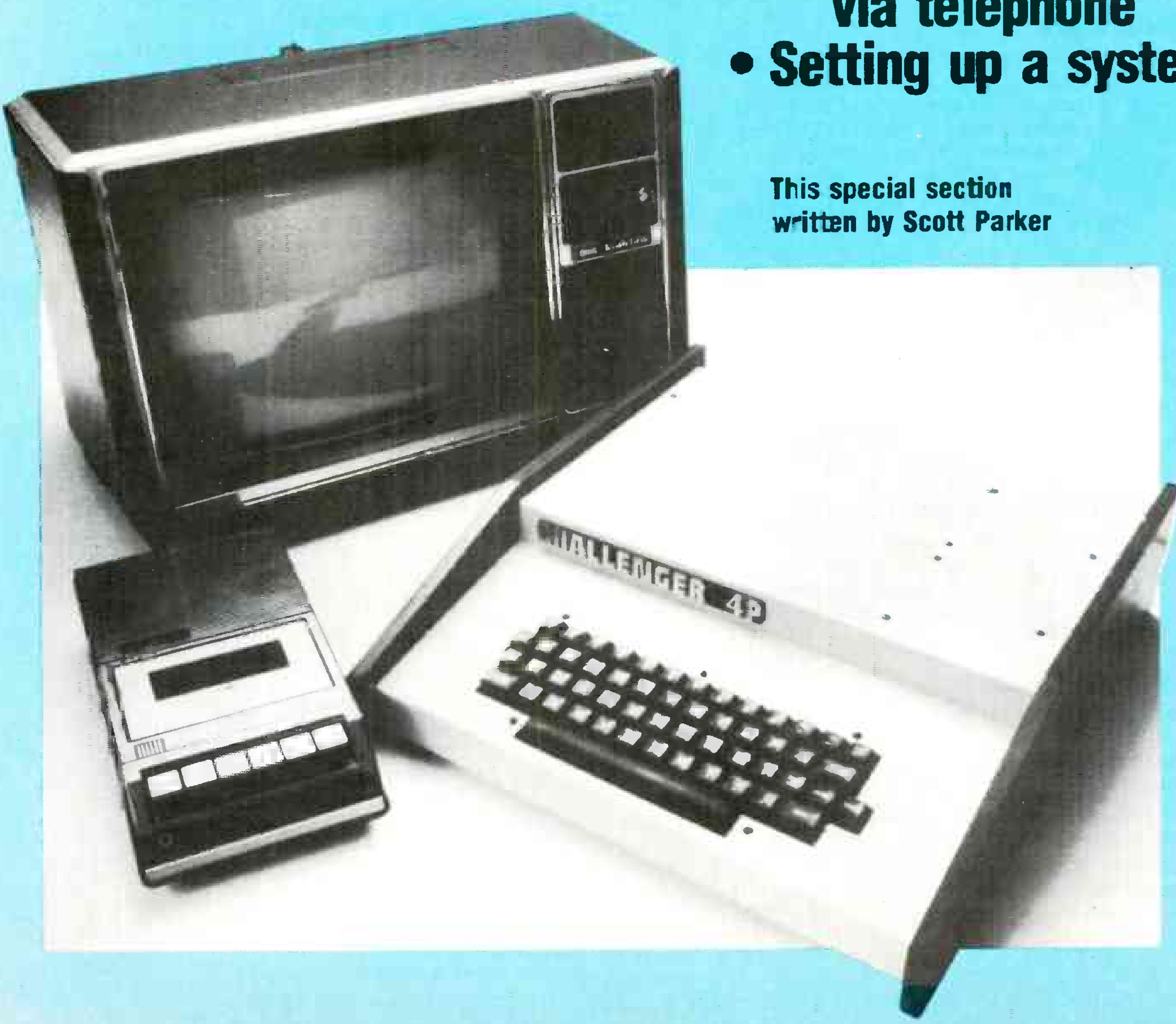

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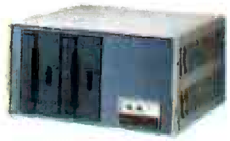

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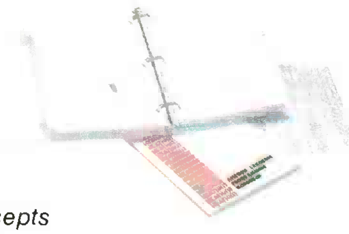

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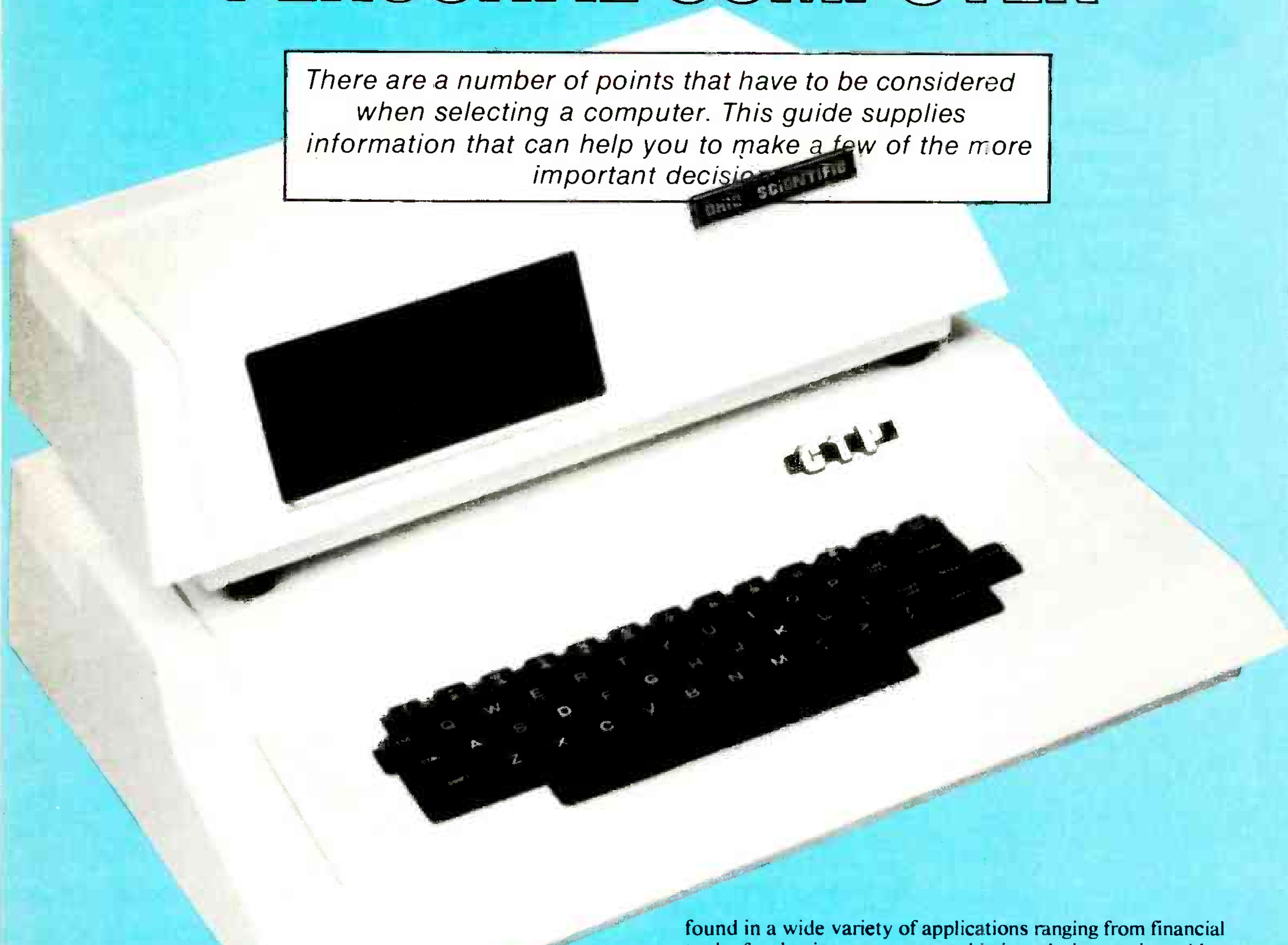
WHAT TO LOOK FOR IN A PERSONAL COMPUTER

There are a number of points that have to be considered when selecting a computer. This guide supplies information that can help you to make a few of the more important decisions.



WHEN PERSONAL COMPUTERS WERE FIRST INTRODUCED, SIX years ago, they were a novelty to be enjoyed only by a few dedicated hobbyists. But today, the personal computer has advanced far beyond that initial, limited use and is now found in a wide variety of applications ranging from financial tools for businessmen to sophisticated, interactive video games for the consumer.

For those of you who have not yet been bitten by the computer bug, there are probably a lot of unanswered questions that are bothering you. For example, you might want to know just what a personal computer system is and what it's composed of. How is it possible for something to be both an aid for the businessman and a toy for a youngster? While some of those things may bewilder you at first, once you understand some of the basics of personal computers, it will be easy for you to answer such questions.

Getting down to basics

To begin with, let's take a look at just what a computer system is composed of. In its simplest form, a computer system can be broken down into four basic elements as shown in Fig. 1. The first is the central processing unit (often abbreviated CPU) which handles all of the computations and controls everything connected to the system. That is the "brain" of the system.

In order to send information to the central processing unit, it is necessary to connect some sort of input device to the system. When large mainframe computers were in their heyday, one of the most common input devices was a punch-card reader. With personal computers, typewriter-like keyboards and CRT terminals are the most common input devices.

Getting information *into* the computer is only half the job. It must also be possible to get information *out* of the computer. Two common ways of outputting information are by using a printer or a video display.

The last block in our generalized drawing of a computer system is memory. Memory is a very important component in any computer system. It allows the computer to perform calculations and store temporary results for later use. It also makes it possible to use the computer like an electronic filing cabinet. The amount of memory that is available has a great effect on the complexity of the programs you can run on the computer. The more memory you have, the more complex the programs that can be handled.

Getting a closer look

Now that we have an overall idea of what a personal computer is, let's take a closer look at the individual components. All personal computers available today use a microprocessor as the central processing unit. Also known as a computer-on-a-chip, a microprocessor is an integrated circuit that contains all the circuitry necessary for it to act as the "brain." It usually contains several temporary storage registers and something known as an arithmetic logic unit (sometimes abbreviated ALU). The ALU is a logic circuit that manipulates and transforms the data.

There is a wide variety of microprocessors available today, but the most commonly used ones are the 6502 and the Z80. Which one is better? Does it really matter? Should you select the computer you are going to buy based on the microprocessor used? Answering the last question first: Unless you have a very specific reason for using a particular microprocessor, such as wanting to use CP/M-based software, your choice of computer should not depend on the type of microprocessor used. That statement is probably going to upset some people, but they are mostly dedicated hobbyists who are interested in getting into the nuts and bolts of things. For the majority of people, who are interested in eating an omelette and not in how an egg is laid, the question of which microprocessor is used is irrelevant.

To be sure, there are some significant differences between the Z80 and the 6502: but unless you're going to write

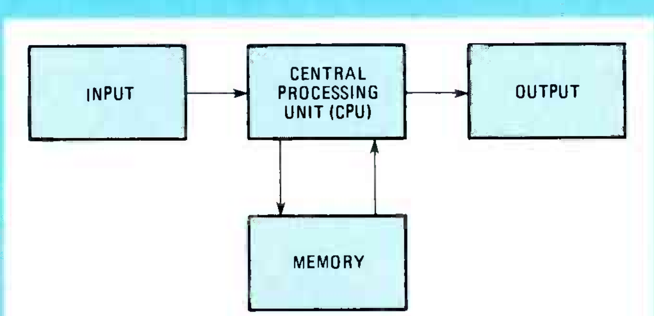


FIG. 1—The CPU is the heart of the system and manipulates and routes all the data handled by the computer.

THE IMAGINATION MACHINE, from APF, with peripherals.

machine-language programs, you'll never notice them. When the *PET* and *TRS-80 Model I* computers were first announced, a lot of people wanted to buy the *TRS-80* because it had a Z80 microprocessor with a speed specification that was twice as fast as that of the 6502 (in the *PET*). It also had a more powerful machine-language instruction set. That seemed to mean that anything containing a Z80 should be faster and more efficient than its 6502 counterpart—but such was not always the case.

One example is Sargon II, a popular chess program for personal computers. If one compares the *TRS-80* Z80 version to the *Apple II* 6502 version, one finds that the *Apple II* implementation is significantly faster than the *TRS-80* version, even though the *TRS-80* is operating at a clock speed that is almost twice that of the *Apple II*. That does not mean that *all* 6502 software is faster than all Z80 software; it only means that unless you take advantage of all the subtleties associated with the various microprocessors, you're not going to reap all of the potential advantages.

For CP/M use a Z80

The one exception to my previous statement about the unimportance of the microprocesor used arises if you are considering using the CP/M (*C*ontrol *P*rogram for *M*icrocomputers) operating system. That is a popular operating system that is compatible with a lot of business software. It is compatible with the 8080 and Z80 microprocessors, as well as some of the newer microprocessors introduced by Intel. While it is possible to use CP/M on an *Apple II* computer (which is a 6502-based machine), to do so requires the installation of an accessory card that contains a Z80 microprocessor.

While the microprocessor is rightly considered the "brain" of the system, it would not be possible for it to do very much without some memory. There are several different types of memory used in computer systems. Some contain information and instructions for the microprocessor that always remain the same and must be available to the CPU whenever it is powered up. That type of memory is known as ROM (*R*ead-*O*nly *M*emory) and is generally provided by the manufacturer of the computer because it is usually not modified by the user. (To do so would require changing some of the integrated circuits within the computer.)

The main advantage of ROM's is that they never lose the information that is stored in them, even if the power to the computer is removed. For that reason, computer manufacturers generally build into the computer a set of ROM's that contain a special program called the monitor.

For those of you who are not familiar with it, a monitor program is a short machine-language program that is capable of handling some of the elementary functions required by the system. Those include interfacing to the keyboard, so that data can be entered, and generally an interface to a video circuit so that information can be displayed.

Not all of the memory for a computer system is of the ROM type. And in fact, much of the memory in a computer *must* have the ability to be easily and quickly changed. That type of memory, known as RAM (*R*andom *A*ccess *M*emory) can be changed at will and is the type of memory that is normally used to store a person's own programs. It is also used as temporary storage for variables used by the program being run. Unlike ROM's, RAM's have the disadvantage that as soon as power to the computer is removed, they lose all of the information that was stored.

How much memory is enough?

A question frequently asked by new and prospective computer users is, "How much memory do I need?" The answer is: It depends on the user. Just as a gas always expands to fill the volume of the container that it is housed in, programmers will tend to use as much memory as is available. A corollary to that rule is that no matter how much memory you have, somehow it is never enough.

Computers come with a wide range of memory sizes. They range from 4K for the *TRS-80 Color* computer to 128K for the new *Apple III* computer. For games and home applications, 4K to 16K of memory is generally sufficient, but for business applications 32K and 48K is required. And if you want to use CP/M, 56K of memory is generally needed.

The ins and outs of computers

It is frequently necessary or desirable to connect additional equipment to a personal computer to perform a certain task. One common piece of equipment is a printer for producing printed reports and program listings. Further peripheral devices that can be connected to a computer include: plotters, modems, graphics tablets, music synthesizers, speech sythesizers, speech processors, EPROM programmers, and a host of other devices.

THE APPLE III, with built-in disk drive.

With the possibility of connecting all of those devices to a personal computer, some thought must be given to how they are connected. In general, there are two ways in which peripheral devices can be connected to a computer: via a serial interface (or port), or via a parallel one. Each has its advantages and disadvantages.

If the distance between the computer and the accessory is going to be a large one, it is best to use a serial interface. The reason for that is that only a relatively few number of wires is needed. That reduces the cabling cost, but more importantly reduces the susceptibility to stray noise pick-up. A limitation of this approach is speed of data transmission, since data are sent serially, one bit at a time, until all of it has been sent.

Since a lot of devices communicate with computers in a serial fashion, the industry has developed a standard serial interface that simplifies the interconnection of peripherals. That standard is known as RS-232C and it defines the type of connector to be used and which pins on the connector contain which function.

Do it faster in parallel

For short distances, and where it is very important to transfer data quickly (such as to a floppy disk), a parallel interface is used. With such an interface, 8 or more bits of information are sent to the peripheral device simultaneously.

Unlike serial interfaces, where there is one dominant method of interconnection, several exist for parallel interfaces. Two of the most common are the Centronics-compatible printer-interface standard and the IEEE 488 interface standard. While the former is used almost exclusively to connect to printers, the latter is frequently used to connect to scientific instruments and other computers as well as printers.

Each interface connection is called a port. There are two types of ports, input and output. A single port can either input data or output data, but not both. If you want to connect a device that only receives data, such as a printer, then the device must be connected to an output port on the computer. A device that both receives and sends data requires two ports; an input port and output port. Both input and output ports can be of the serial or parallel type. In addition to ports, a computer generally has its own internal connectors, called a bus structure, whereby additional circuit boards can be added to the computer. Using those connectors, you can add circuit boards that contain additional RAM memory, input and output ports, and various other circuits. In the *Apple II* computer, for example, there are 8 internal connectors into which external devices can plug. The *TRS-80 Model I* also has a provision for connecting external devices to it, but those require an extra piece of hardware known as the expansion interface.

How many ports you will need depends on how many accessories you want to connect to the computer. In general, the manufacturer's standard configuration for the computer provides sufficient room for most accessories that will be available for it.

Keyboards vary with the computer

The keyboards that are available on today's personal computers vary quite a bit, and it is wise to pay attention to that when you think about buying a computer. Most people are familiar with typewriters and their keyboards, so it is not surprising that most manufacturers of personal computers and computer terminals have opted for a keyboard that is similar to that on a typewriter.

Some manufacturers however, felt that they could provide more functions in a smaller space (or save money), by using the widely available and inexpensive calculator-type switches for a keyboard. The public has resisted that. People know how to use a typewriter and many are even quite proficient with it. But the calculator-type keyboards have non-standard spacing and do not permit touch typists to work efficiently. Commodore discovered this the hard way with their 8K *PET 2001* computer and after a few years gave up and came out with a unit that had a standard typewriter keyboard on it.

Texas Instruments, which was a latecomer to the personal computing field, unfortunately did not learn from Commodore's mistake and had to find out for itself that the public

THE ATARI 800. Top opens to accept plug-in modules.

THE H89 ALL-IN-ONE-computer from Heathkit.

wants a typewriter-quality keyboard on its computers. The result was that its *99/4* computer was not as successful as it could have been. But like Commodore, they did learn and have recently introduced a new version of the computer known as the *99/4A* which has a full-size typewriter keyboard in it. Already TI has indicated that there has been a substantial increase of interest in its computer because of that.

Typewriter compatibility is not the only important factor to be considered with keyboards; configuration is, too. Some keyboards go a step beyond and include, in addition to the standard typewriter keyboard, a numeric keypad on the right-hand side of the keyboard to speed the entry of numeric data. Radio Shack offered that initially as an option on their early *Model I* computers, and found it so popular that they made it a standard feature. And, because the *Apple II* computer does not have this feature, an independent manufacturer has developed an add-on set of numeric keypads.

While most typewriters can be used to produce both upper and lower-case letters, some of the early computers could only produce upper-case letters. For most applications, that was OK. But when people started to use those computers as word processors, a serious problem arose because the computers didn't support lower-case letters. Ingenious programmers overcame the limitation by writing special software to accommodate the lower-case characters, and even more ingenious hardware designers figured out ways to display those lower case letters on the screen.

How wide is the display screen?

One thing that should be considered when purchasing a personal computer is the number of characters it can display on the video screen. Depending on the computer, you will be limited to 40, 64, or 80 characters per line. Apple, Atari and *PET* computers are limited to 40 characters. The primary reason is that they use standard television technology for the display, and that is inherently limited to 40 characters per line. The *TRS-80 Model I* and *Model III* computers use a specially designed monitor so that they can display 64 characters per line, while the *TRS-80 Model II* and the *Apple III* use standard video monitors and can display 80 characters per line.

The desirable line length is 80 characters, because that is roughly what you get on a piece of paper in a standard typewriter. Shorter line lengths limit the amount of information that can be displayed on the screen at one time and make the presentation of columnar data difficult.

In addition to the line length, the user interface to the information displayed on the screen is important. Most personal computer systems have what is known as memory-mapped video displays, which simply means that the memory dedicated to displaying information on the screen looks like any other memory in the computer and is treated as such. That means that it is possible to write to the screen by storing data in specific memory locations directly, rather than through the standard video-output circuitry.

Most personal computers have a blinking prompt, either an underline or a little square, that is called a cursor. Frequently the ability to move that cursor anywhere on the screen in combination with internal software makes it possible to edit things that appear in the screen. That is a feature of the Atari, Apple and *PET* computers. Radio Shack has opted for the line editor approach where only numbered lines can be edited. While this has some definite advantages, it also has some shortcomings and programmers have come up with screen-editor programs for the *TRS-80* to make it more flexible. **R-E**

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RCA MICROCOMPUTER MARKETING
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2000 hrs BATTERY LIFE

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CIRCLE 54 ON FREE INFORMATION CARD

FLOPPY DISKS ADD VERSATILITY

Floppy-disk systems are not inexpensive, but the advantages they offer frequently makes them worth their cost.

THE MORE YOU USE YOUR COMPUTER, THE MORE YOU WILL learn about it. You will soon want to put the computer to practical use. Unfortunately, complicated tasks require a sizeable amount of computer memory and you will soon need more memory than is available with your computer's internal RAM. Also, you will want a fast method for saving and loading your computer programs. You can enter programs using the computer's keyboard, but for long and complicated programs this method is tedious and time consuming.

The solution to those problems is to add a mass-storage device to your computer. A mass-storage device, such as a floppy-disk system or an audio cassette-recorder, will increase your computer's memory capacity. In addition, a mass-storage device provides a nonvolatile method of storing programs and data.

Chief among the advantages of a floppy-disk system over cassette tapes are higher speed and faster access time. Yes, a cassette recorder is cheap, fairly reliable, and easily adaptable to a personal computer. But it is slow, with a typical data-transfer rate between 30 to 150 characters-per-second (CPS). This means it may take as long as five minutes to load 10K of RAM. A floppy disk is faster and has other distinct advantages.

Access is faster since the read/write head in a floppy-disk system can reach a desired block of information without the need to pass through preceding data; that is termed random-access. On the other hand, data stored on a cassette tape is recorded serially, so all data preceding a desired block of information must first pass by the read/write head.

Let's illustrate what long access times can mean. A typical audio cassette used for small personal computers operates at a speed of 1.875 inches-per-second, and a 60-minute or 500-foot tape can store 500K bytes. To read one side of a cassette would take 30 minutes. Suppose you were to enter a list of names and addresses into your computer and then store it on cassette tape. If you then wanted to retrieve a particular name and address that was in the middle of the list, it would take 15 minutes to locate the address. A floppy-disk system with its random-access capability would retrieve that particular address in less than one second.

Once the particular block of information was located, the cassette recorder would transfer the data to the computer at a much slower rate than a floppy-disk system would. Stating it another way, a cassette system may have a data-transfer rate of 500 bits-per-second, compared to 15,600 bits-per-second for a 5¼-inch floppy disk, and 31,000 bits-per-second for an 8-inch floppy disk. (Eight bits are required for each character transferred. Also, bits-per-second is commonly referred to as baud rate.) In addition, most cassette recorders require manual operation, whereas a disk drive runs automatically after the disk is inserted.

Each 8-inch floppy disk can store up to 500K bytes (single-sided, double-density) or one megabyte (double-sided, double-density) of data. The smaller 5¼-inch diskette can store about 180K bytes (single-sided, double-density) or 360K bytes (double-sided, double density).

What is a floppy disk?

The flexible or floppy disk was introduced in the late 1960's by IBM to replace keypunch cards. It is soft and easily bent: hence the name "floppy disk". The disk is currently available in two sizes. 8-inch (203 mm) and 5¼-inch (135 mm). The smaller 5¼-inch floppy disk is commonly referred to as a minifloppy diskette. The size is a measure of the sides of a nonremovable square cardboard jacket that houses and protects the .003-inch thick, flexible Mylar disk. The disk is coated on both sides with a layer of magnetic oxides and revolves inside the protective jacket. The 8-inch disk rotates at 360 rpm while the minifloppy runs at the slightly slower speed of 300 rpm.

During reading or recording, a read/write head makes light contact with the disk surface. When data is not being written to or read from the disk, the read/write head is lifted from the disk surface to reduce wear.

As shown in Fig. 1, the jacket does not totally cover the Mylar disk. There is a slot to allow the read/write head to contact the oxide, a center hole to permit the drive-motor spindle to rotate the disk; an index hole to provide specific timing information, and a notch (optional on the 8-inch disk, always present on the 5¼-inch disk) for "write-protection" to avoid accidental erasure of data recorded on the disk.

The "write-protect" notch is similar to the plastic tab on cassette tapes; when the tab is snapped off, the tape cannot be re-recorded. On a 5¼-inch floppy disk, the "write-protect" notch is covered to write-protect the disk and thus prevent wiping out programs and data stored on it. The procedure is reversed with the 8-inch disk. If the optional write-protect notch is present, it is covered to write-enable the disk.

Tracks and sectors

In some ways, a floppy disk is similar to a phonograph record. A record stores music within grooves on a plastic surface; a floppy disk stores data as a sequence of magnetic pulses on a smooth magnetic surface. To read, or sense, the music on a phonograph record, a needle rides in the spiral groove and its mechanical vibrations are converted into electrical signals. In a disk system, there are no grooves; instead there are invisible tracks along which magnetic pulses are recorded. To read the data, a magnetically-sensitive read/write head is placed over the track while the disk is rotated. When data is to be stored on a floppy disk, the read/write head either changes the magnetic state of the oxide area it is contacting or else makes no changes; that produces the equivalent of a logic "1" or "0".

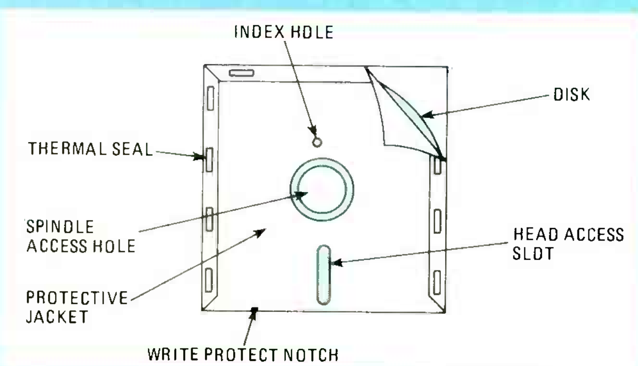

FIG. 1—THIN MYLAR DISK with its oxide coating is protected by a non-removable jacket.

Continuing the analogy to a phonograph record, music is recorded in one continuous groove or track on the record surface, starting from the outermost edge of the record to the center hole. That arrangement is fine, since the music will be played from start to finish—generally without the need for interruption. In a floppy-disk system, a great deal of data will be stored and fast access to any particular section of the data is essential. Now think how difficult it would be to locate a particular passage exactly on a phonograph record. It's not easy, but fortunately it's not often necessary.

To allow more rapid access of data on a floppy disk, a series of concentric tracks is arranged, with each track located at a specific distance from the center (or the edge) of the disk, as shown in Fig. 2. Now each track can be identified easily or addressed by its specific location. Although there is a standard number of tracks (77) in the IBM 8-inch disk format, some manufacturers use different numbers of tracks. Some floppy disks are single-sided, with data stored on one side of the disk, while others are available with tracks and data stored both sides (double-sided floppies).

Although it is easier to locate a specific section of data using concentric tracks instead of a single continuous track, let's consider some of the drawbacks. If an 8-inch disk is divided into 77 tracks and various blocks of data (files) are assigned to individual tracks, there may be some degree of inefficiency. It is possible that one file may contain a relatively small amount of data; thus the track assigned to this file would barely be used. Another file may be much larger and use almost an entire track. A third file may require a bit more than one track and thus be assigned two entire tracks, again with little data on the second track.

To improve efficiency, tracks are divided into sectors, as shown in Fig. 3. Now data can be placed, and located quickly, by assigning a specific track and sector as its address. In the IBM format, for example, each 8-inch disk is divided into 77 tracks with 26 sectors per track for a total of 2002 sectors. Each sector holds 128 bytes or 1024 bits of information. Thus, a short file might fill a dozen sectors while a larger file could use an entire track of 26 sectors.

To locate the sectors on the surface of the floppy disk,

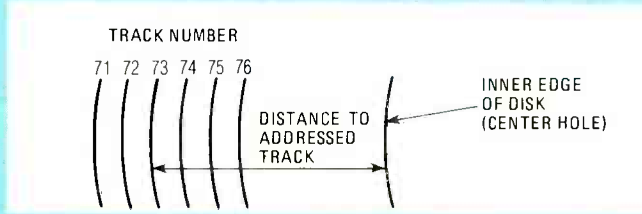

FIG. 2—THE SURFACE of the floppy disk is divided magnetically into concentric tracks for data storage.

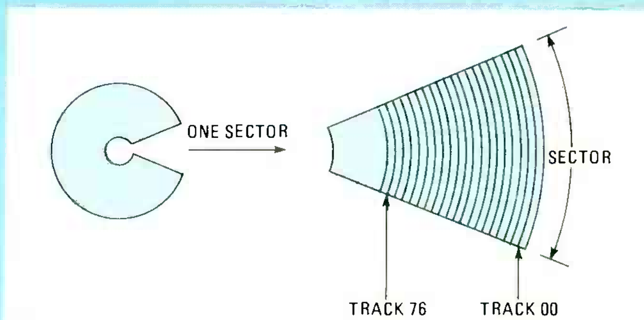

FIG. 3—EACH TRACK is divided into sectors so that the data can be stored more efficiently.

either soft-sectoring or hard-sectoring is used. A soft-sectored disk has a single index hole; sector locations are identified by information recorded on the disk. That information must be stored within the sector and thus reduces the disk's actual storage capacity. A hard-sectored disk (Fig. 4) uses a number of punched holes to act as index markers; this scheme is about 25% more efficient in data storage. Hard-sectored disks contain 10 to 16 holes (32 holes in the case of some 8-inch disks) in addition to the index hole that is centered between two of the sector holes. Circuits in the disk controller sense the shorter spacing between the index hole and the holes on either side of it and thus the system is aware of the starting point.

Still another analogy to the phonograph record: Just as an audiophile builds up a distinctive collection of choice records lovingly, so too can a computer buff collect pre-programmed disks or disks that he has written and perfected. Disks, just like records, can be exchanged to permit other users to borrow special programs without the need to develop them. However, to exchange software via floppy disks, the formats of the disks must be compatible. In other words, you can not purchase software recorded on a 5¼-inch hard-sectored disk and enter it into your computer if your floppy-disk system requires soft-sectored disks.

One final analogy. Audiophiles take precautions when they handle their prized records; they hold the records by the edges to prevent fingerprints, dirt, or body oils from penetrating the record grooves and thus mar the fidelity of the sound. Floppy disks are considerably more vulnerable to careless handling; a dust particle or a strand of human hair deposited on the surface of a floppy disk could damage a number of sectors or impair good contact between the read/write head and the oxide coating. For that reason, users are advised to store the disk in its original envelope after use.

Floppy-disk formats

To promote the exchange of software among users, the computer industry has adopted the IBM 3470 format as a standard. Unfortunately, that standard can only be applied to 8-inch disks. If you are contemplating the purchase of a floppy-disk system, you should be aware that there is no industry-standard format for 5¼-inch disks. Also, if you are contemplating the purchase of an 8-inch disk system, you should make sure that the system is compatible with the IBM 3470 format.

The IBM 3470 format is shown in Fig. 5. The disk is divided into 77 tracks or concentric circles, with the count (00) starting at the outer edge; the innermost track is No. 76. Each track is subdivided into 26 sectors. Thus, there are 2002 sectors on a standard single-density 8-inch disk. The sectors are identified by soft-sectoring. Each sector is further subdivided into four sections; one to identify the sector and track number, one to accommodate 128 bytes (or 1024 bits) of data, and two gaps to separate the ID and data sections. The ID and data sections are further broken down so that in addition to containing the ID and data information, they contain pulses that are used to synchronize the controller circuitry to allow for variations in the rotational speed of the floppy disk. The ID and data sections also contain error-checking bits so that the controller circuitry can recognize an error when it occurs.

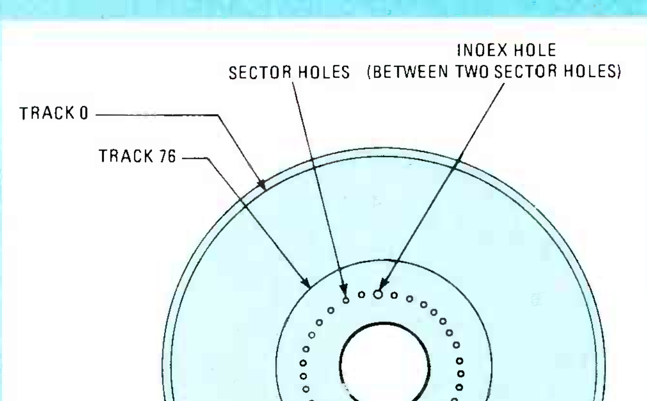

FIG. 4—SECTOR LOCATION is accomplished using an index hole. Hard-sectored disks use a series of holes, one for each sector plus the index hole.

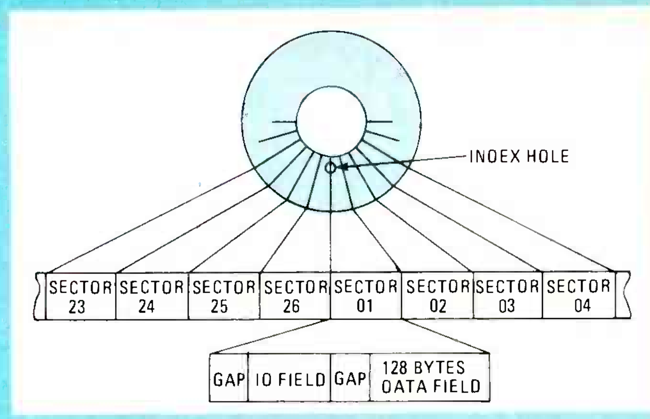

FIG. 5—WITH THE IBM 3470 FORMAT, each disk is divided into 77 tracks. Each track is subdivided into 26 sectors, and each sector is subdivided into four sections.

When a blank floppy disk is first purchased, its surface is non-magnetized and thus it must first be formatted to organize tracks and sectors. The microcomputer performs this function upon command, using the pulse representing the index hole as the reference point. After the disk has been formatted, it is ready to have information written on it or read from it. An unformatted 8-inch disk has a capacity of 400K bytes while its IBM 3470 formatted version can accommodate 256K bytes.

As previously stated, there is no standard format for the 5¼-inch minifloppy diskettes. The number of tracks and sectors can and does vary. For example, 5¼-inch diskettes for the *Apple II* computer were originally formatted with 35 tracks, each subdivided into 13 sectors with 256 bytes-per-sector. Later, that format was modified to 35 tracks with 16 sectors-per-track, resulting in a net increase of 24K of storage capacity. Diskettes for the Heath *H89* computer are formatted with 40 tracks and 10 sectors-per-track.

A 5¼-inch minifloppy diskette has an unformatted capacity of 110K bytes. With soft-sectoring, this figure drops to 80.6K bytes. The minifloppy diskette can be formatted with anywhere from 35 to 77 tracks and 10 to 16 sectors-per-track.

Single density, double density

Data is placed on a disk using frequency modulation (FM). A 250-kHz clock generator produces pulses that repeat every four microseconds to form data cells on the surface of the Mylar disk. When writing data to the disk, if a data bit is supplied during the interval between clock pulses, a magnetic transition will occur as the read/write head contacts the oxide surface of the disk; that corresponds to a logic 1. If no data bit is sent, there will be no magnetic transition and thus the oxide is unchanged, representing a zero, as shown in Fig. 6.

When reading data from the disk, the stream of pulses would include the 250-KHz clock pulse and pulses representing ones and zeros. When a data cell includes a clock pulse and a data pulse, the presence of the two pulses identify a logic 1; the presence of only the clock pulse indicates a logic 0. That encoding technique is called FM encoding and is commonly referred to as single-density.

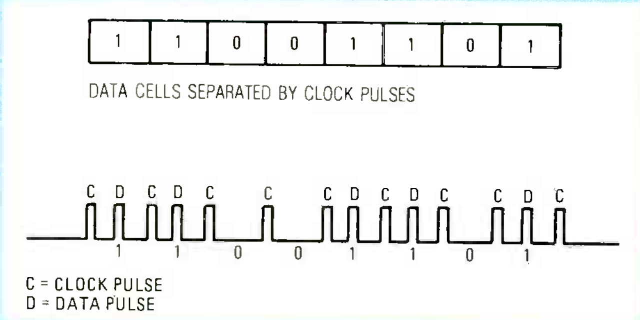

FIG. 6—WHEN RECORDED ON THE DISK, a logic 1 consists of a clock pulse plus a data pulse; a logic 0 consists of only the clock pulse.

With FM encoding, the IBM 3470 format specifies a recording density of 3408 bits-per-inch. Thus, with 77 tracks, 26 sectors, and 128 bytes-per-sector, a total of 256,256 bytes can be stored on a single-sided 8-inch disk.

To double the storage capacity, a double-density technique was developed based on an MFM (*M*odified *FM*) encoding. Basically, many of the clock pulses are removed and the presence of a pulse signifies a logic 1 while the absence represents a logic 0. Synchronization is accomplished by inserting a clock pulse at certain intervals. By eliminating many of the clock pulses, more room for data is available within each sector and twice as much information can be stored on a given length of track using MFM encoding rather than FM. Of course, there is a tradeoff...more sophisticated pulse-circuitry is required for clock timing and data writing.

Other techniques have been developed to increase the storage capacity of disks even farther. One scheme involves the use of drives with two read/write heads, one for each side of the disk. Thus, data can be stored on both sides of the disk. Some manufacturers have even introduced a quad-density recording technique that they claim will offer four times the storage capacity of a single-density drive.

Table 1 lists the unformatted storage capacity for both 5¼ and 8-inch disks using various data storage techniques. As shown, a single-sided single-density minifloppy (5¼ inch) provides 128,000 bytes of storage capacity while a double-sided double-density 8-inch disk provides almost 2 megabytes. In practical terms, a single-sided minifloppy would hold the equivalent of 30 single-spaced typewritten pages while the 2-megabyte capacity of a double-sided double-density 8-inch floppy could hold as many as 400.

Those storage capacities, however, are for unformatted disks. After the disk is formatted, the data-storage capacity decreases depending on the formatting technique used. The actual storage capacity of a double-sided double-density 8-inch disk formatted with 77 tracks and 26 sectors-per-track is around 1.1 megabytes. A dual-drive, double-density, double-sided 8-inch disk drive system can store over 2 million bytes.

Obviously, the added capacity of the double-sided double-density technique is a definite asset. However, drawbacks include the lack of standardization. Thus, a double-density diskette prepared on one system very often cannot be used with another disk system. Double-sided drives also have a drawback. Here, two read/write heads are used—one acting as the pressure pad for the other. Excess head wear and/or diskette damage is more likely to occur than with single-sided systems.

