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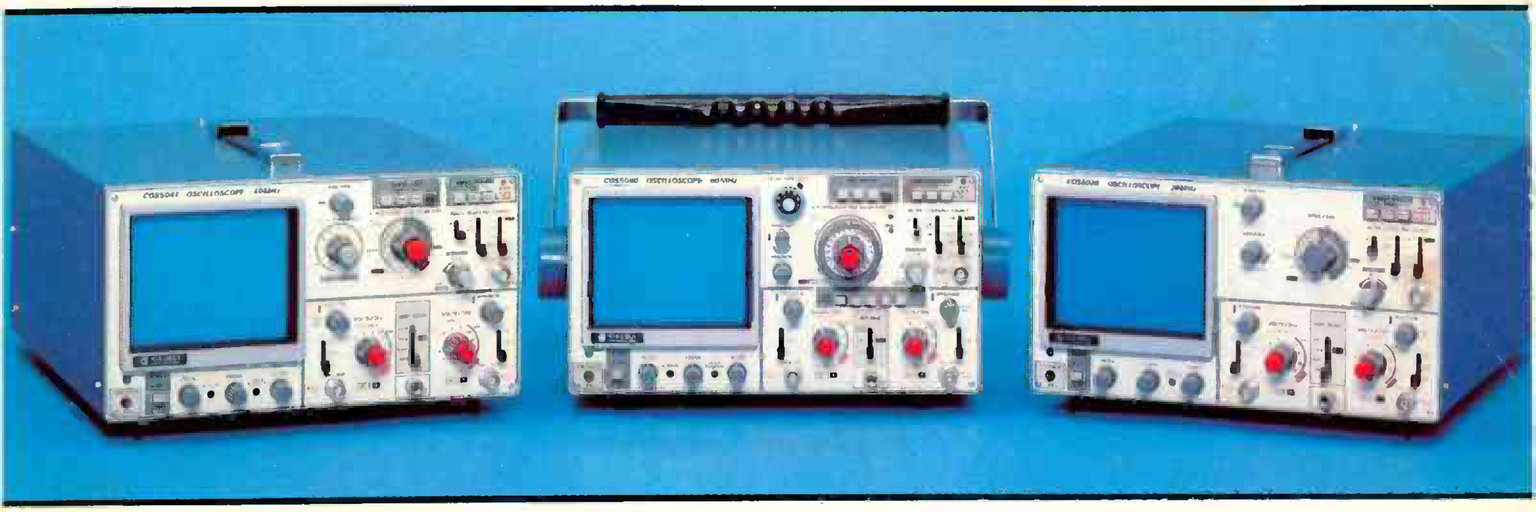

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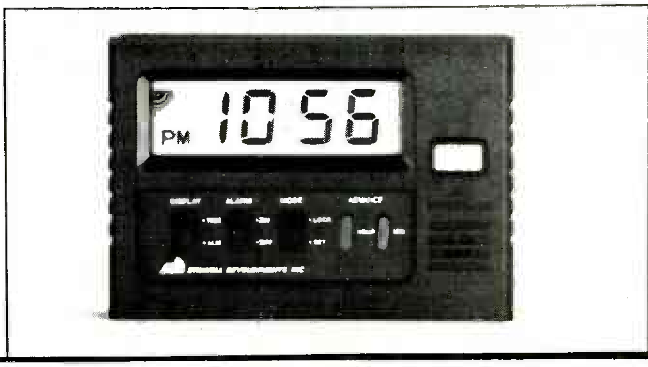
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8" DSDD Soft Sector (256 B/S, 26 Sectors)	3103	3.34
8" DSDD Soft Sector (512 B/S, 15 Sectors)	3114	3.34
8" DSDD Soft Sector (1024 B/S, 8 Sectors)	3104	3.34
5¼" SSDD Soft Sector w/Hub Ring	3481	2.34
5¼" SSDD 10 Hard Sector w/Hub Ring	3483	2.34
5¼" SSDD 16 Hard Sector w/Hub Ring	3485	2.34
5¼" DSDD Soft Sector w/Hub Ring	3491	3.09
5¼" DSDD 10 Hard Sector w/Hub Ring	3493	3.09
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SSSD = Single Sided Single Density; SSDD = Single Sided Double Density; DSDD = Double Sided Double Density; SSQD = Single Sided Quad Density; DSQD = Double Sided Quad Density; TPI = Tracks per inch.

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Memorex Quantum 2400 feet Wrightline Seal	27JW	16.20
Memorex Quantum 2400 feet Easy Load II Cart.	27JR	16.99
Memorex Quantum 1200 feet Wrightline Seal	27FW	12.50
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NCR Cartridge	98-26600-32	160.00
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Flag Free	72-26600-03	320.00
Mark XI 200 MB. Error Free	03-35041	720.00
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Mark XII 200 MB. NCR/CDC Flag Free	03-39001-01	515.00
Honeywell Flag Free	03-39000-01	515.00
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Mark XIV 80 MB. Unformated Error Free	74-16600-03	365.00
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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

December 1982 Vol. 53 No. 12

SEASON'S GREETINGS

The editors and staff of Radio-Electronics join in sending holiday greetings and our best wishes for a happy new year

ON THE COVER

If you like to tape those vintage black-and-white movies that show up late at night on TV—but don't like to tape the commercials that accompany them—this automatic commercial editor is for you! It watches the movie along with your VCR and, when a commercial turns up, stops the tape until the movie begins again. The result is a tape of the movie, and nothing else. It's easy to build, and will...literally...provide you with hours of pleasure. Get started building your own editor. Plans begin on page 43.

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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

STEREO TV HITS SNAG

The dream of stereophonic sound for television in 1983 vanished in a puff of hostile smoke when an industrywide committee studying the subject went back to the drawing board instead of recommending a system. Since 1979, a subcommittee of EIA's Broadcast TV Systems Committee has been examining and testing three proposed multichannel TV sound systems. Each of the systems—proposed by EIA of Japan, Telesonics Systems Inc., and Zenith Radio Co.—met the subcommittee's basic criteria: (1) Stereo sound quality comparable to FM stereo. (2) An additional "picture-related" sound channel for such uses as foreign-language translation. (3) Compatibility with existing monophonic-sound receivers.

The subcommittee completed its tests of the three systems on time, and its timetable called for it to select a system for recommendation to the FCC in mid-October. Everything was going according to plan when the subcommittee's steering committee met to tally members' votes for a system. However, it was confronted unexpectedly by a charge from Telesonics Systems that the tests were incomplete. Telesonics requested that the subcommittee reopen its record—and implicitly threatened legal action unless the subcommittee agreed. Accordingly, the subcommittee decided to reopen the entire subject to cover the Telesonics objection, as well as another problem. That new problem related to the discovery that most cable-TV systems would be unable to relay stereophonic sound under any of the systems, and, in fact, the presence of a stereo signal could disrupt the carriage of mono programs on cable by causing adjacent-channel interference.

The delay could be six months to a year, or longer—if the subcommittee ever completes its work at all. At press-time, the group was preparing to ask the FCC to hold off any action on the issue of multichannel TV sound until new tests could be completed. But the FCC staff had already prepared a proposal for issuance by the Commission to permit TV stations to choose any stereo sound system which would meet certain criteria—a so-called "marketplace" decision similar to the one that permitted any of a number of AM stereo systems, all mutually incompatible, to be broadcast simultaneously. (The AM stereo order resulted in such confusion that few stations bothered to add stereo, and set manufacturers held off making AM stereo receivers.) TV broadcasters and set makers are concerned that the FCC will issue its proposal for "marketplace" stereo TV standards (meaning no standard) before the subcommittee can complete its new tests. If such an order is proposed by the FCC, the subcommittee will be dissolved, in view of legal opinions that it would be unlawful for representatives of competing systems to meet while the FCC is considering the issue. No matter what happens, it now appears there will be a long delay, and if you want to hear stereo sound with your TV you'll have to tune to a PBS simulcast or go to Japan or Germany.

BANK-BY-TV

The first major home banking and information system has been inaugurated commercially by Chemical Bank in the New York City area after a 10-month test in 200 homes. Chemical's *Pronto* system uses any home computer, a telephone modem, automatic phone dialer, and special program cartridge; the Bank will supply the entire receiving system (except the TV set), based on an *Atari 400* computer, at around $500, but other home computers can be used.

Pronto customers, who pay a monthly fee of about $10, are able to call up bank statements on their TV screens, transfer funds among different Chemical Bank accounts, pay bills by electronic fund transfer, and send electronic mail messages to other Pronto subscribers. The system plugs into a modular telephone jack and is connected to the bank's Tandem computer. Future services to be offered on the Pronto system include financial services such as portfolio management, teleshopping, educational courses, home budgeting, and security monitoring. Chemical hopes that its system will become nationwide, and has already presented seminars to 250 other banks and institutions.

The bank said that more than 250 major companies already are accepting electronic bill-payment via Pronto—including American Express, Master Charge, Visa, major oil companies, most department stores, Sears, utilities, insurance companies, and major New York landlords. In paying bills, Pronto users can specify regular monthly payments, and even which day of the month they wish bills to be paid. Privacy is assured by a triple-security system including household and personal ID numbers, as well as an individual password. Bank officials predicted that 10 million American households will have interactive devices attached to their TV sets by the end of the decade. **R-E**

WHAT'S NEWS

"Father of Television" is dead at age 93

Vladimir Kosma Zworykin died this past July 29, at the Princeton (NJ) Medical Center, just one day short of his 93rd birthday. Called "The Father of Television" by many, he always declined the honor, pointing out that hundreds had contributed to the art over many years. Invention, he said, is like building a ladder, and that as each engineer added a rung, "It enabled the others to climb a litter higher and see the next problem a little better."