Table 1—STORAGE CAPACITY

Type	Sector Type	Unformatted Storage Capacity (Kilobytes)	Transfer Rate (Kilobytes Per Second)
5¼-inch Floppies			
Single-density/single-sided	Soft	128	15.6
Single-density/dual-sided	Soft	256	15.6
Double-density/single-sided	Soft	512	31.2
8-inch Floppies			
Single-density/single-sided	Soft	400	31.2
Single-density/dual-sided	Soft	800	31.2
Double-density/single-sided	Soft	800	62.4
Double-density/dual-sided	Soft	1,600	62.4

Access time and transfer rate

In addition to storage capacity, access time and transfer rate are important specifications for a disk drive. Access time is the time it takes for the drive to access data in a random manner. Thus, the access time depends on the time it takes for the read/write head to arrive at the proper track (track-to-track seek time) and then wait for the data in the proper sector (latency time). Specifications for disk drives generally list an average access time derived by using one half the unit's poorest access time. Maximum, or worst, latency time is when the read/write head arrives at the proper track just as the correct sector passed by. In that case the head must wait for a full rotation of the disk and thus produces the maximum delay.

Typical average track-to-track seek times vary from 3 ms to 100 ms for an 8-inch disk drive and 3 ms to 25 ms for a 5¼-inch disk drive. Latency time (average) for an 8-inch drive is about 85 ms and about 100 ms for a minifloppy. Total access time for an 8-inch drive might range from 150 ms to 300 ms and about 400 ms to 600 ms for a minifloppy.

The transfer rate, or speed at which the disk drive can transfer its data to the computer, is another measure of disk-system performance. Obviously, a quick access time and rapid transfer rate means the computer can start to perform its operations with less time wasted. Typically, a single-sided minifloppy can transfer data at a 15 kilobytes-per-second rate and at twice this speed with double-density techniques. An 8-inch disk can transfer data at typical rate of 62.5 kilobytes-per-second, although models are available with transfer speeds as high as 125 kilobytes-per-second.

Disk-system components

So far we've talked abut the floppy disk and the disk drive. However, a complete floppy-disk systsem consists of more components, as shown in Fig. 7. So, let's list all of the components that make up a complete disk system.

1. The floppy disk itself.
2. A disk-drive assembly to rotate the disk and position the read/write head to the desired track position. Inside the cabinet that houses the drives is a power supply to provide the operating voltages to power the drives.
3. A disk controller to specify head position, control the drive motor, check and correct errors, and perform other functions.
4. Interface circuits to connect the computer control-signals properly to the disk controller.

continued on page 66

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FLOPPY DISKS ADD VERSATILITY

continued from page 64

5. Programs (software) to control the operation of the disk drive, such as specifying to which track and sector of the disk data should go, handling the actual reading and writing of data, and monitoring that the data transfer is correct. Those programs are called disk-operating systems (DOS's) and they operate with a file management system (FMS) to identify files of data and route data to individual tracks and sectors on the disk.

The disk controller has the responsibility of read/write head positioning, sector identification, disk-motor control, head loading and unloading, error detection and correction, and of controlling the transfer of data to the interface circuits between the disk drive and the main computer. In most instances, the interface board contains the disk controller circuitry. This board mounts inside the computer and is connected to the disk drive(s) by a ribbon cable.

The disk-operating system (DOS) controls the operation of the controller circuitry. It resides on a floppy disk. One of the functions of the DOS is to transfer data and programs between the computer and the floppy-disk system. Thus, when you first turn on the computer system, it is necessary to load the DOS from the floppy disk into the computer. That task is handled by a short program called a bootstrap loader. The bootstrap loader is contained in a ROM, usually on the interface board. Depending on the computer system, the bootstrap program is called up by a simple keystroke on the computer's keyboard. Once the system has been "booted," the computer and floppy-disk system are ready to accept operator commands. The DOS takes care of labeling the files, editing, error detection, and file copying. A file-management system designates the track and sector allocations on the disk for files.

Since the DOS occupies a rather substantial portion of a diskette, a system with only a single floppy-disk drive is rather limited. Thus, it is common for packaged computers, such as those offered by Radio Shack, Apple, and others, to include two or more floppy-disk drives. One disk controller can generally handle several disk drives.

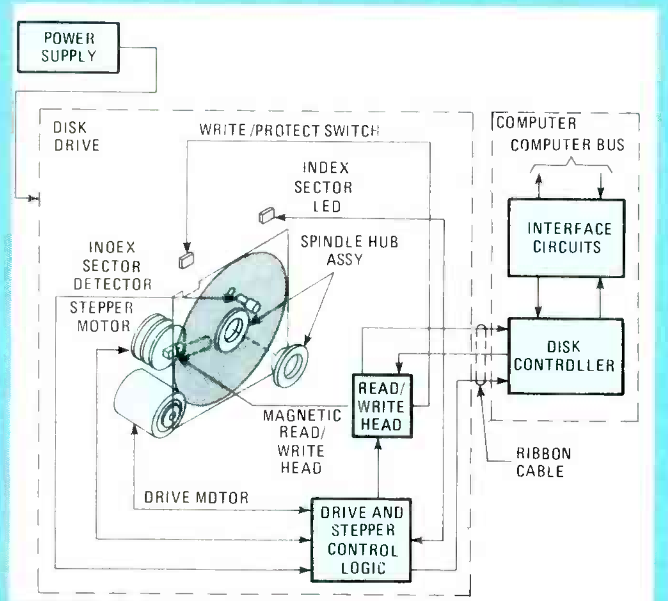

FIG. 7—A COMPLETE FLOPPY DISK SYSTEM consists not only of the disk and disk drive, but also includes control and interface circuits, as well as the software to handle disk-access operations.

After the diskette is inserted through the front door of the floppy-disk drive and the door is closed, the drive spindle grips the center of the diskette and the motor brings the disk up to full rotational speed. The DOS directs the controller circuitry to position the read/write head to track 00 and the index hole, in conjunction with an optoelectronic sensor, generates a location pulse for timing. As the floppy disk spins, the heads are carefully positioned above the desired track. Then, the read/write head is pressed against the oxide coating with the help of pressure pads on the opposite side of the disk. That is called "head loading" and it is directed by the DOS. When a different track is desired, the read/write head is unloaded (lifted off the surface of the disk), moved to a different track, and loaded once again.

Before the read/write head is actually loaded, a sensor inside the drive senses the write-protect notch and determines whether the floppy disk can be written to. Of course, during a read operation, the notch is not sensed. When the read/write head is loaded, an LED on the front panel of the drive alerts the user that the drive is in operation and the disk should not be removed. When the drive completes its operation, the read/write head is unloaded, the LED goes out, and the disk may be removed.

Just as a computer is useless without proper software, so, too, is a disk drive. A well-prepared disk-operating system (DOS) is required to keep track of what is stored on the disk, and where it is located. The DOS handles such tasks as transferring programs from one device to another, locating read/write errors, providing a means to make backup copies of a diskette, and other chores.

Although basically similar, most DOS's are unique in their own way, and vary from one manufacturer to another. The DOS must be configured for the particular computer system it is to be used with. Also, if you decide to buy software on disk, the software must be compatible with the DOS. That condition also includes high-level languages such as BASIC.

Disk errors

Disk errors are categorized as either soft or hard errors. Hard errors are caused by defects on the disk surface; soft errors are due to program or processing troubles or power-line transients. An example of a soft error is what is commonly called a seek error, which occurs when the read/write head appears at the wrong track. Part of the disk-conroller's job is to locate and correct those disk errors. For example, the disk controller will compare the track being read with the track number that was called for by the DOS and determine whether a discrepency exists. If a deviation is noted, the disk controller will initiate a new positioning routine and place the read/write head over the correct track.

A soft error is also classified as a recoverable error, one that the disk controller can spot and (sometimes) correct. A hard error is a non-recoverable error; the controller can detect it but cannot correct it.

It is estimated that a soft-sector disk system has an error rate of one per 108 bits during a read operation; one per 1011 bits during a read operation is the estimate for a hard-sectored disk. Under normal usage a disk is expected to last about two years; a track is considered to be worn or defective when it output level drops to 20 percent of its original value.

Is a backup copy necessary?

A backup is an exact duplicate copy of a disk. A backup copy is almost mandatory since it can be expected, sooner or later, that a disk will become defective due to wear, or dirt contamination, or possibly due to the read/write head's damaging the oxide coating of a disk. When that calamity occurs, and a backup copy has not been made, it will be necessary to reconstruct the lost information (if still available) and prepare a new disk.

How critical the data is, how often it changes, and how costly the loss will be will determine how frequently a data backup copy should be made. Large investment houses or banks might back up data every hour; small-business users perhaps only once a week. To make creating backup copies convenient, the DOS software usually contains a command for duplicating disks.

Selecting your disk drive

Computers and their peripherals are costly. So selecting a computer, printer, disk drive, or other accessory demands a hard look at the future, as well as the present. Among the questions to be answered are: What capacity do, and *will*, you need? A novice, or someone interested in games, can possibly be content with a cassette system and need not invest in a floppy system at all. Others, requiring a mass-memory storage capacity of, say, 250K bytes may settle for a single-drive unit—bearing in mind that an 8-inch disk holds twice as much data as a 5¼-inch diskette at less than double the cost. Generally, a single disk controller and DOS can operate up to three drives; thus it is common to start with a minimum investment and gradually add more drives to it.

Is the disk-drive hardware and software you have selected compatible with your computer? Your computer, keyboard, printers, and display must interface with the disk-system's electronics and DOS. Is the software you intend to use available for the disk system you are about to purchase? How important to you is access time and data transfer rate? Is size critical? Are there any unusual environmental considerations such as excessive heat or humidity where the drive will be located?

And, of course, there are basic considerations that must always be evaluated. How long has the manufacturer, whose units you are considering, been in business, what is his reputation, what is his warranty policy? Are there local places for service or must units be shipped back to the factory? Will spare parts be readily available? Also, it's wise to ask dealers and members of computer clubs about their reliability experiences with the models you are considering. Do they have a good record in their field or are they notoriously poor? Don't hesitate to ask many questions before the final purchase...once you've bought the disk system, you'll be tied to it for a long time. A list of manufacturers of disk drives appears in Table 2; contact them for specs and performance details. Remember, they are in business to respond to your needs. **R-E**

TABLE 2—DIRECTORY OF DISK DRIVE AND CONTROLLER MANUFACTURERS

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A.M. ELECTRONICS
3366 Washtenaw Ave.
Ann Arbor, MI 48108

APPARAT, INC.
4401 South Tamarak Pkwy.
Denver, CO 80237

APPLE COMPUTER, INC.
10260 Bandley Ave.
Cupertino, CA 95014

CALIFORNIA COMPUTER SYSTEMS
250 Caribbean Dr.
Sunnvale, CA 94086

COMMODORE BUSINESS MACHINES
950 Rittenhouse Rd.
Norristown, PA 19403

COMPUTHINK
965 West Maude Ave.
Sunnyvale, CA 94086

CROMEMCO, INC.
280 Bernardo Ave.
Mountainview, CA 94043

DATA SYSTEMS DESIGN
3130 Coronado Dr.
Santa Clara, CA 95051

DELTA PRODUCTS
15392 Assembly Lane
Huntington Beach, CA 92649

HEATH COMPANY
Benton Harbor, MI 49022

IMS INTERNATIONAL
2300 Lockheed Way
Carson City, NV 89701

INTERFACE, INC.
20932 Cantara St.
Canoga Park, CA 91304

INTERNATIONAL MEMORIES, INC.
10381 Bandley Dr.
Cupertino, CA 95014

JADE COMPUTER PRODUCTS
4901 West Rosecrans
Hawthorne, CA 90250

LOBO DRIVES INTERNATIONAL
935 Camino Del Sur
Goeleta, CA 93017

MATCHLESS SYTEMS
18444 South Broadway
Gardena, CA 92048

MICROMATION
1620 Montgomery St.
San Francisco, CA 94111

MICROPOLIS
7959 Deering Ave.
Canoga Park, CA 91304

MICRO-SCI
1405 East Chapman, Suite E
Orange, CA 92666

MORROW DESIGNS
5221 Central Ave.
Richmond, CA 94804

NETRONICS RESEARCH & DEVELOPMENT
333 Litchfield Road
New Milford, CT 06776

NORTH STAR COMPUTERS, INC.
1440 Fourth St.
Berkeley, CA 94710

OHIO SCIENTIFIC
1333 South Chillicothe Rd.
Aurora, OH 44202

PERCOM DATA CO.
211 North Kirby
Garland, TX 75042

QT COMPUTER SYSTEMS, INC.
15620 South Inglewood Ave.
Lawndale, CA 90260

QUANTUM CORP.
448 Whitehead Rd., Box 5141
Trenton, NJ 08619

RADIO SHACK
1400 One Tandy Center
Fort Worth, TX 76102

SD SYSTEMS
10111 Miller Rd., Suite 105
Dallas, TX 75228

SMOKE SIGNAL BROADCASTING
31336 Via Colinas
West Lake Village, CA 91361

SOUTHWEST TECHNICAL PRODUCTS CORP.
219 West Rhapsody
San Antonio, TX 78216

TARBELL ELECTRONICS
950 Dovlen Place, Suite B
Carson, CA 90746

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Choosing a printer for your personal computer is not the simplest of tasks. The information presented here can make it easier for you to make your decision.

ALL ABOUT PRINTERS

ONCE THE PROUD OWNER OF A PERSONAL COMPUTER HAS learned how to operate his machine, write programs, and beat the computer at some of its games, he tends to turn serious. He'll prepare his taxes, perhaps file his wife's favorite recipes, and use his computer to keep track of his stamp, coin, or record collection. If he owns a business, he may file his inventory, prepare payrolls, and list bills on the computer. At this point he can no longer rely on his CRT display alone for there comes a time when the data from the computer cannot be analyzed sufficiently while the user stares at his display. He needs hard copy, on paper, to put in his briefcase, to carry to meetings and discussions, and to distribute to others involved in decision-making.

So it's off to the computer store to select a printer. And that's where the fun (or frustration) begins. A multitude of different models are available from close to 100 printer manufacturers. Salesmen will confront the puzzled buyer with a flurry of terms such as "dot matrix," "KSR or RO," "daisy wheel," "pin feed," "characters per second," and the like. So, rather than face that bewildering barrage of terms unprepared, it is appropriate for the prospective buyer of a printer costing from hundreds to thousands of dollars to learn a bit about them before taking the plunge.

To start, let's differentiate between a *print head*, a *printing mechanism*, and a *printer*. A *print head* is the component that creates the character on the paper. It can be a dot-matrix impact-type, thermal non-impact-type, or one of a number of other designs. Without the mechanical elements to move that print head to the proper position, without the electronics to control positioning and carriage return, the print head is entirely useless.

The *printing mechanism* is a mechanical assembly, including a print head, with the necessary gears and drive to perform the movements required for printing; it may or may not include a cabinet or electronics section. The *printer* is the complete assembly, including print head, printing mechanism, cabinet, and the necessary electronics (see Fig. 1).

KSR and RO

Printers can be classified in a number of ways. First, whether they include a keyboard to enable them to send, as well as receive, data. A printer/terminal includes a keyboard that permits the user to input or output data by direct connection to the computer, or via a telephone line and modem. Those two-way units are called KSR (*K*eyboard *S*end/*R*eceive) printers. Many manufacturers supplying KSR's also market similar assemblies—less the keyboard and output-electronics section—that serve as one-way or *R*eceive-*O*nly (RO) printers.

Impact vs. non-impact

Impact printers generate a character by having the print head strike the paper through an inked ribbon; portable and office typewriters are common examples of impact printers. Non-impact printers generate characters without mechanical force; the small thermal printers in some low-cost printing calculators are examples of non-impact printers.

Impact printers have two major advantages over their non-impact rivals: they produce high-quality print, and can provide multiple copies. Their major drawbacks are a high noise-level and low speed. Non-impact printers are quiet and many are low in cost. They generally operate at much higher speeds than impact types. Their drawbacks include the inability to produce more than one copy at a time and the need for relatively expensive paper. Also, their output is frequently less legible than that of impact types.

Impact printers that use solid type-fonts (as opposed to dot-matrix fonts) have their character sets on cylinders, balls (like the IBM *Selectric* print-elements), drums, bands, or wheels. As the computer informs the printer of the character required, that character is moved into position and struck so that an inked ribbon makes an impression on the paper. The next character is then moved into place and the process is repeated.

Non-impact printers include thermal, electrosensitive, ink-jet, and laser types. While the latter two are still far too expensive for the personal-computer user, thermal and electrostatic printers are generally available for less than $1000 and that, coupled with their quietness, makes them well suited to home or small-business applications.

Low-cost printers (under $400) in those categories may use narrow rolls of paper, similar to those used by printing calculators, that are limited to 32 characters (or columns) per line. Printers costing over $500 generally accept 8½-inch wide paper and can print 80 or more characters per line.

Generally speaking, printers selling for under $1000 are of the dot-matrix type (with the exception of used Teletype machines). Dot-matrix printers with special features—like very high speed, or special head or paper-movement capabilities—may be more expensive.

In the $2000-and-up range are the "solid-character" printers using "golf balls," daisy wheels, or thimbles. They offer very high print quality, suitable for business letters and lengthy reports.

Serial printers vs. line printers

Printers can also be classified as *serial* or *line*. *Serial* printers—which are what we are discussing here—print one character at a time. *Line* printers print an entire line at a time and are generally used where very high volume and speed are required, as in the case of printing thousands—or even millions—of mailing labels or paychecks.

Serial printers have a single print head that moves horizontally across the page, printing one character at a time. If the printer is fast enough, it can print each character as it is received from the computer; otherwise the data must be stored in a *buffer* and fed to the print mechanism more slowly.

FIG. 1—THE *MODEL IPS 5000A* FROM DATAROYAL is a dot-matrix printer with a 120 cps print speed and a tractor-type paper feed.

Line printers contain many print heads and hammers, or print actuators—one for each column. When an entire line's worth of characters has been stored in the line printer's buffer, the print mechanism is actuated and the entire line printed at once.

Speeds of serial printers are usually given in characters-per-second (cps); speeds of line printers are specified in lines-per-minute (lpm). A low-speed line printer may be rated at 300 lpm, a medium-speed one at 300-600 lpm and a high-speed one at over 600 lpm.

Typically, dot-matrix serial printers operate at speeds in the range of 60-400 cps. "Solid-character" serial printers operate at the rate of 25-60 cps.

Naturally, the high-speed line printers are considerably more expensive than the slower serial printers. The most popular types of line printers are *drum*, *chain*, and *scanning matrix*.

Fully-formed (solid) or dot-matrix characters

Depending on the type of printer used, the characters formed may be either *fully-formed* (solid, typewriter-quality) or *dot-matrix*.

Dot-matrix characters are formed by a series of dots arranged in a matrix measuring from four to seven dots horizontally by seven to nine dots vertically (see Fig. 2-a). Thus, a 7 × 7 matrix could have up to 7 dots in both directions.

continued on page 74

SOME QUESTIONS BEFORE BUYING

Here are some of the points you will have to consider:

1. Will noise be a problem? If so, a non-impact printer is recommended.
2. Will print quality be critical? If the printer is to be used for word processing or for correspondence, a fully-formed-character printer is the best choice.
3. Will multiple copies (for billing, records, etc.) be required? If so, a non-impact printer is ruled out.
4. Will frequent changes of typeface be required? If so, a printer with interchangeable elements ("golf balls" or print wheels), or a programmable matrix-printer, will be needed.
5. Will a lot of printing be done? If so, paper costs could become prohibitive if a thermal or electrosensitive printer were used. (Also make sure that ribbon changes on impact printers are simple to accomplish.)
6. How fast does the printer have to be? Speed is directly related to cost—the faster the printer, the more expensive it will be. There also tends to be a tradeoff between speed and print quality—the higher the speed, the lower the quality.
7. What form of paper transport is required? For continuous-form paper, or for multiple copies, pin or tractor feed is the choice.
8. Will the printer be running unattended? If so, it should have alarms and/or shut-off devices to handle "out-of-paper" and other situations.
9. What is the maximum number of columns (characters per line) that will be required?
10. Will both upper and lower case characters be required? Will any special characters or symbols be needed? Make sure they are available.
11. Will a one-way, receive-only (RO) device be sufficient or will a two way (KSR) unit be required? The obvious choice is a RO printer, but give some thought to future needs.
12. How reliable is the printer manufacturer? How long has he been in business? What have you heard or read about his equipment? A "steal" on a printer whose manufacturer has gone out of business could mean problems should the device require parts or servicing.

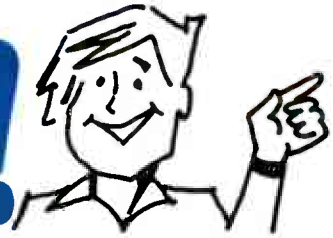
Don't be afraid to ask questions—of yourself, of dealers, and of printer owners at local computer clubs. Remember, you'll be spending hundreds—if not thousands—of dollars on a piece of equipment that you'll be depending on for years.

Take your time; call or write to manufacturers for specifications or definitions of terms on their data sheets. And, once you've made up your mind, visit your dealer and ask him to let you get some first-hand experience with the printer you've chosen to make sure it really is right for you.

AH-HA!

EUREKA!

ALL-RIIIGHT!



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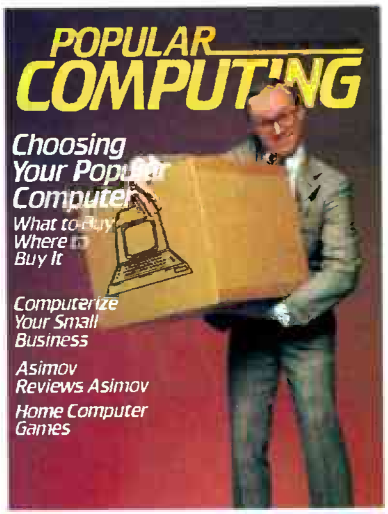

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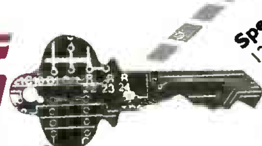

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ALL ABOUT PRINTERS

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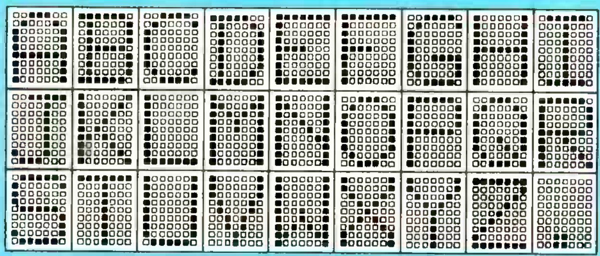
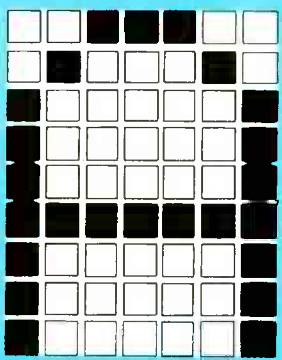


a



b

FIG. 2—DOT-MATRIX CHARACTERS are formed by dots in a matrix as shown in *a*. The "dots" in the 7 × 9 matrix shown in *b* form the letter "A".

Characters are determined by the number and positions of the dots within the matrix, as shown in Fig. 2-b. Since the characters are not formed from continuous lines, legibility is not as good as that obtained from printers using fully-formed characters. The more dots used in the matrix, however, the better the appearance will be.

Impact-type dot-matrix printers produce characters using a moveable print-head mechanism that consists of solenoid-actuated pins arranged as shown in Fig. 3. As data arrives from the computer, a character-generator ROM in the printer selects the appropriate dot-pattern for the character to be printed and energizes the solenoids required. The solenoids cause print needles to strike the ribbon and form the dot-pattern on the paper.

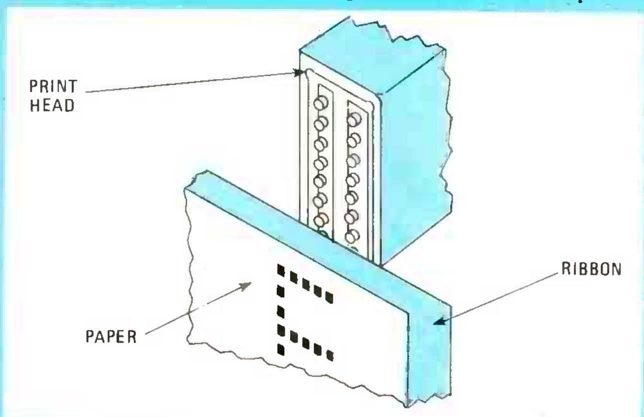


FIG. 3—SOLENOID-ACTUATED PINS produce the dots that form the characters in an impact-type dot-matrix printer.

Some dot-matrix printers, instead of using a ribbon, make use of a special paper that contains "micro-bubbles" of encapsulated ink. When the bubbles are struck by the print needles they burst and release the ink.

One technique used to obtain higher-quality output from dot-matrix printers involves multiple passes of the print head across the same line, with the head position *slightly* offset for each pass. That allows more dots to be printed and creates denser, more legible, characters. The drawback, of course, is a reduction in print speed.

A recent innovation in the dot-matrix field is the "throw-away" print head. When it wears out—as will eventually happen in any case—no expensive service is needed. You can just unplug the worn-out head yourself and replace it with a new one that costs about $30.

Cylinders, balls, and wheels

The earliest version of a full-character printer was the cylinder or Teletype, which had its type on a cylinder that rotated along a vertical axis on a moveable carriage, (see Fig. 4). As the computer requests a particular character to be printed, the carriage moves to the correct location on the paper and the cylinder is rotated, and also raised or lowered, to place the proper character into position so that a hammer can strike and force the character against the ribbon, printing the letter on the paper. The Teletype models 33, 35, and 38 are considered noisy, slow, (10 cps) unreliable and difficult to service—but they do fulfill the need for a low-cost printer.

The "golf-ball" print head (see Fig. 5) developed by IBM for its *Selectric* typewriters, contains a full set of characters embossed on a sphere. Printing is performed as the ball strikes an inked ribbon placed between the ball and the paper. When a change in font or typeface is required, ball replacement is simple and the cost for the print elements is low. Speed is relatively slow, about 15 cps, and the mechanism is quite noisy. However, print quality is good, and used, reconditioned models are available at low cost.

The daisy wheel, introduced by Diablo Systems, Inc. in 1972, is three to five times faster than the "golf-ball" or cylinder types, with speeds of up to 80 cps. Its name is derived from a resemblance to a flower with its petals outstretched (see Fig. 6). The mechanism consists of a central hub which has up to 96 arms, each containing an embossed character. When the required petal or character is rotated into the proper position, a hammer strikes the petal against an inked ribbon to produce the letter-image on the paper. The daisy-wheel elements, available in steel or plastic, come in a variety of typefaces and can be interchanged simply and rapidly. Print quality is very good but noise level is somewhat high.

Thermal, electrosensitive and ink-jet printers

The thermal matrix-printer is a popular form of a non-impact system. As the print head moves horizontally across the

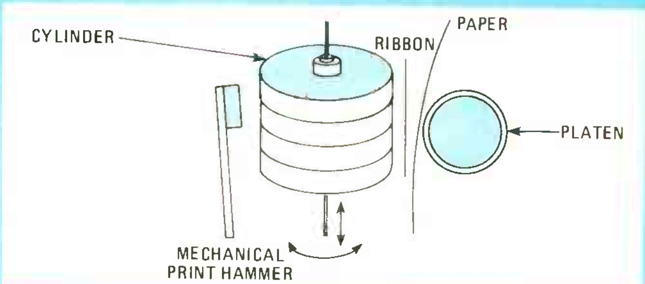


FIG. 4—CYLINDER PRINTERS USE a rotating cylinder on a movable carriage. When the cylinder is in position, a hammer strikes it to print a letter.

specially manufactured paper, characters are formed as the heating elements in the print head discolor the paper into a dot-matrix pattern. Thermal printers are light, compact and quiet, and the print head is inexpensive and easy to replace. However, the heat-sensitive paper is expensive and only one copy at a time can be produced.

The electrosensitive matrix printer requires a special aluminum-coated paper which forms a dot-matrix pattern when voltage is applied between the print head and a metal plate, burning off the aluminum to expose a black layer below. The paper travels between the print head and the metal plate (see Fig. 7). As data is fed to the print head, electrodes in the print-head housing are pulsed selectively, causing a charge to jump between the electrode and metal plate (rear electrode), creating black dots on the paper and thus the character. Although the electrosensitive printer is inexpensive and its quality is good, paper is expensive and requires delicate handling. A newcomer to this printer family is the laser printer which uses a low-power laser to burn dots off of a specially-treated paper.

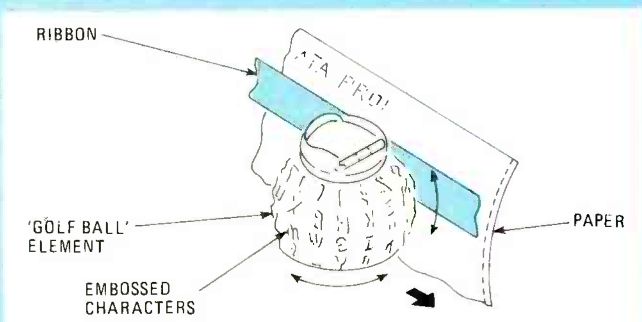


FIG. 5—THE IBM *SELECTRIC* PRINT HEAD is a "golf-ball" like sphere embossed with a full set of characters.

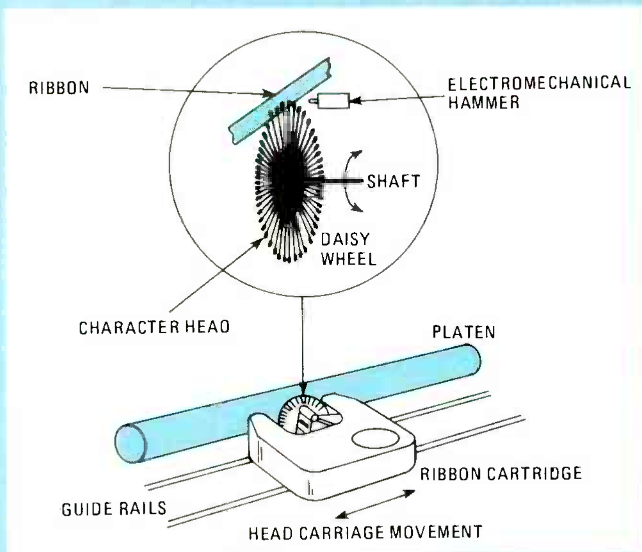


FIG. 6—A DAISY-WHEEL printer is much faster than a *Selectric* or cylinder-type. The print wheel gets its name from its resemblance to the flower.

Ink-jet printing is a non-contact process. Neither cylinders nor "golf balls" nor ribbons touch the paper. In an ink-jet mechanism, ink is pumped through a tiny nozzle, forming a steady stream of fluid; the nozzle is vibrated to modify the stream into a series of droplets rather than a steady flow. As an individual droplet leaves the nozzle and is directed towards the paper, its position is controlled so that its final placement, relative to other released droplets, will form the desired characters.

Several droplet-placement techniques are in use, including electrostatic deflection, controlled nozzle movement, and controlled paper movement. Another technique involves the use of a number of independent nozzles tightly packed into a print head with selective firing of individual nozzles determining character creation. In the "drop-on-demand" technique, shown in Fig. 8, an electrical signal is converted into a pressure pulse in the ink chamber. That causes droplets of ink to be discharged from the independently controlled ejection chambers and form printed characters.

Serial vs. parallel transmission

Computers transmit data to a printer in either serial or parallel format. In serial transmission, single bits of a byte follow each other in a steady stream; in parallel transmission, all the bits required to define a character are routed along parallel wires at the same time. Therefore, serial transmission is slower than parallel transmission. However, only one communications channel is required for serial transmission which means that serial data can be transmitted over a telephone line; in addition, serial data can be transmitted over a longer distance than parallel data without the need for special amplifying repeaters.

Serial data-transmission can be synchronous or asynchronous. In synchronous transmission, it is necessary for the system to be aware of the exact time-position of each data byte representing a character to be fed to the printer. The flow of characters is split into blocks, with all bits in each block transmitted at equal time intervals. Even if no data is fed during a brief time period, data bits, called "nulls," must be used to fill in the blocks. Stable oscillators act as clocks at both ends of the transmission to maintain synchronization and precise timing. The computer, acting as the transmitter, starts each block with a series of synchronization signals to denote the start of a block and thus synchronize the oscillators; the block is generally ended with an error-checking character.

Asynchronous transmission is less complex and does not rely on precise timing-blocks. The receiver (printer) and transmitter (computer) are synchronized by a "start bit" which is inserted before the bit-pattern for a character and a "stop bit" added after the character. Specific spacing between bytes is not required; however, it is necessary to establish the baud rate, or transmission speed in bits-per-second, between the transmitter and receiver. Commonly used baud rates are 110, 300, 600, 1200, 2400, 4800, 9600, and 19,200.

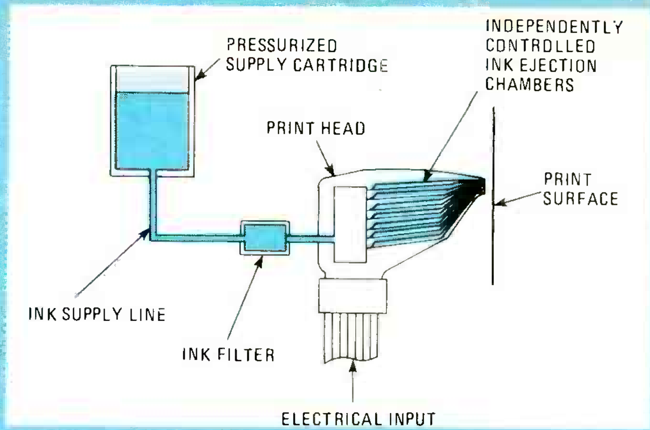


FIG. 8—INK IS DISCHARGED from independently-controlled ejection chambers to form letters in the "drop-on-demand" technique.

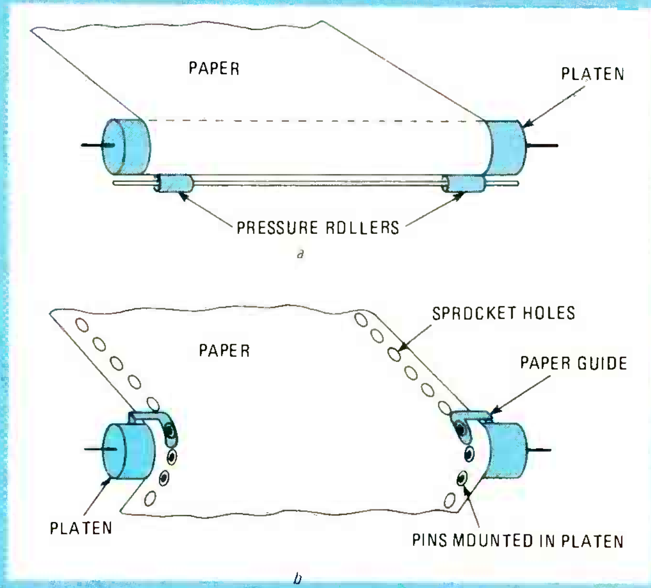


FIG. 9—A FRICTION PAPER-FEED SYSTEM (*a*) works well if just one copy is required. For multiple copies, a pin-feed system (*b*) can be used.

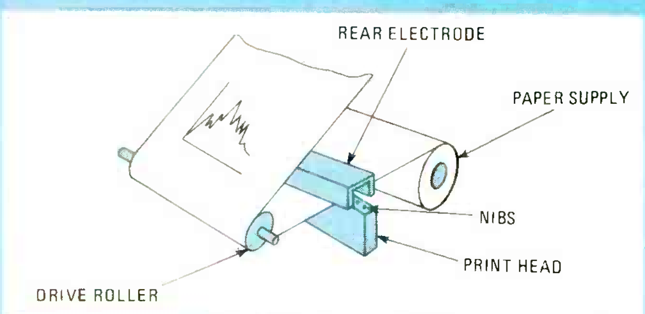


FIG. 7—AN ELECTROSENSITIVE PRINTER uses a spark from the print head to "burn" dot-matrix characters on specially-treated paper.

Paper-feed mechanisms

An important, and commonly overlooked, consideration in printer selection is the paper-transport arrangement. The three common transport mechanisms are friction feed, pin feed, and tractor feed.

In a friction-feed system, like that used in an office typewriter, gear-driven rollers hold and move the paper (see Fig. 9-a). The system is simple and relatively trouble-free, provided a single sheet of paper is used; when multiple sheets are loaded, it is not uncommon for them to become misaligned.

To solve that annoying problem, pin-feed systems (Fig. 9-b) were developed. Metal pins are mounted around the outer rim of the platen and engage holes punched in the outer margins on the paper. That arrangement allows long rolls of paper (with multiple copies if desired) to be used without alignment problems. Since the pins are at a fixed distance apart on the roller, only one width of paper can be used.

To accommodate a variety of paper widths, the tractor-feed mechanism was developed. The pins in the platen are eliminated and adjustable sprockets are connected to two chain-drives that slide on rods extending the width of the paper opening. A gear train, driven by the paper-feed drive-motor, turns the sprockets, which pull the paper as a tractor would pull a cart. The sprockets can be moved and locked to handle any paper width. **R-E**

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Cupertino, CA 95014

AXIOM CORPORATION
5932 San Fernando Road
Glendale, CA 91202

BASE 2, INC.
P.O. Box 3548
Fullerton, CA 92634

CENTRONICS DATA COMPUTER CORPORATION
1 Wall Street
Hudson, NH 03051

C. ITOH ELECTRONICS, INC.
666 Third Ave.
New York, New York 10017

COMMODORE BUSINESS MACHINES
950 Rittenhouse Rd.
Norristown, PA 19403

DATAPRODUCTS
6200 Canoga Ave.
Woodland Hills, CA 91365

DATAROYAL
235 Main Dunstable Road
Nashua, NH 03060

DATASOUTH COMPUTER CORPORATION
4740 Dwight Evans Road
Charlotte, NC 28210

DIABLO SYSTEMS, INC.
24500 Industrial Blvd.
Hayward, CA 94545

DIGITAL EQUIPMENT CORP (DEC)
129 Parker Street
PK3/M18
Maynard, MA 01754

DIP, INC.
745 Atlantic Ave.
Boston, MA 02111

EATON PRINTER PRODUCTS
Technical Industrial Park
Riverton, WY 82501

EPSON AMERICA, INC.
2384 Hawthorne Blvd.
Torrance, CA 90505

GENERAL ELECTRIC COMPANY
GE Drive
Waynesboro, VA 22980

HEATH COMPANY
Benton Harbor, MI 49022

HOWARD INDUSTRIES
1 North Dixie Hwy.
Milford, IL 60953

INTEGRAL DATA SYSTEMS, INC.
Milford, NH 03055

LEAR SIEGLER, INC.
714 N. Brookhurst St.
Anaheim, CA 92803

MALIBU ELECTRONICS
2301 Townsgate Road
Westlake Village, CA 91361

MICROTEK INC.
9514 Chesapeake Drive
San Diego, CA 92123

MPI
4426 South Century Drive
Salt Lake City, UT 84119

NEC INFORMATION SYSTEMS, INC.
5 Militia Drive
Lexington, MA 02173

OKIDATA CORPORATION
111 Gaither Drive
Mt. Laurel, NJ 08057

QUME CORPORATION
P.O. Box 50039
San Jose, CA 94140

RADIO SHACK
1400 One Tandy Center
Fort Worth, TX 76102

SANDERS TECHNOLOGY, INC.
Columbia Drive
Amherst, NH 03061

TELETYPE CORPORATION
5555 Touhy Ave.
Skokie, IL 60077

TEXAS INSTRUMENTS, INC.
P.O. Box 225012
M/S 84
Dallas, TX 75265

TRENDCOM
480 Oakmead Parkway
Sunnyvale, CA 94086

XEROX CORPORATION
Xerox Square
Rochester, NY 14644

XYMEC
17905 Skypark Circle, Suite J
Irvine, CA 92714

MODEMS-COMPUTING via TELEPHONE

Whether it's a printer in Peoria, a terminal in Texas, or a data base in Denmark, your computer can communicate with it using a modem and a telephone.

LIFE CAN BE SIMPLE AND UNCLUTTERED IF YOU ARE CONTENT TO have your keyboard and printer at arm's length from your computer. If you are satisfied writing and running your own programs, with contact to the outside world limited to reading magazine articles, purchasing pre-packaged programs and exchanging ideas with others via computer clubs, letters and/or phone calls, then that's fine.

But should you decide to expand your world, and tie your personal computer to a time-sharing system—or write your output to a distant printer or terminal—you suddenly are involved with data trasmission and the need for a modem (*M*odulator-*DeM*odulator). Your computer can send its data stream to a remote terminal over telephone lines with a modem at each end. The modem at your end converts the digital bits to a more convenient form to transmit over the phone lines, and another modem at the distant location restores the original stream of data bits.

Similarly, if you wish to make use of the rapidly-growing time-shared computer networks, such as the Source or MicroNet a modem must be inserted between your terminal (or computer) and the telephone line.

Why are modems necessary? Why not simply route computer signals along the telephone wires to a peripheral device such as a printer or remote terminal?

Telephone lines were designed to carry audio signals in the 300 Hz to 3500 Hz range. Frequencies below 300 Hz are attenuated and thus a stream of data pulses routed along such a line would suffer waveform distortion as shown in Fig. 1. Here a logic-pulse train of three 0's is followed by five 1's as shown in Fig. 1-a. If this pulse train were to be transmitted over the telephone lines, then attenuation would result as shown in Fig. 1-b. Many of the logic 1's transmitted over the telephone line would be recognized as 0's at the remote peripheral, with resultant errors.

Since the telephone line is optimized to handle the 300-Hz to 3500-Hz frequency range, it is practical to convert the data bits to sine waves or sinusoidal tones that can be trans-

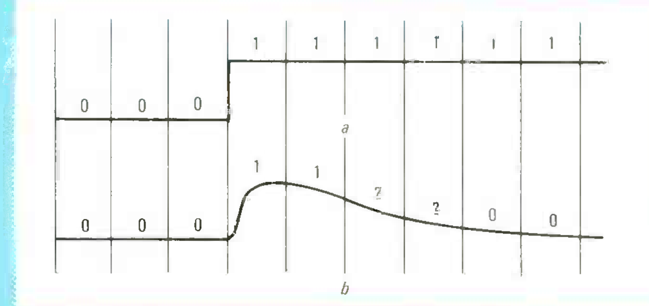


FIG. 1—A STREAM OF DATA PULSES (a) would be distorted (b) if sent over a telephone line because of the bandwidth limitations of that line.

mitted without distortion. Computer data is in the form of pulses—a pulse represents a logic-1 level, the absence of a pulse represents a logic-0 level, as shown in Fig. 2. Thus, a pulse or digital signal has two distinct states with nothing in between.

An analog signal, or sinusoidal signal, is a continuously-varying voltage, as shown in Fig. 3; its frequency and amplitude remain constant as long as nothing is done to alter or modulate it. In that form, the sinusoidal voltage is termed a carrier and, since it is at a fixed frequency and amplitude, it conveys no information. However, if its amplitude were deliberately changed—such as reduced to zero for a few seconds—and then allowed to return to its original condition, it would convey information that some input had caused the change in the carrier.

As an example, the light beam in a photosensitive burglar alarm system sends a steady beam of light from a lamp, across a doorway, to a detector. The beam is a carrier that conveys no information until someone passes through the doorway, interrupting the light beam; the short duration during the absence of light at the detector conveys information that something has changed the carrier. Changing or altering the carrier is termed modulation.

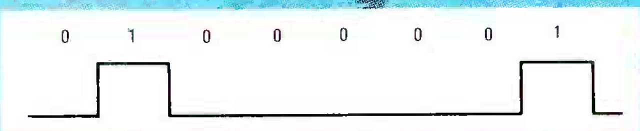


FIG. 2— IN COMPUTER DATA, a pulse represents a logic-1, the absence of a pulse a logic-0.

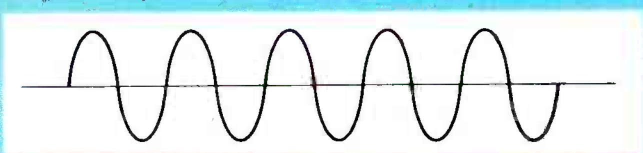


FIG. 3—THE FREQUENCY AND AMPLITUDE of a sinusoidal signal remain constant as long as it is unmodulated.j

AM, FSK, and PSK

The three common techniques used to modulate or alter a fixed-frequency signal (carrier) are: amplitude modulation (AM), frequency modulation (FM), or phase modulation (PM).

With amplitude modulation, Fig. 4, the level or intensity of a constant-frequency sinewave is varied. For example, an increase in amplitude could signify a logic-1 level while a decrease in amplitude would signify a logic-0 level.

In frequency-modulation, shown in Fig. 5, the amplitude of the sinewave is kept constant but the frequency of the carrier is changed. For example, a logic-1 level could be represented by a carrier frequency of 1270 Hz; a 1070-Hz tone could be generated if the logic state changes to a 0. The term FSK (frequency-shift keying) is often used to indicate that the carrier's frequency is shifted between two distinct frequencies to designate logic 1's or 0's.

Phase modulation, shown in Fig. 6, involves instantaneous changes in the phase of the carrier relative to a fixed reference phase angle. A standard sine wave starts at zero amplitude and zero phase angle, rises to a peak positive amplitude at 90 degrees, and drops to zero at 180 degrees before returning to zero at 360 degrees (see Fig. 3.) It is possible to represent a logic-1 level as a signal with a particular phase angle and a logic-0 level as the same amplitude, same frequency carrier but displaced in phase by 180 degrees (see Fig. 6.) A phase-detector circuit can be used to detect the phase of the carrier and thus determine whether a logic 1 or logic 0 is present. That technique is called PSK or Phase-Shift Keying.

It is possible to combine amplitude modulation (AM) that has two states (high or low) with phase modulation, which

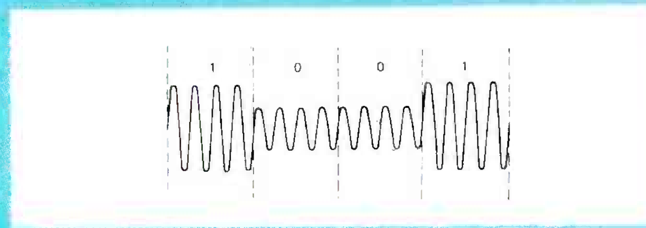


FIG. 4—IN AMPLITUDE MODULATION (AM), a change of amplitude is used to convey information.

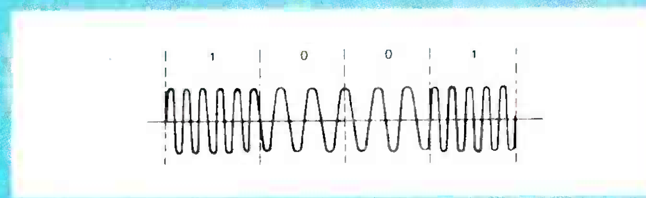


FIG. 5—THE FREQUENCY OF A CARRIER is varied while the amplitude is held constant in frequency modulation (FM).

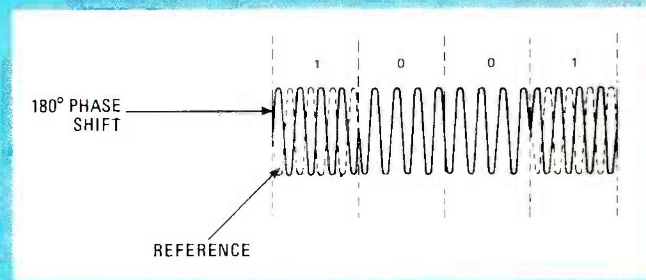


FIG. 6—IN PHASE MODULATION (PM) if a logic-1 is a signal with a particular phase angle, a logic-0 is the same signal shifted in phase 180 degrees.

can be extended to four phase shifts, to provide eight signal-state conditions; that technique is termed quadrature phase modulation. Using that technique, data rates as high as 9600 bits-per-second are achieved.

Frequency modulation or FSK is most commonly used for modems operating at 300 bits-per-second or less.

Parallel-to-serial interface

Letters or characters generated by a computer are generally coded in an 8-bit ASCII (*A*merican *S*tandard *C*ode for *I*nformation *I*nterchange) set. ASCII is a seven-bit code with 128 combinations for letters, numerals, and control functions. During serial transmission, the ASCII code is sent as an eight-bit word, with the additional bit used for parity or error checking. Those bytes of information, containing eight bits or pulses, cannot be sent over the conventional two-wire telephone line; the parallel or simultaneous transmission of bits must first be converted to a serial transmission, with bits moving along the phone line one at a time. The necessary parallel-to-serial conversion is performed by a RS-232 serial interface.

Assume that the computer is transmitting the letter "r", represented by Ø1Ø1ØØ1Ø in the ASCII code: The serial interface would accept the simultaneous group of bits and output them one bit at a time, as shown in Fig. 7. The string of bits would be represented by voltage levels of 0 and +5 for a logic 0 and a logic 1, respectively. Those pulses would then be fed to the modem that would convert them into audio tones. Those audio tones would be transmitted along the phone lines to the distant computer or terminal, where a receive modem would convert or demodulate the audio tones to their binary equivalents.

The RS-232 interface standard, adopted by the Electronic Industries Association (EIA), is the equivalent of the international CCIT TV24 standard. The 25-pin connector arrange-

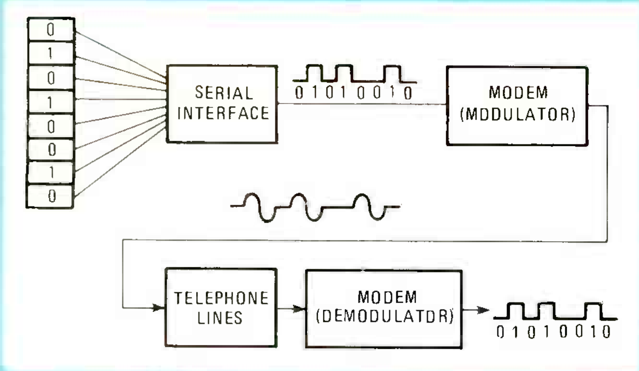


FIG. 7—ALL OF THE COMPONENTS required for serial communications are shown in this generalized block diagram.

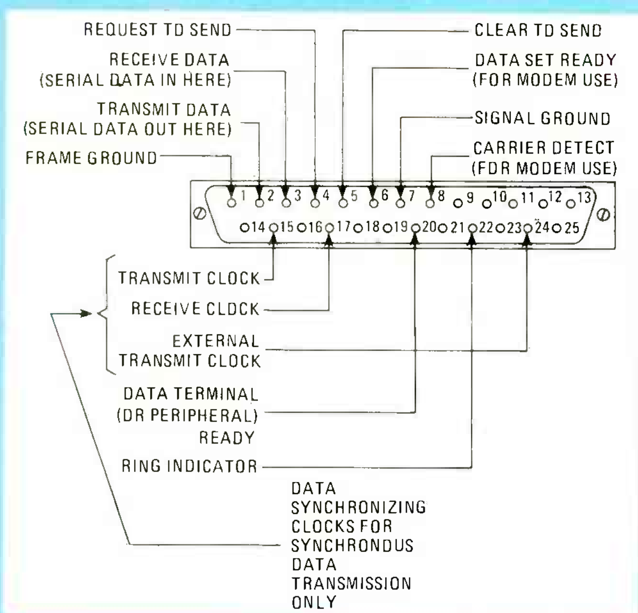


FIG. 8—THE FUNCTION OF EACH PIN in the RS-232 interface standard is shown here. The ±12-volt input shown in Table 1 have been omitted.

TABLE 1—MODEM INTERFACE FUNCTION

PIN NUMBER	SYNCHRONOUS	ASYNCHRONOUS
1	Frame ground	Frame ground
2	Transmit data	Transmit data
3	Receive data	Receive data
4	Request to send	Request to send
5	Clear to send	Clear to send
6	Data set ready	Data set ready
7	Signal ground	Signal ground
8	Carrier detect	Carrier detect
9	---	+12V
10	---	−12V
15	Transmit clock	
17	Receive clock	
20	Data terminal ready	Data terminal ready
22	Ring indicator	Ring indicator
24	External transmit clock	

ment used for modems involved with serial data transmission is shown in Fig. 8. Table 1 lists the pin functions for modems that are used for synchronous and asynchronous transmission.

Although EIA does not define how data is to be transmitted, it does define the control functions and their use. It also standardizes the pin connections on a 25-pin interface connector; the computer or terminal holds the male connector while the modem uses the female 25-pin connector. Terminals can be connected to a computer if cable length is less than 50 feet; for lengths extending to hundreds of feet, errors due to lost bits or extraneous noise-pickup may compromise the system.

If distances within a building involving several terminals exceed 50 feet, line drivers may be used at each terminal and at the computer. The line driver is basically a signal converter to amplify digital signals routed from an RS-232 interface connector; twisted-pair wires can be used between line drivers.

Simplex, half duplex, full-duplex

Data can be transmitted between a computer's I/O port and a peripheral device by simplex, half-duplex (HDX), or full duplex (FDX) modems. Simplex modems allow transmission in one direction only and thus are not often used. In a half-duplex system, data may be sent in either direction but not simultaneously. With full-duplex modems, transmission can take place in both directions at the same time. With full-duplex, two telephone channels are required, while simplex and half-duplex modems require only one. Most modems are designed for either half-duplex or full-duplex operation.

Modems are available for long-haul (extremely long distances) or short-haul (relatively limited distances). Long-haul modems are capable of satisfactory performances over thousands of miles of regular telephone or leased lines. Short-haul modems, generally slightly less expensive than long-haul versions, are designed to operate over limited distances with short, leased lines. There is no specific industry standard or definition for short- or long-haul distances. Modems may be classified by the speed of operation with these definitions. Low-speed: up to 600 bits per second; medium-speed: up to 2400 bits-per-second; high-speed: up to 9600 bits-per-second; and wideband: above 9600 bits-per-second. It is common to refer to data-transmission speed as baud or bits-per-second; however, this is strictly true if the transmission system only involves two signal states (on or off), as is the case with a computer.

Peripherals, such as a slow-speed printer, must operate at the same baud rate as the modem. Thus modems with multiple transmission rates may include a switch (or wiring connections) to match the data-transfer rate of the modem to the printer. For most installations, modems are hooked up to a dial-up line in a standard telephone network or perhaps an AT&T leased line; for short distances, one or several twisted pairs of wires may be used. When modems are used with the Bell telephone network, signals are limited to a specified level to avoid line overload and interference. Modems carrying FCC approval can be connected directly to the phone lines; otherwise, users must include a Data Access Arrangement (DAA), which is an FCC-approved interface, between the modem and telephone circuit.

Here's a simple example of how a modem would transmit and receive data in a full-duplex system (see Fig. 9).

The ASCII output from the computer, converted to serial form, is routed to the send modem that converts the logic state of 0 to a frequency of 1070 Hz and a logic 1 to 1270 Hz. The frequency-shifted (or FSK) signals are then sent along the telephone lines to a distant location where a receive modem accepts the signals from the telephone line via a band-pass filter that passes signals in the range of 950 to 1500 Hz and rejects all other frequencies. The 1070-Hz tones are

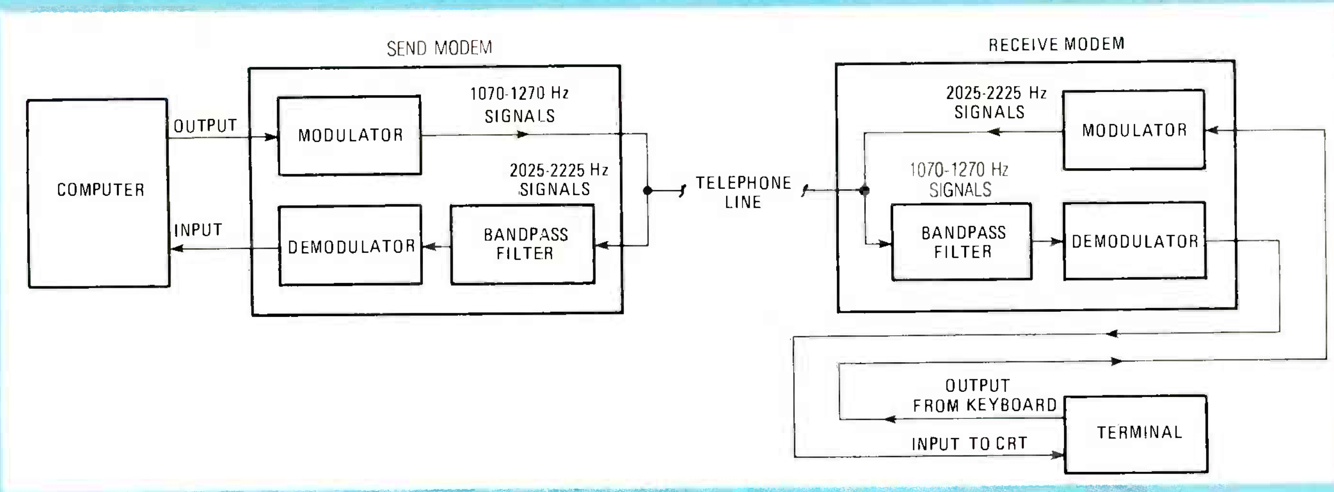


FIG. 9—THIS BLOCK DIAGRAM SHOWS how a modem would be used to transmit and receive data in a full-duplex system.

converted back to logic 0's and the 1270-Hz audio signals to logic 1's, restoring the original string of ASCII-coded pulses.

Now, the operator at the distant location may wish to send data or instructions back to the main computer to answer or respond. The keyboard output, in the form of ASCII-coded pulses, is fed to the modulator at the receiver modem where a logic 0 state generates a 2025-Hz audio tone and a logic 1 develops a 2225-Hz tone. Those audio signals are sent back, along the same telephone wires, to the main computer. At the main computer, a bandpass filter accepts the 2025-Hz and 2225-Hz signals and rejects other tones before they reach the demodulator. At the demodulator, the 2025-Hz and 2225-Hz tones are converted back to their logic 0's and logic 1's. Since two different sets of frequencies (1070-1270 Hz and 2025-2225 Hz) are used together, specially-designed bandpass filters are required to make the full-duplex system feasible using only one set of telephone lines.

Some modems on the market are available as originate only or answer only; although those units are less expensive than modems that include both originate and answer, they are obviously limited in performance.

An originate-only modem converts the logic 1's and 0's to the 1070/1270-Hz tones that are sent over the telephone lines. It cannot, however, receive tones in that frequency range. It can only receive tones in the 2025/2225-Hz tones. Therefore, two originate-only modems cannot talk to each other. This type of modem is the kind that you will probably use with your home computer.

An answer-only modem converts logic 1's and 0's to the 2025/2225-Hz tones, but it cannot receive these tones. It can only receive 1070/1270-Hz tones. Some answer-only modems have the capability to answer the telephone and connect the computer to the telephone line. A modem with answer and originate capabilities can both send and receive data on both tone pairs. That kind of modem can therefore, carry on a conversation with either an originate-only or an answer-only modem.

Synchronous vs. asynchronous transmission

Data is in the form of a stream of logic 1's and 0's, representing letters, numbers, and symbols. As they are transmitted over the telephone lines, some method of synchronization—either synchronous or asynchronous—at the sending and receiving ends is required to maintain the bit code.

Asynchronous transmission involves defining the beginning and end of each individual character or 8-bit byte sent over the lines. The word asynchronous can be misleading since it implies no synchronization. Actually, a begin and end (or start and stop) bit is inserted between each 8-bit word to synchronize the transmitter and receiver; a parity bit is included to detect errors.

THE *MODEL VA3451* direct-connect modem from Racal-Vadic.

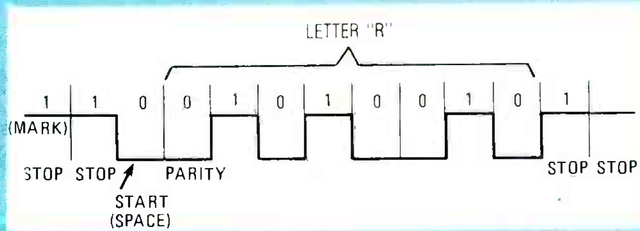


FIG. 10—AN ASYNCHRONOUS TRANSMISSION of the letter "R" with start, stop, and parity bits.

Synchronous transmission does not involve individual timing signals for each character; instead, timing signals are provided for long, lengthy stretches or blocks of data flow. Thus, there are no start and stop bits between characters.

Binary data transmission may be expressed as one of two conditions, mark for a binary 1 and space as binary 0, shown in Fig. 10. In asynchronous transmission, the transmitter rises to a mark condition at the end of each byte and remains at that level until the next byte is heralded by a space; thus, the mark at the end of the byte is the stop bit and the space at the beginning of the byte is the start bit. Those two synchronization bits permit the receiver at the end of the line to lock in or sync with the transmitter. However, an 8-bit byte requires an additional two bits to signal when a byte is arriving and is completed: those bits do not convey data and thus the system is relatively inefficient. The clock or timing signals at the transmitter and receiver are synchonized or locked each time a byte arrives; there may be lengthy periods (in the fast nanosecond world of computers) when bytes are not transmitted. However, as a new byte appears, synchronization will again take place. Asynchronous transmission of the letter "R" with start, parity, and stop bits included, is shown in Fig. 10. If data bits would be sent in a continuous stream, efficiency would be increased. For high-speed data, synchronous transmission is used whereby the transmitter clock triggers the receiver clock and is allowed to run for a lengthy sequence of bytes or blocks of data. Bytes are transmitted in a rapid, steady stream; in the event that gaps occur in the data flow, the transmitter must inject idle-bytes to maintain synchronization. The synchronous transmission system is initiated by a predetermined bit pattern or code sent by the transmitter.

Hard-wired modems vs. acoustic couplers

Modems are available either as hard-wired (sometimes called direct connection) or acoustic coupled. The hard-wired units are connected to the telephone lines directly by means of a plug fitted into the telephone's wall jack. An acoustic coupler, shown in Fig. 11, is designed to accept the telephone handset physically; the analog/digital signals entering and leaving the telephone lines are fed to the modem through tight-fitting, soundproof rubber cups to reduce external noise that might enter and upset transmission. ASCII input (in serial form) from the computer is fed to the modulator which converts logic-0's and 1's to either of two tones, FSK audio signals are converted to logic-1's and 0's by the demodulator to reproduce the ASCII coded information.

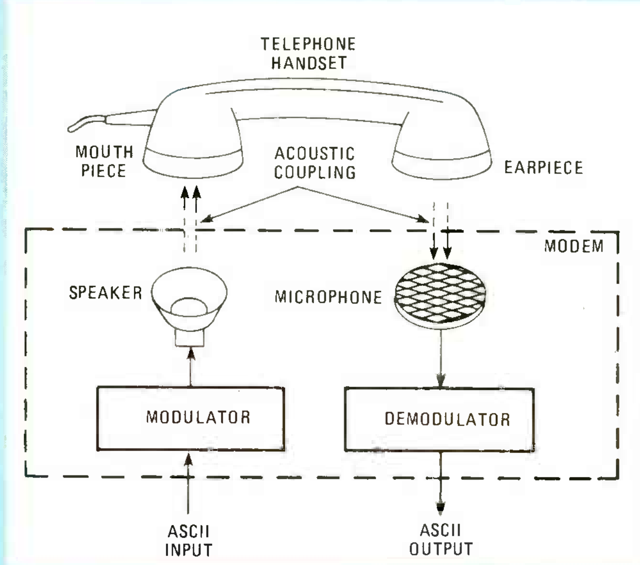


FIG. 11—AN ACCOUSTIC COUPLER is designed to pass and receive information through a telephone's handset.

tightly pressed against the mouthpiece of the telephone handset; the audio tones are then transmitted along the phone lines. Assuming that a full-duplex system is used, incoming audio tones reach the earpiece of the handset, which is closely coupled to a microphone. The two-tone FSK audio signals are converted to logic 1's and 0's by the demodulator to produce the ASCII coded information sent by the distant computer or terminal.

Hard-wired modems are generally more expensive than acoustic coupled types; however, they are not susceptible to external noise interference. A list of manufacturers supplying modems is shown in Table 2. **R-E**

TABLE 2—DIRECTORY OF MODEM MANUFACTURERS

To receive information from the manufacturers listed below, circle No. 99 on the Free Information Card inside the back cover.

APF ELECTRONICS, INC.
1501 Broadway
New York, NY 10036

ATARI, INC.
1265 Boregas Avenue
Sunnyvale, CA 94086

BIZCOMP
Box 7498
Menlo Park, CA 94025

HAYES MICROCOMPUTER PRODUCTS
5385 Peachtree Corners East
Norcross, GA 30092

HEATH COMPANY
Benton Harbor, MI 49022

LEXICON CORPORATION OF MIAMI
1541 NW 65th Avenue
Plantation, FL 33313

LIVERMORE DATA SYSTEMS
2050 151st Place NE
Redmond, WA 98952

THE MICROPERIPHERAL CORP.
2643 151st Place NE
Redmond, WA 98052

MULTI-TECH SYSTEMS, INC.
82 Second Avenue SE
New Brighton, MN 55112

NOVATION
18664 Oxnard St.
Tarzana, CA 91356

OHIO SCIENTIFIC
1333 South Chillicothe Road
Aurora, OH 44202

QUEST ELECTRONICS
P.O. Box 4430E
Santa Clara, CA 95054

RACAL-VADIC INC.
222 Caspian Drive
Sunnyvale, CA 94086

RADIO SHACK
1400 One Tandy Center
Fort Worth, TX 76102

TNW CORP.
3351 Hancock St.
San Diego, CA 92110

US ROBOTICS
203 N. Wabash, Suite 718
Chicago, IL 60601

UNIVERSAL DATA SYSTEMS
5000 Bradford Drive
Huntsville, AL 35805

SETTING UP A SYSTEM

Choosing a computer system is very much like getting married—it pays to give it a lot of thought first. Consider these points when making your choice.

WELL, THAT FATEFUL DAY HAS FINALLY ARRIVED: YOU'VE gotten up your courage and decided to go out and buy a home computer system. Just one problem remains—what do you do first? The answer is simple: Ask questions!

Ask questions about the system you intend to buy; ask questions about any dealer that you may do business with; ask *any* question that may help you make an intelligent choice, but most important, ask those questions and get them answered *before* you spend the first dollar.

What questions should you ask? That all depends on your requirements, but the ones listed in "Before you Buy A Computer" elsewhere in this article can serve as a good starting point. Use those questions as a checklist for some of the basic things to consider before making your purchase.

One more point: When you think you know what it is you intend to do with your computer, define your requirements in as much detail as you can. Simply saying that you want your computer to help you with your business is not enough. The more information you can provide a good computer salesman regarding your needs (For example: If you're going to be using it to keep an inventory, how many different items and categories will be involved?), the better he will be able to help you find the system best suited to you.

Putting your system together

Of course there's more to a computer system than just a computer. What's more, the peripherals, software, and incidentals that make up a system can often cost more than the computer itself. The most important thing to keep in mind when you are putting your system together is that the peripherals must be compatible with your computer—otherwise they are worse than useless!

Don't always believe what you're told at the store about compatibility; although most computer salesmen are knowledgeable, there are a few who probably know less than you do. Also, just because a manufacturer says that his product is compatible with a particular system does not necessarily mean that it is.

There are many instances where ambiguous specifications or sudden hardware or software changes have crossed up the best of intentions. If you want to play it safe, insist on seeing a demonstration of all the components of the system you intend to purchase working together. By the way, the same advice holds true for the computer itself—if the computer is delivered in a factory-sealed box, *don't accept it!* All too often, a computer is damaged in transit, so, unless the idea of bringing that bulky box back to the store (and waiting for repair or a replacement) doesn't bother you, it is advisable to have the salesman open the box and make sure the computer is working properly before you take it home.

What you'll need

Let's look at some of the peripherals that you'll need to get the best use out of your computer. For instance, unless you purchase a computer with an integral video monitor (such as the *PET*), you'll need some way to view your programs and their results.

Using your television set is one solution, and that is what is done in many cases. There are some limitations to that approach however, the most serious of which is that the bandwidth of most TV receivers restricts the display size to lines of about 40 characters. If that's all you'll need, fine; otherwise you'll have to obtain a video monitor. With some systems you may require a terminal, which combines a video monitor with a keyboard. Also, if color graphics are important to you, be certain that the monitor you choose is appropriate.

What about disk drives? If you need them, it's best to buy the kind that are already assembled and need only to be plugged in. Unless you are experienced in computer electronics, the do-it-yourself units can be more trouble than they are worth.

A printer is a necessity if you're going to require "hard copy" from your computer. There are two types of printer interfaces: serial and parallel. They differ in the way that they accept information from the computer. A serial printer is recommended if the unit is going to be located more than a few feet from the computer, but it requires an RS-232 interface. Some computers have an RS-232 interface built in, and if yours does, you're all set; if yours doesn't, that is another accessory that you are going to need.

An RS-232 interface is also required if you intend to use your computer with a modem, to communicate with other computers over the telephone.

Everything that we've discussed so far has one thing in common—it all has to be plugged into a 117-volt source... which also means that in the event of a power failure, it will all stop working. If you are in an area where power failures are common, or if your computer system is going to be in continuous use, consider getting a battery-powered backup supply. It can keep things going for about 15 minutes, enough time to shut everything down in an orderly fashion without losing any data. Also, if the power lines in your area are subject to electrical-spike noise, a transient filter would be a good investment.

While we're on the subject of power, you should take care not to overload your computer's power supply. Some computers can accept plug-in boards such as disk controllers, additional memory, communications interfaces, etc. It is possible, in some cases, to plug in a combination of boards that will draw more current than the computer's power supply is designed for. The result is erratic operation at best, and total failure at worst.

Software and incidentals

What we said earlier about peripherals also holds true for software: Make sure it's compatible with your system and that it does everything you expect it to! Have the dealer demonstrate the package in the store and put it through its paces. (Taking this step can also save you some of the time and effort it would take to figure out how it works by yourself.) And when setting up your system, don't forget the incidentals such as paper; disks or cassette tapes, and a place to store them, and the like.

While much of what we've discussed here is simple common sense, in the excitement of buying a computer many people tend to overlook the simple things that are really important. Don't be timid—if you are unsure of anything, ask about it before you buy. Bear in mind what you've just read and you'll greatly increase the chances of making the right decisions. Happy computing! **R-E**

BEFORE YOU BUY A COMPUTER

Below are some basic questions that you should have the answers to before you purchase any personal computer. Use them as a starting point and add any that are pertinent to your special requirements.

Questions about your computer

1. Is the software you require available for the computer or would you be required to write it yourself?
2. Is the computer supported by software from outside vendors or would you be required to buy it from the manufacturer?
3. Is the manufacturer's documentation (manuals) reasonably complete?
4. Will the dealer and/or manufacturer assist you if you run into problems?
5. Is there a user's group for that particular computer in your local area?
6. Are many manufacturers producing compatible hardware for that computer?
7. What has the hobby press said about the computer?
8. Does that computer have a history of user problems?
9. Is the display's line length long enough? If it isn't, can it be extended?
10. Can the computer grow with your needs? Can additional memory, disk drives, etc. be added as the need arises?
11. If graphics are important, can the computer support them?
12. If color is important, can the computer support it?
13. Does the computer have a standard typewriter keyboard?
14. Does the computer support upper and lower case characters? If not, are accessories available that will enable it to?
15. Does the computer have all the interfaces that you will require, and if not, are they available at a reasonable price?

Questions about your dealer

1. What is his reputation? Will he give you a list of satisfied customers that you can check out?
2. Has he been in business long?
3. Is he responsive to customer needs?
4. Does he have the technical expertise to assist you if trouble should arise?
5. Does he have an in-store service facility?
6. Can he offer a service contract that offers fast response and includes use of a loaner system if yours should go down for more than a day?
7. Does he have a wide selection of software and does he know how to use it?
8. Does he offer training classes?

A DYNAMIC NOISE REDUCTION SYSTEM

When you want to reduce noise in non-encoded material, or when the noise is in the program source itself, this new noise-reduction system promises to be the number.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

BASICALLY, THERE ARE TWO WAYS TO reduce noise in any sound system. The first of those is generally referred to as a complementary, or companding type. In it, signal encoding takes place before transmission or recording; the signal is decoded during playback. The second type of noise-reduction system is referred to as non-complementary, or single-ended; it operates during playback only. As a result, it does not require any special encloding of the program material.

For consumer audio equipment, the most popular noise-reduction system to date has been the *Dolby B* system, which falls into the first (complementary) category. While *Dolby B* provides only 10 dB of noise reduction at high frequencies (not enough to make tape hiss totally inaudible), it's widely accepted because it is a "compatible" noise-reduction system. That is, one can listen to a Dolby-encoded program source without using a Dolby decoder and still find the music acceptable.

However, the fact that *Dolby B* does not render tape hiss completely inaudible has prompted other designers to come up with companding systems that deliver greater amounts of noise reduction. Among those are the *dbx* companding system and, more recently, the *Dolby C* system. The *dbx* system offers over 35 dB of noise reduction while the new *Dolby C* system cascades two *Dolby B* circuits (with some other circuit refinements) and delivers 20 dB of noise reduction in the mid and high frequency bands.

Over the years, some designers have concentrated on single-ended, or non-complementary noise-reduction systems as well. Perhaps the best known of those is the *Dynamic Noise Filter* developed by Burwen. Now, National Semiconductor has developed a noise-reduction system, called *DNR*, based upon the same Burwen *Dynamic Noise Filter* that does not require signal encoding and, as a result, is effective for RM broadcast signals, tape, and other program sources. According to National Semiconductor, the system is particularly useful in automotive entertainment systems and would be effective when used with video cassettes as well. An integrated circuit, the LM1894, is available in a 14-pin dual-in-line, molded package to equipment manufacturers at an extremely low price, when bought in large quantities.

Advantages of non-complementary noise reduction

While companding noise-reduction systems are capable of reducing noise that is added to a program source *during* the recording process itself, they cannot eliminate noise that is already *in* the program source. When it is necessary to remove or reduce noise levels in a program source, a non-complementary type of noise-reduction system is preferred and, since such a system requires no encoding, complete compatibility is retained. Another advantage of single-ended noise-reduction systems is their low cost, compared with companding encode/decode systems. Remember, too, that most of the program material that we listen to (radio, records, TV, etc.) is *not* encoded at all. Few FM stations now use *Dolby FM*, despite its early promise, and therefore an effective non-complementary noise-reductions system may well be an idea whose time has come.

How *DNR* works

The National Semiconductor noise-reduction system can provide up to 14 dB of noise reduction in stereo program-material and is based upon two principles. The first of those states that noise output is proportional to system bandwidth. Suppose system noise is caused solely by resistive noise (noise added by the circuit resistors). In such a system, noise amplitude is uniform over the frequency bandwidth. Thus, if the bandwidth of the system is reduced, the noise

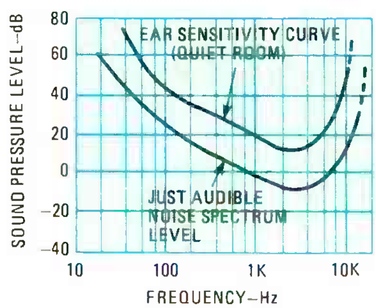


FIG. 1—THE EAR IS MOST SENSITIVE to sounds that have a frequency between 600 Hz and 6 kHz.

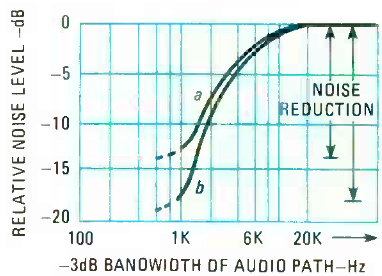
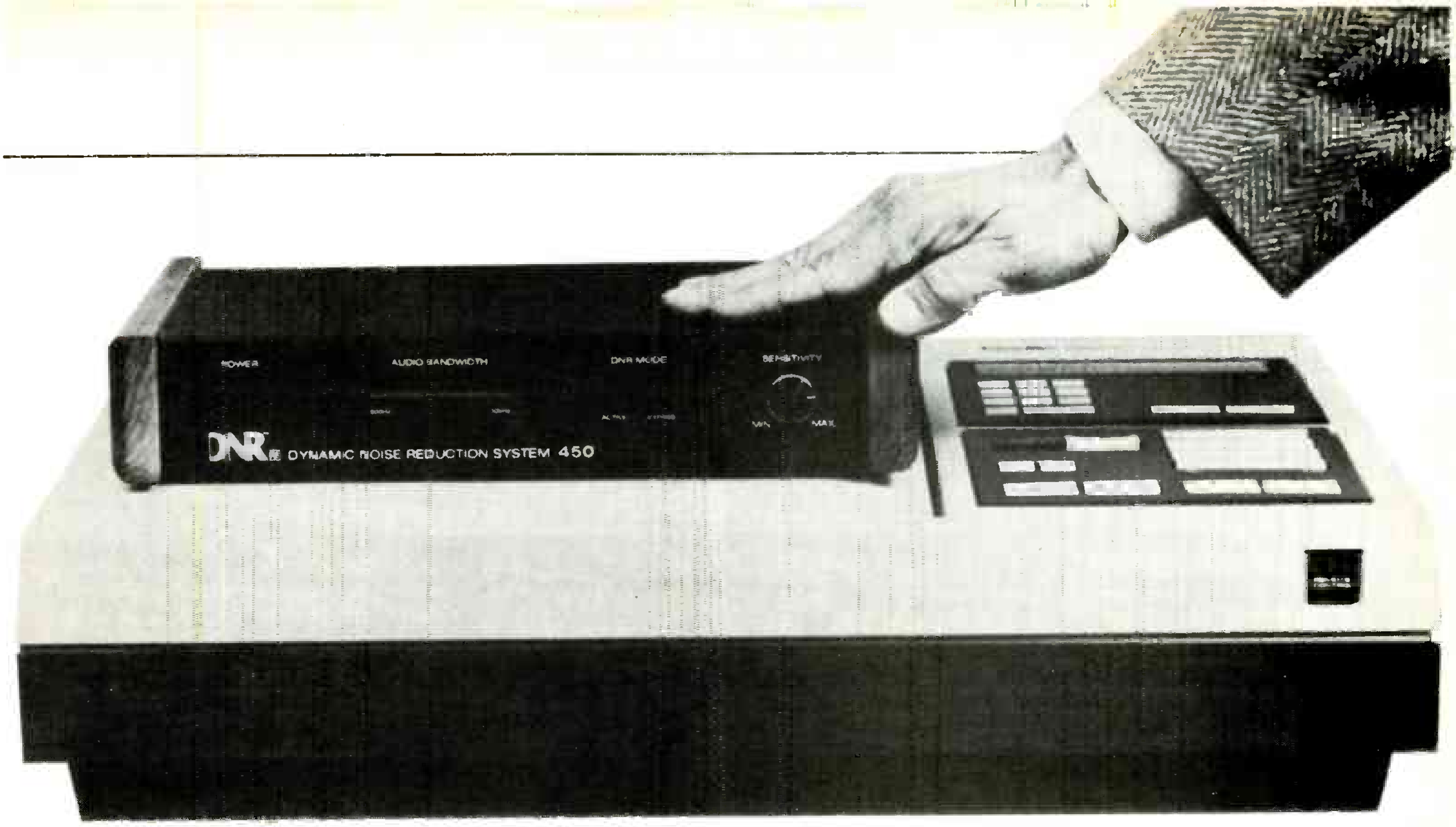


FIG. 2—THIS GRAPH SHOWS how decreasing bandwidth affects noise reduction when the DNR is configured as a single-pole (*a*) or double-pole (*b*) low-pass filter.



content is also reduced.