The development of modern television, however, is based on Zworykin's steady work from the 1920's onward, especially his invention of the iconoscope, the first practical camera tube.

Dr. Zworykin was born July 30, 1889, in Mourom, Russia. He attended the Petrograd Institute of Technology, receiving an Electrical Engineering degree in 1912. At the Institute he studied under Professor Boris Rosing, and was his lab assistant. Rosing believed as early as 1908 that the cathode-ray tube was the solution to practical television. Dr. Zworykin, who credits both his decision to become a scientist and his special interest in television to Boris Rosing's influence, followed that line of reasoning in his work on the iconoscope and kinescope.

Dr. Zworykin joined RCA in 1929, serving as Director of the RCA Electronic Research Laboratory in Camden, NJ until 1942, and afterward at Princeton, until his retirement in 1954.

Besides television Dr. Zworykin was interested in a wide variety of subjects, ranging from gunnery controls through multiplier tubes to electronically controlled automobiles. For a number of years after his retirement, he directed the Medical Electronics Center at the Rockefeller Institute in New York, working for the development of electronics methods in medicine and the life sciences.

Zworykin received his doctorate from the University of Pittsburgh in 1926. In 1966, President Johnson awarded him the United States' highest honor, the National Medal of Science, "for major contributions to the instruments of science and television, and for stimulation of the application of engineering to medicine." Altogether, he received 27 major awards and much other recognition from groups throughout the world.

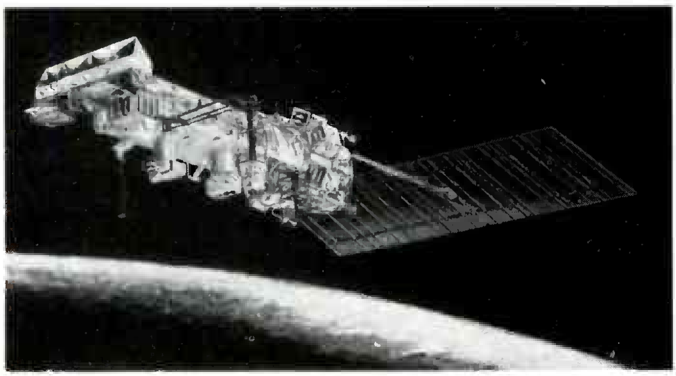
Aircraft entertainment carried by infrared

A wireless-entertainment system using infrared light to carry the signal is being developed by the microelectronic systems division of Hughes Aircraft Co. The new system is known as AIRES (*A*dvanced *I*nfra-*R*ed *E*ntertainment *S*ystem). It uses a digital system transmitted throughout the plane by infrared rays. The signal is received and decoded by a headset worn by the passenger.

AIRES can transmit up to 16 channels. Each headset has a program-select and a volume control. A self-test feature assures that each unit remains in operating condition.

The use of infrared cuts the weight of the full system to less than half that of a conventional entertainment system, and the cost by one-third. Another great advantage of the infrared approach is that—unlike earlier wireless-entertainment systems—AIRES will not interfere with other aircraft equipment. It is expected that the new system will be on the market by the middle of 1983.

NEW METEOROLOGICAL SATELLITE



TIROS-N (ATN) METEOROLOGICAL SATELLITE is the first of a series of advanced TIROS-N/NOAA meteorological satellites that is being designed and built for the National Oceanic and Atmospheric Administration (NOAA). In addition to its usual weather-charting duties, the satellite will be used to relay distress calls from the emergency beacons of downed aircraft and ships in distress. Launch is scheduled for February 1983. NASA will act as program manager for the mission.

KEYFAX, SSS Systems plan teletext magazine

KEYFAX Electronic Publishing and Satellite Syndicated Systems have announced that KEYFAX National Teletext Magazine will be ready for delivery to cable households shortly. This is stated to be the first large-scale teletext consumer operation in the United States, and is expected by its founders to grow to 200,000 cable households within 30 months.

The new teletext magazine will be delivered via the vertical blanking interval (VBI) of the WTBS satellite service, which is available to more than 20 million cable households.

The service will be offered to subscribers at a suggested $19.90 per month. That covers $9.95 for the service itself and $9.95 for rent of the necessary decoder. Operators will retain $3.95 per month as revenue ($4.95 after penetration to 1 percent of their system's basic subscribers).

KEYFAX has been on the VBI of WFLD-TV in Chicago since April 1981, on a test basis. It has also been on the VBI of the WTBS satellite service since May 1982, and was displayed (via satellite and then through two TV stations) at the Knoxville World's Fair.

N.J. State Police Improve their radars

The State Police of New Jersey have recently publicized their acquisition of "beam-interrupter" switches for their radar units. Those switches, when fitted to the devices, permit cutting off the radar beam without turning off the equipment. When a car suspected of speeding is sighted, the beam can be turned on instantly. If he has a radar detector, the speeder is not warned until police actually start taking a reading.

Manufacturers of radar detectors state that such a device is only minimally effective: "Once the officer activates the unit to obtain a speed reading on a vehicle, every detector-equipped motorist within its range will receive a warning. ... The beam will alert all detector-equipped vehicles within several miles."

The State Police believe that, in spite of any claimed deficiencies, the beam interrupters are effective, and point out as evidence of that effectiveness that manufacturers have begun to install the beam interrupters on new radars as a standard equipment.

Video programs aid technical training

RCA's Corporate Engineering Education (CEE) unit at Cherry Hill, NJ, reports that a company-wide program of video courses has simplified the problem of keeping engineers, managers, and other technical personnel at RCA up to date on the very latest technological advances.

The company has recently begun to augment the video programs with live courses on subjects requiring extensive hands-on exercises and courses for small group projects.

Most video courses consist of 12 two-hour sessions, conducted as discussions, exercises, and hands-on activities supervised by an associate instructor.

In addition to the more than 70 video courses listed in CEE's catalog, CEE maintains a library of videotapes of technical seminars and talks; the library is maintained so that the tapes can be borrowed and viewed by RCA personnel at their convenience. **R-E**

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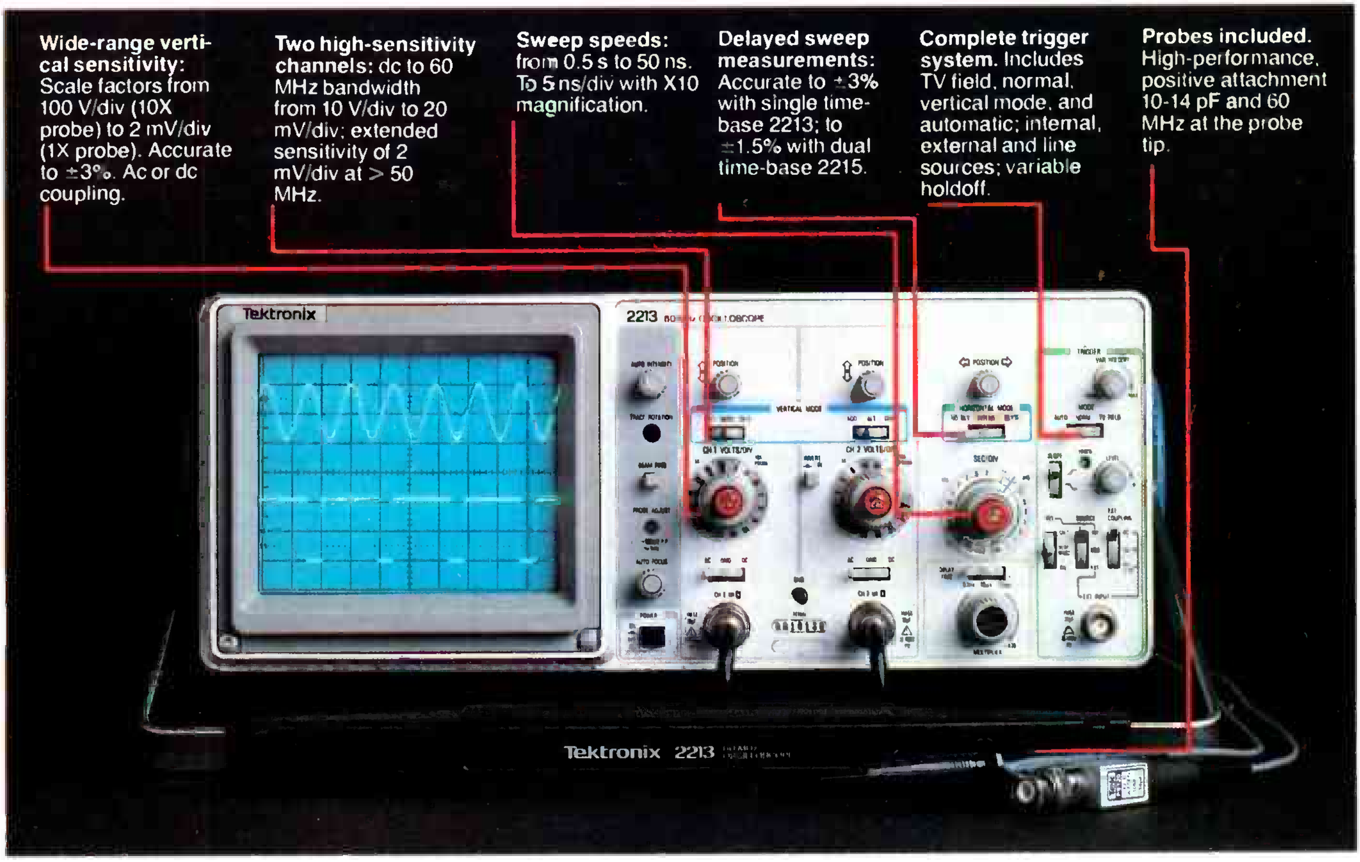

In 30 years of Tektronix oscilloscope leadership, no other scopes have recorded the immediate popular appeal of the Tek 2200 Series. The Tek 2213 and 2215 are unapproachable for the performance and reliability they offer at a surprisingly affordable price.