Unfortunately, there isn't a simple correlation between the amplitude of the noise signal and the amplitude of the noise perceived by the listener. As shown in Fig. 1, the ear is most sensitive to noise in the 600-Hz to 6-kHz frequency range. For this reason, when measuring noise content in a system, a weighting filter is usually inserted in the measuring instrument to give better correlation between the measured signal-to-noise ratio and the subjective impression of noise. When a CCIR/ARM weighting filter (commonly used when measuring signal-to-noise ratios of cassette tape and decks) is used, it will yield noise-reduction numbers of between 14 and 18 dB when the bandwidth of a system is restricted to 1 kHz with single-pole and two-pole low-pass filters, as shown in the curves of Fig. 2.

Auditory noise masking

The second principle that *DNR* is based on is the face that whenever we hear one sound, that sound decreases our ability to hear another. White noise (random noise that contains all audible frequencies at equal amplitude), for example, raises the threshold of haring a pure tone by a level that depends on the frequency of that tone, as shown in Fig. 3. The curve shows a general trend. At a higher frequency, a tone has to be increased in amplitude (compared to a 1-kHz tone) to be heard. That is because a wider range of noise frequencies contribute to masking as the tone's frequency increases. But regardless of the tone's frequency, there will be some range of noise frequencies that will be capable of masking that tone.

The results are not quite the same when we measure the ability of a single tone to mask undesired noise. Experimental results show that extremely high sound-pressure levels of a single tone are required to provide masking. Even at the most effective frequencies (between 700 Hz and 1 kHz, near the natural resonance of the ear), sound-pressure levels in excess of 75 dB are required to mask noise at a very low 16 dB SPL (*S*ound *P*ressure *L*evel). Fortunately, those results apply only to *pure* single tones. With the complex signals that are a characteristic of music and speech, masking effects are much better. The broadband spectral components, and high concentration of energy around 1 kHz that is produced by most musical instruments (Fig. 4) improve the noise-masking ability by more than 30 dB over a pure 1kHz tone. Comparing the frequency spectrum of musical instruments with the ear-sensitivity curve of Fig. 1, we see that the high-energy content is just where it needs to be for effective noise masking.

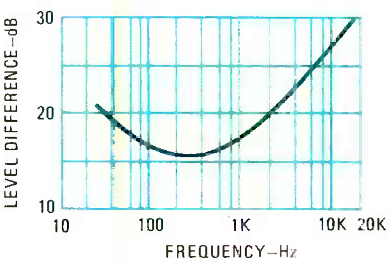
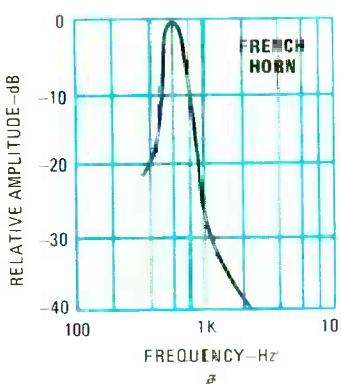
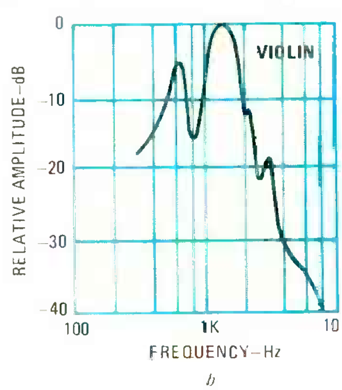


FIG. 3—WHEN NOISE IS PRESENT, the volume (amplitude) of a tone must be increased for it to be heard. How much that volume must be increased depends on the frequency of the tone.



a



b

FIG. 4—MOST MUSICAL INSTRUMENTS produce spectra that have a high concentration of energy around 1 kHz. The spectrum of a French horn is shown in *a*; the spectrum of a violin in *b*.

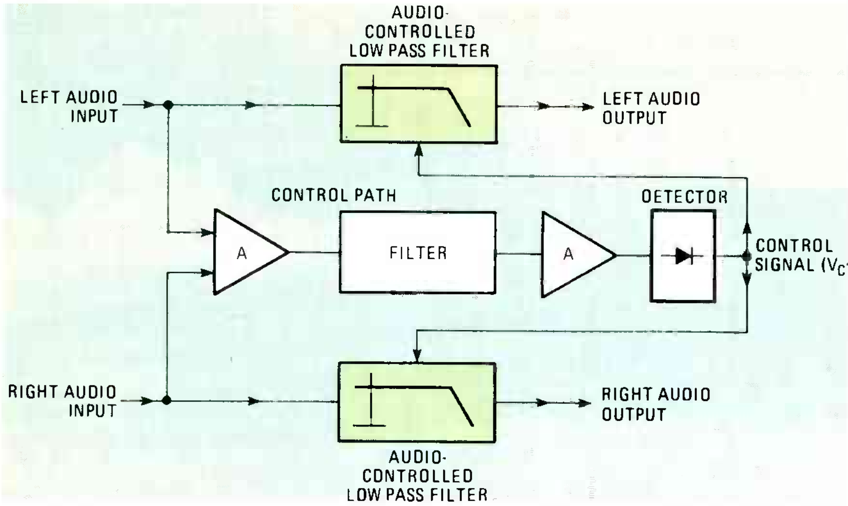


FIG. 5—TWO LOW-PASS FILTERS, one for each stereo channel, are placed in the audio-signal path as shown in this general block diagram of the *DNR* system.

From all of that, the designers at National Semiconductor concluded that if source material is at least 29 dB above the "noise floor", adequate masking can usually be obtained. Therefore, any noise-reduction system that dynamically restricts audio bandwidth (by virtue of its previously calculated 14-dB improvement) will insure a minimum perceived signal-to-noise ratio of 43 dB (29 dB + 14 dB) without audibly degrading the music program. A cassette tape recorded at a mean signal level of around −10 VU (*Volume Units*, as on a VU meter)—40 to 45 dB above the noise floor of the tape/system—will, with the aid of a bandwidth-varying noise-reduction system, be improved to a perceived signal-to-noise level of between 55 and 60 dB. If the recording was made at 0 VU, the improvement can be expected to provide a signal-to-noise ratio of better than 65 dB.

The *DNR* audio filters and control path

The general arrangement of the *DNR* system is shown in the block diagram of Fig. 5. Two low-pass filters (one for each stereo channel) are placed in the audio-signal path, their −3dB bandwidths are controlled by the amplitude and frequency of the incoming signals. Each filter response is flat below its cutoff frequency, with a smooth single-pole roll off above its corner frequency for any control setting. The resulting −6 dB-per-octave slope produces the most satisfactory results with modern and classical music that has a wide frequency range. Steeper slopes can produce greater amounts of noise reduction for a given bandwidth, but are more suited to program material that does not have substantial high-frequency content. Cascading two filters will give a −12 dB/octave slope with noise reduction as great as 18 dB (See Fig. 2.)

Figure 6 shows the various low-pass

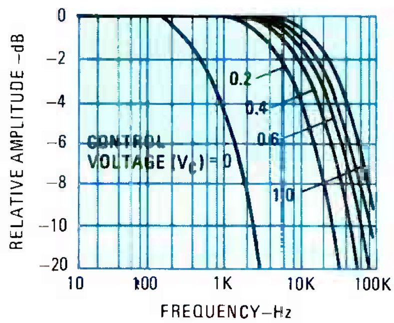


FIG. 6—DIFFERENT LOW-PASS FILTER Response curves are obtained by varying the control voltage.

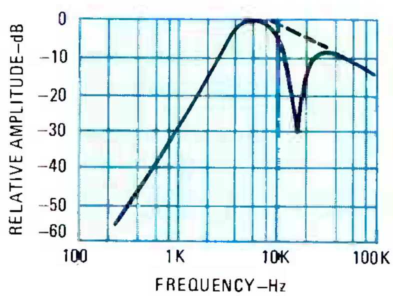
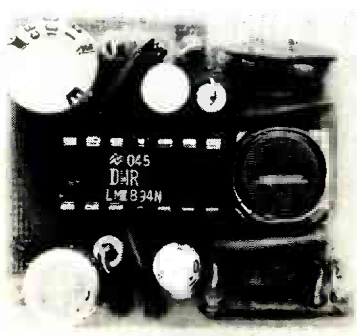


FIG. 7—FREQUENCY vs. AMPLITUDE response curve for the control path includes an optional notch at 19 kHz, needed when source material contains an FM pilot signal.



THE *DNR* NOISE REDUCTION SYSTEM is available as a 14-pin IC from National Semiconductor, the LM1894.

filter response curves that are obtained by varying the control voltage from 0 to 1.0. That voltage is derived from the control path shown in Fig. 5. Since the spectra of musical instruments (Fig. 4) and the ear-sensitivity curve (Fig. 1) imply that masking is most effective at relatively *low* frequencies, you might assume that a low-pass filter would be good for the control path shown in Fig. 5.

That turns out not to be the case. Figure 7 shows the frequency versus amplitude response of the *DNR* IC control path. The *DNR* system uses a *high-pass* filter with a −3dB corner frequency of 6 kHz and −12 dB/octave roll-off slope. An optional notch at 19 kHz is for when the source material contains a stereo-FM pilot signal that might tend to increase minimum bandwidth above 800 Hz when the detector threshold is set at the noise floor.

The control-path frequency-response is weighted in that manner because program material varies substantially in harmonic content, depending both on relative loudness and on the particular instruments being played. As an example, consider the case of a French horn. Most of the energy produced by that instrument is below 1 kHz. If a low-pass filter were used in the control path, it would respond to that energy and open up the filters to full bandwidth, unmasking noise in the 2-kHz and above region.

To avoid that, the system looks for *high*-frequency energy in the music source and, in the case of the French horn, not finding any higher harmonics, the noise remains filtered out and bandwidth remains restricted. Multiple instruments, or a solo instrument such as a violin, for example, may have significant high-frequency energy that will not only provide good noise masking but will require a wider system bandwidth. To summarize then, when high frequencies are detected in the control path, it is an indication that large levels of energy are present at the same time in the critical masking-frequency range, so that audio bandwidth can be safely increased as required to prevent audible degradation of the music. The noise, however, remains masked. To make up for the relatively fast decrease in spectral energy with increasing frequency, the control-path response is increased at a 12 dB-per-octave rate.

Attack and decay times

If the detector of the *DNR* system were allowed to respond instantaneously to any input signal, ticks or noise bursts of short duration but with rapid risetimes would be able to open up the bandwidth of the system without simultaneous program masking. Also, different instruments have widely differing risetime characteristics. With that in mind, the *DNR* system was designed with an attack time of 0.5 milliseconds to minimize potential loss of high-frequency transients. That does constitute a trade-off in that the system is susceptible to impulse-noise interference. Impulse noise, having fast rise- and decay-times and quite a bit of high-frequency energy, must be eliminated using other techniques.

Once the detector has responded to a given musical transient, it must decay back to its inactive level when that transient is over. Once again, a compromise in parameters was required for the *DNR* system. Too slow a decay time would mean that system bandwidth would remain "wide open" for some period after the decay of the transient. A noise burst would be heard at the end of each musical transient since there would be nothing to mask it. If the decay was too rapid on the other hand, a loss in apparent ambience would occur because harmonics occurring at the end of a transient would be suppressed. The *DNR* system decays to within 10% of final value in 50 milliseconds. The ear's inability to recover sensitivity for 100 to 150 milliseconds following a loud sound prevents the noise burst that is present at the beginning of each transient from being heard. R-E

"So this is your second-grade addition. Well, now, let me get the calculator to see if you've got them all right."

HOBBY CORNER

Learning all about the "ABC's" of seven-segment LED's.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

WE ALL KNOW THAT A SEVEN-SEGMENT LED can be used to display the numbers between 0 and 9. But did you know that those LED's can also be used to display letters of the alphabet? Well they can, although not all the letters can be formed and the LED's must be driven somewhat differently.

Take a look at the LED shown in Fig. 1. Each segment is labeled in the standard manner. If you were to light segments "e," "f," "a," "b," "c," and "g," the letter "A" would be displayed. Likewise, lighting segments "d," "e," and "f" would produce a letter "L," and so on.

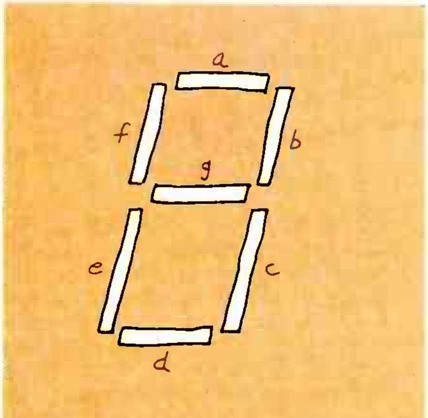


FIG. 1

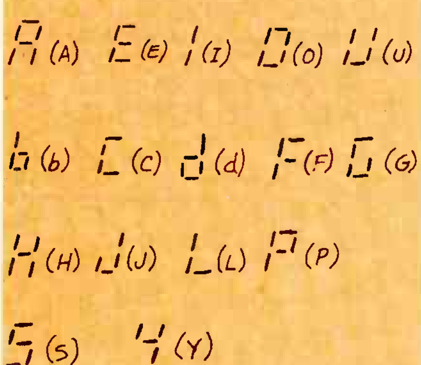


FIG. 2

Although there are special, more costly, readouts that can display all the letters, the lowly seven-segment LED is quite capable of producing 16. Although that may not sound like many, you'd be surprised at the number of words that can be made from the 5 vowels and 11 consonants that are shown in Fig. 2. Note that some of the letters are upper case and some are lower case. Well, you can't have everything. (Some letters, though, can be formed either way. "I" is one—see if you can find the others.)

If you think about it for a few moments I am sure that you'll become convinced that there are literally thousands of words that can be formed from just those few letters. As a short example, consider these: BILL, SUE, JOE, PEG, HELLO, GOOD, SHIP, BAG, BEG, BIG, BOG, and BUG. If you like, you can write a computer program to list all of the possible combinations.

Getting back to lighting the individual segments, you could use an SPDT switch to light each one as shown in Fig. 3. Note the 220-ohm resistors in that circuit; they are current-limiting resistors and are included to prevent burning out the LED. The circuit shown will produce all of the possible combinations but is awkward at best. Fortunately there is a better way to accomplish the same objective.

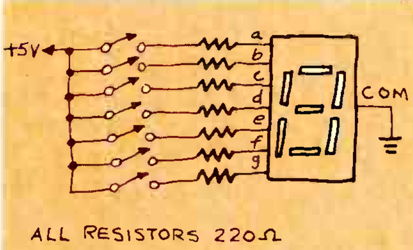


FIG. 3

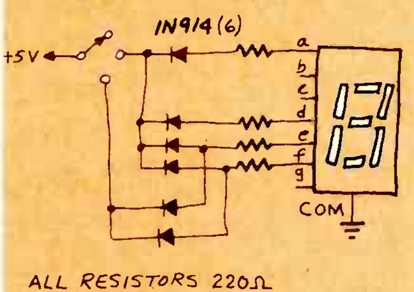


FIG. 4

The circuit in Fig. 4 uses an SPDT switch to choose which of two letters, "C" or "L," is displayed. The 1N914 diodes are used to isolate the switch lines so that the current cannot find a path to light unneeded segments. Without the diodes all four wired segments would be lighted in both switch positions. The diodes connected to segments "a" and "d" are not actually needed because those segments are only connected to one switch position. The diodes were included in case you wish to use those segments later to display other letters.

The example in Fig. 4 can easily be expanded using a multi-position rotary switch. When expanded that way, the circuit can be used to spell a word or words sequentially, letter-by-letter. In that case, don't overlook letters that repeat—the switch positions for those letters can simply be wired together to minimize some of the work required.

For instance, if you wanted the circuit to spell the word "hobby," you could wire the third and fourth switch positions together. You could also minimize the wiring in this example by leaving segments "b" and "c" on all the time; that is because those segments are used in all of the letters of that particular word.

Incidentally, all of the LED's shown in this article are common-cathode devices. If you want to use common-anode LED's, apply power to the common anode, and ground the segments you wish to light. To do that in Fig. 4, for example, simply exchange the ground and power connections, and reverse the diodes.

Now that we have the basics behind us, let's build a game that will be entertaining as well as educational. For now we'll limit our game to words that are just three letters long. If you wish, you can expand it later either by providing more letters per position, or by using more LED's and switches to form longer words.

The circuit for the game is shown in Fig. 5. You'll notice, of course, that all of the resistors and diodes have been omitted. That was done for simplicity; you should have little trouble completing the circuit using the information presented earlier.

Each switch is used to display a letter on the LED it's wired to. The first and third switch/LED are used for consonants; the middle one for vowels. The object of the game is to spell the greatest number of words in a given time. The kids are sure to enjoy this

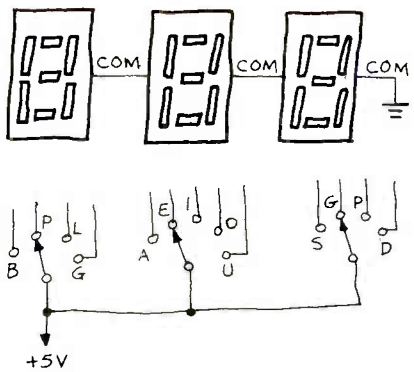


FIG. 5

ANALOG REVERB

continued from page 47

concert levels from the rear speaker with just one watt of power. However, the level of the reverberation should be 10 to 20 dB lower than the level of the front channel. That corresponds to a difference of 5 to 50 watts. Furthermore, the distortion in the system that's caused by the rear (delayed) channel appears to be 10 to 20 dB lower than actually measured because the music from the louder front-channels serve to mask that distortion.

The reverberation effect is not obvious as the reverberation or output levels are gradually increased. It's only when the reverberation decreases or disappears that you really notice it. The effect should be subliminal—you should not be able to hear the reverberation unless you really listen for it, but your mind will always know it is there. There will be a "fullness," without an increase in volume, that is deceiving. You'll often find that you are listening to your stereo system at a lower volume level than before simply because the music no longer needs to be loud just to full a room with sound. **R-E**

game, and you may find yourself playing it too.

There are a couple of variations you may wish to consider before you build this project. You might care to invest in an alpha-numeric readout so that *all* of the letters of the alphabet can be displayed. Alternately, you could use regular (discrete) LED's arranged in a 5 × 7 matrix to form the letters. This method involves more wiring, but it is a less expensive way (especially if you use surplus LED's) to display all of the letters.

Aid for the deaf

Bill Smith of Everett, WA is looking for a circuit to let a deaf person know that there is someone at the door. He wants to rig up a couple of lights that will be turned on by the front and rear doorbell circuits. Of course the lights should lock in with one tap of a button, and should flash to get attention.

Digital circuitry would do the job, but the usual LED indicators would be too easily overlooked. Keep in mind that the typical doorbell circuit works from between 12- and 20-volts AC.

While you're thinking along those lines, there are many similar devices that could help the deaf. For starters, how about a device to signal the presence of any unusual loud noise? Let's see what you can come up with.

Computers and ham radio

If you're interested in computers or ham radio, you know that there has been a marriage of sorts between those two hobbies. Hams are using computers in many aspects of their hobby, including such things as designing circuits, slow-scan TV, aiming satellite antennas, and keeping station records.

Now comes word that K2MI, Marty Irons (46 Magic Circle Drive, Goshen, NY 10924) is heading up a new ham group for users of the Sinclair *ZX-80* and the MicroAce computers. They have a newsletter and, by the time you read this, a net for exchanging technical information. If you're an interested ham, get in touch with Marty for the lastest information. **R-E**

NEW PRODUCTS

For more details use free information card inside back cover.

CASSETTE SEMINAR, *Computers Understood,* is an introduction to computers that consists of more than eight hours of lectures that are coordinated with a comprehensive study manual. It is composed of 10 learning modules, integrated rather than presented as separate lectures, designed for both managers and technical people.

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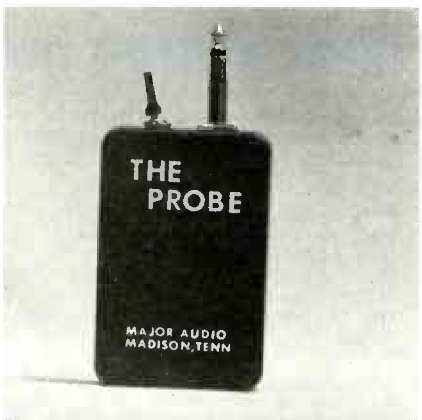
Developed from the experience of leading consultants and educators in the field, the material reflects the state-of-the-art and is presented in a usable rather than an academic manner. *Computers Understood* is priced at $125.00.—**Career Enhancement Institute,** 361 Virginia Street, Crystal Lake, IL 60014.

SIGNAL TRACER, *The Probe,* is a low-cost signal tracer designed to allow the field engineer to trace analog or digital signals without direct connection to the circuit. *The Probe* is entirely self-



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contained with a speaker output and is powered by a 9-volt transistor battery. It is housed in a high-impact plastic case (2 × 4 × 1 inches) and weighs five ounces, including the battery. *The Probe* is priced at $49.95.—**Major Audio,** 1119 Due West Avenue, Madison, TN 37115.

RAM-EXPANSION KIT, is a memory-expansion kit that will upgrade any Atari 8K RAM board to 16K. It provides five times more program space in high-resolution graphics and also allows access to higher-resolution graphics (320 × 192). The kit can be installed in minutes and includes all hard-

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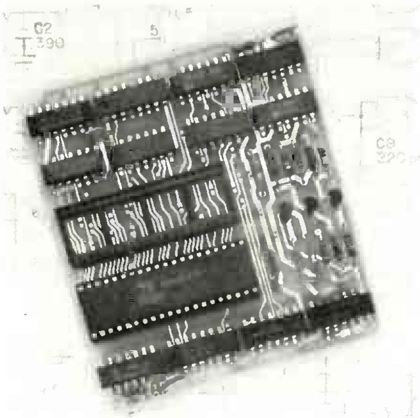
ware and pictorial instructions. Supporting software available includes graphics programs such as Plot and Draw which generate graphics quickly while saving data for incorporation into BASIC program. Other software includes computer-assisted instruction programs, child-education programs, and video games. Suggested retail price is $79.95.—**Mosaic Electronics,** P.O. Box 748, Oregon City, OR 97045.

CAR-STEREO SPEAKER, *model LS-81,* is designed for compact cars. It has a 1-inch air-spring tweeter, and a 4½-inch bass driver with a long-throw voice coil, low mass-cone suspension and a vented center pole. The *LS-81* measures 7⅞ ×

CIRCLE 144 ON FREE INFORMATION CARD

5⅛ inches. Manufacturer's specifications include a frequency response of 80 to 20,000 Hz ±3 dB, and an impedance of 4 ohms. Suggested retail price is $190 including mounts.—**Epicure Products, Inc.,** 1 Charles St., Newburyport, MA 01950.

DISK CONTROLLER ADAPTER, the *Doubler,* is a double-density adapter for the *TRS-80 Model I* computer that allows the user to store almost four times more data on a five-inch disk—up to 354 formatted kilobytes. The *Doubler* plugs into the controller-chip socket of the expansion interface, with no circuit modifications necessary. That system also comes with *DBLDOS*, a



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TRSDOS-compatible double-density operating system, and a utility for converting *TRSDOS*, Percom *OS-80* and other single-density files and programs into double-density format, and vice versa. The data read/write rate of the *Doubler* is twice as fast as single density read/write, and the unit can read, write, and format either single or double-density disks. Suggested retail price of the entire system is $219.95.—**Percom Data Co.,** 211 N. Kirby, Garland, TX 75042.

ZIPPER TOOL CASES, *models 650-ZT* and *655-ZT* are oxford brown, compact, zipper, padded tool cases for service requirements that demand a full complement of small tools.

The model *650-ZT* is 10 × 13 × 1½ inches and is priced at $21.00; the *model 655-ZT* is the same as above, except that the dimensions are 10 × 13

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× 2½ inches, and it is priced at $22.00.—**Platt Luggage, Inc.,** 2301 South Prairie Avenue, Chicago, IL 60616.

SPEAKER, *model MR II*, offers three in-line, solid-state super-tweeters performing in tandem with four 5¼-inch mid/low frequency drivers, all

MR II

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facing forward. Mounted in the rear of the enclosure is a 15-inch passive radiator for tight extended bass. This design produces full-range, high-definition sound from classical to contemporary music, although the unit is half the size of other speakers that offer equivalent performance.

The *model MR II* does not require equalization, and offers wide (90° × 60°) sound dispersion. Frequency response is 46 Hz-20 kHz ± 5dB. The system incorporates a coil-guard circuit to protect speakers from damage from overload; that protective circuit resets automatically.

The *model MR II* is priced at $350.00.—**GLI,** a division of Integrated Sound Systems, Inc., 29-50 Northern Blvd., Long Island City, NY 11101.

PRINTERS, *models MT-80P* and *MT-80S*, are both in the MT-80 series of 125-character-per-second, 80- and 132-column bidirectional printers. They support the full upper case and lower case 96-character ASCII set in three software-

CIRCLE 148 ON FREE INFORMATION CARD

selectable fonts (5, 10, and 16.5 characters per inch). The printers can handle up to three copies plus the original. The 10-character-per-inch font uses a 9 × 7 dot matrix.

These microprocessor-controlled printers contain a 240-character buffer, expandable to 3K in 1K increments. A comprehensive self-diagnostic program is automatically run on power up. The printers have no duty-cycle limitations. Life expectancy of the print heads is 100 million characters. The mean time between failure is 1,000,000 lines. The units weigh 22 pounds and measures 7.3 × 17.7 × 14.8 inches.

The pin-feed paper handling system can be adjusted to accept fan-fold forms varying from 1.0 to 9.5 inches in width. Paper can be loaded from the rear or bottom.

The *model MT-80P* Centronics-compatible parallel interface version is priced at $795.00 in single quantities; the *model MT-80S* serial (RS-232) version costs $895.00 for single units.—**Microtek, Inc.,** 9514 Chesapeak Dr., San Diego, CA 92123.

SOFTWARE-DRIVEN INTERFACE, the *Micro Commander*, connects a microcomputer to the BSR *X-10* system. It provides an easy, inexpensive, and reliable way to control lights and appliances (motors, TV, stereo, heaters, alarms, fans, pumps, etc.) in a home or office using a microcomputer. It is a direct interface to the AC line, so there's no need to purchase the BSR command console.

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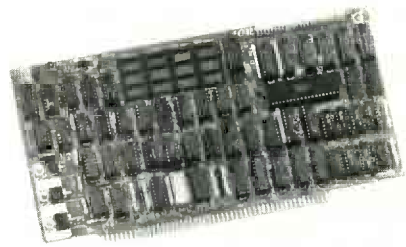
The *Micro Commander* is priced at $59.95.—**Interface Technology, Inc.,** P.O. Box 383, Des Plaines, IL 60018.

I/O PROCESSOR, *model IOP*, provides multiprocessor capability for Cromemco's S-100 bus microcomputer systems. It is a true single-card computer with a fast Z80A microprocessor, 16K bytes of RAM, and up to 32K bytes of PROM capacity.



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The *model IOP* can be used either alone or with other *IOP* cards as a satellite processor on the S-100 bus. It can also be used to interface the S-100 bus processor and a set of peripherals. The *model IOP* is self-contained, excepting external power, making it an ideal choice for off-line control of small-to medium-scale dedicated applications.

To the host processor, the *model IOP* appears as two output ports and two input ports. The base address of those parts is switch-selectable. In addition, it can interrupt the host processor and supply a pre-programmed interrupt vector. A daisy-chain connector is used for interrupt-priority. The *model IOP* is priced at $695.00.—**Cromemco, Inc.,** 280 Bernardo Ave., Mountain View, CA 94043. **R-E**

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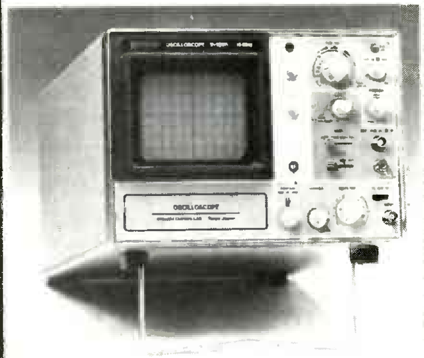

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- Horizontal deflection
  - Sweep mode — Auto, NORM, TV (+), TV (−)
  - TV synchronization — TV sync-separator circuit
    - Internal — Over 1 div (V sync-signal)
    - External — Over 1 Vp-p (V sync-signal)
  - Trigger sensitivity

Frequency	Internal	External
20Hz - 2MHz	0.5div	200mV
2 - 15MHz	1.5div	800mV

  - Trigger slope — ±
  - Sweep time — 0.2µs/div - 0.2s/div ± 5%, 19 calibrated steps
  - Sweep-time magnifier — 10 times (± 7%)
  - Max. sweep rate — 100ns/div
- Amplitude calibrator
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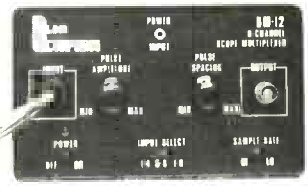

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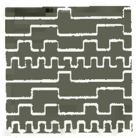

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- Resistance range 10 milliOhms to 20 Ohms
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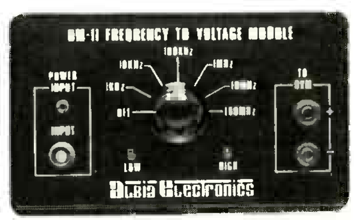

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- Size 6.25" x 3.75" x 2"
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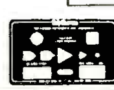

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CIRCLE 52 ON FREE INFORMATION CARD

COMMUNICATIONS CORNER

Computerization can improve radio communications...sometimes.

HERB FRIEDMAN, COMMUNICATIONS EDITOR

THE MARKETPLACE IS GOING COMPUTER-crazy. The price of microprocessor IC's has fallen so low that a manufacturer can put a "computer" into just about any product without increasing its cost very much. We're now seeing computerized automobiles, TV's, stereos, washing machines, microwave ovens and blenders. Perhaps we'll soon see a computerized kitchen sink. But does computerization really make something *better*?

I mention all that because of two recent experiences I had involving computerized communications. In the first, we see computerization making possible a totally new concept that will greatly expand mobile-telephone service. In the other...well, I'll let you decide for yourself, for one man's poison is another's hobby.

Let's start with new technology. A friend asked me to find out about getting a mobile telephone. I wouldn't exactly say my inquiries produced howls of laughter, but I can't imagine how anyone could keep a straight face while telling me it might take months or years on a waiting list to get a mobile phone, and that, even after he finally had it, he would be hard-pressed to find an open channel when he needed it. In large cities a single transmitter per frequency blankets the entire area, and about two dozen conversations is all that can be handled at a time. A heavy rain, not to mention a snowstorm, can cause enough mobile-phone demand to tie up the entire system for hours. But now, through computerization, and the recently approved cellular radio-system the number of simultaneous conversations that can be handled can be increased twenty times and more.

Instead of a single, powerful, transmitter blanketing the city (Fig. 1-a), the area is broken up into small "cells," as shown in Fig. 1-b. Each cell is serviced by a low-power transmitter using a frequency between 800-900 MHz; transmission is essentially line-of-sight with bounce (reflections) off buildings that fill the "canyons" (the area between the buildings).

As a vehicle moves from one cell to another, a computer transfers the signal to the transmitter in the next zone, or the transmitter that will be most effective. If the vehicle is still completely within one zone, but for some reason a transmitter in another zone is better for a particular signal, the computer can transfer the signal to that transmitter. If there were a network of contiguous cells, a vehicle could drive from one end of the country to the other and maintain mobile-phone communications all the way. Obviously, that is too much to expect right away, but rapid development of a contiguous system in the heavily-populated areas of the Northeast, Southern California, and Ohio Valley is not unreasonable to expect. In fact, the FCC predicts that about 70 cities will have cellular systems by the mid '80s.

Another advantage of the cellular system is that it permits the use of hand-held mobile phones, similar to the hand-held transceivers used by radio amateurs on the 2-, 1¼- and ¾-meter bands. Right now, thousands of hams can use a local repeater to access telephones through their hand-held units, generating the control and dialing signals with a Touch-Tone pad built into the transceiver. Non-amateurs, however, cannot use the hand-held phone because the service isn't provided commercially (at least not that I know of). While the signal from a central telephone-transmitter could be received on a hand-held unit, the hand-held's signal couldn't make it to the telephone-system receiver unless the user were located very near the antenna.

But in a cellular system—with its many local transmitters (and receivers)—it's certainly conceivable that most, if not all, hand-helds will be within range of a computer-controlled transmitter.

The cellular telephone system is only possible because of the computer; the computer can keep track not only of the signal strengths of hundreds of signals, but also of frequency availability. It is even possible for the computer to allow several interference-free conversations on the same frequency between several cells, if the signals come from an area where they can use the transmitters in two or more cells.

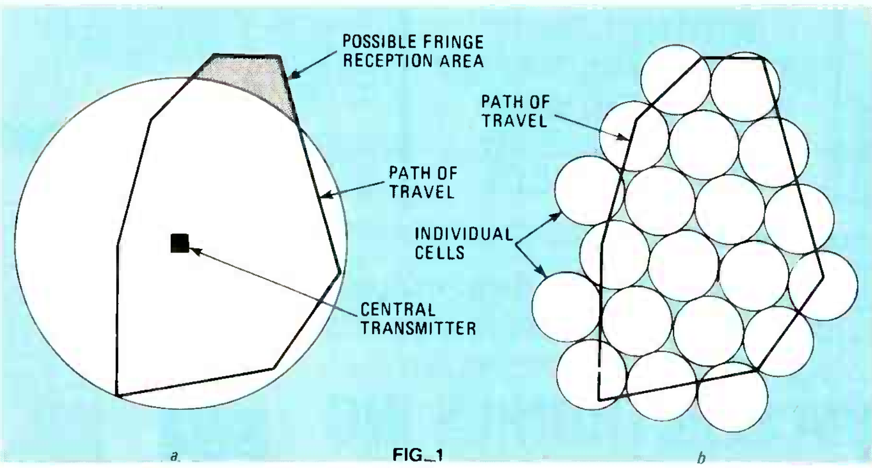


FIG. 1

"English no got"

I recently got tired of fighting ten layers of interference on 20-meter SSB (*S*ingle *S*ide-*B*and) so I moved down to the CW (Morse code) segment of the band. Somewhere under five layers of atmospheric noise I heard this beautiful "fist" with a "Lake Erie swing" I hadn't heard since I was trying to get my code speed up to 20 wpm for a Class A ticket some 35 years ago. It was a European station, and he was racking up contact after contact for QSL's (written confirmations of contact). It must have been a new ham on his first DX (long-distance) opening, although I never did find out for sure. After we went through the usual pleasantries and requests for QSL's in a combination of Q-code and international abbreviations, I commented on his fist and ask if he was using a side-swiper—an elaborate mechanical key. His response was "English no got." The ham didn't know English; he relied on internationally recognized codes—and got along just great because that fist was like a magnet for making contacts.

Shortly afterwards, I was called by a ham who was sending CW like a machine. What a fist! Every character was a study in precision; every sentence a work of art. At a precise 20 wpm I got every detail of his rig, home, and family, and a fast 73 ("best regards"). Since I like to say more than my name, location, and the weather, I commented on my recently worked European's fist and how that ham's musical "swing" compared to this machine-accurate CW. After what seemed like an eternity, a choppy, miserable, conglomeration of errors at about 15 wpm came back to say "OK on Lake Erie swing" and then reverted to machine-precise code when describing his computerized keyer. That was it; a computerized keyer! He had a stock of standard transmissions stored in memory which he sent at the touch of a button. I gather he even had a "merge" function, whereby he could punch in my call letters and name and the computer would slot them into the right place, like "R R R Herb, OK on dx." The trouble was that he was barely readable on a hand key. In fact, had I heard the hand key first there was no way I would have answered him. A novice at five wpm with a "hash" fist is one thing; he's learning. But 15 wpm of hash is too much of a strain for anyone.

I can see the value of a computerized key for contests, and for a physically handicapped ham who might have problems using a straight key—but who can enjoy the excitement and experience of amateur radio through computerized CW? Is there any real value to a computerized key for everyday QSO's? I'd like to read the opinions of you brass-pounders. Personally, I equate the computerized key with the computerized blender. Come to think of it, a computerized blender may have more value! **R-E**

"Of course I flunked spelling! Why didn't she give me plain, ordinary words like 'pre-selector,' 'filter,' or 'impedance'?"

NEW IDEAS

Frequency-Counter Preamp

THIS EASY-TO-BUILD PREAMPLIFIER HAS made a great deal of difference with my frequency counter. Although my counter has a sensitivity of 25 mV, many signals from mixers, oscillators, and IF strips were too weak to get a stable readout on the counter. Some were so weak that I could not get any reading at all. By using the preamplifier with a short length of shielded cable and chip leads, signals that previously could not generate a readout at all generated precise and stable readouts on the counter.

With stronger signals, no direct connection is necessary—just placing the clip leads in the vicinity of the oscillator circuit results in a stable pickup!

The whole preamplifier is made with common junk-box parts and the physical layout is exactly as shown in the schematic (Fig. 1). The preamplifier and the battery fit inside a 2 × 2 × 4-inch aluminum box; the input and output cables enter from opposite sides of the box. The DPDT switch is used to bypass the circuit when amplification is not needed. And, of course, the LED reminds you to turn it off.

The preamplifier can also be used for many other purposes. For example, the unit was also tested as a receiver preamplifier and increased received signal strength about 6 "S" units at 30 MHz.

I also built a line tap so that I could measure the frequency directly at the output of a transmitter. The entire circuit for that consists of two diodes, one resistor and one capacitor, and is housed in a metal box as shown in Fig. 2. The line tap simply picks off a low-amplitude signal for measurement by the frequency counter. The antenna is still used as the load for the transmitter.

The line tap can be connected to transmitters with an output power of between 1 watt and 250 watts. Connect the line tap as shown.