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

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

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

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

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PUBLISHER'S LETTER

This December issue of **Radio-Electronics** magazine brings the year 1982 to a close. It has been an exciting one. We delivered four special sections during 1982—"Video Electronics" in January, "Your Own Computer " in April and again in October; plus a "Video Games" section in July. Along the way we were able to publish more than 150 articles covering a variety of subjects—audio, video, computers, radio, construction, how-to—to name just some of the varied areas we covered. We also logged a couple of exceptional construction stories—we showed how to build your own satellite TV receiver; and a first for home constructors: your own picture phone.

In 1983 we promise to bring you more of the same. The same quality, the same wide range of subject areas, the same first-rate electronics that kept you reading **Radio-Electronics** in record numbers all the way through 1982. We've enlarged our staff, we've added more pages to the magazine, and we've added a sister publication, **Special Projects,** that is specially designed to cater to the needs of the project builder.

However, there are some things we won't do. We will *not* become a computer magazine; we will *not* become a video-games magazine, and we will *not* dive into and follow blindly every one of the paths in electronics that is bound to develop during 1983. We *will* remain the broad-based, all-encompassing electronics magazine that we have been for the past 53 years. Each year we learn a little more, and that makes us better.

One bit of bad news, however—subscription prices are going up starting in January 1983. They are going up an average of $2.00 per year. So if you want to save yourself a few dollars, use the subscription-order form in this issue—it's inside the back cover. Next month the prices on that card will be higher.

I'd like to thank you for your continued support and pledge that we will continue to do our very best to make **Radio-Electronics** the finest *"electronics"* magazine you read.

Larry Steckler

LARRY STECKLER
PUBLISHER

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A Hot Tip from Ungar

A FREE 9100 Electronic Soldering System when you buy either desoldering system by December 15, 1982.

HOT VAC® MODEL 4001 PORTABLE DESOLDERING SYSTEM WITHOUT SHOP AIR. SUGGESTED RETAIL PRICE [illegible]

Take this ruggedly constructed, lightweight unit anywhere—plugs into any 120V outlet. Solid-state control adjusts tip temperature from 500° to 1000°F and suppresses transient spikes.

High-flow vacuum is activated by a switch mounted in a handle that's biomechanically designed to reduce fatigue and increase productivity.

Super quiet and virtually maintenance-free, with Ungar's exclusive low-noise exhaust and unique vibration-absorbing pump mounting. All built into a galvanized steel case with a scratch-resistant, baked enamel finish.

Comes complete with: Long Life Tips #2005, #2006, #2007, #2008; Tip Cleaning Tool #2002; Kleen-Tip Sponge and Tray #400; and Pack of 10 Filters #2039.

GET A FREE MODEL 9100 ELECTRONIC SOLDERING SYSTEM. SUGGESTED RETAIL PRICE [illegible]

Ungar's newest electronic soldering system. Electronic, closed-loop variable control permits temperature adjustment from 400° to 800°F. Thermo-Duric® heater delivers heat to tip and away from easy-to-hold Micro-Size handle.

Includes neon "on/off" light, right- or left-hand mount and flexible, heat-resistant cord.

Comes complete with: base unit with built-in controller, handle, 1/16" screwdriver, tip #9012, sponge and tip tray, sponge and iron holder.

HOT VAC® MODEL 2001 WORKS ON SHOP AIR FOR ECONOMICAL DESOLDERING. SUGGESTED RETAIL PRICE [illegible]

A solid-state control adjusts tip temperature from 500° to 1000°F. The load modulated heater assures instantaneous recovery and suppression of transient spikes.

The switch that activates the high-flow vacuum is conveniently built into a handle that is biomechanically designed to reduce fatigue and increase productivity.

Comes complete with: Long Life Tips #2005, #2006, #2007, #2008; Tip Cleaning Tool #2002; Free-Standing Holder #8800 with Kleen-Tip Sponge; and Tray #400.
Pack of 10 Filters, #2039.

Contact your nearest authorized Ungar dealer or call the Ungar Hotline, toll-free 1-800-421-1538. In California, call collect, 1-213-774-5950.

Offer good until December 15, 1982.

Ungar
Division of Eldon Industries,
[illegible] California [illegible]

CIRCLE 9 ON FREE INFORMATION CARD

SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

SATELLITE APPLICATIONS

The FCC has adopted a new procedure for accepting applications for satellite orbital slots, tailored for use with the pending proposal to push the slots closer together. The new plan, which probably will give preference to the 10 companies that have already filed applications, calls for proposals submitted by mid-May to be considered first in any processing procedure. After those projects have been acted upon, the FCC will consider new applications. The action reduces the likelihood that the FCC will conduct competitive hearings if two companies seek the same orbital slot.

MORE SATELLITE DATA SERVICES

There's more competition than ever for satellite space—and some of the major computer companies are now joining the fray. For example, Satellite Business Systems—the partnership of IBM, Comsat General, and Aetna insurance—is setting up a new medium- to high-speed Data Network Service, designed for customers with lower-volume data communications requirements. In a separate development, American Satellite Company and Tandem Computers Inc. are jointly developing the world's first computer network with full-integrated satellite transmission. The ASC-Tandem project, called Infosat, will offer continuous online transaction processing, distributed data processing, and information systems management.

AROUND THE SATELLITE CIRCUIT

Legal action on many fronts involving satellite reception: satellite master antenna TV operators in several cities are suing program suppliers such as Showtime, The Movie Channel, and others, for failing to deal with them to carry shows; in some cases the SMATV operators contend that pressure from local cable systems has prompted the retrenchment by programmers. Meanwhile, in a case that could set a precedent for satellite-TV reception, a federal court in Washington came down hard on a local dealer who sold unauthorized receivers deisgned to pick up HBO shows on multipoint distribution service microwave channels. The court awarded more than $102,000 in damages to Marquee TV Network, the local MDS-HBO service, resulting from the "illegal conduct" of a small local company which advertised, sold, and installed MDS receivers; the award was the highest amount ever granted in a pay-TV piracy case, and represented reimbursement of funds which Marquee claimed it lost because of the unauthorized devices, which could pick up its HBO signal. The court also granted permanent injunctions against several other companies that sold similar reception equipment.

WORLDWIDE CNN

Cable News Network may become an international service, transmitted via Intelsat, if CNN's Ted Turner has his way. Turner is negotiating with Comsat for access to the Intelsat system so that CNN can be sent to South America, Africa, Europe, and Asia. CNN has already signed a deal with a Japanese cable TV company to carry CNN in Japan 17 hours per day as soon as an overseas transponder lease is completed. In return, CNN will begin picking up a daily round-up of Japanese business news, fed by satellite from Tokyo.