—John A. Crookshank

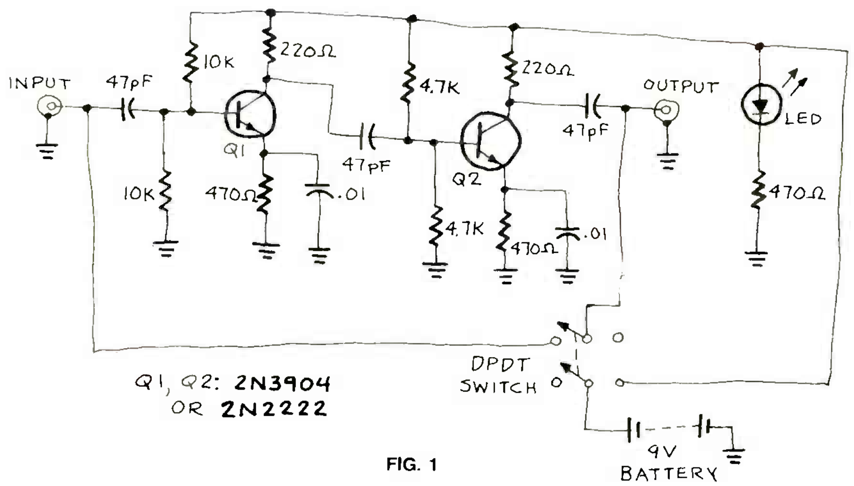


FIG. 1

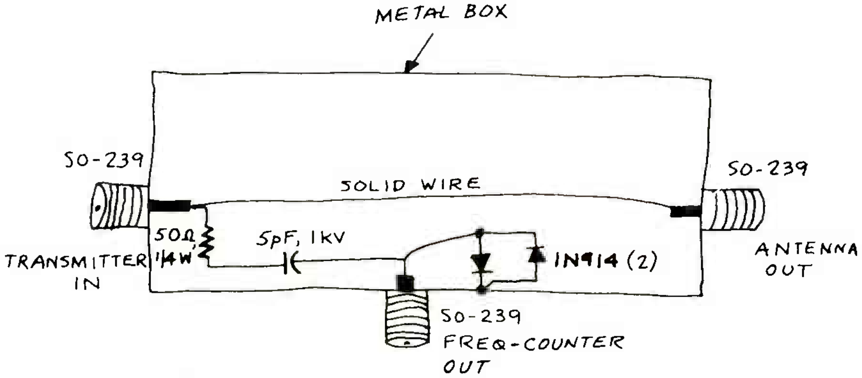
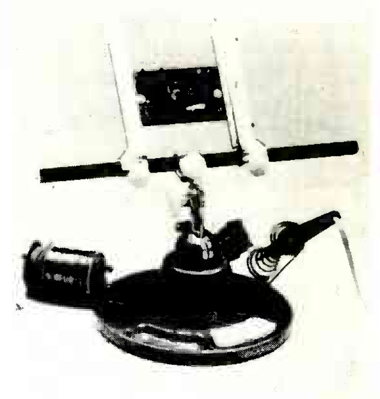


FIG. 2

NEW IDEAS

This column is devoted to new ideas, circuits, device applications, construction techniques, helpful hints, etc.

All published entries, upon publication, will earn $25. In addition, Panavise will donate their model 324 Electronic Work Center, having a value of $49.95. It combines their circuit-board holder, tray base mount, and solder station (see photo below). Selections will be made at the sole discretion of the editorial staff of **Radio-Electronics.**



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COMPUTER CORNER

An introduction to computer applications

LES SPINDLE *

COMPUTERS IN THE 80'S ARE INFILTRATING our everyday existence at a mind-boggling pace. Whether you're an electronics whiz with an Einstein IQ or an electronics student, the automation blitz is making inroads into every facet of your daily existence.

If during the course of a day you: deposit a check at the bank; call directory assistance; use a credit card; find your mailbox overflowing with junk mail; time a meal in your microwave oven, or go through the checkout stand at your local market, your life is affected by computer technology.

If you own, or work for, a small, medium, or large business, chances are that you work directly with computer equipment in your office (or will be in the near future).

And finally, the average consumer will probably have a personal computer in his or her home by the 1990's. When that happens, a computer such as the one shown in Fig. 1, will become important in shaping the user's daily activities.

Exactly what is this awesome device we call a computer, what does it mean to you, and how will it affect your life in the years to come? In this column, we hope to present a comprehensive introduction to the microcomputer, its burgeoning use for small business and home applications, and the utilitarian, scientific, economic, cultural, and social repercussions that will undoubtedly follow.

The emphasis will be on home and business applications, for those are the areas that will most directly affect you in the years to come. You will need a working knowledge of the jargon, equipment, applications, and elementary technical concepts to cope with this fast-moving phenomenon, as it charges head-on into the mainstream of your daily routine.

How has all of that managed to come about so fast? A mere 25 years ago, computer technology was a concept that sounded about as futuristic as Tom Swift and his incredible flying machine—1984 and beyond. Capabilities that were feasible only for huge corporations that could afford to pay millions of dollars are now available for the average consumer at a cost of $10 or less.

The lightning-paced progress followed the birth of one very important concept in the mid-70s: large-scale integration technology (LSI), wherein thousands of electronic circuits were integrated into a miniscule device only a fraction of a square inch in size. That miniature marvel, the microprocessor chip, is now at the heart of modern computer technology, from an everyday kitchen appliance to a room-size piece of mainframe equipment that transmits data to thousands of terminals across the nation. As the technology continues to improve, the capabilities go up—and the cost of producing them goes down. As a result, the microprocessor is continually being adopted for more widespread usage, increasing the efficiency of human endeavors—from the vitally important to the mundane—from the ridiculous to the sublime.

What does all this advancing technology hold for you? How can a microcomputer make your business transactions more efficient and economical? There are hundreds of ways—the machines are having a profound impact on virtually every industry and profession. Legal, medical, retail sales, insurance, stock market, publishing, and government-agency operations depend on computer technology for countless recordkeeping, filing, and financial functions. Computers are accomplishing work faster, more efficiently, and more inexpensively than humans could ever hope to do.

A typical business system might include a CPU (central processing unit, the actual "brains" of the computer); about 48K of memory, mass storage on one or more floppy disk drives (where all recorded data is stored); a printer (for data output), and a CRT terminal with keyboard (for input). The price is highly variable, depending upon the number of floppy disk drives, the amount of memory, the speed of the printer, and the level of software support.

Many business systems are preprogrammed to answer standard questions, such as what reports it has on file in memory and what types of information it can supply from other sources (tapes, disks, etc.). That guide, or menu, directs the user through a concise summary of the program and what it has to offer, serving as a step-by-step instructor for the uninitiated. Generally, each sub-topic is accompanied by a 3- to 5-digit code, which the user will then re-enter for a more detailed menu of the sub-topic, with further steps listed for using that specific data.

Often, businesses will purchase pre-

continued on page 111

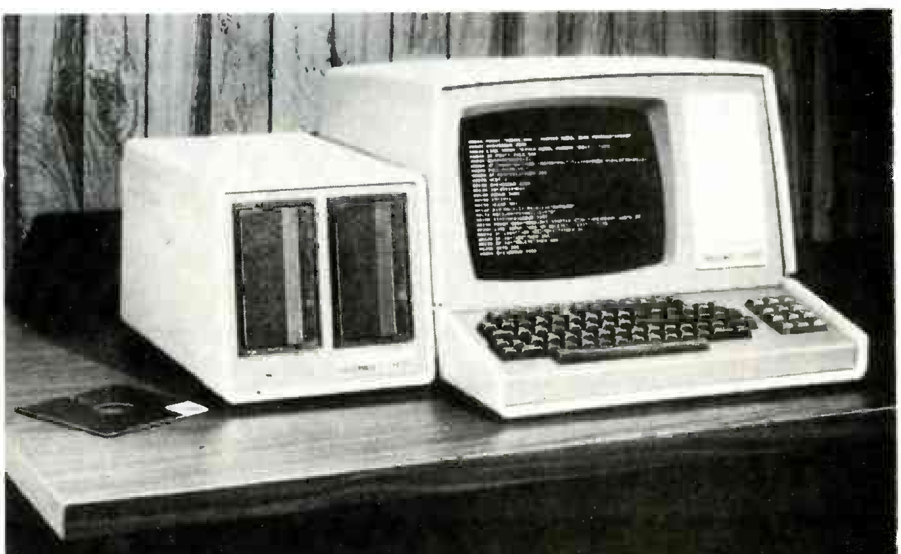

FIG. 1

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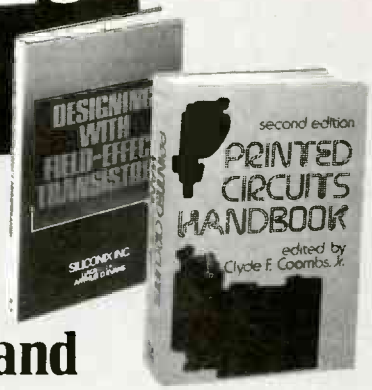

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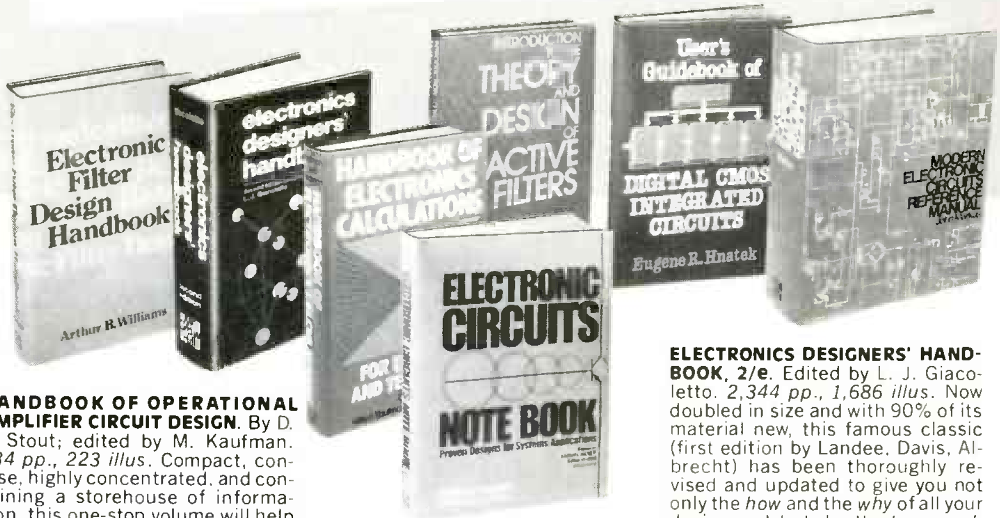

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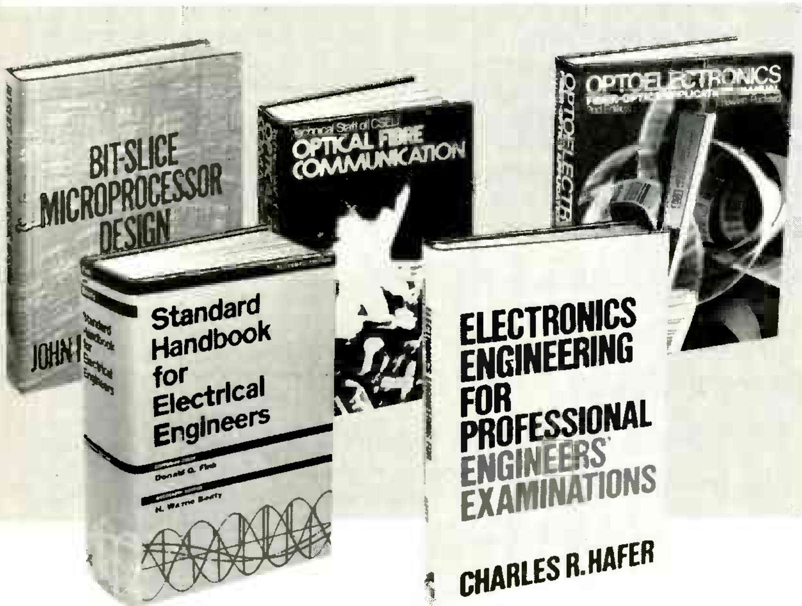

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SERVICE CLINIC

If you're stumped, try using your sweep generator.

JACK DARR, SERVICE EDITOR

ELECTRONICS HAS ALWAYS HAD ITS share of fads. Perhaps "fad" isn't the best word, for most of them were really bursts of enthusiasm over some new piece of equipment or technique that improved the state-of-the-art. Good examples of that are VTVM's, signal tracers, and sweep-alignment generators.

Frankly speaking, early sweep-alignment setups were a mess. There were leads going everywhere and most of them were hot! If you touched anything the curve changed. They weren't easy to use, but it *was* possible. Compare that with the modern sweep generators that need just three connections to the TV chassis (input, output, and ground) and that automatically add markers to the curve at critical frequencies after the generator has swept through the IF. Today's generators even provide bias supplies.

Sweep generators can be used for things other than alignment; you can get a lot of information by simply hooking up a sweep generator and looking at the IF response curve. I used to do that in the days before television to diagnose odd problems in 4- and 5-tube radios. (The technique itself is fairly old; it just got a bit more complicated when TV came along.)

If everything in the radio's IF was working properly, the curve on the oscilloscope would look like a haystack, as shown in Fig. 1. If the scope showed a curve like the one in Fig. 2, it meant that the radio had a tendency toward regeneration—the radio would whistle as it tuned across a station. The problem was often caused by a bad filter capacitor. Once that capacitor was changed, the curve—and the radio's operation—returned to normal.

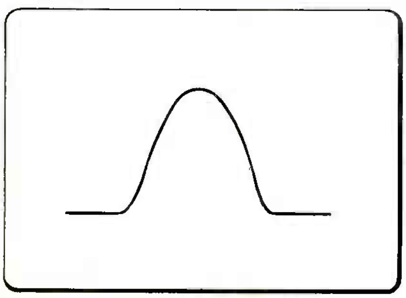

FIG. 1

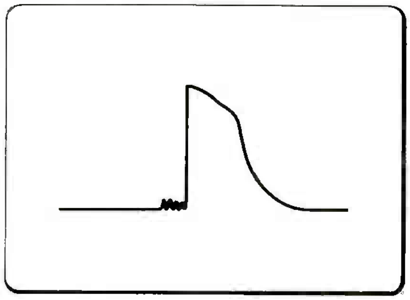

FIG. 2

The same technique can be used to diagnose the cause of an odd symptom in a television set. You don't have to make any adjustments (at least not right away)—just hook up a sweep generator and a scope. Switch on the four critical markers—41.25 MHz (sound-carrier trap), 42.17 MHz (color-carrier IF), 45.75 MHz (video-carrier IF), and 47.25 (adjacent-sound trap), then *look* at the curve.

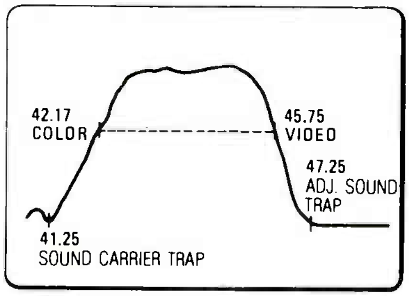

FIG. 3

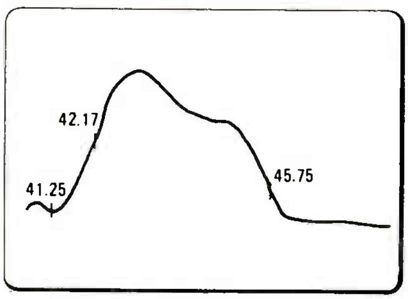

FIG. 4

The curve you see should be similar to the one shown in Fig. 3; all the markers should appear exactly where shown and the curve should be shaped more or less like a haystack, although there may be a slight dip across the top. If that is what you see, you can eliminate the question of IF alignment as the cause of the problem.

But what if the curve indicates that the problem *does* lie in the IF? The information that the curve gives you can make finding and fixing the problem relatively simple. For example, say the problem is weak video and the IF curve looks like the one in Fig. 4. Notice that the 45.75-MHz marker is not where it should be but instead is almost at the curve's baseline. That indicates that the video IF is off frequency, reducing the amplitude of the video signal. Peaking the adjustment for this IF frequency should restore the curve to its correct shape and the set to proper operation.

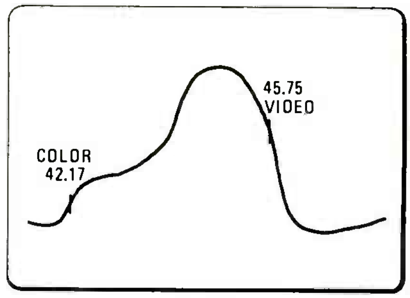

FIG. 5

Figure 5 shows the IF-response curve when the color-carrier IF is out of alignment. Like the example in Fig. 4, the marker is near the baseline instead of halfway up the side of the "haystack" as it should be. Again, peaking the adjustment for the frequency should restore everything to normal. If you have "herringbones" in your picture, check the 41.25 sound-carrier trap. If the carrier frequency is not squarely in the notch as shown in Fig. 3, too much sound signal is getting through and causing the oscillation that forms the pattern you see on the screen.

Let's take a closer look at the traps. The purpose of those tuned circuits is to get rid of any frequencies that are outside of the IF amplifier's passband. But if the circuits are out of alignment, the traps themselves can be the cause of your problems.

The 41.25- and 47.25-MHz markers should sit in notches at the baseline. All traps make a notch or dip in an IF-response curve and those are no exception. If the 41.25-MHz trap, for instance, is set too high, it will pull down the left side of the curve and lower the color carrier. To correct this problem, tune the trap until the notch is at the baseline as shown in Fig. 3, and the 41.25 sound-carrier marker sits squarely in that notch. The lower-frequency traps not shown in Fig. 3 can also cause problems. If you move the 3.58-MHz trap too far, for instance, it can get over into the bandpass-amplifier output curve and cause some real problems.

Using the sweep generator does not mean that you will *have to* align the IF, but hooking the generator up and looking at what's going on can be a great help if you're lost. At worst, using your sweep generator can eliminate the IF as a source of your trouble—and eliminating *anything* as a source of trouble can only help. After all, that's the servicing "game"—eliminating all possible sources of trouble until you find the one that's to blame. **R-E**

SERVICE QUESTIONS

OOOOPS!

In the May 1981 issue of **Radio-Electronics** I mentioned World-Wide Systems as a source for Broadmoor parts. The only problem, according to Ken Greenberg of Skokie, IL, is that somehow the last digit of the address got lost. The correct address for World-Wide Systems is 3424 W. Touhy Ave., Chicago, IL 60645.

THERMAL PROBLEMS

This RCA CTC-53 had an odd problem. When the brightness was turned down, the picture would shrink about two inches at the top and bottom, and the vertical and horizontal would go out of sync. Also a vertical line of white dots that pulsated about a half-second apart would appear directly in the middle of the screen. The cause of all that turned out to be R40, a 220,000-ohm, ½-watt resistor; it had gone way down in value. That resistor is close to the 6GH8 horizontal oscillator tube, and heat could be the reason behind the change in value. I replaced the resistor with a 1-watt type and left the leads long enough to get it away from the tube.

Thanks to John Conti, of Texas City, TX for that one.

HEIGHT PROBLEM SOLVED

I had only a little deflection on this Magnavox T995. You gave me a few things to check, for which I thank you. The problem turned out to be L1, a vertical "output choke," that had gone down from its normal 7.3 ohms to less than 5 ohms. That choke operates at near its rated value and overheating may have caused some of it's turns to short out.

Thanks to Leroy Dahm of Waukegan, IL for that one.

TOUCHY AGC

This 12-inch Sylvania black and white set had an odd problem: raster, but no picture or sound. If the AGC pot was adjusted you would get a fair picture, but the AGC had to be reset each time you changed the channel. You suggested several tests, including checking the emitter voltages in the IF stages. Sure enough, I found that Q200—the 1st video IF—had an open base-emitter junction. Replaced Q200, reset the AGC pot, and now the set's doing just fine. Many thanks!—*Leslie Crumbaker, Needham, MA*

MORE ON ELECTROLYTICS

Some time ago I did a Clinic on the electrolytic capacitors found in the cathode circuit of vertical-output tubes in color sets. Bill Stiles, CET, of Hillsboro, MO has found a situation that I've never run into. It concerns C6 and C7 on the convergence board in an

Admiral 12H1073 chassis (Sams 1054 and 1186). Capacitor C6 is a big one and is fairly easy to see, but C7 (50 μF, 10 volts) is one of the little plastic-cased ones; it looks like a tubular paper capacitor. Bill says that if C6 is good, but C7 is open, you get a severe loss of vertical sweep at the bottom of the screen, and misconvergence. The capacitor in the set he had measured only 3 F. A new capacitor cured the problem.

PULSING RASTER AND SOUND

The raster and sound on this Admiral 4M10C pulse. In fact, there is no raster at all except for a small dot or streak that pulses. I have B+ voltages on all of the fuses. This is a weird one.—T.D., Bellevue, OH

I remembered a service note that I saw on that chassis some time ago. What you have is a shutdown problem: the chassis is designed so that the high-voltage shutdown circuit will make the raster and sound pulse.

Try putting a Variac on the set and monitoring the B+ supply to the horizontal output. Bring up the line voltage slowly until the regulated DC voltage output is what it is supposed to be. Check to see if the set now works. If it does, you have a problem in the DC voltage-regulator circuit; its output is too high. **R-E**

EQUIPMENT REPORTS

continued from page 33

tions varying between 1 millivolt and 1 volt—again depending on the range in use. Current (both AC and DC) can be measured on two ranges: 20 milliamps and 200 milliamps full-scale. Resolutions of 10 and 100 microvolts respectively are claimed. Resistance is measured over five ranges from 200 to 200,000 ohms full-scale with a maximum open-circuit voltage of 1.5 volts on the 200-ohm range and 0.65 volt on the others. The open-circuit voltage on the low-power resistance ranges is 0.4 volt, as previously mentioned. Resolution varies from 0.1 to 1000 ohms depending on the range in use.

The *model EZ-6100* requires two "AA"-size cells; their expected life is 300 hours. There is no provision for AC operation. While the instruction booklet does not contain a schematic, parts list, or troubleshooting hints, it does do a very good job of explaining how to use the meter.

In our tests we found that the unit was as accurate as the manufacturer claimed. In addition, we found it to be very handy to use, especially in the field. The *Model EZ 6100* sells for $142.00, about the same as many meters with fewer features. **R-E**

SATELLITE TV ANTENNA

continued from page 50

FIG. 32—TWO STRINGS, installed after alignment as shown, make it easy to detect any warps in the reflector surface.

have one rear leg uneven with respect to the other. That causes a "twist" in the frame, and therefore, in the reflector surface. One way to check for a twist is to look at the antenna from the side and see if all the vertical ribs are parallel, or take an inclinometer and check each of the three middle vertical ribs. They should all have the same tilt angle.

Another, and perhaps the most accurate, way of making sure that the antenna retains its shape after it is aligned with the radius wire is to criss-cross a pair of strings as shown in Fig. 32. The strings must be installed after alignment, but *before* the antenna is moved. Install the strings from the top-right to the bottom-left corners, and from the top-left to the bottom-right corners. Adjust the strings as necessary so that they *just* touch at their centers. When you move the antenna, any twist will be apparent and can be quickly corrected by placing shims under one leg until the strings again just touch.

That wraps up our look at the 8-Ball. If you want a more complete picture on what satellite TV is all about, refer to the series of articles on this subject by Bob Cooper that appeared in previous issues of **Radio-Electronics.** If you would like to order a reprint of that series, see page 95. **R-E**

PARTS LIST—FEED HORN

Galvanized sheet metal
PVC pipe, 5-inch diameter, 10 inches long
PVC pipe, 6-inch diameter, 12 inches long.
Miscellaneous: Soft spacers or pads (see text), hardware, etc.

The following are available from McCullough Satellite Systems, PO Box 57, Highway 62-East, Salem, AR 72576: The 12-foot 8-Ball Satellite Television Antenna Kit, $750. Includes everything except staples and concrete for mounting base. Frame is 1½ × 1½-inch angle iron with all pieces cut to fit and drilled. One coat of primer applied. All ⅝ × 2 and ⅝ × 3 redwood strips. Aluminum screen is 0.011-inch diameter wire in a 1/16-inch mesh. Add $60.00 for heavy-duty mesh, $50.00 for extra bracing and $100.00 for galvanized frame.

The heavy mesh (0.025 inch diameter wire, ⅛-inch mesh) is about 2½ times as heavy as the regular mesh and will withstand abuse by hail, ice, etc. much better than the regular mesh. The extra bracing is necessary if you plan to move the antenna about. It makes the framework very rigid.

The 12-foot 8-Ball with galvanized frame, heavy mesh and extra bracing is a commercial-grade antenna named "Octasphere" and is available for $1195.00. Feed horn (fits LNA with WR-229 input): Sheet metal with brass flange, $40.00; Aluminum $60.00 RG-213 cable (loss 25 dB/100 feet at 4 GHz), $0.50 per foot. FM-8 cable (loss 13 dB/100 feet at 4 gHz), $0.60 per foot. Avantek 120° LNA (50 dB gain) $690.00 including DC block; $650.00 without DC block. All prices are FOB, Salem, AR.

COMPUTER CORNER

continued from page 103

assembled and tested systems that have been designed specifically for specialized needs. Those are called turnkey systems—all you have to do is turn on the machine and it's up and running. Of course, the more work you do in assembling your own system, the less you'll have to pay in initial costs—or, later, for outside consultation by professional systems analysts, who examine a client's needs, then devise an efficient hardware and software combination for him.

There are thousands of business-software packages available, with software companies offering new releases every day. Among the most popular offerings are accounts-receivable programs. A good A/R package can be one of the most cost-justified packages for a business—often paying for itself in less than a year.

Some typical functions of an A/R package include: summaries of general ledger accounts; keeping track of unpaid invoices and reports; on-line inquiry (a user may easily inquire about the status of an account and receive an immediate answer); categorizing billing cycles for individual customers... and the list goes on.

Another important business application—it has created a revolution in the publishing field alone—is word processing. Just as the typewriter replaced the hand-written word and made the production of memos, letters, and manuscripts thousands of times more efficient and economical, the word processor is now multiplying that level of efficiency thousands of times over again.

A typical word-processing system might include a desk-top display and electronic modules; a typewriter-like keyboard; a printer, and removable disk storage. When a letter or manuscript is typed, a copy is placed in the memory. The copy contains all the corrections and modifications the user makes, so when the letter is finished, it comes out perfectly. If an error does slip by, there's no need to retype the whole letter, since it is kept in storage and can be fed into the memory again. Days, even weeks, later that same letter can be corrected by stopping at the point where the error occurred and keying in the correction.

Letters, words, and paragraphs can be moved around, deleted, or revised in seconds. A secretary can save at least half the time of typing a manuscript, in comparison to using a traditional typewriter.

There are a multitude of considerations in selecting a word processor. The important approach to selection, as with all other computer equipment, is to examine your individual word-processing needs, then go out in search of equipment that includes the features that best satisfy those specifications.

There are countless other business applications possible: inventory control; mass mailing; payroll; accounts receivable; job cost and work-flow analysis; general ledger; timecard records; filing; accounts payable; tax accounting; medical-monitoring functions, etc.

The micro is obviously destined to become an integral part of the office of the future, as more and more small businesses discover that micros are now not only affordable to them, but essential to keep up with the competition.

The average consumer is gradually making similar discoveries about the micro in the home. The hobbyist era of the home-computer buff is expanding to make way for the home computer as a practical tool—no longer just a recreational diversion.

A typical home system would be pre-built and tested before sale, and would include a keyboard for input and a TV screen for output. Rather than a disk system, which is more expensive, personal systems most often employ a cassette tape recorder for storage of program data.

Prices range from about $300 up to $2,000. Although it may seem as if computers that inexpensive couldn't do much more than provide entertainment, they *do* have the capacity to solve problems and accept various types of programs.

Some practical home applications include: financial recordkeeping; monitoring of heating, lighting and cooling systems; travel planning; kitchen inventory; stock-market analysis; mailing lists, and tax computation. Beyond all that, of course, are the entertainment aspects of home software, reaching their ultimate versatility with the latest in videocassette, videodisc, and videotext technology.

But the ultimate impact of home computing has even more profound implications. Data base telecommunications networks, such as MicroNet and the Source, make it possible for home users not only to communicate with each other in a CB-radio type pastime, but also to share programs and miscellaneous useful data. Data is transmitted from terminal to terminal via telephone lines for subscribers to the service. Not only can users share data with one another, but they can also access a growing list of powerful data bases with everything on file from Congressional records to the latest news as well as history.

Next time we'll take a look at several microcomputer systems, weighing the pros and cons of each, to aid a potential buyer in making a choice. **R-E**

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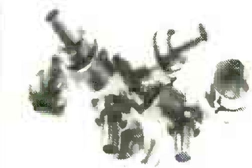

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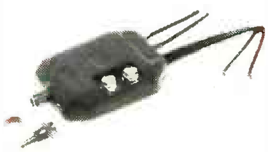

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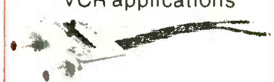

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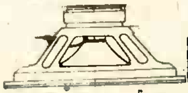

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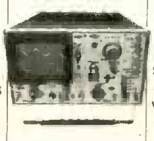
30MHz DUAL TRACE 1 mV SENS 5" PDA CRT SIGNAL DELAY with 2 X-10 PROBES V-302B $995.00		7MHz S.T. PORTABLE WAVEFORM MONITOR / OSC Single Trace, 10mV, 3.5" CRT w/Bat. Pack & Probe V-059B $1200.00
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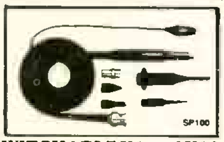

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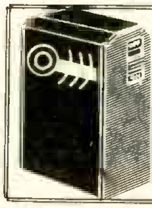

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.068uf	.25	1.30	12.00
.1uf	.30	1.75	13.50
.15uf	.35	2.25	14.00
.22uf	.40	2.55	20.00
.33uf	.45	2.75	25.00
.47uf	.50	3.50	30.00

POLYESTER CAPACITOR KIT
5 ea of above $14.95

TANTALUM CAPACITORS

solid dip - radial

	1-	10-	100-
.1mf/35V	.35	.30	.28
.22mf/35V	.35	.31	.29
.33mf/35V	.35	.31	.29
1mf/35V	.37	.32	.30
1.5mf/20V	.37	.32	.30
2.2mf/20V	.40	.35	.33
3.3mf/35V	.45	.40	.35
4.7mf/16V	.45	.40	.35
4.7mf/25V	.50	.45	.40
5.6mf/10V	.50	.45	.40
6.8mf/6V	.50	.45	.40
6.8mf/16V	.55	.50	.45
10mf/20V	.65	.55	.50
15mf/6V	.60	.50	.45
15mf/20V	.65	.55	.50
22mf/10V	.65	.55	.50
22mf/16V	.68	.57	.52
33mf/6V	.65	.55	.50
33mf/10V	.70	.65	.60
47mf/6V	.75	.70	.65
56mf/6V	.85	.75	.70
100mf/10V	1.25	1.10	1.00

ELECTROLYTIC CAPACITORS

axial leads

	1-	10-	100-
1mf/50V	.15	.12	.10
2.2mf/25V	.15	.12	.11
2.2mf/50V	.15	.12	.11
3.3mf/50V	.16	.13	.11
4.7mf/63V	.16	.13	.11
10mf/35V	.16	.13	.11
10mf/50V	.17	.14	.11
10mf/150V	.18	.16	.14
22mf/16V	.17	.13	.12
22mf/50V	.18	.14	.13
25mf/25V	.18	.14	.12
30mf/25V	.18	.14	.12
33mf/25V	.18	.16	.13
47mf/35V	.18	.16	.13
100mf/10V	.19	.16	.14
100mf/16V	.20	.18	.16
100mf/35V	.22	.19	.17
150mf/25V	.23	.20	.18
220mf/16V	.25	.21	.19
220mf/25V	.27	.22	.20
330mf/16V	.29	.24	.22
470mf/16V	.30	.25	.22
470mf/35V	.34	.29	.26
500mf/15V	.29	.24	.22
1000mf/16V	.90	.85	.80
1000mf/35V	.95	.90	.85
2200mf/16V	1.25	1.15	1.05
2200mf/40V	1.35	1.10	1.00
4700mf/16V	1.35	1.25	1.10
4700mf/50V	1.45	1.30	1.15

radial leads

	1-	10-	100-
1mf/50V	.15	.12	.10
2.2mf/350V	.18	.15	.11
4.7mf/35V	.18	.15	.13
10mf/16V	.15	.13	.12
10mf/160V	.18	.15	.13
20mf/50V	.17	.14	.12
47mf/35V	.18	.16	.14
80mf/40V	.15	.13	.11
100mf/25V	.18	.16	.14
220mf/35V	.25	.22	.20
470mf/25V	.33	.28	.25
1000mf/16V	.85	.80	.75

LEDs

Jumbo dif:used .20"d x .34"l	pk-10	pk-25	100-	1000-
RED	$1.00	$2.25	.08ea	.078ea
CLEAR	1.10	2.50	.09ea	.085ea
WHITE	1.10	2.50	.09ea	.085ea
YELLOW	1.40	3.25	.11ea	.10ea
GREEN	1.40	3.25	.11ea	.10ea

TRI-State (change from red to green by reversing polarity)

1-	10-	100-
.95ea	.75ea	.65ea

Subminiature diffused .125"d x .21"l

	pk-10	pk-25	100-	1000-
RED	$1.00	$2.25	.08ea	.078ea
CLEAR	1.10	2.50	.09ea	.085ea
GREEN	1.40	3.25	.11ea	.10ea
YELLOW	1.40	3.25	.11ea	.10ea

.3" RED LED DISPLAY $.99ea
7 segment RHD 10/$7.95
XAN72(MAN72 equiv) 25/$17.50
common anode 100/$65.00

.6" RED LED DISPLAY $1.25ea
7 segment LHD 10/$11.50
XAN6940 - common cath 25/$26.50
100/$98.00

DIODES

		100-	1000-
1N3064	15/$1.00	.05ea	.04ea
1N4001	12/$1.00	.07ea	.06ea
1N4007	10/$1.00	.11ea	.10ea
1N4148 (1N914)	15/$1.00	.05ea	.04ea
Germanium diodes	12/$1.00	.07ea	.06ea

SOCKETS

low profile - solder tail

	ea	10-	100-	1000-
8 pin	$.20	.18ea	.16ea	.14ea
14 pin	.25	.21ea	.19ea	.16ea
16 pin	.26	.22ea	.20ea	.17ea
18 pin	.32	.28ea	.26ea	
24 pin	.45	.40ea	.38ea	
28 pin	.55	.52ea	.50ea	
40 pin	.65	.62ea	.60ea	

Wire Wrap
3 level gold plate contacts
tin plate tails

	ea	10-	100-
14 pin	.55	.52ea	.49ea
16 pin	.60	.57ea	.51ea

SOLID STATE BUZZER - 6V

(operates from 4V - 9V)

ea	10-	100-
$1.35	1.10ea	1.00ea

BREADBOARD $1.25ea
10-24 1.05ea
100- .95ea

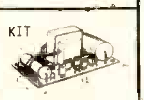
MINIATURE CERMET TRIMMER

TRIMPOT - Single Turn
Mepco - Cermet 8014
.5w, ± 100 PPM/°C ± 20%

available sizes
500ohm, 1K, 2K, 10K, 20K, 50K, 100K, 500K, 1M

1-99	100-
$ .89	.79

POWER SUPPLY KIT



±5V, ±12V, ±15V
A regulated power supply using a 115V/29V CT transformer, 3-LM340T and 3-LM320T regulators to supply the above voltages. Heat sink provided for ±5V.