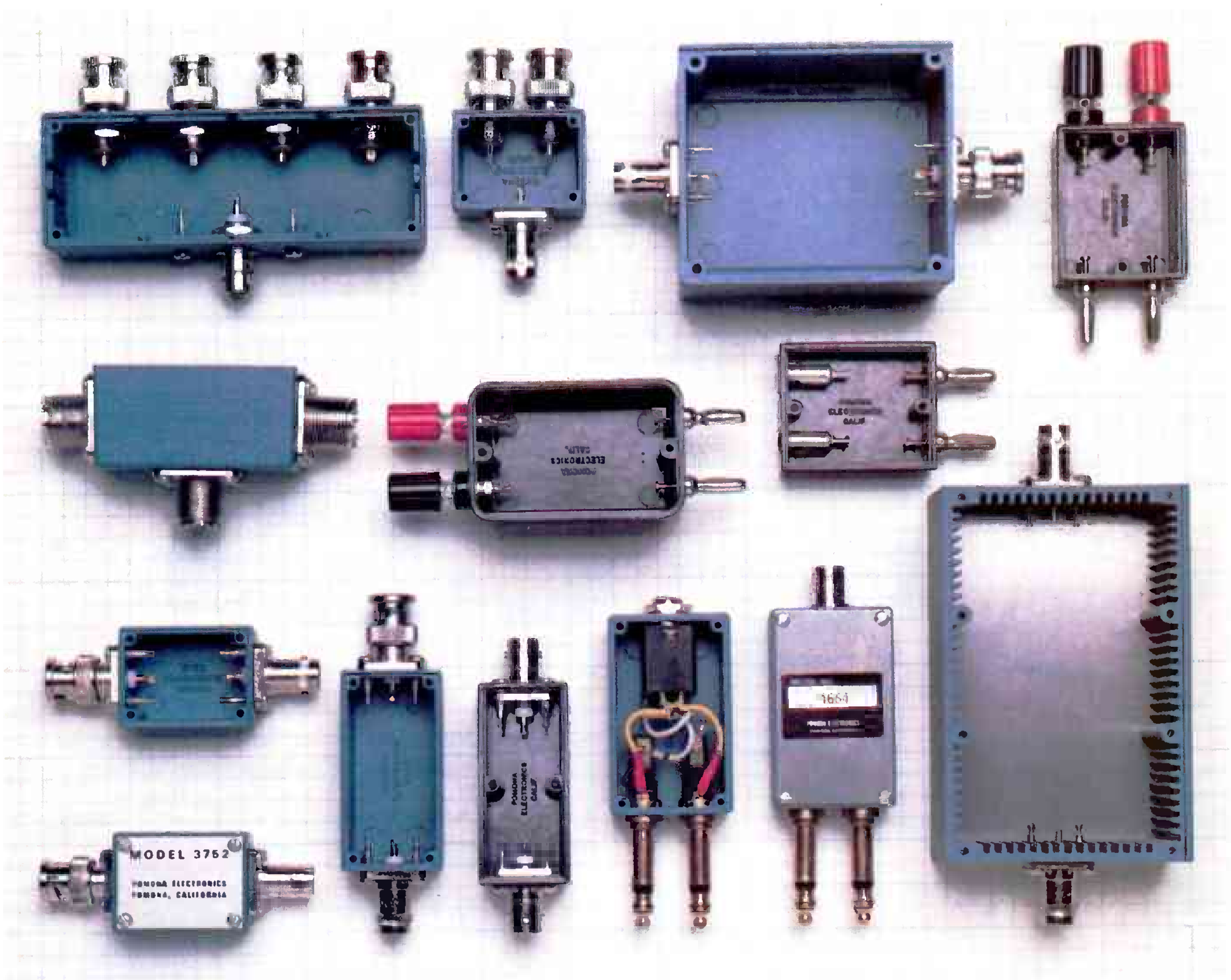
"DISH STRETCHER"

Imagine a little red wagon—the kind kids play with—equipped with a four-foot satellite dish, a 12-volt battery for power, 100° LNA, and a satellite receiver. Tulsa-based Automation Techniques Inc. called this portable set-up "Toysat"—and used the micro-miniature arrangement to emphasize the potential value of its new electronic "Dish Stretcher." That unit is intended to erase "sparklies" as well as the other kinds of interference that often afflict small-dish receiver systems.

According to ATI, the level of sparklies or impulse noise in a satellite picture has been a function of either the size and efficiency of the antenna, noise figure of the LNA/receiver, or the carrier-to-noise threshold of the receiver. ATI attacked the sparklie problem in a fourth area of the receiver system: detected video signal. The sparklies generated because of the smaller dish are identified by Dish Stretcher technology as improper video information and are removed from the picture signal after entering the receiver. The $500 unit is available from ATI, 1846 N. 106th E. Ave., Tulsa, OK 74116. **R-E**

THE POMONA PROMISE

We provide the design engineer with the best "black boxes" made in this country. Or anywhere.



That may seem like a tough promise to deliver on. But if you talk to the professionals of the electronics industry, you'll learn quickly and with great assurance that the "black boxes" designed and produced by ITT Pomona Electronics are looked upon as the best in the business. Bar none.

The reason goes back to when we first introduced the idea of providing convenient containers for special test circuits. We promised then that ours would be the best. And that's the way it's been.

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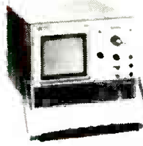
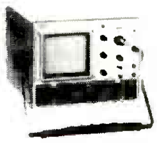


1466 SINGLE TRACE

$329^{95}

WAS $480^{00}



1476 DUAL TRACE

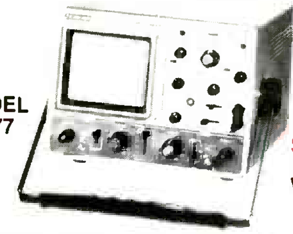
$395^{00}

WAS $570^{00}

PRICE DOES NOT INCLUDE PROBES

- Triggered and automatic sweep
- 18 calibrated sweeps
- On 1476 mode automatically shifts between CHOP and ALTERNATE
- Bright P31 blue phosphor
- Front panel X-Y operation using matched vertical amps
- Video sync separators
- Check most digital logic circuitry

B+K PRECISION 15 MHz TRIGGERED SWEEP SCOPE



MODEL 1477

$495^{00}

WAS $645^{00}

PRICE DOES NOT INCLUDE PROBES

- Mode automatically shifts between CHOP and ALTERNATE
- Bright P31 blue phosphor
- Front-panel X-Y operation
- Differential input capability
- 19 calibrated sweeps—.5μSEC/cm to .5SEC/cm
- Sweep to .1μSEC/cm with 5x; 1.5SEC/cm with uncalibrated vernier

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MODEL 420

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- Sine, square and triangle output
- Variable and fixed TTL outputs

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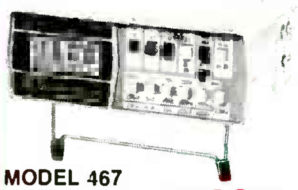

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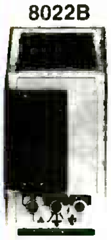
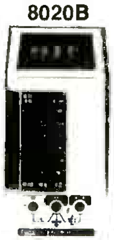


$144.

MODEL 8020B



$194.

MODEL 8024B

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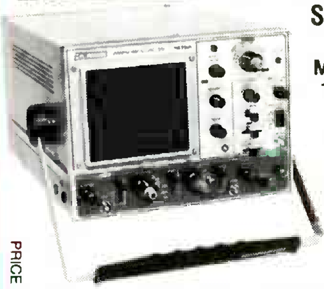


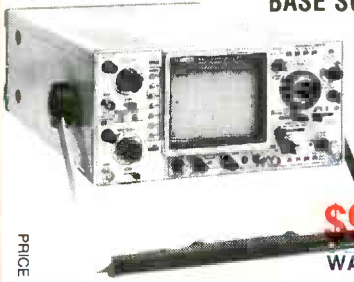
MODEL 1479B

$595.00
was $895.

PRICE DOES NOT INCLUDE PROBES

- Built-in signal delay line permits view of leading edge of high frequency pulse rise time.
- Triggers on signals up to 50MHz
- Rectangular *CRT* with P31 phosphor
- Mode automatically shifts between *CHOP* and *ALTERNATE*

B+K PRECISION — 70 MHz. Dual Time BASE SCOPE



MODEL 1570

$995.00
WAS $1570

PRICE DOES NOT INCLUDE PROBES

- 1 mV/division sensitivity to 70 MHz
- 500 μV/division cascade sensitivity
- Four-input operation provides trigger view on 4 separate inputs.
- Alternate time base operation
- Switching power supply delivers best efficiency and regulation at lowest weight

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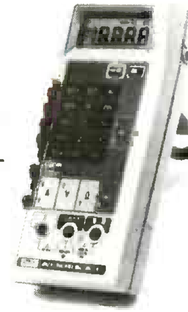
MODEL 8060A

- Frequency measurements to 200KHz
- dB measurements
- Relative measurements
- True RMS
- High-speed Beeper

$349.00

MODEL 8062A



- .05% accuracy
- True RMS
- 30KHz bandwidth
- Relative measurements
- Beeper

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MODEL 520B

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- Works in-circuit when others won't
- Identifies all three transistor leads
- Random lead connection
- Audibly and visually indicates GOOD transistor

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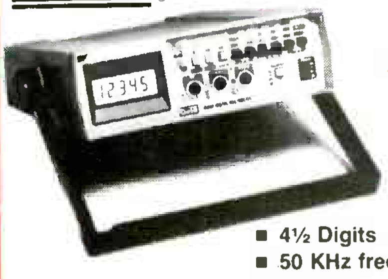

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MODEL 8050A

- 4½ Digits
- 50 KHz frequency response
- 10 μV resolution
- .03% accuracy
- True RMS
- dB
- measurements and memory relative

8050A-01
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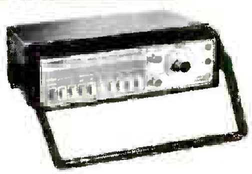

MODEL 3010 **$179.95**
was $220.

MODEL 3020 **$299.95**
was $379.

MODEL 3010

- Sine, square and triangle output
- Variable and fixed TTL outputs
- 0.1 Hz to 1MHz in six ranges
- Push button range and function selection
- Typical sine wave distortion under 0.5% from 1 Hz to 100kHz

SWEEP FUNCTION MODEL 3020

- Four instruments in one package—sweep generator, function generator, pulse generator, tone-burst generator
- Covers 0.02Hz-2MHz
- 1000:1 tuning range
- Low-distortion high-accuracy outputs

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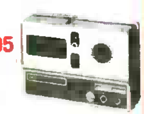
was $229.

$149.95
was $185.



MODEL 830

- Automatically measures capacitance from 0.1pF to 200mF
- 0.1pF resolution
- 0.2% basic accuracy
- 3½ digit LCD display

MODEL 820

- Resolves to 0.1pF
- 4 digit easy-to-read LED display
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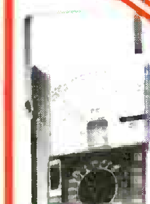

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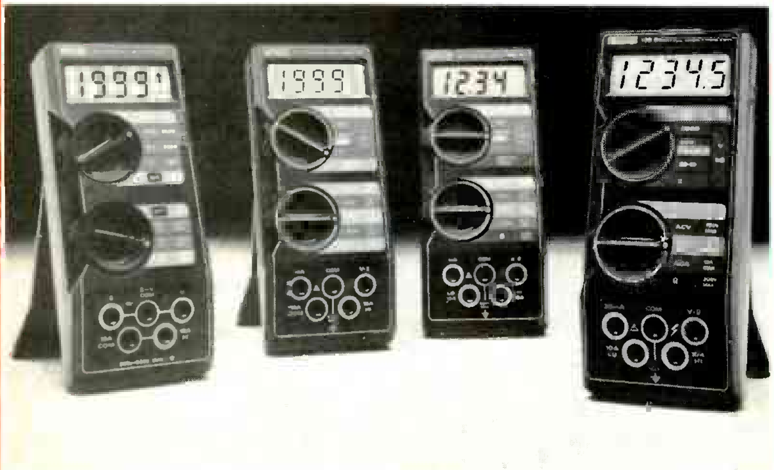

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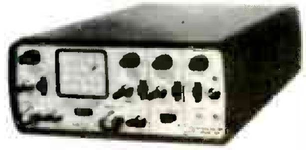
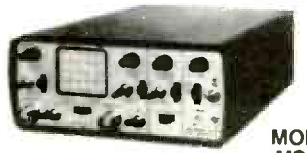


Dual Trace 15 MHz

MODEL MS215

Single Trace 15MHz

MODEL MS15



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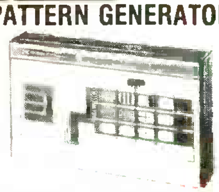

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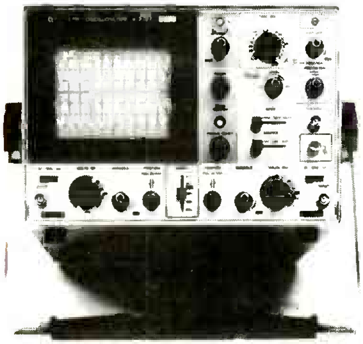

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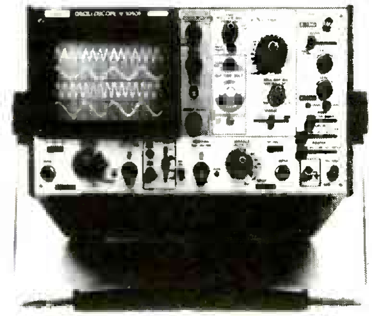
100MHz DUAL TRACE DUAL TIME BASE



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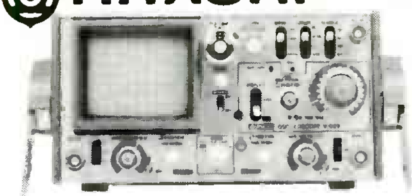

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$109.95 was $135.

- Fast GO/NO-GO in-circuit transistor testing
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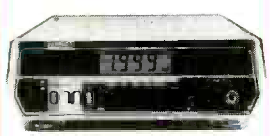

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MODEL 176 4½ DIGIT **$269.00**

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LETTERS

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ROAD-INFORMATION SYSTEMS

I wish to respond to a letter in the July 1982 **Radio-Electronics** by Mr. Charles E. Koontz regarding road-information systems. First thing, I feel that such systems are really not needed in most areas of the United States. Just listen to any local radio station during the morning or afternoon drive-times, and you will hear plenty of traffic information. I think that the functions of roadside-information stations and auxiliary services that Mr. Koontz is discussing are already fulfilled by most radio stations. I also think that the FM system discussed in his letter is not as practical as the proposals for roadside stations that would have been located at the low end of the standard AM broadcast-band. Those AM stations could give better coverage and at lower transmitter power for the same area served. Also low-power and auxiliary services broadcast in FM would only be more difficult to receive in a moving automobile. I also wonder whether the public and the radio stations are interested at all in a system to transmit pictures over the existing FM band. That *sounds* interesting—but what real purpose could it serve?

Mr. Koontz must understand that the main-channel carrier space of a modern FM broadcaster is very valuable material. To the broadcaster, it is far more profitable to sell advertising time than to rent space on his carrier for SCA or other auxiliary services, possibly downgrading his signal. Mr. Koontz should remember that the broadcaster must give up about 10% modulation percentage for each auxiliary service. In most cases, that is not permissible. Note that most stations that carry SCA or other auxiliary services are non-commercial. The FM broadcast industry is more competitive now than it was 25 years ago. Modern broadcast-equipment designers are really more concerned in allowing the broadcaster to get the most out of his main channel.

Now to a discussion on modern FM-broadcast technology: Mr. Koontz points out "reduced coverage" from Class-B and Class-C FM-radio stations; that is far from the real truth. Modern FM broadcasting antennas, built from the late 1960's to date, use a circularly polarized radiation pattern—that is, the antenna radiates in *both* the horizontal and vertical planes. Older antennas radiated only a horizontally polarized signal. Such horizontally polarized antennas are totally useless to the modern broadcaster. A majority of the FM receivers now used by the public use *vertically* polarized antennas. That includes portable radios and automobile receivers. A modern broadcaster is most concerned with "penetration"—the number of receivers that

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CIRCLE 92 ON FREE INFORMATION CARD

his signal can reach in the station's service area. It is true that horizontal-polarized antennas could give the station better range, but that would be useless to people who have vertically polarized antennas on their receivers.

As far as transmitters and exciters are concerned, any station still using a 25-year-old exciter and transmitter would not survive. You could get by with using a 25-year-old transmitter in AM radio and TV, but not FM broadcast. In fact, most of those old FM transmitters were relegated to auxiliary service, or even scrapped, when FM stereo came about. This is why: Old transmitters used modulator and multiplier stages that had insufficient bandwidth to handle the stereo-modulating signal. Also, the multiplier stages distorted the stereo information. A modern, solid-state FM exciter is actually a marvelous instrument compared to the primitive exciters. Its solid-state modulator and AFC circuits require little or no adjustments, and are capable of far lower distortion and greater bandwidth. There are only a few or no multiplier stages that don't require tuning. The new exciters are compact and efficient, and not susceptible to microphonics.

The modern transmitter is a far superior performer compared to the older models. The newer and more efficient stages give wider bandwidth, easier tuning, and are much more efficient. They are less likely to cause distortion and harmonics. The modern transmitter is very "transparent" to the exciter's signal. As far as interference is concerned, such problems are very rare, because both transmitters and exciters are well shielded.

Here are some other considerations that broadcasters use in evaluating transmitters: They want something that is very energy-efficent, because the transmitter uses more electricity than any other device that the station uses. Older transmitters are just too inefficient, and every kilowatt the transmitter uses means bigger bucks each year on the power bill. That is getting very important. Also, parts and tubes for 25-year-old transmitters are getting very expensive, and difficult—if not impossible—to obtain, because so many of the manufacturers have long gone out of business. Even parts for equipment 10-15 years old have become hard to obtain. Also, old transmitters were not available in the power levels that broadcasters require now. The use of lower-gain, wide-beamwidth antennas requires a higher-power transmitter.

To sum it up: If Mr. Koontz would listen carefully to an FM radio station using new equipment, he would be surprised at how well it can perform: far better than 25-year-old or even 10-year-old technology. It's just like trying to say that a 20-year-old black-and-white tube-type TV set is better than a solid-state 1982 color receiver.