PARTS INCLUDED
Transformer 115/29CT-1A
6 regulators
PC board
4 diodes
Capacitor 1000uf
Capacitor 500uf
3 Capacitors 10uf

ea $17.50
10- 16.00
25- 15.00

+ shipping/handling -
$1.50 UPS
$2.50 Mail

CARBON FILM RESISTORS 1/4W & 1/2W

CARBON FILM ±5%
1/4watt (R.Ohm R25) .095"dia X .250"long
1/2watt (R.Ohm R50) .146"dia X .354"long

Total qty	ea	pk-5	pk-10	pk-100	pk-1000
1-999	$.10	.25	.45	2.00	
1000-	.10	.25	.40	1.90	1.75/C
5000-	.10	.20	.40	1.80	1.65/C

METAL FILM RESISTORS 1/4W

METAL FILM ±1%
RN60 (R.Ohm CRB60FY) 1/4watt
Low temp coef - 50ppm/°C
.138"dia X .355"long (body)
color banded

Total qty	ea	pk-5	pk-10	pk-25	pk-100
1-999	$.25	.65	1.10	2.00	7.50
1000-	.25	.60	1.00	1.90	7.00
5000-	.25	.55	.95	1.80	6.50

STANDARD 1% METAL FILM VALUES FROM 10 OHM TO 1.21 MOHM

METAL FILM RESISTORS 1/8W

METAL FILM ±1
RN55 (R.Ohm CRB14FY) 1/8watt
Low temp coef - 50ppm/°C
.094"dia X .225"long (body)
color banded

Total qty	ea	pk-5	pk-10	pk-50	pk-100
1-999	$.25	.65	1.10	4.00	7.50
1000-	.25	.60	1.00	3.80	7.00
5000-	.25	.55	.95	3.60	6.50

VALUES STOCKED (ohms)

10.0	30.1	84.5	200	576	1.82K	4.02K	7.50K	13.0K	24.9K	44.2K	76.8K	[illegible]	255K	536K
10.2	31.6	90.9	210	604	1.87K	4.12K	7.68K	13.3K	25.5K	45.3K	78.7K	143K	267K	549K
10.5	33.2	95.3	221	649	1.96K	4.22K	7.87K	13.7K	26.1K	46.4K	80.6K	147K	274K	562K
11.0	34.8	100	232	698	2.00K	4.32K	8.06K	14.0K	26.7K	47.5K	82.5K	150K	287K	576K
11.5	35.7	105	243	715	2.05K	4.42K	8.25K	14.7K	27.4K	48.7K	84.5K	154K	294K	590K
12.1	37.4	107	249	750	2.21K	4.53K	8.45K	15.0K	28.0K	49.9K	86.6K	158K	301K	604K
13.0	39.2	110	255	806	2.32K	4.75K	8.66K	15.4K	28.7K	51.1K	88.7K	162K	309K	619K
14.0	40.2	115	267	845	2.43K	4.87K	8.87K	15.8K	29.4K	52.3K	90.9K	165K	324K	649K
14.7	43.2	121	274	909	2.49K	4.99K	9.09K	16.2K	30.1K	53.6K	93.1K	169K	332K	681K
15.0	45.3	127	287	976	2.61K	5.11K	9.31K	16.9K	30.9K	54.9K	95.3K	174K	348K	715K
16.2	47.5	130	301	1.00K	2.74K	5.23K	9.53K	17.4K	31.6K	56.2K	97.6K	178K	365K	750K
17.4	49.9	137	316	1.02K	2.87K	5.36K	9.76K	17.8K	32.4K	57.6K	100K	187K	374K	768K
18.2	52.3	140	332	1.10K	3.01K	5.49K	10.0K	18.2K	33.2K	59.0K	102K	191K	392K	806K
19.1	54.9	143	348	1.15K	3.16K	5.76K	10.2K	19.1K	34.0K	60.4K	105K	196K	402K	825K
20.0	57.6	150	357	1.21K	3.24K	5.90K	10.5K	19.6K	34.8K	61.9K	107K	200K	432K	866K
21.0	60.4	154	374	1.27K	3.32K	6.04K	10.7K	20.0K	35.7K	63.4K	110K	205K	442K	909K
22.1	64.9	158	402	1.30K	3.40K	6.19K	11.0K	20.5K	36.5K	64.9K	113K	210K	453K	976K
23.2	66.5	162	422	1.40K	3.48K	6.34K	11.3K	21.0K	37.4K	66.5K	115K	215K	464K	[illegible]
24.9	68.1	165	453	1.47K	3.57K	6.49K	11.5K	21.5K	38.3K	68.1K	118K	221K	475K	[illegible]
25.5	71.5	174	464	1.50K	3.65K	6.81K	11.8K	22.1K	39.2K	69.8K	121K	226K	487K	1.10M
26.1	75.0	178	475	1.58K	3.74K	6.98K	12.1K	22.6K	40.2K	71.5K	124K	232K	499K	1.15M
27.4	76.8	187	499	1.65K	3.83K	7.15K	12.4K	23.2K	42.2K	73.2K	130K	243K	511K	1.21M
28.7	78.7	191	549	1.74K	3.92K	7.32K	12.7K	23.7K	43.2K	75.0K	137K	249K	523K	

TRANSISTORS

			ea	pk-10	pk-25	pk-100	1000
MPSA06	TO-92	NPN	$.25	1.65	3.25	12.00	.11ea
2N2222A	TO-92	NPN	.30	1.75	4.00	15.00	.13ea
2N2222A	TO-18	NPN	.45	3.50	8.00	29.00	.26ea
2N3053	TO-5	NPN	.55	5.00	11.75	45.00	.42ea
2N3904	TO-92	NPN	.25	1.65	3.25	12.00	.10ea
2N3906	TO-92	PNP	.25	1.65	3.25	12.00	.10ea

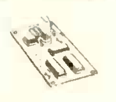
DIPSWITCH - 4 sw
8 pin DIP SPST
1-9 $1.65ea
10-24 1.55ea
25- 1.49ea

DIPSWITCH - 8 sw
16 pin DIP SPST
1-9 $2.10ea
10-24 1.95ea
25- 1.85ea

DIPSWITCH - 10 sw
20 pin DIP SPST
1-9 $2.20ea
10-25 2.05ea
25- 1.95ea

CRYSTAL CONTROLLED TIME BASE KIT

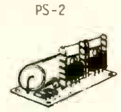
PARTS INCLUDED
MM5369 divider
4049 buffer
2-4018 counter
3-12pf var. cap
47pf cap
.1uf cap
2-10Mohm res
1Kohm res
3.57954 Mhz crystal
PC board (1 5/8" X 3")



Produces accurate 1hz, 10hz and 60hz outputs--three of the most popular frequencies for any piece of test equipment. $15.50ea

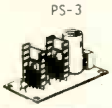
REGULATED POWER SUPPLY KIT

PS-2



Uses +5V and +12V TO-220 regulators. Kit includes PC Board(1 11/16" X 3"), Rectifiers, 7805 & 7812 Regulators, Capacitors & Heat Sinks. Transformer not included. Fits PCB slots of Hammond Case 1591DGY. $6.00ea

PS-3



Uses +5V and +12V TO-220 Regulators. Kit includes PC Board (1 1/4" X 2 3/8"), Rectifier Bridge, 7805 & 7812 Regulators, Capacitors and Heat Sinks. Transformer not included. Fits PCB slots of Hammond Case 1591CBU $7.50ea

BEZELS WITH FILTERS

Snap-in BEZELS of black polycarbonate thermoplastic resin. Red slide-in filter. Provides attractive finish for standard panel cut-out and displays.
No. 140-2 $2.10ea
cut-out 1.156" X 2.375"
(up to .062" thick panel)
viewing area 3" X .812"
No. 140-3 $2.50ea
cut-out 1.156" X 3.375"
(up to .125" thick panel)
viewing area 3" X .812"
No. 140-4 $2.85ea
cut-out 1.15" X 4.375"
(up to .125" thick panel)
viewing area 4" X .812"

WALL MOUNT TRANSFORMER

117V/12VAC 250ma 60hz $3.75
117V/12VAC 1 amp 60hz 4.95

VOLTAGE REGULATORS

10% OFF ON $25.00
15% OFF ON $50.00

7805	+5V	$1.19	7905	-5V	$1.19
7808	+8V	1.19	7912	-12V	1.19
7812	+12V	1.19	7915	-15V	1.19
7815	+15V	1.19			
7824	+24V	1.19			

EXAR CIRCUITS

10% OFF ON $25.00
15% OFF ON $50.00

XR320N-14	$ .95	XR4136N-14	$1.19
XR2201N-16	.95	XR4202N-16	1.95
XR2203N-16	.95	XR4212N-14	.95
XR2206N-16	4.50	XR4558N-8	.95
XR2207N-14	3.49	XR4739N-14	.95
XR2567N-16	2.49		

MEMORIES AND LSI

2708	8K EPROM 450ns	$4.50
2716	16K EPROM (5V)	7.50
8080A	CPU	7.50
1602B	UART	3.79
5316	Alarm Clock	3.25
7010	Calendar Clock	5.50
2102	1024 x 1 static RAM	.95
5261	1024 bit dyn. RAM	.95
82S23	256 bit PROM	3.25
74S200	256 bit PROM t-state	3.75
F93410	256 bit RAM bi-pol	.95
2114	STATIC RAM 1024 x 4 Low Power 200NS	$3.75
4116	DYNAMIC RAM 16K 200NS	$3.75
MM5369	OSCILLATOR/DIVIDER	$2.50
	COLOR TV CRYSTAL (3.58 Mhz)	$2.00
2510	dual 100bit stat.S.R.	.75
2511	dual 200bit stat.S.R.	.75
2522	dual 132bit stat.S.R.	.75
2532	quad 80 bit stat.S.R.	.75
5013	1024 bit dyn accum	.75
5016	500/512 bit dyn	.75
8038	Function generator	3.79

TTL - 7400

10% OFF ON $25.00
15% OFF ON $50.00

7400	$.18	7464	.30	74155	.50
7401	.18	7465	.30	74156	.64
7402	.18	7470	.49	74157	.60
7403	.18	7472	.32	74158	.75
7404	.20	7474	.18	74160	.70
7405	.25	7475	.49	74161	.79
7406	.20	7576	.49	74162	.85
7407	.20	7480	.35	74163	.85
7408	.27	7482	.25	74164	.85
7409	.27	7483	.65	74166	.85
7410	.18	7485	.50	74170	1.50
7415	.29	7486	.42	74173	1.25
7416	.20	7489	1.75	74174	1.05
7417	.20	7490	.59	74175	.85
7420	.20	7491	.64	74176	.70
7425	.39	7492	.59	74177	.70
7426	.35	7493	.35	74180	.35
7427	.25	7494	.59	74181	1.85
7430	.25	7495	.35	74182	.35
7432	.20	7496	.35	74189	.50
7437	.20	74105	.48	74190	1.15
7438	.18	74107	.35	74191	1.15
7440	.18	74121	.35	74192	.50
7441	.59	74122	.39	74193	.79
7442	.35	74123	.39	74194	.85
7443	.55	74125	.50	74195	.69
7444	.60	74126	.50	74196	.80
7445	.50	74132	.75	74197	.75
7446	.59	74141	.35	74198	1.40
7448	.59	74145	.50	74199	1.25
7450	.18	74148	1.25	74S200	3.75
7451	.22	74150	1.35	74279	.65
7453	.18	74151	.50		
7454	.18	74153	.35		
7460	.18	74154	1.45		

CMOS - 4000

10% OFF ON $25.00
15% OFF ON $50.00

4000	$.25	4020	1.14	4050	.45
4001	.39	4021	.95	4051	1.15
4002	.25	4022	.95	4066	.79
4006	.95	4023	.30	4069	.39
4007	.39	4024	.75	4071	.29
4008	.95	4025	.22	4072	.39
4009	.46	4027	.59	4073	.39
4010	.45	4028	.85	4078	.39
4011	.45	4030	.49	4081	.39
4012	.25	4035	.95	4082	.30
4013	.59	4040	1.15	4518	1.25
4014	.95	4041	1.20	4528	1.50
4015	.95	4042	.95	4585	1.50
4016	.64	4043	.85	4901	.59
4017	1.08	4046	1.69		
4018	.95	4049	.45		

LINEAR CIRCUITS

10% OFF ON $25.00
15% OFF ON $50.00

301N-8	$.25	741N-8	.32
307N-8	.32	741N-14	.29
309H	1.05	748N-8	.25
311N-8	.29	1310N-14	2.50
318N-8	1.45	1414N-14	.35
324N-14	.95	1456N-8	1.29
339N-14	.29	1458N-8	.65
376N-8	.30	1496N-14	.89
380N-14	1.09	1800N-16	2.40
380N-8	.45	2208N-8	.79
386N-8	.89	2209N-8	.79
387N-8	.89	3046N-14	1.29
555N-8	.45	3081N-16	1.25
556N-14	.79	3082N-16	1.25
560N-16	2.95	3900N-14	.45
565N-14	.95	75150N-8	.35
567N-8	1.09	75450N-8	.35
703N-8	.49	75453N-8	.35
723N-14	.45	75491N-14	.75
733H	.45	75492N-14	.89

PAYMENT BY CHECK, MONEY ORDER, UPS/COD, MC OR VISA. ADD $1.25 FOR SHIPPING/HANDLING IN U.S., CANADA AND MEXICO. OTHER COUNTRIES ADD $1.50 PLUS 5% OF ORDER TOTAL. CHECKS MUST BE IN U.S.$ DRAWN ON U.S. BANK. ADDITIONAL CHARGE FOR UPS/COD OR BLUE LABEL(AIR). CALIFORNIA RESIDENTS ADD SALES TAX. MINIMUM ORDER $10.00

ORDERS FROM SCHOOLS, GOVERNMENTS AND RATED BUSINESSES (SUBJECT TO APPROVAL) ACCEPTED ON OFFICIAL PURCHASE ORDERS. TERMS: NET 30, FOB SHIPPING POINT. MINIMUM ORDER $20.00.

INTERNATIONAL ELECTRONICS UNLIMITED
435 FIRST ST. Solvang, Ca. 93463
phone 805 688 2747

CIRCLE 41 ON FREE INFORMATION CARD

CIRCLE 4 ON FREE INFORMATION CARD

7400

SN7400N	.20	SN7472N	.29	SN74156N	.79
SN7401N	.20	SN7473N	.35	SN74157N	.69
SN7402N	.25	SN7474N	.35	SN74160N	.89
SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
SN7407N	.35	SN7482N	.99	SN74165N	.89
SN7408N	.29	SN7483N	.69	SN74166N	1.25
SN7409N	.29	SN7485N	.89	SN74167N	2.79
SN7410N	.25	SN7486N	.35	SN74170N	1.95
SN7411N	.29	SN7489N	1.75	SN74172N	4.95
SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74104N	.89	SN74184N	2.49
SN7426N	.29	SN74105N	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

74LS00	.29			74LS192	1.15
74LS01	.29			74LS193	1.15
74LS02	.29	74LS92	.75	74LS194	1.15
74LS03	.29	74LS93	.75	74LS195	1.15
74LS04	.35	74LS95	.99	74LS197	1.19
74LS05	.35	74LS96	1.15	74LS221	1.19
74LS08	.35	74LS107	.45	74LS240	1.49
74LS09	.35	74LS109	.45	74LS241	1.49
74LS10	.35	74LS112	.45	74LS242	1.49
74LS11	.39	74LS113	.49	74LS243	1.49
74LS12	.35	74LS114	.49	74LS244	1.49
74LS13	.59	74LS122	.89	74LS245	2.95
74LS14	.99	74LS123	1.25	74LS247	1.19
74LS15	.35	74LS125	.59	74LS248	1.19
74LS20	.35	74LS126	.59	74LS249	1.19
74LS21	.35	74LS132	.99	74LS251	.99
74LS22	.35	74LS133	.89	74LS253	.99
74LS26	.35	74LS136	.49	74LS257	.89
74LS27	.35	74LS138	.89	74LS258	.89
74LS28	.35	74LS139	.89	74LS260	.69
74LS30	.35	74LS151	.89	74LS266	.69
74LS32	.35	74LS153	.89	74LS273	1.95
74LS33	.59	74LS154	1.75	74LS279	.89
74LS37	.45	74LS155	.89	74LS283	.89
74LS38	.39	74LS156	.89	74LS290	.99
74LS40	.35	74LS157	.89	74LS293	.99
74LS42	.89	74LS158	.89	74LS298	1.25
74LS47	.89	74LS160	1.15	74LS352	1.29
74LS48	1.15	74LS161	1.15	74LS353	1.29
74LS49	1.15	74LS162	1.15	74LS365	.69
74LS51	.35	74LS163	1.15	74LS366	.69
74LS54	.35	74LS164	1.15	74LS367	.69
74LS55	.35	74LS165	1.15	74LS368	.69
74LS73	.45	74LS168	1.19	74LS373	1.95
74LS74	.45	74LS169	1.19	74LS374	1.95
74LS75	.59	74LS170	1.95	74LS375	.89
74LS76	.45	74LS173	.99	74LS386	.69
74LS78	.49	74LS174	.99	74LS393	2.49
74LS83	.89	74LS175	.99	74LS399	2.49
74LS85	1.25	74LS181	2.95	74LS670	2.49
74LS86	.49	74LS190	1.15	81LS95	1.95
74LS90	.69	74LS191	1.25	81LS97	1.95

74S

74S00	.45			74S243	3.25
74S02	.45	74S124	3.95	74S244	3.25
74S03	.45	74S133	.55	74S251	1.45
74S04	.55	74S134	.69	74S253	1.45
74S05	.55	74S135	1.19	74S257	1.35
74S08	.50	74S136	1.75	74S258	1.35
74S09	.50	74S138	1.35	74S260	.79
74S10	.45	74S139	1.35	74S280	2.95
74S11	.45	74S140	.79	74S287	3.25
74S15	.45	74S151	1.35	74S288	2.75
74S20	.45	74S153	1.35	74S373	3.49
74S22	.45	74S157	1.35	74S374	3.49
74S30	.45	74S158	1.35	74S387	2.95
74S32	.55	74S160	2.95	74S471	10.95
74S38	1.25	74S174	1.59	74S472	10.95
74S40	.50	74S175	1.59	74S473	10.95
74S51	.45	74S188	2.95	74S474	12.95
74S64	.50	74S194	1.95	74S475	12.95
74S65	.50	74S195	1.95	74S570	5.95
74S74	.75	74S196	1.95	74S571	5.95
74S86	.79	74S240	2.95	74S572	9.95
74S112	.79	74S241	2.95	74S573	9.95
74S113	.79	74S242	3.25	74S940	3.15
74S114	.79			74S941	3.15

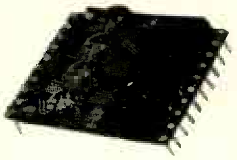
CA—LINEAR

CA3010H	.99			CA3089N	3.75
CA3013H	2.15	CA3060N	3.25	CA3096N	3.95
CA3023H	3.25	CA3080H	1.25	CA3130H	1.39
CA3035H	2.49	CA3081N	2.00	CA3140H	1.25
CA3039H	1.35	CA3082N	2.00	CA3160H	1.25
CA3046N	1.30	CA3083N	1.60	CA3401N	.59
CA3059N	3.25	CA3086N	.85	CA3600N	3.50

CD—CMOS

CD4000	.39			CD 4098	2.49
CD4001	.39			CD4506	.75
CD4002	.39			CD4507	.99
CD4006	1.19	CD4041	1.49	CD4508	3.95
CD4007	.25	CD4042	.99	CD4510	1.39
CD4009	.49	CD4043	.89	CD4511	1.29
CD4010	.49	CD4044	.89	CD4512	1.49
CD4011	.39	CD4046	1.79	CD4514	3.95
CD4012	.25	CD4047	2.50	CD4515	2.95
CD4013	.49	CD4048	1.35	CD4516	1.49
CD4014	1.39	CD4049	.49	CD4518	1.79
CD4015	1.19	CD4050	.69	CD4519	.89
CD4016	.59	CD4051	1.19	CD4520	1.29
CD4017	1.19	CD4052	1.19	CD4526	1.79
CD4018	.99	CD4053	1.19	CD4528	1.79
CD4019	.49	CD4056	2.95	CD4529	1.95
CD4020	1.19	CD4059	9.95	CD4543	2.79
CD4021	1.39	CD4060	1.49	CD4562	11.95
CD4022	1.19	CD4066	.79	CD4566	2.79
CD4023	.29	CD4068	.39	CD4583	2.49
CD4024	.79	CD4069	.45	CD4584	.75
CD4025	.23	CD4070	.55	CD4723	1.95
CD4026	2.95	CD4071	.49	CD4724	1.95
CD4027	.69	CD4072	.49	MC14409	17.95
CD4028	.89	CD4073	.39	MC14410	18.95
CD4029	1.49	CD4075	.39	MC14411	15.95
CD4030	.49	CD4076	1.39	MC14412	15.95
CD4034	3.49	CD4078	.55	MC14419	7.95
CD4035	.99	CD4081	.39	MC14433	15.95
CD4040	1.49	CD4082	.39	MC14538	2.49
		CD4093	.99	MC14541	1.95

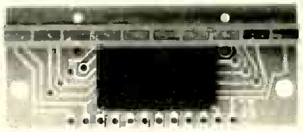
4-Digit 16 Segment Alphanumeric Intelligent Display with Memory, Recorder, Driver



End-stackable, 4-character package. High contrast, 160mil high, magnified monolithic characters. 64-Character ASCII format. Built-in memory, decoder, multiplexer and drivers. Direct access to each digit independently and asynchronously. Five volt logic. TTL compatible. Five volt power supply only. Independent cursor function. Size: 1"L x 1-3/16"H x .225"D.

DL-1416 Alphanumeric Display $19.95 ea.

10-Segment Bargraph Displays
(with On-Board Driver IC-Chip)



Size: 2"L x 7/8"H x 3/16"D

Bar or dot display mode externally selectable by user. Packages are end-stackable for expanded displays. Can be cascaded to 10 arrays (100 bargraph elements). LED current programmable from 2mA to 30mA. Stable internal voltage reference for full scale analog inputs from 1.2 to 12V. Each LED output of driver IC with external access. Size: 2"x7/8"x3/16".

NSM3914	Linear Function (10 bars red)	$5.96
NSM39146	Linear Function (6 bars green/4 red)	6.96
NSM3915	Logarithmic Function (10 bars red)	5.96
NSM39158	Logarithmic Func. (6 grn./2 yell./2 rd.)	6.96
NSM3916	VU-Meter Function (10 bars red)	6.96
NSM39168	VU-Meter Func. (6 grn./2 yell./2 rd.)	6.96

DISCRETE LEDS

XC556R	.200"	red	5/$1	MV50	.085"	red	6/$1
XC556G	.200"	green	4/$1	XC209R	.125"	red	5/$1
XC556Y	.200"	yellow	4/$1	XC209G	.125"	green	4/$1
XC556C	.200"	clear	4/$1	XC209Y	.125"	yellow	4/$1
XC22R	.200"	red	5/$1	XC526R	.185"	red	5/$1
XC22G	.200"	green	4/$1	XC526G	.185"	green	4/$1
XC22Y	.200"	yellow	4/$1	XC526Y	.185"	yellow	4/$1
MV10B	.170"	red	4/$1	XC526C	.185"	clear	4/$1

.200(T1¾) Red/Green

Diffused Bi-Color LED

Part No.	1-99	100+
XC5491	.79	.69

XC556 RED LED, METAL MTG. HDW. 2-¼" LEADS.
RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

C.A. — Common Anode
D.D. — Double Digit
C.C. — Common Cathode
RHD — Right Hand Decimal

Type	Polarity	Ht	Price	Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95	DLG507	C.A.—green	.500	1.25
MAN 2	5x7 D.M.—red	.300	4.95	DL704	C.C.—red	.300	1.25
MAN 3	C.C.—red	.125	.25	DL707	C.A.—red	.300	1.25
MAN 52	C.A.—green	.300	.99	DL728	C.C.—red	.500	1.49
MAN 54	C.C.—green	.300	.99	DL741	C.A.—red	.600	1.25
MAN 71	C.A.—red	.300	.75	DL747	C.A.—red	.600	1.49
MAN 72	C.A.—red	.300	.75	DL750	C.C.—red	.600	1.49
MAN 74	C.C.—red	.300	1.25	DLO847	C.A.—orange	.800	1.49
MAN 82	C.A.—yellow	.300	.49	DLO850	C.C.—orange	.800	1.49
MAN 84	C.C.—yellow	.300	.99	DL33B	C.C.—red	.110	.35
MAN 3620	C.A.—orange	.300	.49	FND358	C.C. ± 1	.357	.99
MAN 3630	C.A.—orange ± 1	.300	.99	FND357	C.C.	.357	.75
MAN 3640	C.C.—orange	.300	.99	FND500	C.C. (FND503)	.500	.99
MAN 4610	C.A.—orange	.400	.99	FND507	C.A. (FND510)	.500	.99
MAN 6610	C.A.—orange—DD	.560	.99	HDSP-3401	C.A.—red	.800	1.50
MAN 6630	C.A.—orange ± 1	.560	.99	HDSP-3403	C.C.—red	.800	1.50
MAN 6640	C.C.—orange—DD	.560	.99	HDSP-3406	C.C. red ± 1	.800	1.50
MAN 6650	C.C.—orange ± 1	.560	.99	5082-7751	C.A., R.H.D.—red	.430	1.25
MAN 6660	C.A. orange	.560	.99	5082-7760	C.C., R.H.D.—red	.430	1.25
MAN 6710	C.A.—red—DD	.560	.99	5082-7300	4x7 Numeric (RHD)	.600	22.00
MAN 6740	C.C.—red—DD	.560	.99	5082-7302	4x7 Numeric (LHD)	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7340	4x7 Hxdcl. (0-9/A-F)	.600	22.50
DLO304	C.C. orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.69
DLO307	C.A.—orange	.300	1.25	LIT-1	Photo Xsistor Opto-Isol.		.69
DLG500	C.C.—green	.500	1.25	MOC3010	Optically Isol. Triac Driver		1.25

INTERSIL

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	24.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
72401JE	CMOS Bin Prog. Timer/Counter	4.95
72421JA	CMOS Divide-by-256 RC Timer	2.05
72501JE	CMOS BCD Prog. Timer/Counter	6.00
72601JE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band-GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

74C00	.39			74C221	1.95
74C02	.39	74C95	1.59	74C240	2.25
74C04	.39	74C107	1.89	74C244	2.25
74C08	.39	74C151	2.95	74C373	2.49
74C10	.39	74C154	3.95	74C374	2.59
74C14	.75	74C157	2.25	74C901	.69
74C20	.39	74C160	1.69	74C903	.69
74C30	.39	74C161	1.69	74C911	10.95
74C42	1.39	74C162	1.49	74C912	10.95
74C48	1.95	74C163	1.69	74C915	1.69
74C73	.79	74C164	1.59	74C917	10.95
74C74	.79	74C173	1.39	74C922	5.49
74C85	1.95	74C174	1.39	74C923	5.75
74C86	.99	74C175	1.19	74C925	7.50
74C89	6.95	74C192	1.69	74C926	7.50
74C90	1.29	74C193	1.69	80C95	.79
74C93	1.29	74C195	1.59	80C97	.79

LINEAR

LH0002CN	6.85			LM702H	.79
LM10CLH	4.50			LM703CN	.89
LM11CLH	4.75	LM340T-5	1.25	LM709N	.29
LH0070-OH	4.95	LM340T-12	1.25	LM710N	.79
TL071CP	.79	LM340T-15	1.25	LM711N	.79
TL072CP	1.39	LM341P-5	.75	LM723N	.69
TL074CN	2.49	LM341P-12	.75	LM733N	1.00
LH0082CO	35.80	LM341P-15	.75	LM739N	1.19
TL082CP	1.19	LM342P-5	.69	LM741CN	.35
TL084CN	2.19	LM342P-12	.69	MC1741SCG	3.00
LH0094CD	36.80	LM342P-15	.69	LM747N	.79
LM300H	.99	LM348N	1.25	LM748N	.59
LM301CN	.35	LM350K	5.75	LM1014N	2.75
LM302H	1.95	LF351N	.60	LM1310N	1.95
LM304H	1.95	LF353N	1.00	LM1458CN	.59
LM305H	.99	LF355N	1.10	LM1488N	1.25
LM307CN	.45	LF356N	1.10	LM1489N	1.25
LM308CN	1.00	LM358N	1.00	LM1496N	1.95
LM309H	1.95	LM359N	1.79	LM1556V	1.75
LM309K	1.25	LM370N	4.49	LM1800N	2.95
LM310CN	1.75	LM373N	3.25	LM1871N	5.49
LM311/CN	.90	LM377N	2.95	LM1872N	5.49
LM312H	2.49	LM380N	1.25	LM1877N-9	3.25
LM317MP	1.15	LM381N	1.95	LM1889N	3.20
LM317T	1.75	LM382N	1.79	LM1896N	1.75
LM317K	3.95	LM384N	1.95	LM2002T	1.49
LM318CN	1.95	LM386N-3	1.29	LM2877P	2.05
LM319N	1.95	LM387N	1.45	LM2878P	2.25
LM320K-5	1.35	LM389N	1.35	LM2896P-1	2.25
LM320K-12	1.35	LM392N	.69	LM3189N	2.95
LM320K-15	1.35	LF398N	4.00	LM3900N	.69
LM320T-5	1.25	LM399H	5.00	LM3905CN	1.25
LM320T-12	1.25	TL494CN	4.49	LM3909N	1.15
LM320T-15	1.25	TL496CP	1.75	LM3914N	3.95
LM323K	5.95	NE510A	6.00	LM3915N	3.95
LM324N	.99	NE529A	4.95	LM3916N	3.95
LM329DZ	.65	NE531H	3.95	RC4136N	1.25
LM331N	3.95	NE536H	6.00	RC4151NB	3.95
LM334Z	1.30	NE540H	6.00	RC4194TK	6.95
LM335Z	1.40	NE544N	4.95	RC4195TK	5.49
LM336Z	1.75	NE550A	1.30	LM4500A	3.25
LM337T	1.95	NE555V	.39	ICL8038B	4.95
LM337MP	1.15	NE556N	.99	LM13080N	1.29
LM338K	6.95	NE564N	3.95	LM13600N	1.49
LM339N	.99	LM565N	1.25	75138N	1.95
LM340K-5	1.35	LM566CN	1.95	75450N	.89
LM340K-12	1.35	LM567V	1.25	75451CN	.39
LM340K-15	1.35	NE570N	4.95	75492	.89

SOCKETS — RECEPTACLES

Test TEXTOOL Sockets

ZERO INSERTION FORCE

- Nickel Boron Plating
- G.F. PSF Plastic Body
- For testing IC's

- Nickel Boron Plating
- G.F. PSF Plastic Body
- Wire Wrap Contacts

Part No.	Pins	Price	Part No.	Pins	Price
214-3339	14 pin	5.95	222-3343	22 pin	9.95
216-3340	16 pin	6.49	224-3344	24 pin	9.75
218-3341	18 pin	7.95	228-3345	28 pin	11.95
220-3342	20 pin	8.95	240-3346	40 pin	12.95

Part No.	Pins	Price	Part No.	Pins	Price
214-3592	14 pin	9.75	222-3596	22 pin	12.95
216-3593	16 pin	9.95	224-3597	24 pin	12.75
218-3594	18 pin	10.95	228-3598	28 pin	13.95
220-3595	20 pin	11.95	240-3599	40 pin	15.95

LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

1/4 WATT RESISTOR ASSORTMENTS – 5%

		Values		
ASST. 1	5 ea.	10 Ohm 12 Ohm 15 Ohm 18 Ohm 22 Ohm 27 Ohm 33 Ohm 39 Ohm 47 Ohm 56 Ohm	50 pcs.	$1.95
ASST. 2	5 ea.	68 Ohm 82 Ohm 100 Ohm 120 Ohm 150 Ohm 180 Ohm 220 Ohm 270 Ohm 330 Ohm 390 Ohm	50 pcs.	$1.95
ASST. 3	5 ea.	470 Ohm 560 Ohm 680 Ohm 820 Ohm 1K 1.2K 1.5K 1.8K 2.2K 2.7K	50 pcs.	$1.95
ASST. 4	5 ea.	3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K	50 pcs.	$1.95
ASST. 5	5 ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	50 pcs.	$1.95
ASST. 6	5 ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	50 pcs.	$1.95
ASST. 7	5 ea.	1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M	50 pcs.	$1.95

ASST. 8R Includes Resistor Assts. 1-7 (350 pcs.) **$10.95 ea.**

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

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

+20% DIPPED TANTALUMS (Solid) CAPACITORS

.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.16	.14	.12	.47/50V	.16	.14	.13
3.3/50V	.19	.16	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.15	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

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SN7404N	.22	SN74132N	.69
SN7405N	.23	SN74136N	.75
SN7406N	.23	SN74139N	.95
SN7407N	.23	SN74141N	.79
SN7408N	.26	SN74142N	2.95
SN7409N	.23	SN74143N	2.95
SN7410N	.22	SN74144N	2.95
SN7411N	.29	SN74145N	.62
SN7412N	.29	SN74147N	1.95
SN7413N	.39	SN74148N	1.20
SN7414N	.59	SN74150N	1.09
SN7416N	.29	SN74151N	.67
SN7417N	.29	SN74152N	.67
SN7420N	.22	SN74153N	.67
SN7421N	.35	SN74154N	1.19
SN7422N	.29	SN74155N	.78
SN7423N	.29	SN74156N	.78
SN7425N	.29	SN74157N	.69
SN7426N	.29	SN74158N	1.65
SN7427N	.25	SN74160N	.88
SN7429N	.45	SN74161N	.88
SN7430N	.23	SN74162N	.89
SN7432N	.29	SN74163N	.87
SN7437N	.25	SN74164N	.87
SN7438N	.29	SN74165N	.87
SN7439N	.29	SN74166N	1.20
SN7440N	.19	SN74167N	1.95
SN7441N	.79	SN74170N	1.69
SN7442N	.57	SN74172N	4.75
SN7443N	.95	SN74173N	.79
SN7444N	.95	SN74174N	.89
SN7445N	.79	SN74175N	.85
SN7446N	.79	SN74176N	.75
SN7447N	.65	SN74177N	.75
SN7448N	.79	SN74179N	1.34
SN7450N	.19	SN74180N	.75
SN7451N	.19	SN74181N	1.75
SN7453N	.19	SN74182N	.75
SN7454N	.19	SN74184N	2.25
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SN7474N	.34	SN74192N	.85
SN7475N	.38	SN74193N	.85
SN7476N	.34	SN74194N	.85
SN7479N	4.60	SN74195N	.68
SN7480N	.49	SN74196N	.85
SN7482N	.95	SN74197N	.85
SN7483N	.55	SN74198N	1.39
SN7485N	.65	SN74199N	1.39
SN7486N	.35	SN74221N	1.19
SN7489N	1.75	SN74251N	.95
SN7490N	.39	SN74273N	1.05
SN7491N	.57	SN74279N	.75
SN7492N	.45	SN74283N	1.40
SN7493N	.45	SN74284N	3.90
SN7494N	.69	SN74285N	3.90
SN7495N	.65	SN74290N	1.25
SN7496N	.69	SN74298N	.95
SN7497N	2.90	SN74365N	.68
SN74100N	1.20	SN74366N	.68
SN74107N	.32	SN74367N	.68
SN74109N	.37	SN74368N	.68
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CD4021	1.19	CD4515	2.75
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CD4031	3.25	74C04	.35
CD4032	2.15	74C08	.35
CD4034	3.25	74C10	.35
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CD4040	1.29	74C30	.35
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CD4043	.85	74C48	1.89
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CD4050	.69	74C93	1.19
CD4051	1.10	74C95	1.49
CD4052	1.10	74C107	1.19
CD4053	1.10	74C151	2.49
CD4055	3.95	74C154	3.50
CD4056	2.95	74C157	2.10
CD4059	9.25	74C160	1.65
CD4060	1.39	74C161	1.55
CD4066	.75	74C163	1.65
CD4069	.35	74C164	1.55
CD4070	.49	74C173	1.35
CD4071	.35	74C174	1.35
CD4072	.35	74C175	1.35
CD4073	.35	74C192	1.65
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CD4076	1.29	74C195	1.55
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74LS00

74LS00N	.26	74LS164N	1.19
74LS01N	.28	74LS165N	.89
74LS02N	.28	74LS166N	2.48
74LS03N	.28	74LS168N	1.15
74LS04N	.35	74LS169N	1.15
74LS05N	.28	74LS170N	1.99
74LS08N	.28	74LS173N	.89
74LS09N	.35	74LS174N	.89
74LS10N	.28	74LS175N	.89
74LS11N	.39	74LS181N	2.20
74LS12N	.33	74LS190N	1.15
74LS13N	.47	74LS191N	1.15
74LS14N	.95	74LS192N	.98
74LS15N	.33	74LS193N	.98
74LS20N	.26	74LS194N	1.15
74LS21N	.33	74LS195N	.95
74LS22N	.33	74LS196N	.89
74LS26N	.33	74LS197N	.89
74LS27N	.33	74LS221N	1.15
74LS28N	.33	74LS240N	1.69
74LS30N	.26	74LS241N	1.69
74LS32N	.33	74LS242N	1.69
74LS33N	.55	74LS243N	1.69
74LS37N	.45	74LS244N	1.49
74LS38N	.39	74LS245N	2.20
74LS40N	.26	74LS247N	1.10
74LS42N	.79	74LS248N	1.10
74LS47N	.79	74LS249N	1.19
74LS48N	.95	74LS251N	1.40
74LS51N	.26	74LS253N	.98
74LS54N	.29	74LS257N	.85
74LS55N	.29	74LS258N	.98
74LS73N	.45	74LS259N	2.95
74LS74N	.42	74LS260N	.65
74LS75N	.59	74LS261N	2.49
74LS76N	.45	74LS266N	.59
74LS78N	.45	74LS273N	1.75
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74LS107N	.45	74LS347N	1.95
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74LS161N	1.15	81LS97N	1.69
74LS162N	1.05	81LS98N	1.69
74LS163N	1.05		

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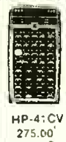

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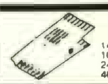

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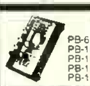

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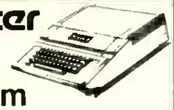

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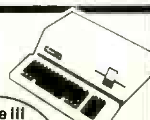

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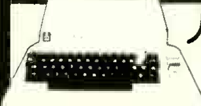

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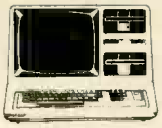

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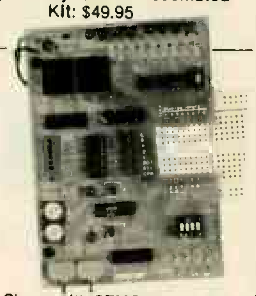

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Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double-duty!

PRICES:

CT-50 wired, 1 year warranty	$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95

DIGITAL MULTIMETER $99.95 WIRED

PRICES:

DM-700 wired, 1 year warranty	$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack +AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include; 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts:	100uV to 1 KV, 5 ranges
DC/AC current:	0.1uA to 2.0 Amps, 5 ranges
Resistance:	0.1 ohms to 20 Megohms, 6 ranges
Input impedance:	10 Megohms, DC/AC volts
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells

AUDIO SCALER

For high resolution audio measurements, multiplies UP in frequency.

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

$29.95 Kit $39.95 Wired

ACCESSORIES

Telescopic whip antenna - BNC plug	$ 7.95
High impedance probe, light loading	15.95
Low pass probe, for audio measurements	15.95
Direct probe, general purpose usage	12.95
Tilt bail, for CT 70, 90, MINI-100	3.95
Color burst calibration unit, calibrates counter against color TV signal	14.95

COUNTER PREAMP

For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer-included.

- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop

$34.95 Kit $44.95 Wired

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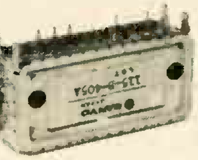
MC 1330	$3.00	Connectors Set	$1.00
LM 1458	$1.00	I.C. Socket Set	$2.00
LM 380	$2.00	Matching Transformer	$1.40
Sanyo UHF Tuner	$35.00	Toriod Coils (Set of 4)	$3.00
Capacitors Set	$12.50	Speaker Cabinet	$12.95
Resistors Set	$2.00	Transformer 18V 800MA	$3.00
Trim Pots; Trim Caps Set	$13.50		
Pots and Knobs	$2.00		

We sell you all the above components in a package for **$125.00** and you will receive a free predrilled P.C. board and instructions at no charge!

SANYO UHF VARACTOR TUNER

For UHF CH 14 83

Tuning voltage +1V~+28V D.C. Input Impedance 75 OHM. I.F. band width 7~16 MHz. Noise figure 11.5dB MAX. Size 2⅝" x 1¼" x ¾". Supply voltage 15V D.C.
Sound I.F. = 58.0 MHz.
Video I.F. = 62.5 MHz.



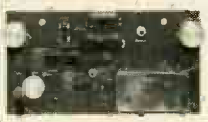
All units are brand new from Sanyo.
MODEL 115-B-405A
$35.00 EACH

Tuner is the most important part for the circuit. Don't let those $19.00 tuners fool you!

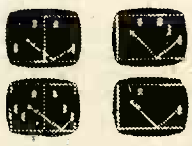
TV GAME BOARD

PLAYS 4 GAMES: TENNIS; HOCKEY; HANDBALL AND JAI-ALAI.

All boards complete with all parts ready to play. Requires 6C size batteries and a small speaker for sound effects. The boards were surplus from a famous game manufacturer. They will play on all US standard black and white or color TV sets. (Regular price for these games were $39.50 each) **OUR PRICE ONLY $6.50 EACH**



PART #57456



TENNIS JAI-ALAI
HOCKEY HANDBALL

ELECTRONIC PIN BALL MACHINE

That sounds and plays like the real thing. All units are brand new but without the case. Functions of the game include double flipper control, kicker control, 1-4 players, 3 speed ball control, tilt switch, automatic score, extra bonus cave and many more. All solid state with LED panel, no moving parts. Requires 9V battery to operate, speaker not included.

A perfect gift for yourself or friends.
SPECIAL **$8.99** EACH SPEAKER **$1.25** EACH

ELECTRONIC MUSICAL TELEPHONE REST KIT

This telephone rest can be used as a door charm, an audible indicator and for many other sound projects. The special custom made I.C. is pre programmed with 4 musical tunes. Kit comes with a nice looking plastic case, pre-drilled P.C. board, volume control, special sound I.C. speakers and all electronic components and instructions. Ideal for home or school projects.

BUY NOW!

SPECIAL PRICE! ONLY
$15.50 PER KIT

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LCD CLOCK MODULE!

• 0.5" LCD 4 digits display • X'tal controlled circuits • D.C. powered (1.5V battery) • 12 hr. or 24 hr. display • 24 hr. alarm set • 60 min. countdown timer • On board dual back-up lights • Dual time zone display • Stop watch function.