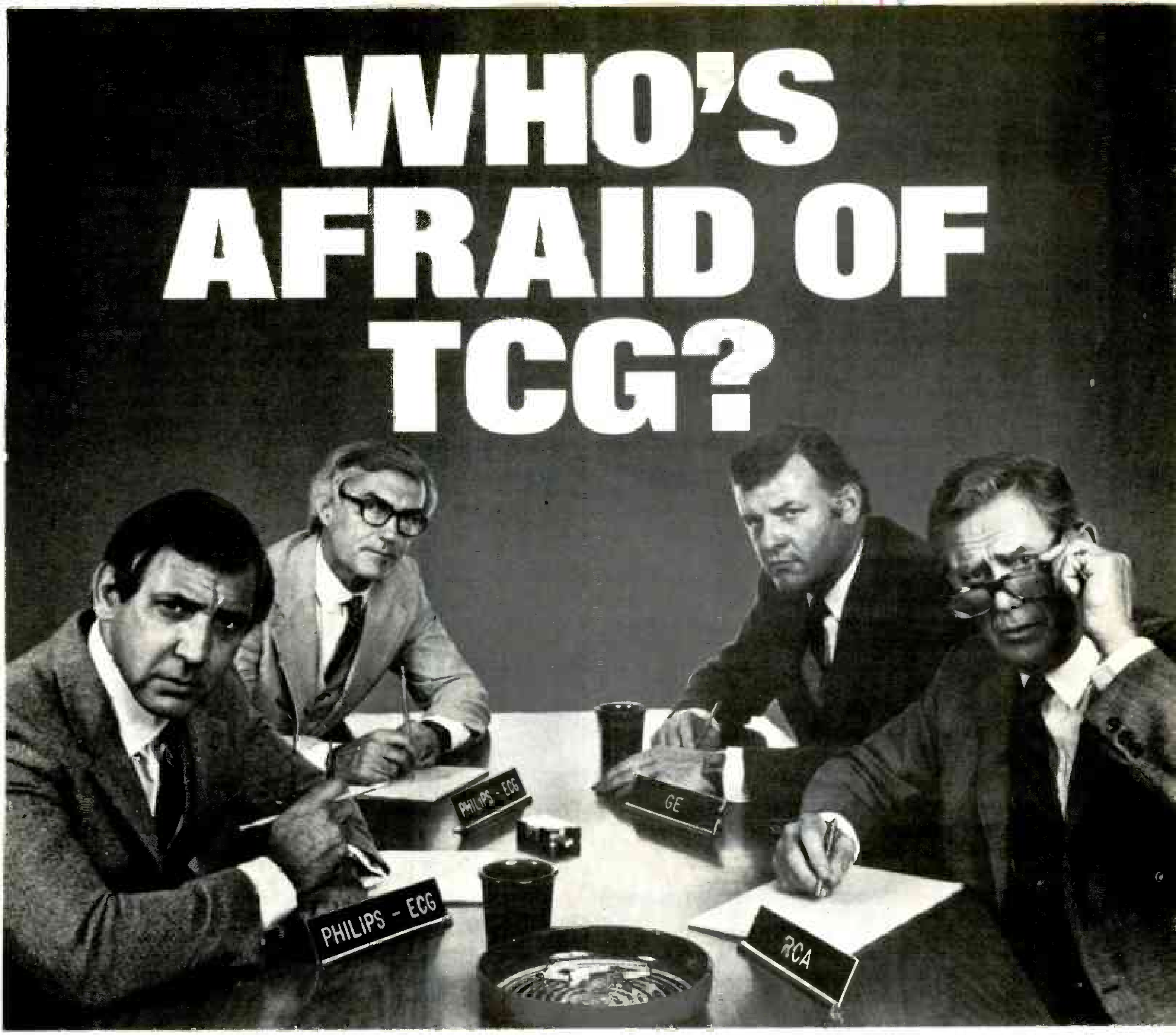
I can agree with Mr. Koontz on FM tuners. If someone asks me about them, I will reply that spending more than $500 on a tuner is a waste of money. I laugh at people who spend $1000 on a tuner and brag about the reception. These days, hi-fi FM listeners are in a minority; modern radio stations try to cater to those listeners who have portable radios. What sounds good on a portable may sound loud, dense, and harsh over your stereo. Whether you like it or not, that's the way it is—I don't agree with it, either.

To tell Mr. Koontz more: The transmitter is actually a minor cause of signal degradation for his station. The most probable cause is the telephone lines that the station may be using to relay program material to a remotely located transmitter. Those telephone lines can have unstable frequency response and distortion. Also, transients, intermodulation, and phase distortion over those lines are a problem. I don't want to downgrade the telephone companies that provide those lines. Most of them try to be cooperative and are sympathic to the stations' needs; they do try very hard to provide adequate service under tough conditions.

If the station is lucky enough to be using a microwave STL system, the improvement in sound quality can be very startling. Another problem that stations have is distortion in phono and tape systems—those can have more distortion than a typical new transmitter. The problems are the same as those you have with phono and tape machines in your stereo at home.

I can also agree with Mr. Koontz about the Grundig FM receivers: They were high quality for their time. True, the older ones aren't stereo, but they could give excellent results. I have a Grundig radio-phono console that has an AM/FM shortwave tuner that suffered the same fate as some of Mr. Koontz's receivers: bad switches, old capacitors, and old age. The person who gave it to me said that he purchased it in 1959. I am now unable to repair it because the switches are unavailable, along with some of the tubes.

I apologize for the length of this letter, but I had to go to lengths to explain what is going on these days in modern radio stations. I



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know because I have worked, and still work, as a Maintenance Engineer for a prominent AM/FM station in the Washington, DC area. I have lived here for close to 10 years.
THOMAS REX OLIVER,
Forestville, MD

COLOR COMPUTER

I believe that Marc Stern made an error when he stated on page 51 of the October 1982 **Radio Electronics** (in the section dealing with Radio Shack's *TRS-80 Color Computer*) that "...the number-crunching capabilities of this system are slowed by its clock speed of .894 MHz."

While the CPU clock speed certainly affects the overall speed of a system, it does not tell the whole story. The *Color Computer* can hold its own against a Radio Shack *Model III* with Z-80 Processor running at 2.03 MHz. When output to the screen is required during a benchmark test, the *Color Computer* gains almost a 2-1 advantage in speed because of the additional circuitry that it possesses to control the video. A quick glance at the benchmark article in the August 1981 issue of *Interface Age* will convince any reader that the CPU clock speed does not tell the whole story when number-crunching speed is being considered.

Another point: While it is true that a 32 × 16 screen format is certainly restrictive for word-processing tasks, many word-processing programs for the *Color Computer* now come with a 51 × 24 upper/lower case character generator in software.
GOLDEN RICHARD III

CHANGES

The October 1982 issue of *Popular Electronics* announces that its name is to be changed to *Computers & Electronics*. The editorial annoucing that seemed proud of the change. I regret it. There are lots of computer publications, and there will be more, but it is becoming increasingly difficult to find major publications dealing with electronics concerns not directly involved with computers. There *are* readers whose interests who do not revolve around computers.

I hope that a similar change will not come upon **Radio-Electronics.** Your magazine has done a lot to emphasize and clarify basic principles, and for a long time has been very useful in any number of practical ways. It has looked to the future through those means. I hope that you do not allow it to become more specialized.
CARL F. HARTMAN
Newport Beach, CA

As we stated at the end of our *October 1982 editorial: "...we do not* intend to become a computer magazine. **Radio-Electronics** *remains dedicated to the broad coverage of the entire electronics industry."*—Editor

STANDARDS

I would like to comment on Dane E. Ericksen's letter in the July 1982 **Radio Electronics,** concerning FCC-mandated standards for teletext, color TV, and other such things.

Among my other gadgets and toys, I own a Sony Betamax VCR, a cassette tape player (several, in fact), the typewriter upon which this letter is being written, and many other things that started out by competing in a free market with devices that did the same job differently.

All of those things have prospered and survived without any government agency mandating any standards at all. In fact, the struggle between VHS and Beta videotape formats goes on as we speak. I buy Beta tapes, while the owner of a VHS machine buys VHS tapes. It is clearly to my advantage to force the VHS people, by law, to change to Beta format so that I can always find the tapes I like in my format.

However, what if VHS turns out to be a better format in the long run? What if, in five years, a new system based on presently unforeseen technology comes out? A mandatory system freezes out such advances. Color TV here, which is seen to be such a success by advocates of mandatory standards, is actually quite inferior to the PAL standards in Europe, because they froze their technology a year or two later than the U.S. did. Who can tell what standards we might enjoy today if there had been no freeze, considering how much difference a couple of years' progress in Europe made in picture quality?

If we are to engage in predictions, let me make some: Teletext will prosper unless the space is needed for other uses (like captioning). AM stereo will be used and will prosper if people care. (I don't believe that it can compete with FM, because of bandwidth limitations.) If those and other ideas fail, it will be because people do not really need them, or want them, and not because the government failed to lead us to them by the nose.
MARWAN E. NUSAIR,
Cincinnati, OH **R-E**

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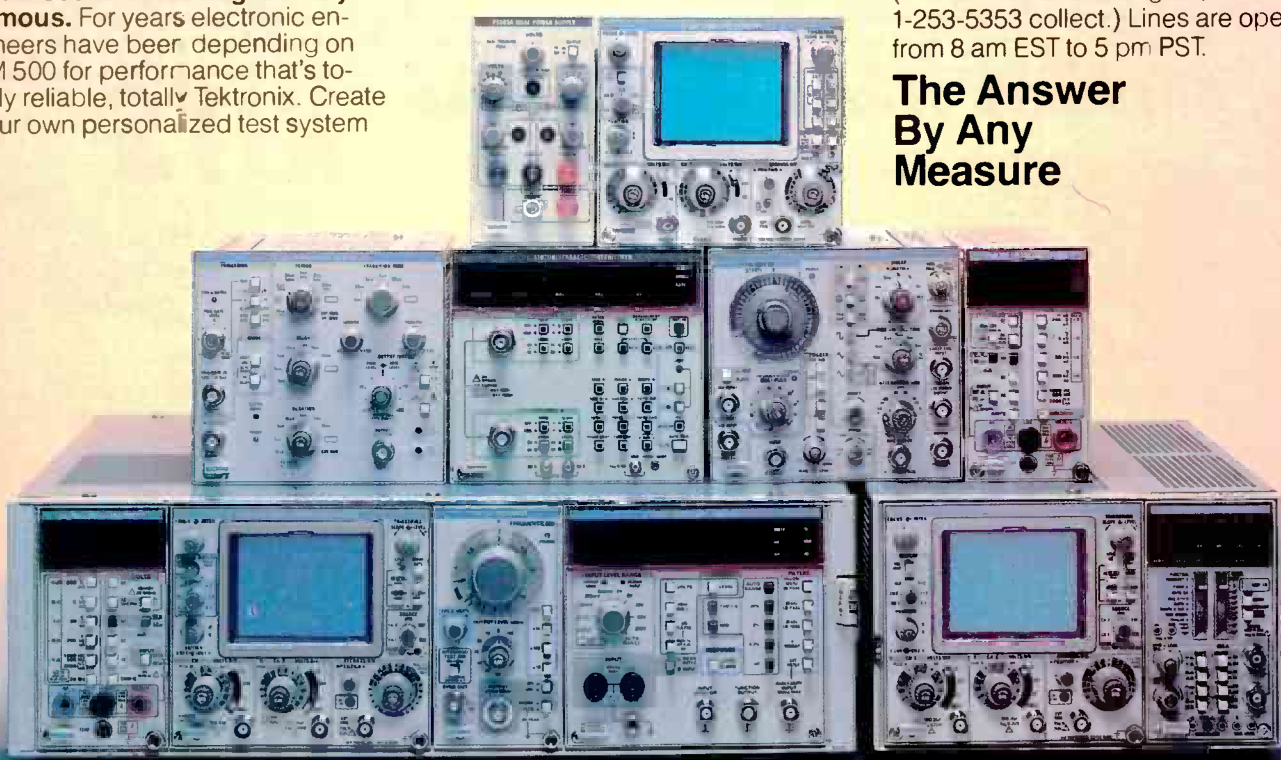