NIC1200 (12 hr)
NIC2400 (24 hr)
ON SALE
$16.99 EACH

0.5" LED ALARM CLOCK MODULE

Assembled! Not a Kit!

Features: • 4 digits 0.5" LED Displays • 12 hours real time format • 24 hours alarm audio output • 59 min. countdown timer • 10 min. snooze control.

ONLY **$7.00** EACH
SPECIAL TRANSFORMER FOR CLOCK
$2.50

DIGITAL TIMER/CLOCK

- 24 Hour preset time to turn on or off
- 12 Hour green 0.5" display for time
- operated on 12~16V A.C

The whole timer is self contained in a compact plastic case (as seen in photo). Designed for VTR with push button switch for easy setting. Limited quantity available.

MODEL VEQ 0143

SPECIAL! NOW ONLY $12.94

MATCHED PAIR POWER TRANSISTORS BY MOTOROLA

MJ2955 PNP / 2N3055 NPN	150 Watts	BV=60 V / I.C.=15 A	$3.50 per pair
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MJ15003 NPN / MJ15004 PNP	250 Watts	BV=140 V / I.C.=20 A	$12.00 per pair

All above parts guaranteed to be prime and come with data sheets.

MUFFIN FANS FOR EQUIPMENT COOLING

These fans are pulled out from used computers. But carefully cleaned by ultrasonic cleaner. All in "like-new" condition. Size 4 11/16" x 1-1/2" x 4 11/16".
MODEL MF505
$9.50 EACH

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED

Lights up 8~15 Watt Fluorescent Light Tubes. Ideal for camper, outdoor, auto or boat. Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!

$6.50 Per Kit

PRESS-A-LIGHT SELF GENERATED FLASHLIGHT

EXCLUSIVE! **$3.95 ea.**

Never worry about battery, because it has none! Easy to carry in pocket and handy to use. Ideal for emergency light. It generates its own electricity by squeezing grip lever. Put one in your car, boat, camper or home. You may need it some time!

Model F-179

CRYSTAL CONTROLLED WIRELESS MICROPHONE SYSTEM

No FCC license required.
OUR PRICE
$49.50
ADDITIONAL MICROPHONE (TRANSMITTER) AVAILABLE AT $28.00 EACH

Transmitter: FET mic for flat 30 ~18 KHz response extra controlled 49MHz AM Band for drift-free performance. 100 MW output (range approx ¼ mile) for reliable long range transmission. Powered by a 9V radio battery (included).
Receiver: Extra controlled locks on 49MHz transmitter signal. With on panel VU meter monitors the signal strength from the microphone. Standard phone jack outlet connection to a P.A. or other phone input. 9V battery included. This professional set is ideal for on stage, in field, church, in house or outdoor use.

MURA WMS-49

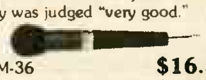
SUPER FM WIRELESS MIC KIT—MARK III

This new designed circuit uses high FEQ. FET transistors with 2 stages pre amp. Transmits FM Range (88-120 MHz) up to 2 blocks away and with the ultra sensitive condensor microphone that comes with the kit, allows you to pick up any sound within 15 ft. away! Kit includes all electronic parts, OSC coils, and P.C. Board. Power supply 9V D.C.

FMC-105 **$11.50 PER KIT**

WEM-36 FM WIRELESS MICROPHONE

TEET MODEL WEM-36 is a factory assembled FM wireless microphone powered by two AA size batteries. Transmits in the range of 88-108 MHz with 3 transistor circuits to meet with F.C.C. part 15 regulations. Element is built in a plastic tube type case with an omni-directional electret condenser microphone unit. By using a standard FM radio, signal can be heard anywhere on a one-acre lot. Sound quality was judged "very good."



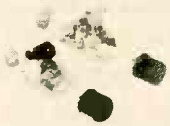
MODEL WEM-36 **$16.50 EACH**

WHISTLE ACTIVATED SWITCH BOARD

All boards are pre-assembled and tested. Your whistle to its FET condenser microphone from a distance, as far as 30 feet away (sensitivity can be easily adjusted) will turn the switch on, then match your whistle to it again, then it turns off. Ideal for remote control toys, electrical appliance such as lights, coffee pots, TV, Hi-Fi, radio or other projects. Unit works on 9V D.C.

MODEL 968
$4.50 EACH

ULTRASONIC SWITCH KIT



Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver. All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operates by 9-12 DC.
$15.50

ELECTRONIC SWITCH KIT

CONDENSER TYPE
Touch On Touch Off
uses 7473 I.C. and 12V relay

$5.50 each

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Quad 2-Input NOR Gate	74LS02	276-1902	.79	.59
Hex Inverter	74LS04	276-1904	.79	.59
Quad 2-Input AND Gate	74LS08	276-1908	.79	.59
Quad 2-Input OR Gate	74LS32	276-1915	.89	.69
Dual D Flip-Flop	74LS74	276-1919	.79	.59
4-Bit Bistable Latch	74LS75	276-1920	.99	.79
Decade Counter	74LS90	276-1923	1.09	.89
Retrig. Monostable Multivibrator	74LS123	276-1926	1.49	1.19
1 of 8 Decoder/Demultiplexer	74LS138	276-1939	1.19	.99
4-Binary Counter	74LS161	276-1931	1.39	1.09
8-Bit Shift Register	74LS164	276-1932	1.39	1.09
Quad D Flip-Flop	74LS175	276-1934	1.19	.99
Up/Down Binary Counter	74LS193	276-1936	1.49	1.19
Octal Inverting Bus/Line Driver	74LS240	276-1940	1.99	1.49
Octal 3-State Non-Inv. Driver	74LS244	276-1941	1.99	1.49
Octal Non-Inv. Bus Transceiver	74LS245	276-1942	2.99	1.99
Hex Buffer (3 State)	74LS367	276-1835	1.29	.99
Octal D Latch, Fall-Through	74LS373	276-1943	2.39	1.59
Octal D Flip-Flop (Edge Trig)	74LS374	276-1944	2.39	1.59

Archer Project Boxes For the "Pro" Look

A

NEW! 7.95

NEW! 3.95

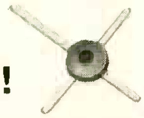
B

A Distinctive coloring, end-panels of ABS plastic, slots and standoffs for PC boards. Includes screws, self-sticking feet. 2¼x5x5¼ in. **270-218** 7.95

B Portable case has compartment for batteries, too. 1⅛x3⅝x5¾. With hardware. **270-219** 3.95

Microwave Transistor

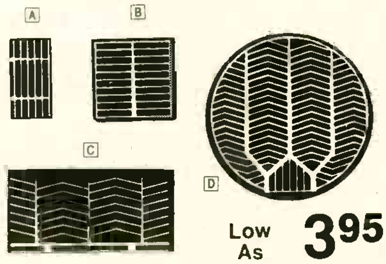
NEW!



2.99

MRF-901. Small-signal UHF/microwave amp useable to beyond 2 GHz. Gain: 10dB. noise: 2.0dB (typical at 1.0 GHz). With full specs. **276-2044** 2.99

NEW Solar Cells—Harness The Power of the Sun

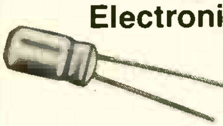


Low As 3.95

Solar cells convert light directly into electricity. Use them to power electronic projects, radios, calculators, and small DC motors, or to charge batteries. Connect in series for more voltage, and in parallel for more current. Typical voltage, 0.42V. Prime quality—ideally suited for solar panels.

Fig.	Size	Max. Current (Short Circuit)	Cat. No.	Each
A	2.5x5cm	0.2A	276-124	3.95
B	5x5cm	0.5A	276-125	5.95
C	5x10cm	1.0A	276-126	9.95
D	4 in. dia.	2.0A	276-127	16.95

Low-Leakage Electronics



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16 WVDC Minimum

Premium capacitors with radial leads replace tantalum types in most applications. Subminiature.

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.47	272-1417	.49
.68	272-1418	.49
1.0	272-1419	.49
2.2	272-1420	.59
3.3	272-1421	.59
4.7	272-1422	.59
6.8	272-1424	.59
10.0	272-1423	.59
22.0	272-1425	.69
33.0	272-1426	.69

DIN-Type 5-Pin Inline Socket

NEW! 1.49

Accepts male DIN-type plugs with three or five pins. Extend audio, video, computer connections. Solder terminals. **274-006** 1.49

SPST Toggle Switch With LED Indicator

NEW! 2.99 Mini LED in Toggle

Illuminates when in "on" position. 5A. 12VDC use only. ¾x¾x½. 7/16 in. mounting hole. **275-680**. . 2.99

Receiver ICs

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A **MC1330.** Fully-balanced multiplier detector with excellent linearity. Replaces original equipment in many solid-state TV sets. With specs. 8-pin DIP. **276-1757** 2.49

B **MC1350.** Universal IF amp with AGC. At-home in both radio and TV receiver circuits. Usable in DC to beyond 60 MHz. AGC range is -60dB min. With specs. 8-pin DIP. **276-1758** 2.19

C **MC1358/CA3065.** Greatly simplifies home-brew receiver projects! Also popular replacement IC in many TV sets. IF amp. limiter, FM detector and audio driver in 14-pin DIP. With specs. **276-1759** 1.79

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NEW! 89¢

Suitable for IR switching links, data links, wireless remote control. NPN. 50-mW dissipation. **276-145** .... 89¢

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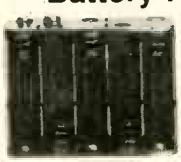
565. For SCA and RTTY decoders, modems, frequency synthesizers. TTL, CMOS compatible. 14-Pin DIP. **276-1720** 1.59

Battery Holder



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Holds ten "AA" batteries. Perfect for making a nickel cadmium pack. Series wiring, snap terminals, less batteries. **270-395** 1.29

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NEW! 3.19

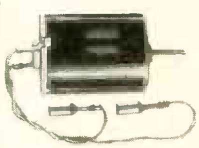
Automatic spring return to the center-off position. For experimental projects, more. Six amps @ 125VAC. **275-637** 3.19

Very High-Speed Diodes

NEW! 1.99 Pkg. of 2

5082-2835. Schottky barrier diodes. Use with UHF and Microwave mixers. Maximum capacitance: 1pF. **276-1124** .... **Pkg. of 2/1.99**

Three DC Motors



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3600 RPM

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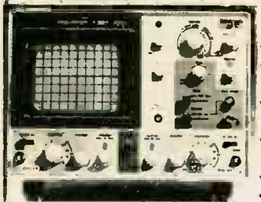
HITV302B List $995.00



SALE $819.00

- TV sync-separator circuit
- High-sensitivity 1mV/div (5MHz)
- Sweep-time magnifier (10 times)
- Z-axis input (intensity modulation)
- Signal delay line
- Complete with 2 probes
- CH1, CH2, DUAL, ADD, DIFF, Vertical Deflection Modes
- X-Y operation
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30MHZ DUAL TRACE OSCILLOSCOPE

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HITV152B DUAL TRACE 15MHZ (no delay)

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HIT-V202
20MHz DUAL TRACE

LIST PRICE: $850
SALE PRICE **CALL**

- Dynamic range 8 div.
- TV sync separator circuit
- Built-in signal delay line (V-352)
- X-Y operation
- Sweep-time magnifier (10 times)
- Trace rotation system
- Fine adjusting, click-positioning function

HIT-V352
35MHz DUAL TRACE WITH DELAY

LIST PRICE: $1150.00
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- Economically priced dual trace oscilloscope
- Square CRT with internal graticule (illuminated scale)
- High-accuracy voltage axis & time axis set at ±3% (certified at 10° to 35°C)
- High-sensitivity 1mV/div.
- Low drift
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50 MHz & 100 MHz DUAL TRACE WITH CALIBRATED TIME DELAY

HIT V550B
50MHz with 3rd TRACE TRIGGER VIEW
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SALE
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HIT V1050
100MHz with 3rd & 4th TRACE TRIGGER VIEW
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The HITACHI V550B (50mHz) and V1050 (100mHz) offer all the capabilities you might expect from a lab grade oscilloscope. Capabilities such as 3rd trace trigger view, a bright 6" square CRT, and a max. sweep rate of 2ns/div (V1050) 5ns/div (V550B). Also, features you may not expect like, sensitivity of 1mv/div (V550B) .5m/div (V1050) @ 10mHz, automatic focus correction.

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  5. resistance
  6. diode test
  7. conductance (1-R)
  8. logic level and continuity detect
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  10. Peak hold on voltage and current functions
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  12. 3½-digit resolution
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SYNCHRONOUS SERIAL INTERFACE

THE ULTIMATE IN DATA COMMUNICATIONS FOR THE APPLE II

The new CAT for Apple by Novation is a complete data communications system for the Apple II computer. It consists of a single card LSI modem that offers automatic dialing, answer and disconnect functions plus fully selectable operation from 110 to 1200 baud including the BAUDOT code for the Deaf Network.

- 300/1200 Baud, LSI Dual Speed. Direct connect Modem with receiver sensitivity greater than —40dBM
- Auto answer/auto pulse 7 touch tone dialing/auto disconnect
- Single Unit card with pluggable firmware
- Software selectable communication speeds compatible with Bell 103 (300 Baud) or Bell 202 (1200 Baud)
- FCC approved for direct connect to phone network-no external coupler required
- Full/Half duplex at 300 Baud or Half duplex at 1200 Baud
- Modem plugs into Apple Bus (No external units)
- Easy to use operating programs supplied on Disc
- Separate RS232 3-wire port for operating Printer/Terminal at 110 to 1200 Baud
- Power supplied to Apple (minimum load)
- Optional handset provides full telephone capability
- Optional program ROM's for pascal and CPM
- Optional Tape Input for recording incoming voice messages

		List Price	Our Price
NOV-APLCAT		$389.00	$359.00
NOV-490403	Expansion Module		$ 39.00
NOV-490404	Handset		$ 29.00
NOV-490405	BSR Control*		$ 19.00
NOV-490406	Cassette Rec. Cable*		$ 5.00
NOV-490407	Touch Tone Receiver		$ 99.00
NOV-490408	Firmware		$ 29.00
NOV-490409	Deaf Firmware		$ 29.00
NOV-490410	Software Diskette		$ 29.00

*Requires expansion module

5¼ DISKETTES

Part No.	Sectoring	Application	heads	Box/10
VRB-MD525-01	Soft Sector	TRS-80 Apple 40 Track Cert	1	$32.00
VRB-MD525-10	Hard 10 Sector	North Star 40 Track Cert	1	$32.00
VRB-MD525-16	Hard 16 Sector	Micropolis 40 Track Cert	1	$32.00
VRB-MD557-01	Soft Sector	77 Track Cert 100 TPI	2	$56.00
VRB-MD557-10	Hard 10 Sector	77 Track Cert 100 TPI	2	$56.00
VRB-MD557-16	Hard 16 Sector	77 Track Cert 100 TPI	2	$56.00
VRB-MD557-01	Soft Sector	77 Track Cert 100 TPI	1	$48.00
VRB-MD557-10	Hard 10 Sector	77 Track Cert 100 TPI	1	$48.00
VRB-MD577-16	Hard 16 Sector	77 Track Cert 100 TPI	1	$48.00

VRBMD Series comes with reinforced hub ring mounted.

8" DISKETTES

VRB-F032	Hard Sector	Shugart 801R	1	$37.00
VRB-FD34	Soft Sector	IBM 3740	1	$37.00
VRB-FD32-2	Hard Sector	Flippy	1	$66.00
VRB-FD34-2	Soft Sector	Flippy	1	$66.00

Verbatim 8" Diskettes have all the Datalife Improvements without the hardhole reinforcement rings.

ALL VERBATIM DISKETTES ARE DOUBLE DENSITY CERTIFIED

3M SCOTCH® BRAND PERSONAL COMPUTING TAPE WITH LEADER

MMM-PCC-10 10 Minute $1.30
MMM-PCC-20 20 Minute $1.40
MMM-PCC-30 30 Minute $1.50

CCS2422A LIST $425.00 **SALE**
FLOPPY DISK CONTROLLER WITH CP/M VERSION 2.2 **$365.00**
IEEE S-100 COMPATIBLE SINGLE/DOUBLE DENSITY 5¼"/8" DISK DRIVES
SINGLE/DOUBLE HEADED
ASSEMBLED & TESTED

CCS2810 Z80 CPU
2/4 MHZ CPU W/Serial I/O

		List Price	SALE PRICE
CCS2810	A&T	$310.00	$275.00

Shugart

SA801R SALE

SHU-SA801R $425.00
2 OR MORE **$395. ea.**

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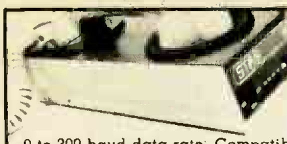


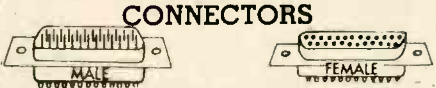
STAR MODEM FROM LIVERMORE

LIST PRICE **$199.00**

SALE PRICE **$129.00**

0 to 300 baud data rate. Compatible with Bell 103 and 113. Answer/Originate. Full/Half Duplex. Special self test features.

RS232 and "D" SUB-MINIATURE CONNECTORS



P=Plug, Male Type - S=Socket, Female Type - C=Cover, Hood

PART NO.	DESCRIPTION	PRICE 1-9	10-24	25-99
CND-DE9P	9 pin male	$ 2.10	$ 1.90	$ 1.70
CND-DE9S	9 pin female	$ 2.70	$ 2.40	$ 2.10
CND-DE9C	9 pin cover	$ 1.50	$ 1.25	$ 1.10
CND-DA15P	15 pin male	$ 2.75	$ 2.45	$ 2.15
CND-DA15S	15 pin female	$ 3.95	$ 3.60	$ 3.20
CND-DA15C	15 pin cover	$ 1.50	$ 1.30	$ 1.10
CND-DB25P	25 pin male	$ 3.50	$ 3.25	$ 3.00
CND-DB25S	25 pin female	$ 4.60	$ 4.35	$ 4.20
CND-DB51212	1 pc. grey hood	$ 1.60	$ 1.45	$ 1.30
CND-P25H	2 pc. grey hood	$ 1.50	$ 1.25	$ 1.10
CND-DB51226	2 pc. black hood	$ 1.90	$ 1.65	$ 1.45
CND-DC37P	37 pin male	$ 5.80	$ 5.10	$ 4.45
CND-DC37S	37 pin female	$ 8.70	$ 7.70	$ 6.70
CND-DC37C	37 pin cover	$ 1.80	$ 1.55	$ 1.30
CND-DD50P	50 pin male	$ 8.75	$ 7.75	$ 6.70
CND-DD50S	50 pin female	$11.65	$10.25	$ 8.90
CND-DD50C	50 pin cover	$ 2.00	$ 1.80	$ 1.60
CND-D2041B	Hardware set 2 pr.	$ 1.00	$ .80	$ .70
CND-RS2328F	RS232, DB25P, EIA Class 1 cable 8 con. 8 ft.	$19.95	$17.95	$15.95
CND-5730360	Cent. 700 Series Printer connector	$ 9.00	$ 7.50	$ 6.00

MICROCOMPUTER PRODUCTS

PART NO.	PRICE
2016P3	8/$100.00
2114N3L	8/$28.00
5257N3L	8/$50.00
2732	8/$120.00
2716	8/$50.00
2708	8/$32.00

8080 SERIES

PART NO.	PRICE
INS 8080A	$5.50
INS 8085A	$19.95
DP8212N	$2.95
DP8214N	$5.25
DP8216N	$2.95
DP8224N	$3.25
DP8224-4N	$9.95
DP8226N	$3.50
DP8228N	$5.55
DP8238N	$5.55
INS8250N	$15.00
INS8251N	$7.50
INS8253N	$17.95
INS8255N	$6.80
INS8257N	$16.45
INS8259N	$18.00
INS8275N	$59.95
INS8279N	$49.95

Z80 SERIES

PART NO.	PRICE
Z80A	$14.95
Z80AP10	$14.95
Z80ACTC	$13.95
Z80ADMA	$45.00
Z80AS100	$59.95
Z80AS101	$59.95
Z80AS102	$59.95

FLOPPY DISC CONTROLLER

PART NO.	PRICE
FD1771B-01	$24.95
FD1791B-01	$44.95

6502 SERIES

PART NO.	PRICE
6502	$12.95
6502A	$18.95
6520	$8.95
6522	$10.95
6530-002	$21.95
6530-003	$21.95
6530-004	$21.95
6530-005	$21.95
6532M	$21.95
6551M	$21.95

6800 SERIES

PART NO.	PRICE
MC6800P	$11.95
MC6802P	$17.95
MC6808P	$9.95
MC6809P	$34.95
MC6821P	$5.95
MC6828P	$14.95
MC6840P	$14.95
MC6845P	$31.00
MC6847P	$14.95
MC6850P	$5.41
MC6852P	$5.79
MC6854P	$24.95
MC6860P	$10.89
MC6862P	$12.00
MC6875L	$7.40
MC66710P	$12.50
MC66750P	$12.50

UARTS

PART NO	PRICE
AY51013A	$5.95
TR1602B	$5.95
TR1863	$6.95
IM6402	$7.95

CompuPro™ from GODBOUT ELECTRONICS

10 MHZ 16K A&T STATIC S-100 RAM

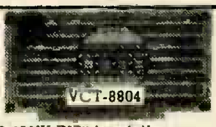
GBT-143A

List $349.00

$169.00 Ea

3/$450.00

• Operates up to 10 MHZ (90 ns RAM Chips) • Assembled & Tested • Meets or exceeds all IEEE 696/S-100 specifications (including timing). • Fully static design eliminates the timing problems associated with dynamic memories. • Switch selectable choice of 24 address lines conforming to the IEEE 696/S-100 extended addressing specifications, or 16 address lines as used in older S-100 systems. • Ideal for multi-user installations. • Board is addressable as one 16K x 8 block on any 4K boundary. • Switch selectable PHANTOM disable and write protect. • + 5 Volt operation (requires no other supply voltages). • Low power operation (900 mA typical, 1200 mA maximum). • 1 year Factory Warranty.



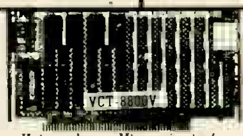
S-100 "ANY DIP" has full power and ground planes back to back. Boards accommodates .3, .4, .6, .9" Dips.

1-4	5-9	10-24
$24.67	$22.34	$20.02

APPLE PLUGBOARD

Vector 4609 Peripheral Interface Plugboard for construction of custom circuits. Plug compatible with Apple II, Commodore PET and Super Kim microcomputers. VCT-4609

1-4	5-9	10-24
$20.74	$18.79	$16.84



Universal Microcomputer/processor plugboard use with S-100 bus. Complete with heat sink & hardware. 53" x 10" x 1/16".

1-4	5-9	10-24
$22.48	$20.37	$18.26

VCT-8801-1

Same as 8800V except plain, less power buses & heat sink

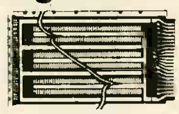
1-4	5-9	10-24
$15.67	$14.24	$12.82

Vector Plugboards

VCT-3682 9.6" x 4.5" $13.63

VCT-3862-2 6.5" x 4.5" $11.04

Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156



VCT3677 9.6"x4.5"

VCT-3667 96" x 4.5" $13.33

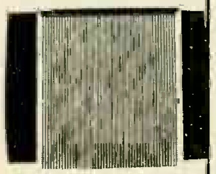
VCT-3677-2 6.5" x 4.5" $10.68

Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced .156

VCT-3662 6.5" x 4.5" $8.69

VCT-3662-2 9.6" x 4.5" $10.85

P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156



VCT-3690-12 $26.64

CARD EXTENDER

Card Extender has 100 contacts 50 per side on .125 centers- Attached connector is compatible with S-100 Bus Systems. VCT-3690 6.5" 22/44 pin .156 ctrs. Extenders . . . $15.66

1/16 Vector BOARD

.042 diaholes on 0.1 spacing for IC's

PART NO.	SIZE	PRICE 1-9	10-19
Phenolic			
VCT-64P44-X	4.5" x 6.5"	$1.56	$1.40
VCT-169P44-X	4.7" x 17"	$3.69	$3.32
Epoxy Glass			
VCT-64P44	4.5" x 6.5"	$1.83	$1.65
VCT-84P44	4.5" x 8.5"	$2.25	$2.03
VCT-169P44	4.5" x 17"	$4.61	$4.15
VCT-169P48	8.5" x 17"	$9.00	$8.10

TRS-80/APPLE MEMORY EXPANSION KITS 4116's RAMS

from Leading Manufacturers

(16Kx1 200)

8 for $20.00

Add $3.00 for programming Jumpers for TRS-80 Keyboard

POWERLINE INSOLATOR

GOF-IBARW3

SH. WT. 3 lbs.

List Price $59.95

Sale Price

$29.00

A MUST FOR EVERY OFFICE WITH DATA PROCESSING EQUIPMENT

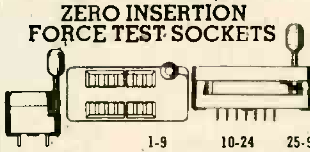
SPECIAL PURCHASE GOLD

16 FIN LOW PROFILE I.C. C-35 BOOKETS

TIG-16LP	pkg. of 100	$16.00
TIG-16LP	pkg. of 1000	$120.00

OEMS Stock up at this LOW PRICE

ZERO INSERTION FORCE TEST SOCKETS



	1-9	10-24	25-99
ZIP-16DIP	$ 5.50	$5.35	$4.95
ZIP-24DIP	$ 7.50	$7.25	$6.95
ZIP-400DIP	$10.25	$9.85	$9.50

6 OUTLET MULTI USE CORD REEL

SH. WT. 5 LBS.

GOF-CR1 22 ft. Cord $24.95

GOF-CR50 50 ft. Cord $39.95

LEDU

1M-10A List $104.95

SPECIAL

$69.95 with tube

Perfectly balanced fluorescent lighting with precision magnifier lens. Tough thermoplastic shade. Easy lens removal. New wire clip design permits easy installation and removal of flourescent tube. Comes with plastic shield to protect tube from soiling and damage. Colors: Gray, Black, and Chocolate Brown. Comes with one 22 watt T-9 Circline fluorescent tube, 3 diopter lens. 10 lbs.

$69.95

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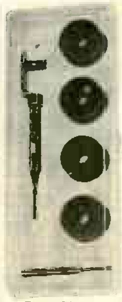
Sales Prices Valid only if **YOU** mention publication and month. Credit Card orders will be charged appropriate freight.

ok PRODUCTS

JUST WRAP KIT



Just Wrap tool for daisy chain wiring. Tool strips as it wraps and cuts. Includes one 50 foot spool of wire.

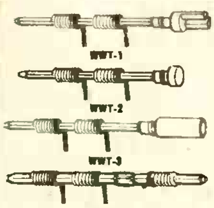
Part No.	Description	Price
JW-1*	Just Wrap Tool	$14.95
JWK-6	Tool w/4 Spools and JUW1	24.95
R-JW*	50 Ft. Replacement Wire	3.49
JUW-1	Unwrapping Tool	3.49

*Specify Color: Red, Blue, White or Yellow.

HAND WRAP TOOL

Part No.	Description	Price
WSU30	Regular	$6.95
WSU30M	Modified	7.95

TERMINALS

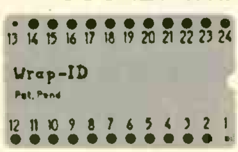


- .025 (0,63mm) Square Post
- 3 Level Wire-Wrapping
- Gold Plated

25 PER PKG.

Part No.	Description	Price
WWT-1	Slotted Terminal	$4.98
WWT-2	Single Sided Terminal	2.98
WWT-3	IC Socket Term.	4.98
WWT-4	Double Sided Terminal	1.98
INS 1	Insertion Tool for above	2.49

SOCKET WRAP — ID



Slipped onto socket before wrapping to identify pins.

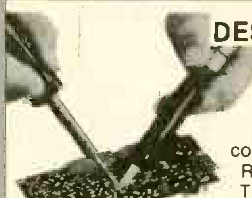
Part #	Price	Bulk Price	Part #	Price	Bulk Price
14ID	1.49/10	5.50/100	22ID	1.49/5	5.95/50
16ID	1.49/10	5.95/100	24ID	1.49/5	5.95/50
18ID	1.49/10	5.00/50	28ID	1.49/5	6.50/50
20ID	1.49/5	5.00/50	40ID	1.49/5	5.00/25

P.C.B. TERMINAL STRIPS

The TS strips provide positive screw activated clamping action, accommodate wire sizes 14-30 AWG (1,8-0, 25mm). Pins are solder plated copper, .042 inch (1mm) diameter, on .200 inch (5mm) centers.

Part No.	Description	Price
TS- 4	4-Pole	$1.69
TS- 8	8-Pole	2.59
TS-12	12-Pole	3.49
TS6MD	2-Pole Interlocking	3/1.79

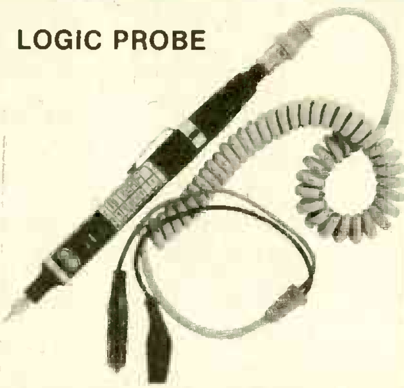
DESOLDERING PUMP



Easy one hand operation. Rugged all metal construction. Replaceable TEFLON® Tip. Self cleaning on each stroke. Suction precisely regulated for reliable desoldering without damage to delicate circuitry.

DSPI	Desoldering Pump	$9.95

LOGIC PROBE



Compatible with all logic families using a 4 to 15V power supply. Thresholds automatically programmed. Visual indication of logic levels to show high, low, bad level or open circuit logic pulses.

- 10 N sec. pulse responses
- 120 K input impedence.
- Automatic resetting memory.
- Includes tip with protective cap & coiled cord.

PRB-1 $36.95

LOGIC PULSER

Superimposes a pulse train (20 pps) or a single pulse onto the circuit node under test without un-soldering IC's.

- Automatic polarity sensing
- 2 us pulse width
- Finger tip push button actuated
- Includes tip with protective cap & coiled cord.

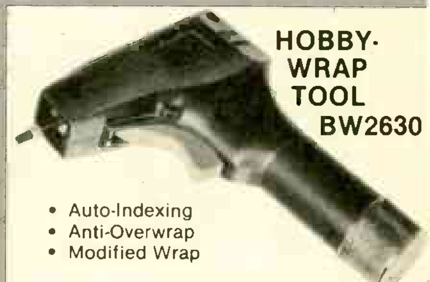
PSL-1 $48.95

VACUUM VISE

Unique vacuum-based light duty vise for precision handling of small components and assemblies. Rugged ABS construction. 1½" (32mm) travel for maximum versatility. Also features screw lugs for permanent installation.

VV1	Vacuum Vice	$3.49

HOBBY-WRAP TOOL BW2630



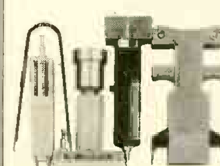
- Auto-Indexing
- Anti-Overwrap
- Modified Wrap

Part No.	Description	Price
BW2630	Tool	$19.85
BT30	#30 Bit (not incl.)	3.95
BT2628	#28 Bit (not incl.)	7.95
BC1	Batteries & Charger	14.95

INSERTION/EXTRACTION TOOLS

Part No.	Description	Price
INS1416	14-16 pin Inserter	$3.49
MOS1416	14-16 pin MOS Safe Inserter	7.95
MOS2428	24-28 pin MOS Safe Inserter	7.95
MOS40	40 pin MOS Safe Inserter	7.95
EX1	14-16 pin IC Extractor	1.49
EX2	24-40 pin IC Extractor	7.95

WK-7 IC INSERTION KIT



Complete IC Inserter/ Extractor Kit Individual Components (listed above) $22.95

IC DISPENSER

Allows IC's to be dispensed from their tube 1 at a time and picked up by insertion tools above.

• Dispenses 8-42 pin IC's • Compatable with all IC carrying tubes • Use with WK7 for MOS safe insertion. •

Part No.	Description	Price
MDD1	1 Chan. Dispenser	$21.85
MDD5	5 Chan. Dispenser	83.43
MDD10	10 Chan. Dispenser	160.45

*No Discount.

CIRCLE 80 ON FREE INFORMATION CARD

TOLL FREE ORDERING NUMBER 1-(800) 423-7144

IDC CONNECTORS

RIGHT ANGLE HEADERS

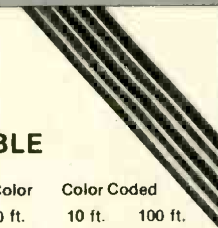
	SOLDER TAIL		WIRE WRAP	
Size	Part No.	Price	Part No.	Price
10	IDH10SRB	$1.20	IDH10WRB	$2.60
20	IDH20SRB	1.90	IDH20WRB	4.15
26	IDH26SRB	2.75	IDH26WRB	5.35
34	IDH34SRB	3.75	IDH34WRB	6.25
40	IDH40SRB	3.75	IDH40WRB	7.35
50	IDH50SRB	4.75	IDH50WRB	9.20

.1" Spacing. Mounts on PC Board & Mates with IDS Socket below. Ejector Bars - 4/1.00.

EDGE CARD CONNECTORS

Size	Part No.	Price
10	IDE10B	$3.95
20	IDE20B	4.35
26	IDE26B	5.00
34	IDE34B	6.05
40	IDE40B	6.90
50	IDE50B	7.50

.1" Spacing. Crimps onto cable with ordinary vise & mates with standard .062" Card Edge.



RIBBON CABLE

	Solid Color		Color Coded	
Size	10 ft.	100 ft.	10 ft.	100 ft.
10	2.90	17.00	4.00	30.00
14	3.40	23.80	5.00	42.00
16	3.70	27.20	5.60	48.00
20	4.40	34.00	7.00	60.00
24	5.00	40.80	8.00	72.00
26	5.40	44.20	8.60	78.00
34	6.80	57.80	11.00	102.00
40	7.80	68.00	13.00	120.00
50	9.50	85.00	16.00	150.00

25 PIN "D" CONNECTORS

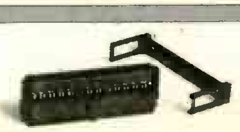
Solder Style	Part No.	Price
Male	DB25P	$2.95
Female	DB25S	3.95
Cover	DB25C	1.50
IDC Style		
Male	IDB25P	6.25
Female	IDB25S	6.60
Cover	IDB25C	1.60

Solder Style solders onto cable, IDC Style crimps onto cable with vise. 9, 15, 37 and 50 pin available also.

CABLE PLUGS

Size	Part No.	Price
14	IDP14B	$1.45
16	IDP16B	1.65
24	IDP24B	2.50
40	IDP40B	4.15

.1" Spacing. Crimps onto cable with ordinary vise & plugs into standard IC Socket.



SOCKETS

Size	Part No.	Price
10	IDS10B	$1.88
20	IDS20B	2.75
26	IDS26B	3.50
34	IDS34B	4.50
40	IDS40B	5.40
50	IDS50B	6.50

.1" Spacing. Crimps onto cable with ordinary vise & mounts to header sold above.

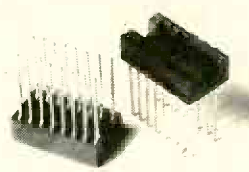
WIRE WRAP SUPPLIES

WIRE WRAP WIRE

#30 Wire Wrap Wire

Length	100/Bag	500/Bag	1K/Bag
2.5"	$1.38	$3.94	$6.81
3.0"	1.43	4.25	7.46
3.5"	1.51	4.57	8.11
4.0"	1.56	4.88	8.73
4.5"	1.63	5.21	9.39
5.0"	1.69	5.54	10.04
5.5"	1.74	5.92	10.69
6.0"	1.82	6.23	11.34
6.5"	2.11	7.08	12.99
7.0"	2.19	7.44	13.68
7.5"	2.29	7.78	14.40
8.0"	2.35	8.12	15.10
8.5"	2.40	8.46	15.80
9.0"	2.46	8.92	16.51
9.5"	2.53	9.15	17.22
10.0"	2.63	9.58	17.91

All lengths are overall, including 1" strip on each end. Choose from colors; Red, Blue, Black, Yellow, White, Green, Orange, and Violet.



Size	Part No.	Each	Tube
08	ICN083WBSG	.44	52x .39 = $20.28
14	ICN143WBSG	.53	30x .46 = $13.80
16	ICN163WBSG	.58	26x .50 = $13.00
18	ICN183WBSG	.78	23x .68 = $15.64
20	ICN203WBSG	1.00	21x .85 = $17.85
22	ICN224WBSG	1.07	19x .92 = $17.48
24	ICN246WBSG	1.09	17x1.09 = $15.98
28	ICN286WBSG	1.43	15x1.23 = $18.45
40	ICN406WBSG	1.85	10x1.60 = $16.00

Selective Plating provides gold in contact where it counts. 3-level wrap. Save by buying sockets by the tube. All gold available at ½¢/pin extra charge.

* * * No Discount

WIRE KITS

Kit No. 1 — $9.95

250	3"	100	4½"
200	3½"	100	5"
100	4"	100	6"

Kit No. 2 — $24.95

250	2½"	250	5"
500	3"	100	5½"
500	3½"	100	6"
500	4"	100	6½"
250	4½"	100	7"

Kit No. 3 — $34.95

250	2½"	500	4½"
500	3"	500	5"
500	3½"	500	5½"
500	4"	500	6"

Kit No. 4 — $59.95

500	2½"	1000	4½"
1000	3"	1000	5"
1000	3½"	1000	5½"
1000	4"	1000	6"

ORDERING INFORMATION

Prepaid orders over $50 shipped prepaid via UPS. All others add $3.00 for handling. VISA, MC, COD's and open account orders will be charged freight. $15 minimum order. $100 minimum open account order.

DISCOUNT SCHEDULE

Order	Amount
$15 - 99	Net
100 - 199	less 10%
200 - 499	less 15%
500 - 999	less 20%
1000 up	less 25%

Discount and the name of this magazine must be mentioned at time of order to get discount. Discount applies on all items except as noted, "No Discount."

CIRCLE 80 ON FREE INFORMATION CARD

page 1858 EVERGREEN • DUARTE, CALIFORNIA 91010 • TELEPHONE (213) 357-5005

CIRCLE 43 ON FREE INFORMATION CARD

SURPLUS ELECTRONICS CORP.

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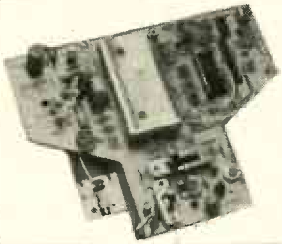
Miami, Florida 33166

WHOLESALE/RETAIL

Phone: (305) 887-8228
TWX: 810-848-6085
We accept MasterCard and Visa.

EQUIPMENT/COMPONENTS/WIRE & CABLE/ACCESSORIES

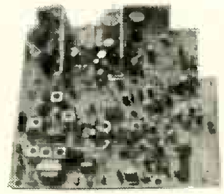


"TANK BATTLE" TV GAME

In just a short time and with a few minor parts, the most novice hobbiest can complete this exciting Tank Battle game. Create a fun-filled evening for the whole family. Two independent tanks rumble thru land mine fields, shoot shells and fragment when hit. Four distinct engine sounds are produced for the different speeds. Sounds of gunfire, shell bursts and tank explosions are realistic. Automatic on-screen scoring. Supplied with schematic drawing.

SOLD AS IS

$9.95 ea.



C.B. SPECIAL

CONVERT THESE TO 10 METER FM

New printed circuit board assembly. (Squelch pot, volume control and channel switch not included.) Boards sold as is, the way we bought them from the manufacturer. Board dimensions 6"x 6½".

1-9 **$7.50** 50-99 **$6.00**
10-49 **$6.50** 100-UP **$5.50**

COPPER CLAD BOARD

(Double Side)

Size 9.25 x 10.75
Thickness .062

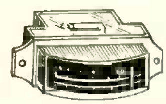
$2.00 ea.

PANEL METERS

25-0-25 VDC, 2¼" x 3"
0-25 VDC, 2¼" x 2¼"
0-50 VAC, 2¼" x 2¼"
(Shunt required)

$4.00 ea. **2/$7.00**

E. F. JOHNSON S METER



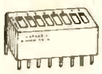
Edge Meter 250 UA, fits in ⅝"x 1⅜" hole. Black background. Scale 1-20 Top, 0-5 Bottom.

$1.25 ea. **5/$5.00**

COMPUTER GRADE ELECTROLYTICS

VALUE/MFD		VOLTS	DIAM./LGTH.	PRICE
63,000	@	15V	3" x 5½"	**$4.00** ea.
10,000	@	20V	1½" x 5¾"	**$3.00** ea.
2,700	@	25V	1¼" x 2¼"	**$2.00** ea.
2,900	@	25V	1¼" x 2"	**$2.00** ea.
3,000	@	25V	1½" x 4½"	**$2.00** ea.
100,000	@	30V	3" x 5½"	**$6.00** ea.
39,000	@	30V	1" x 5¾"	**$4.00** ea.
34,800	@	50V	3" x 5½"	**$3.00** ea.
450	@	75V	1¼" x 2¼"	**$2.00** ea.
500	@	100V	1½" x 3¼"	**$2.00** ea.
240	@	300V	1¼" x 3¼"	**$2.00** ea.
50	@	450V	1¼" x 2"	**$2.00** ea.

DIP SWITCH



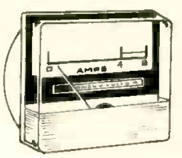
7 POSITION **$1.30** ea.
8 POSITION **$1.50** ea.
12 POSITION **$2.00** ea.

TRIMMER CAP

1.5-20pF (ARCO PC-402)

50¢ ea.

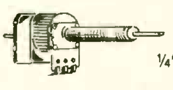
AMP METERS



2¼' square, no shunt required. Easy to read dial. Movement: 0-6, 0-10, 0-17

$2.50 ea.

SUB-MINI 10K POT



with On-Off
¼" hole mount,
⅛" D shaft,
¾" thread section.

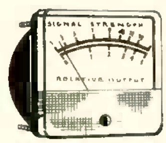
5/$1.00

ASTATIC T-UG8-D104 MICROPHONE

Pre-amp desk-top microphone with crystal element 3-pin plug.

$35.00 ea.

E.F. JOHNSON SIGNAL STRENGTH METER



$4.95 ea.

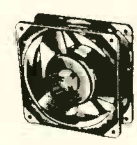
200 UA, 2½"x 2½" Sq.
Scale: 1-30 db top (orange), 0-50 bottom (black)

9 VOLT NiCd RECHARGEABLE BATTERY

NEW. Replaces the popular 9V Transistor Battery.

$4.75 ea.

MUFFIN FANS



MFG By Rotron Inc.
3 Blades 4¾" Square
USED
110 VAC **$5.95** ea.
NEW
230 VAC Model MU3A1
$12.00 ea.

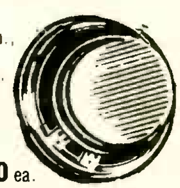
MAHOGANY PROJECT BOX

$1.50 ea.

4⅝" w x 7⅜" l x ¾" to 1½" h
Has a lip for recessed face plate and a felt bottom

SPEAKER

3" Diam., 8 OHM, 5 Watts.



$2.00 ea.

SPEAKER

Weather & water-proof (can be used underwater), mfg. by University Sound, 16 OHM, 25 Watt, 350-10,000 HZ. 6" diam. x 5" deep. Model #MM-2

$25.00 ea.

AXIAL LEAD ELECTROLYTIC CAPACITORS

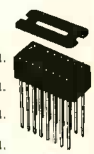
2 uF @	15V	12/**$1.00**
10 uF @	15V	12/**$1.00**
20 uF @	15V	12/**$1.00**
50 uF @	15V	12/**$1.00**
2.2 uF @	25V	12/**$1.00**
3.3 uF @	25V	12/**$1.00**
1 uF @	35V	12/**$1.00**
2 uF @	150V	12/**$1.00**
25 uF @	25V	15/**$2.00**
3 uF @	50V	15/**$2.00**
5 uF @	50V	15/**$2.00**
10 uF @	50V	15/**$2.00**
250 uF @	25V	10/**$2.00**
100 uF @	50V	10/**$2.00**
50 uF @	75V	10/**$2.00**

NEW SPRITE FAN

Mfg. by Rotron Inc., Model SU2A5. 115v AC. 19 amps. (Impedance protected.) 3¼"x 3¼"x 1¾"

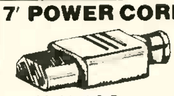
$12.00 ea.

IC SOCKETS GOLD-PLATED WIRE WRAP



14 pin **40c** ea.
16 pin **45c** ea.
24 pin **75c** ea.
40 pin **$1.75** ea.

7' POWER CORD



Molded 3 Prong Plug with molded receptacle Belden 16 AWG

$3.00 ea.

COAX CONNECTORS

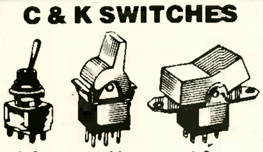
UG-273/U BNC-F/UHF-M	$2.50
UG-255/U BNC-M/UHF-F	$3.00
UG-146 A/U N-M/UHF-F	$4.50
UG-83B/U N-F/UHF-M	$4.50
UG-175 RG-58 Adapt	$ .20
UG-176 RG-59 Adapt	$ .20
UG-1094 BNC-F/Panel	$1.00

SO239 **50c**
PL259 **60c**

COAXIAL CABLE

50 OHM-RG 174
$4.95/100' $3.00/50'
75 OHM-RG 62/U
$12.00/100'

C & K SWITCHES

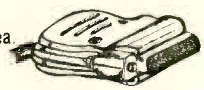


	Part #	Movement
J-60	7101	SPDT
J-60	7103	SPDT (center off)
L-3	7108	SPDT (momentary)
J-3	7201	DPDT (special large rocker)

$1.00 ea. **6/$5.00**

D.P. CABLE ASSEMBLIES

$5.50 ea.

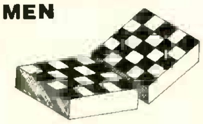


Conn & Hood	22 AWG # Cond	Length
25 P	14	15'
25 S	10	17'

MAGNETIC CHESS BOARD WITH MEN

Folds in half to carry men
11" w x 11" l x 1' h

$4.00 ea.



TERMS: All material guaranteed unless otherwise stated. If you are not satisfied with our product, it may be returned within 10 days for a refund (less shipping). Please add $4.00 for shipping and handling on all orders. COD's accepted for orders totaling $50 or more. All orders shipped UPS unless otherwise specified. Florida residents please add 4% sales tax. Minimum order, $15.00. Foreign orders – US funds only, add 20% for shipping and handling.

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Your Parts Supermarket

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615-242-7575

Power Supply Kit 120 VAC input 9 to 15 V regulated controlled output All parts & step by step inst. plus schematic includes PC board, transformer And all parts needed for making (Less Cabinet & Line Cord) Approx. 2.5 AMP rating thru range continuous duty order #JCO-1 ONLY $12.00

Order # TR-54 Xformer 120 VAC primary 6, 12, 24 VAC Sec. 2.75 A	EA. 6.25
Order # LED - 1 Readout 6 DIG 7 Seg. 7/10" Characters Pinout Furn.	EA. 2.75
Order # IC-25 Drivers for LED-1 USES 3 Drivers SCL-4433abe	(3) for 1.20
Order # ECK-48 (48) Electrolytics (Unmarked and Marked Good Usables)	kit 1.40
# TRA33-K3 (3) NPN 75 watt 10 amp TO-220 Case RCA and SGS	(3) PCS 1.25
#TRA 8-K12 (12) NPN Transistor Formed Leads (Good Gen Purp.)	(12) PCS 1.00
# TRA-105K4 (4) PNP Asst. TO-3 Case Transistors (Some Unmarked)	(4) TO3 1.70

Remember: JAVAN Warranty: (All Parts sold to you to be good or full credit)

ICS9-K4 40 Pin Low Profile IC Sockets	(4) 40 PIN Sockets 1.00
28 Pin Low Profile IC Sockets	(5) 28 PIN Sockets 1.00

A word for thought (have you ever looked at retail prices closely???) They usually end in .95c .99c .98c .77c .88c (Buy at Wholesale)

WWC-1 Wire Wound Choke (100 Microhenry @1000 Hertz and .01Ω)	EA. 43c
CTR—31 Contactor Reversing Magnetic 110 VAC Coil Approx. 18 amp rate on Contacts Furnas # 44NA30AF	EA. 16.00
PCB-Single Side PC Board 7¼" × 24" (Tuff Stuff) 6#6 Holes	EA. side 2.25
TL-3 4 Piece Screwdriver Set in Handle (A Must for !Mom!)	EA. .45
MC-85K6 .22 MFD Capacitor @ 50 VDC (6) .22 @ 50 VDC	6 for 1.00
LA5-7K GE 455 Bayonet Base Lamp (Built in Flasher) 7 GE 455	1.00
EC-162K5 500 MFD. @ 15 Volts Axial Lead Lytic. (7) PC'S 500 @ 15 V	1.00
FP-51 6800 MFD. 50 Volts Nichicon FP Can Electrolytic	EA. 1.00
MC-253 .47 MFD @ 50 V TRW Axial Lead Capac w/Slip on Lugs	EA. .17c
SW-12K5 Leaf Switches Single Set Contact Points	(5) Leafs .85c

Please Remember: We have one of the largest stock of parts in the USA. If you should use or know someone who wishes large quantities call or write. We stock very large quantities - but sometimes items are limited.

We will never intentionally mis-represent an item (We Want Repeat Orders)

SPK-64 Speaker 2 × 3 inches 50 ohm Good Intercom ohmage	EA. 1.75
RY-55 Coto-coil Relay Very Small Encapsulated DPST	EA. 29c
TC-22 Tantalum Capac. DIP .33 MFD @ 35 V PC Leads	EA. 12c
TC-31 Tantalum Capac. DIP 10 MFD. 20 V PC Leads	EA. 22c
TC-32 Tantalum Capac. DIP 3.3 MFD. 25 V	EA. .24c
SW-20 Momentary Push Button Switch (Large) Pinball Flipper	EA. .25c
PR-161 Power Resistor 20 OHM 22 watt Squareohm Type	EA. .40c
FP-54 Can Electrolytic Quad 20 MFD @450 Volts (Many Combinations)	EA. 1.50
WRC-9 50 Conductor Ribbon Cable (9 Feet Long) Connector EA. End	EA. 2.85
CH-3 Card Holder (Socket) Single Side	EA. .22c
EC-19K6 Electrolytic 25 MFD 15 V Non-Pol Axial Capacitor	(6) for 1.00
CP-98 Capacitor .1@ 2000 V Screw Ends (Extended Foil)	EA. $1.30
MC-1 Capacitor 1.25 MFD Axial American Radionics 5%	EA. .60
VL-9 Solenoid Valve Approx. $46.00 Wholesale 115 VAC Coil 50-60 CY (Brass) 10.5 watts ¼" Pipe in and outlets for Gases, Liquid and Steam	EA. $18.00
DI-10K Assorted Signal Diode Kit (10) Signal Diodes in Reuseable Pak	kit .50c
ML 8205 IC Tone Ringer, Diagram Furnished (Only 14 Small Parts Needed To Make External Ringer Instead Of Bell	EA. $1.90
MC-10K 10 Mylar Capacitors Assorted (Good Useable Values-10 Mylars	kit $1.00
TPU-1 Pulse Transformer (Dime Size) 300 UH TPU-5 200 UH	EA. .24c
TH-K5 Tape Heads Assorted 5 Tape Heads	5 for $1 75
TPU-K8 Pulse Transformer Asst. (Dime Size)	(8) Pulse Transformers for $1.50
TRK-25 Small Case Transistors (25) PC'S Very Assorted	(25) for $1.90

A new list will be enclosed with ea. order so order now and keep a step ahead

BXK-1 3×5" Index Card Box with Hinged Top Loaded With a Grab Bag of All Sorts of Small Items (A Must for Experimenters) Yours Absolutely Free With an Order of $40.00 or More. Otherwise Price EA. $3.25
BXK-1 Offer Expires Dec. 10, 1981 or Until Stock is Depleted

$15.00 Minimum Order Add $2.50 Shipping Charges (Tenn. Residents Add 6.75% Tax

Call Collect 615-242-7575 To Place Orders Over $25.00
(COD's Will be shipped on Orders Over $50.00 w/25% Deposit)
Orders Can Be Shipped Within 24 Hrs. With Money Order

JAVANCO 150 Second Ave., South Nashville, TN. 37201 (Try Us You'll Like Us)

CIRCLE 75 ON FREE INFORMATION CARD

4K X 16 MEMORY board with 64 IC chips (2101) in sockets. Complete board with data. Super deal	50.00
4116-4 MEMORY 16K $2 each or 8 for . .	14.00
MK 8164 MEMORY 64K Dynamic Ram	25.00
MPI 8 inch single side disc drive (OK, used)	175.00
MPI 8 inch dual sided disc drive (OK, used)	350.00
SHUGART 8 inch drive 850 FDD (ok, used)	425.00
MOTOROLA MONITOR 9 inch 115 volt	60.00
MOTOROLA MONITOR 12 inch 115 volt	85.00

Above 2 units accept composite video, no case, used.
2 units below accept TTL. Hi volt supply only. Used.

BALL BROS. 12 inch monitor	50.00
BALL BROS. 5 inch monitor, cased, used	60.00

DATA STATION CONSOLE w/keyboard & 9 inch monitor, power supply. Logic boards broken send for details on this one. $ 80.00

IR SCOPE see in the dark, new, portable.	260.00
IR SCOPE KIT pre-assembled, modular	150.00
12 VOLT GEL CELL 2½ AH $14.00 5 AH	17.00

12 inch CRT bonded face plate, new, with specs. Made for computer work. $25 each 5 for $100.00

UNDERWATER HYDROPHONE 200 KC 10.00

WALKY TALKIES Govt surplus used condition. 47-55.4 mc range. With schematics. Govt AN/PRC-6 $25 each 2 for $45. Ant. $5 each

ASCII KEYBOARD parallel $50

RED LED's . . . . 10 for $1.00

MIN ORDER $10.00 CATALOG No. 20 now ready

Shipping extra on all merchandise

Meshna Inc., PO Box 62, E. Lynn, Mass. 01904

CIRCLE 23 ON FREE INFORMATION CARD

For faster service USE ZIP CODE on all mail

NOW! A 12 HOUR TAPE RECORDER for only $95.00*

LONG PLAY

High quality AC-DC Cassette Recorder provides 6 continuous hrs. of recording & play back of top quality true fidelity, distortion free sound on each side of cassette for a total of 12 hrs. Built-in features incl. • Voice level control • Auto. tape stop • Digital counter • LED indicator, etc. AC Adapter & TDK DC-180 Cassette incl.

Model 1000LP

PHONE RECORDING ADAPTER

Record incoming and outgoing calls automatically with this all solid state unit connected to your telephone jack and tape recorder. Starts recording when phone is lifted. Stops when you hang up. $24.50* FCC APPROVED

VOX VOICE ACTIVATED CONTROL SWITCH

Solid state. Self contained. Adjustable sensitivity. Voices or other sounds automatically activate and control recorder. Uses either recorder or remote mike. $24.95*

*Add for ship. & hdlg. Phone Call Adapter & VOX $1.50 ea—Recorder $4.00. Cal. Res. add tax. Mail order, VISA, M/C, cod's ok. Qty. disc. avail. Money back guar. Free data. Dlr. inq. inv. AMC SALES, Dept. 19, 9335 Lubec St., Box 928, Downey, CA 90421 Phone (213) 869-8519

CIRCLE 31 ON FREE INFORMATION CARD

COMPONENTS

00N	.18	SN7482N	.30
02N	.22	SN7492N	.49
04N	.21	SN7493N	.45
08N	.22	SN7495N	.50
10N	.18	SN7496N	.69
12N	.20	SN74122N	.39
13N	.22	SN74136N	.95
14N	.29	SN74141N	.69
16N	.27	SN74151N	.65
17N	.29	SN74153N	.55
20N	.17	SN74154N	1.25
25N	.20	SN74155N	.75
30N	.17	SN74157N	.58
37N	.26	SN74160N	.89
38N	.26	SN74161N	.65
40N	.18	SN74163N	.85
42N	.45	SN74164N	.87
43N	.42	SN74165N	.55
45N	.64	SN74174N	.88
51N	.19	SN74175N	.79
54N	.19	SN74180N	.75
74N	.27	SN74181N	1.15
75N	.35	SN74393N	1.65

74LS00

LS00	.28	74LS158	.69
LS02	.28	74LS161	.83
LS03	.28	74LS162	.89
LS04	.28	74LS163	.98
LS05	.22	74LS164	.85
LS08	.29	74LS165	.85
LS09	.28	74LS169	1.55
LS10	.26	74LS170	1.75
LS14	.89	74LS174	.85
LS20	.22	74LS175	.85
LS21	.26	74LS190	.85
LS26	.40	74LS191	1.25
LS27	.27	74LS196	.95
LS28	.37	74LS197	.78
LS30	.29	74LS221	1.25
LS32	.31	74LS240	1.65
LS38	.31	74LS241	1.65
LS42	.63	74LS243	1.55
LS48	.77	74LS244	1.55
LS74	.38	74LS245	2.45
LS75	.55	74LS251	1.25
LS86	.45	74LS253	.85
LS90	.59	74LS257	.85
LS93	.65	74LS259	1.95
LS96	.80	74LS260	.55
LS107	.43	74LS273	1.55
LS113	.45	74LS279	.45
LS122	.45	74LS290	1.25
LS123	.89	74LS293	1.65
LS125	.89	74LS365	.85
LS126	.79	74LS367	.75
LS138	.64	74LS373	1.45
LS139	.59	74LS374	1.45
LS151	.49	74LS377	1.25
LS153	.49	74LS669	1.55
LS157	.69	74LS670	1.85

74S00

74S00	.39	74S138	.75
74S02	.45	74S140	1.00
74S03	.38	74S158	.75
74S04	.39	74S174	1.35
74S05	.39	74S175	1.35
74S10	.39	74S182	.75
74S15	.45	74S189	4.25
74S20	.55	74S201	6.75
74S22	.55	74S240	2.75
74S30	.75	74S244	2.95
74S37	.55	74S251	2.75
74S50	.65	74S287	2.95
74S51	.49	74S288	2.95
74S64	.55	74S299	5.75
74S74	.65	74S470	9.25
74S86	.95	74S471	9.50
74S112	1.95	74S473	9.50
74S132	1.45	74S474	9.50

EPROMS

2716 5V 450NS		6.95 ea	8 for 6.25ea
TMS2716			
2708		8.25ea	8 for 7.50ea
	450NS	4.10 ea	8 for 3.95ea
2732		19.95 ea	4 for 16.95ea
4116	300NS	2.00ea	8 for 14.00
	200NS	2.35ea	8 for 16.00
2114L	300NS	2.95 ea	4 for 2.75ea
	200NS	3.50ea	4 for 3.00ea
2111	450NS	2.50ea	10 for 2.00ea

CPUs

Z-80	7.95
Z-80A CTC	10.50
Z-80A CPU	10.50
Z-80 002 16-64K	129.00
8085A	13.50
2901A	7.50
MC6800	9.50

MISC.

02			
450NS	.95		
38	2.95	1103A	.75
555	.27	UPD765 floppy disk controller	17.85 w/spe
5-1013A	4.25		
88	1.10		
89	1.10	ULN2001	1.95
26	1.30	TMS4400	1.40
28	1.30	MC4008P	1.75
12	2.75	MH0026	1.55
16	2.75	D3624	1.95
410SCR	.95	D3001	1.95
410TRIAC	.95	D3002	1.95
05	.85		
08	.85		
15	.85		
18	.85		
05	.85	IC SOCKETS	
66	.85	8 PIN	10/1.20
48	.85	14	10/1.40
12	.85	16	10/1.60
C1330A1P	1.60	18	10/1.90
C1350P	1.15	20	10/2.80
C1358P	1.50	22	10/2.80
4480	1.20	24	10/2.80
465N	.95	28	10/3.80
741	.25	40	10/4.75
C1458P	.55		
720	.30		
386	1.75		

"1981"
I.C. Master
$59.95

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Logic Probes

LP–1: $40.00
Pulse width to 50nsec Rep. rates to 10mhz.

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Pulse width to 6nsec. Rep. to over 60MHz.

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Logic Probe Kit - complete nothing extra to buy. Min. pulse width 300nsec.
$18.95

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MICROSOFT:
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VIDEX:
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BASE II, inc:
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Apple Expansion Kit
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3inch MUFFIN FAN w/line cord!
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UPD 765C: Floppy Disk Controller
$17.95 w/spec's

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$24.50

AY5–1013A: 30K Band UART
$3.95

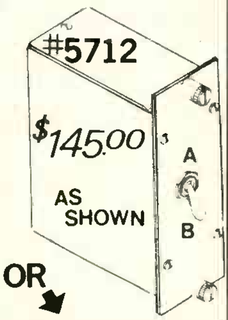
REAL–TIME CLOCK CALENDAR (MSM 5832)

Description: Mono. Metal Gate CMOS I.C.

Features
- Time, Month, Date, Year, & Day of Week
- Bus Oriented
- 4 Bit Data Bus
- 4 Bit Address
- R/W Hold Selec.+
- Inter. Signal
- 32.768Khz. xtal Control.
- 5v Pow. Sup.
- Low Power Dissipation

$7.45 W/SPEC's

XTAL $3.85



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RS-232 COMPATABLE DIGITAL TRANSFER. SWITCH WILL SWITCH MODEMS BETWEEN PROCESSORS/PRINTERS. 24 PINS ARE SWITCHED. PIN 1 WIRED TO GROUND.

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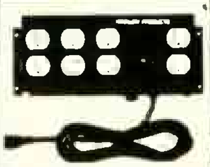

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output → 5vdc
At 6amps
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$10. MIN. ORDER / CA. RES. ADD 6%

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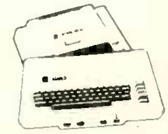
COMPUTERS

ATARI® 800™ COMPUTER SYSTEM



400 Computer 8K → $350.00
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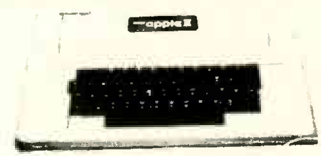
"APPLE II Plus"



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12inch 12MHz BLACK & WHITE VIDEO MONITOR "AMDEK" (LEEDEX) Corp.

video 100

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COLOR 13"
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LOW COST TERMINAL WITH KEYBOARD AND VIDEO 100
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8080A	3.75	8226	2.75
8085A	7.50	8228	4.50
AMD 2901	8.95	8251	5.50
8212	2.25	8259	6.95
8214	3.60	8257 (AM9517)	7.95
8216	2.90	Z8A CPU	8.75
8224	3.25	Z80A S10	12.95
MM5307	9.95	8275	16.95

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2114L-3	2.75	2708	4.95
4116-3	2.50	2716 +5V	7.50
4116-2	3.50	2532	16.95
21L02-3	.90	82S23	1.95
2102-4	.80	82S112	4.95
MK4027-3	3.50	82S115	4.95
MK4096-11	2.95	82S123	2.25
TMS4046-25	4.50	82S126	1.95
MS4050NL	3.95	82S129	1.95
2101-1	2.45	82S130	1.95
MM5270	3.45	82S131	2.25
MK4008P	1.95	AM9218C	2.95
IM7001	4.95	8256-5 (74188A)	1.25

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AY5-1013	3.75	M8868A	8.95
TR1602B	3.95	COM2017	3.75
PT1482B	3.25	AY3-8500-1	1.95
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1488	.90	MM1402	1.75
1489	1.10	MM1403	1.75
8130	2.50	MM1404	1.75
8830	2.50	MM5013	2.50
8833	2.50	MM5016	2.50
8834	2.00	MM5055	2.50
8837	2.00	MM5056	2.50
8838	2.00	MM5057	2.50
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16 PIN HEADERS .... .40
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50 PIN EDGEBOARD CONN. 3.95
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4" × 6" DOUBLE SIDED
EPOXY BOARD 1/16" THICK
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1/16" thick with 1/10" spacing
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74S00	.30	74S74	.70	74S158	1.25
74S02	.30	74S86	.60	74S169	1.75
74S03	.30	74S89	1.90	74S174	1.40
74S04	.40	74S112	.85	74S175	1.40
74S05	.45	74S133	1.40	74S194	1.10
74S08	.40	74S135	1.50	74S287	1.50
74S10	.30	74S138	1.25	74S258	1.40
74S11	.35	74S139	1.10	74S280	1.50
74S15	.40	74S140	1.00	74S280	1.50
74S20	.40	74S153	1.10	74S373	2.25
74S30	.40	74S151	1.25		
74S32	.40	74S157	1.25		

7 WATT LD 65 LASER DIODE IR $8.95

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

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

DISC CAPACITORS
.1UF 16V .... 10/$1.00 .... 100/$8.00
.01UF 35V .... 16/$1.00 .... 100/$5.00

IN4148 (IN914) 15/1.00

TANTALUM CAPACITORS

.47UF 35V	5/$1.00	10UF 35V	$ .40
.68UF 35V	5/$1.00	22UF 10V	$ .30
1UF 35V	5/$1.00	15UF 16V	3/$1.00
2.2UF 20V	5/$1.00	30UF 6V	5/$1.00
3.3UF 20V	4/$1.00	33UF 20V	$ .60
4.7UF 35V	4/$1.00	47UF 20V	$ .85
6.8UF 35V	3/$1.00	120UF 6V	$ .75
		200UF 20V	$1.75

SANKEN AUDIO POWER AMPS
Si 1010 G 10 WATTS .$ 7.50
Si 1020 G 20 WATTS .$12.50
Si 1050 G 50 WATTS .$27.50

200 PRV 1A LASCR .95

RS232 CONNECTORS
DB 25P male $3.25
DB 25S female ... $4.25
HOODS $1.50

C/MOS

4001	.20	4027	.40	4081	.20	74C74	.50
4002	.20	4028	.55	4082	.20	74C76	.70
4006	.85	4029	.75	4093	.60	74C83	1.30
4007	.27	4030	.35	4099	1.75	74C85	1.40
4008	.65	4034	2.25	4501	.95	74C86	.50
4009	.45	4035	.75	4510	.65	74C90	.90
4010	.46	4040	.65	4511	.65	74C93	.95
4011	.20	4042	.56	4514	1.40	74C151	1.75
4012	.20	4043	.65	4515	1.50	74C157	1.75
4013	.30	4044	.55	4516	.75	74C160	1.20
4014	.56	4046	.90	4518	1.25	74C161	1.15
4015	.56	4047	.90	4520	.70	74C163	1.15
4016	.30	4049	.40	4553	2.75	74C165	1.25
4017	.60	4050	.40	74C00	.27	74C173	1.30
4018	.50	4051	.80	74C02	.27	74C174	1.30
4019	.45	4052	.75	74C08	.30	74C175	1.20
4020	.70	4053	.75	74C10	.27	74C192	1.30
4021	.56	4066	.50	74C14	1.20	74C901	.50
4022	.80	4069	.20	74C20	.27	74C926	5.50
4023	.20	4071	.25	74C32	.45		
4024	.46	4072	.20	74C73	.75		
4025	.25	4076	.65				
		4077	.35				

SPECIALS
8X300 — SIGNETICS 16 BIT MICROCONTROLLER 89.00
4 ea. 2716 (+5V) 22.00
8 ea. 4116-3 RAM'S 16.75
10 ea. 8164E 64K RAM (150NS) ..99.50
L14H4 IR + VISIBLE DETECTOR .3/$1.00
MM5307 — Baud Rate Generator ..$9.95
50 PIN RIBBON CONNECTORS 3.95
40 PIN RIBBON CABLE CONN. 3.25
20 PIN RIBBON CABLE CONN. 2.65
10 PIN RIBBON CABLE CONN. 1.75

RS 232 CABLE
10 Conductor, # 22 color coded wire, gray PVC outer cover, 3/8" diameter
.40 per ft. — 100'/$30.00
Add 20% postage for orders under 100'.
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SPECIALS GOOD THRU OCT. 1981

CRYSTALS $3.45 ea.

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

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CTS 206- 4 — 4 POSITION 1.25
CTS 206- 8 — 8 POSITION 1.50
CTS 206-10 — 10 POSITION 1.95

MINIATURE MULTI-TURN TRIM POTS
50, 100, 5K, 10K, 250K .... $.75 each 3/$2.00

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

40 CONDUCTOR 3M CABLE.
#28 WIRE .... $ .75/FT

SCR's

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

TRIAC's

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

FP 100 PHOTO TRANS .... $ .50
RED, YELLOW, GREEN or AMBER LARGE LED's .2" ..... 6/$1.00
RED/GREEN BIPOLAR LED's .... $ .55
MLED92 IR LED .... $ .75
MRD14B PHOTO DARL. XTOR .... $ .50
IL-5 OPTO-ISOLATOR .... $ .45
1WATT ZENERS: 3.3, 4.7, 5.1, 5.6, 6.8, 8.2, 9.1, 10, 12, 15, 18, or 22V .... 6/$1.00

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

SILICON POWER RECTIFIERS

PRV	1A	3A	12A	50A	125A	240A
100	.06	.14	.35	.90	4.25	6.00
200	.07	.20	.40	1.30	5.25	9.00
400	.09	.25	.65	1.50	6.50	12.00
600	.11	.30	.80	2.00	8.50	15.00
800	.15	.35	1.00	2.50	10.50	18.00
1000	.20	.45	1.25	3.00	12.50	26.00

CLOCK CHIPS
MM5314 ......$4.75 MM5316 ......$4.95
MM5387AA 5.95

.5V at 800ma SOLAR CELLS
3" diameter $4.35

7 SEGMENT DISPLAYS
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FND 510 C.A. .5" ....$ .85 — FND803 .8" CC $1.95
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TIP 111 $ .50 TIP 145 .... $1.35
2N6233 NPN SWITCHING POWER $1.95
MRF 8004 a CB RF TRANSISTOR NPN .... $ .75
2N3772 NPN Si TO-3 .... $1.00
2N4908 PNP Si TO-3 .... $1.00
2N3137 NPN Si RF .... $ .56
2N3919 NPN Si TO-3 RF $1.50
2N1420 NPN Si TO-5 .... 3/$1.00
2N2222 NPN Si TO-18 .... 5/$1.00
2N2907 PNP Si TO-18 .... 5/$1.00
2N3055 NPN Si TO-3 .... $ .60
2N3904 NPN Si TO 92 .... 6/$1.00
2N3906 PNP Si TO 92 .... 6/$1.00
2N5296 NPN Si TO-220 .... $ .55
2N6109 PNP Si TO-220 .... $ .55
TIP 31B NPN Si TO 220 .... $ .60
TIP 32B PNP Si TO-220 .... $ .65
TIP 34 PNP Si .... $ .95
TIP 121 PNP Si U84 .... $ .60

TTL IC SERIES

7400	.17	7473	.35	74164	.60
7401	.17	7474	.40	74165	.60
7402	.17	7475	.40	74166	.70
7403	.17	7476	.40	74170	1.60
7404	.24	7480	.45	74173	.75
7405	.24	7483	.50	74174	.65
7406	.33	7485	.65	74175	.60
7407	.35	7486	.42	74176	.75
7408	.27	7490	.45	74177	.75
7409	.24	7491	.45	74180	.75
7410	.17	7492	.45	74181	1.90
7411	.22	7493	.45	74182	.45
7413	.42	7494	.60	74190	.70
7414	.50	7495	.60	74191	.75
7416	.33	7496	.80	74192	.70
7417	.37	74107	.35	74193	.79
7420	.17	74121	.35	74194	.85
7425	.30	74122	.39	74195	.45
7426	.33	74123	.42	74196	.75
7427	.30	74125	.45	74197	.75
7430	.27	74126	.45	74279	.60
7432	.27	74145	.75	74365	.65
7437	.27	74148	1.25	74367	.65
7438	.27	74150	1.10	74368	.65
7440	.17	74151	.50	74390	.90
7441	.85	74153	.40	75324	2.25
7442	.45	75154	1.10	75491	1.05
7445	.70	74155	.50	75492	1.05
7446	.75	74157	.50	8T98	1.20
7447	.65	74160	.85	9312	.60
7448	.75	74161	.65	9601	.75
7450	.17	74162	.60	9602	.75
7472	.35	74163	.60		

FULL WAVE BRIDGE

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

12V DC RELAYS TTL SIZE
S.P. 1200 ohm coil .95
D.P. 400 ohm coil 1.25

DIP SOCKETS

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

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74LS00	.18	74LS93	.45	74LS196	.85
74LS01	.18	74LS95	.65	74LS197	.85
74LS02	.20	74LS109	.38	74LS221	.80
74LS03	.20	74LS112	.38	74LS240	.95
74LS04	.22	74LS113	.45	74LS241	.95
74LS05	.22	74LS114	.56	74LS242	.95
74LS08	.22	74LS123	.65	74LS243	1.00
74LS09	.22	74LS125	.60	74LS244	1.35
74LS10	.20	74LS126	.50	74LS245	1.60
74LS11	.22	74LS132	.60	74LS247	.75
74LS12	.22	74LS136	.45	74LS248	1.10
74LS13	.45	74LS138	.55	74LS251	.90
74LS14	.40	74LS139	.55	74LS253	.55
74LS15	.35	74LS151	.40	74LS257	.70
74LS20	.18	74LS153	.40	74LS258	.60
74LS21	.18	74LS155	.95	74LS256	1.50
74LS22	.25	74LS156	1.19	74LS266	.45
74LS26	.36	74LS157	.55	74LS273	1.15
74LS27	.28	74LS158	.50	74LS279	.50
74LS28	.45	74LS160	.70	74LS280	1.80
74LS30	.18	74LS161	.70	74LS290	.75
74LS32	.36	74LS162	1.00	74LS293	.40
74LS37	.30	74LS163	.70	74LS365	.65
74LS38	.30	74LS164	.70	74LS366	.65
74LS40	.40	74LS168	1.25	74LS367	.60
74LS42	.44	74LS169	1.75	74LS368	.70
74LS47	.66	74LS170	1.70	74LS373	1.30
74LS51	.20	74LS173	.65	74LS374	1.35
74LS54	.35	74LS174	.45	74LS377	1.40
74LS73	.36	74LS175	.40	74LS386	.50
74LS74	.35	74LS181	2.00	74LS390	1.35
74LS75	.35	74LS190	.80	74LS393	1.25
74LS76	.45	74LS191	.80	74LS670	2.50
74LS83	.75	74LS192	.70	81LS97	1.10
74LS85	.85	74LS193	.95	81LS98	1.10
74LS86	.40	74LS194	1.10		
74LS90	.45	74LS195	.90		
74LS92	.45				

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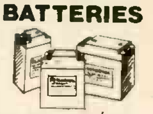
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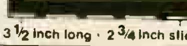
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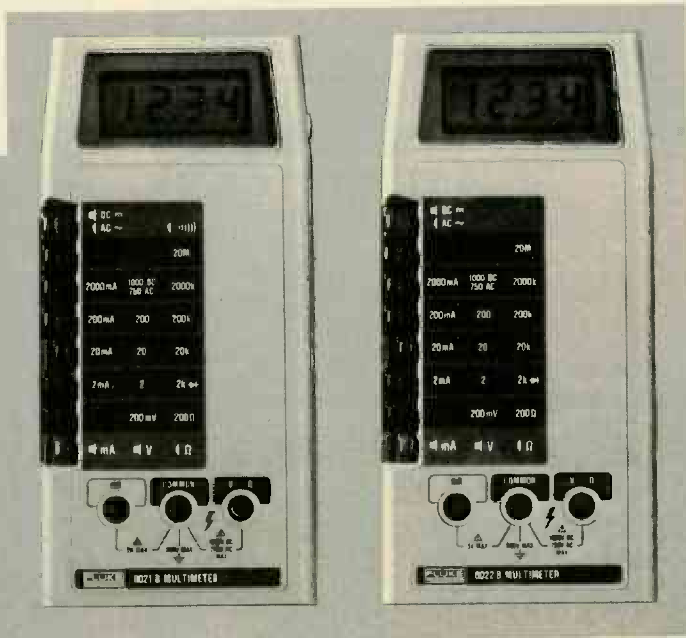

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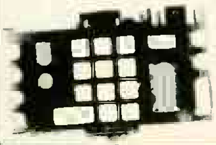

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50mfd/25V	.30
50mfd/50V	.33
50mfd/75V	.42
50mfd/100V	.45
100mfd/15V	.20
100mfd/25V	.25
100mfd/50V	.42
100mfd/100V	.68
150mfd/15V	.30
250mfd/15V	.32
250mfd/25V	.25
250mfd/50V	.57
470mfd/50V	.75
470mfd/75V	.95
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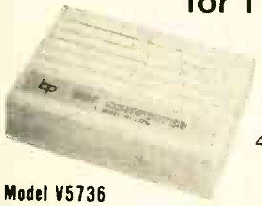

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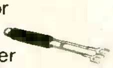
MT-1 75-300 ohms matching transformer  **$ .75** ea.

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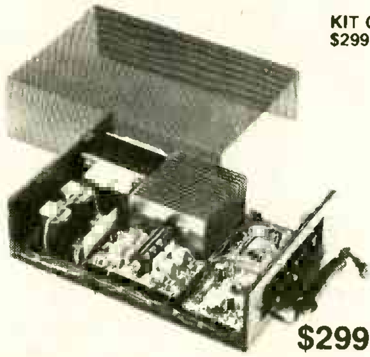

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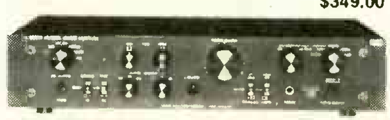

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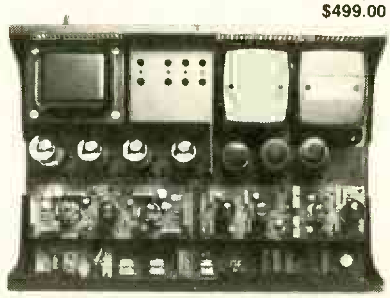

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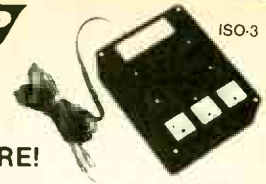

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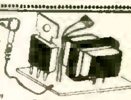

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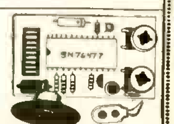

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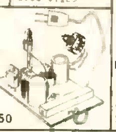

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