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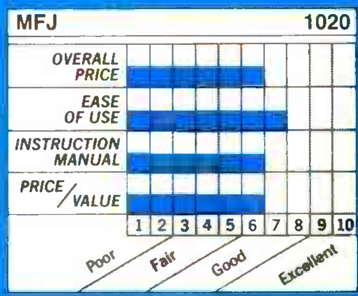

CIRCLE 101 ON FREE INFORMATION CARD

LIVING IN AN APARTMENT CAN WREAK havoc on a shortwave listener's enjoyment. Usually, there's no place to string a decent antenna because of space and/or lease restrictions, but some relief is here—at last—in the form of an indoor active antenna. It may not have the gain of a multi-wavelength long wire, tuned dipole-antenna, or beam system, but it will still give a good account of itself.

Taking advantage of field effect and bipolar transistor technology, MFJ Enterprises (PO Box 494, Mississippi State, MS 39762) has introduced its model *MFJ-1020* indoor active antenna; that device covers 300 kHz to 30 MHz in five bands.

Packaged in an attractive wood-grained and cream-colored case, it measures 6¼ × 6 × 2⅜ inches and weighs only one pound—but the manufacturer has put a lot of performance into that small unit.

The device's frequency range includes all of the international shortwave bands as well as the high-frequency amateur-radio bands. If you wish, you could also use the device as a preselector for an indoor or outdoor wire antenna.

All of that is accomplished using a

three-transistor tuned-input amplifier circuit whose operation is simplicity itself. A signal arrives at the antenna and is coupled to a tuned circuit through one of five inductors; those are chosen using a front-panel mounted BAND selector switch. The signal is then fed to a two-transistor common source amplifier circuit made up of a pair of 2N5468's. From there, the signal is fed to a 2N5179 bipolar transistor for final amplification, and finally out to the receiver.

Setting up the device is also straightforward. Since it is an active antenna, there must be a voltage source—in this case either a 9-volt battery or a 9-volt AC adaptor with a subminiature plug. Also required are a good earth ground and a coax jumper cable between the unit and your receiver. One note about that jumper—both the input and output of the device use phono jacks, not the standard SO-239 coax connectors you might expect. Thus, at least one end of the jumper will have to be fitted with a phono plug. Personally I would have preferred to see SO-239 connectors used here as they are less likely to be accidentally disconnected. MFJ does use them on several of their other products.

Once all of the connections are made, and you've tuned your receiver so that you are receiving a signal, set the antenna's GAIN control to about midrange and adjust the TUNE control for the maximum reading on the receiver's S-meter. If the signal level isn't high enough, you may find that you'll have to adjust the GAIN control to maximum and then adjust it to the proper level. Be careful that you don't leave the device's gain too high, because that could overload the receiver's front end.

Our test

The first thing we noticed when we opened the carton was how well the unit was packed—certainly well enough to withstand the vigorous rough handling that it is likely to encounter during shipping. Once unpacked, very little time is required to set up the unit—in our case, it was operational less than one hour after opening the carton.

Of course, the important thing is how well it works. In a word, the results were amazing. When used with a receiver with poor sensitivity, the device improved that sensitivity by several orders of magnitude. On another receiver, not only did it help with sensitivity, it also improved selectivity as, with proper tuning, unwanted signals could be notched out. In fact, the active antenna tunes so sharply that the first few times you use the unit you'll find it easy to miss signals. Before long, however, the tuning procedure will become second nature.

As mentioned earlier, the device can also be used as a preselector for an indoor or outdoor wire antenna. While we didn't use it for that purpose very much, we did

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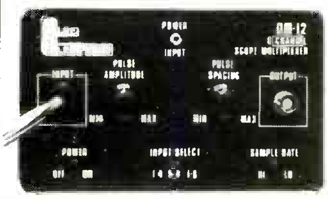

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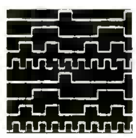

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make it a point to try it out and found that it is indeed useful in bringing a signal out of the noise.

Speaking of noise, one thing that must be remembered is that the unit will not only increase signal strength, but also the noise level in the receiver. That is particularly noticeable on the lower frequencies but, while it can get a bit bothersome at times, it is usually not enough of a problem to interfere with reception. Another and potentially more serious drawback is that the device is sensitive to man-made interference from such things as fluorescent lights and electric motors; of course the same would be true of almost any other antenna system that is located entirely indoors.

The four-page instruction sheet includes all the information a user needs to have the device up and working in as little time as possible. Clearly and concisely written, it includes a schematic of the unit and a PC board component layout. The only problem with those instructions is that it provides little theory—a rather noticeable omission anyone who is the technically inclined.

Overall, however, the MFJ model *MFJ-1020* active antenna works as claimed, and is a good buy at its price of $79.95. It is especially recommended for anyone who needs, but cannot erect, a full-size outdoor antenna. **R-E**

Sanwa Model LCD-900 Multimeter

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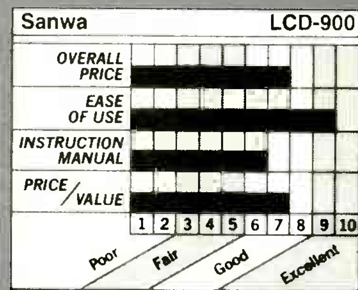

BOTH ANALOG AND DIGITAL MULTIMETERS have been the workhorse in shops and on the bench for quite some time now. One common complaint associated with analog units, however, has been that the multiple scales make reading the device difficult at times. There have been several attempts to solve that problem, but the most novel approach I've seen is featured on the Sanwa model *LCD-900*.

That unit appears to be a standard analog multimeter, at least at first glance. It measures DC voltage in seven ranges, from 1- to 1000-volts full scale; AC voltage in five ranges, from 10- to 1000-volts full scale; resistance in four ranges, from 1000-ohms to 1-megohm full scale, and DC current in four ranges, from 300-microamps to 300-milliamps full scale. AC current is measured on one 0- to 3-amp scale. The meter's sensitivity is specified as 50,000-ohms-per-volt DC and 10,000-ohms-per-volt AC.

But one thing does appear amiss, however, when you first open the carton. The meter's face is completely blank. That's because an LCD is used there. Turn the meter on, with the range-selector switched to any range, and only the scale for that range appears. Neat—no more figuring out which range you're supposed to be reading as only one range is visible at one time. The LCD's readability is good, and the bright orange pointer is easy to spot against the display.

Panel markings are nice and clear. The

input jacks here are rather interesting. The negative jack is the same for all of the meter's functions. The positive jack is used for all ranges except the 0- to 3-amp AC range; that range uses a separate input. A nice touch is that the leads need not be unhooked and reversed to reverse the polarity of the readings. The ON/OFF switch has a provision that will switch the polarity of the readings. What's interesting, however, is the jack marked OUTPUT. Long ago, we tuned up old radios by connecting an AC voltmeter to their audio output, using a blocking capacitor to "block off" the high DC voltage often present. That is what is done here; that jack is wired in series with an internal 0.47-μF, 600-volt capacitor.

The meter requires two batteries for operation—1.5 volts for resistance readings, and 9 volts to power the LCD display. The display is driven by a CD4047AE IC. Battery life is good, although you might run them down just playing with this ingenious little instrument. Seriously, though, the automatic scale-ranging is really quite nice and a pleasure to use.

Soltec (11684 Pendleton Street, Sun Valley, CA 91352) is the exclusive agent for the Sanwa line of analog and digital multimeters. The Sanwa *LCD-900* is available from your local distributor and lists for $139.00. **R-E**

Smith Corona Model TP-1 Daisy Wheel Printer

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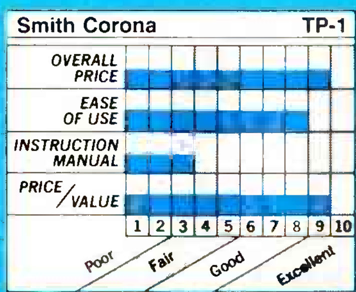

MOST DAISY-WHEEL PRINTERS IN THE under-$1000 price category are simply converted portable typewriters. One notable exception to that general rule is the *TP-1* from Smith Corona (65 Locust Ave., New Canaan, CT 06840). That unit, which carries a price of under $900, is from start to finish a commercial-quality daisy-wheel printer.

The printer measures 6.4 × 12.4 inches and weighs 18.5 pounds. A hinged plate that serves as the paper support also doubles as a dust cover when it is folded flat. A fan built into the rear of the printer provides cooling.

The power switch and a Centronics-type connector are located on the rear apron. A small control panel on the front has the power lamp and a top-of-form positioning switch; that switch is used for positioning continuous-feed paper. Note, however, that at the present time the printer is unable to handle either tractor- or pin-feed forms. You can use friction-feed forms, but be prepared to monitor the printing closely, as that type of form tends to wander across the platen. In fact, the instruction manual warns against the use of that type of paper. So, in the meantime, the printer appears best for printing single sheets in an office-type situation.

The printer is available with a choice of either 10 or 12 pitch (characters-per-inch), and either parallel or RS-232C serial interface. The pitch and interface must both be chosen at the time of purchase. Printwheels with many of the more popular type-styles are available in both pitch and sizes.

The parallel interface has signal lines for 7 data bits, as well for STROBE, BUSY, and ACKNOWLEDGE. The serial interface has selectable baud rates, ranging from 50 to 19,200 bits-per-second—just about any conceivable baud rate ever used for personal and commercial computer equipment can be selected using jumpers on the interface PC-board. The serial interface can generate and acknowledge the following signals: RT (*R*equest *T*o *S*end/printer is ready), CTS (*C*lear *T*o *S*end/computer is ready to send), and DTS (*D*ata *T*erminal *R*eady/busy).

The printer mechanism accommodates paper widths to 13 inches, printing uni-directionally at 12 characters-per-second, which works out to approximately 120 words-per-minute. Just like a typewriter, at the end of each line, the carriage returns to the left for the start of the next line. The line spacing can be set manually for 6, 4.5, or 3 lines-per-inch. There is no provision to allow for program control of the line spacing; once set, it remains that way until changed manually.

Essentially, all the paper handling is done by an uncomplicated typewriter-style mechanism, with the usual end-roller knobs, paper release, paper bail with calibrations, and paper guide. The margins and the tabs, on the other hand, are under full program control, and can be set using PRINT statements from BASIC.

continued on page 38

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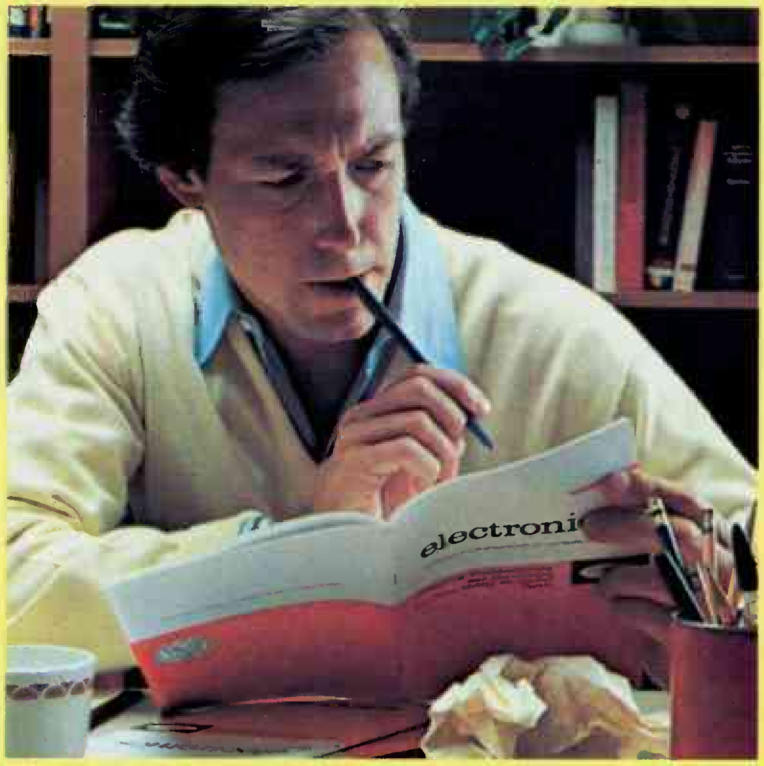

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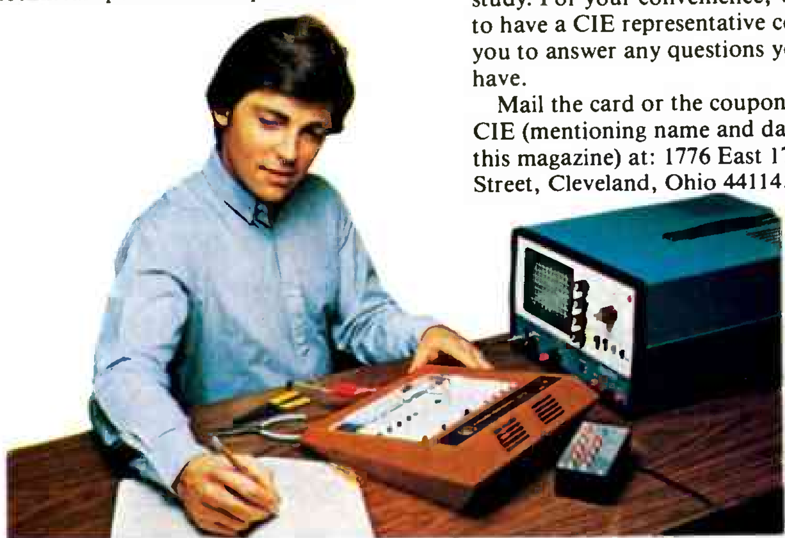

Pattern shown on oscilloscope screen is simulated.

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continued from page 32

If the word-processing software being used permits inserting ASCII control codes from within the program, the tabs and margins can be varied during the printout. If the software does not permit the insertion of control codes, the margins must be set through BASIC before running the word processor.

The unit can print 85 of the 128 ASCII codes and characters. It ignores the character codes for the caret (up arrow), accent grave, or tilde, and spaces for the "less than" (<) and "greater than" (>) symbols, the reverse slash, left brace, right brace, and broken vertical bar. One serious drawback with the printer is that many of the non-printing characters are used in BASIC program listings, and while the ones that generate a space can be written in by hand later, that is difficult to do for the ones that are totally ignored. That problem limits the printer's practical use to an office-type environment, and indeed that appears to be its intended use.

Of the ASCII control codes, the printer responds to CR (carriage return) and LF (linefeed), BS (backspace), HT (tab), DC1 (left margin set), DC2 (tab set), DC3 (right margin set) DC4 (tab clear), NAK (which prints 1/4), SYN (which prints 1/2), CAN (margin release), and EM (which turns the automatic underscore on and off).

The carriage return/linefeed arrangement is standard, and works much like most other printers: the machine looks for a carriage return followed by a linefeed. If it doesn't get a linefeed, it will put one in. If it does, the printer will assume that it is the correct linefeed and not insert another one. That will work fine with most computers, the exception being those from Radio Shack. Every Radio Shack printer always provides its own linefeed after a carriage return. Thus, since Radio Shack software is configured to work with the Radio Shack printers, if you use a Radio Shack word-processing program such as *Scripsit*, and specify double spacing, the printer will produce only single-spaced copy. To get double-spaced copy, triple-spacing must be specified, and so on. Incidently, that problem is not just limited to the *TP-1*, but will happen when you use almost any non-Radio-Shack printer with Radio Shack software.

The printer can use either multi-strike fabric or single-strike carbon ribbon cartridges. Both ribbons and printwheels are easily removed and installed because the operating controls are oversize and conveniently positioned. At each turn on, and whenever the cover is lifted, the machine runs a diagnostic procedure that causes the printhead to travel back and forth. If, for some reason, the cover is lifted during a print, the printer interrupts the computer, the diagnostic runs, and the printhead relocates itself at its last print position so it can pick up correctly when the computer resumes output.

In operation, the printer runs exceptionally well. The mechanism is a little on the noisy side, but the print quality is superb. The characters print on a precise line, and equally well at either side of the paper. While the printer isn't the fastest one around, it's not all that slow either. Besides, anything that will work much faster also is going to cost significantly more.

The only real problem with the machine is the operator's manual. Saying that it leaves a lot to be desired is being kind. For example, you'll need a really good understanding of BASIC to be able to set the margins under program control as there is no description that makes sense. Specifically, the manual says "The printer carriage must be positioned to the desired margin set point....."—there's no way that can be done, either electrically or manually. A print statement filled with spaces directly in front of the margin-set ASCII code must be used to set the margins. The instructions for setting the tab are just as bad. Also, there is no list of how each ASCII code affects the machine. Finally, the ASCII control codes are given only in hex, not decimal, yet most software requires decimal input

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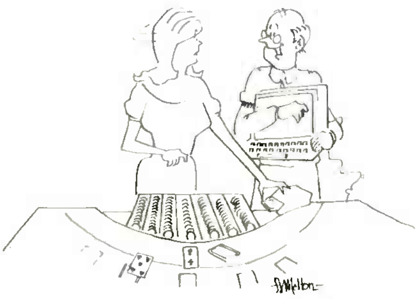
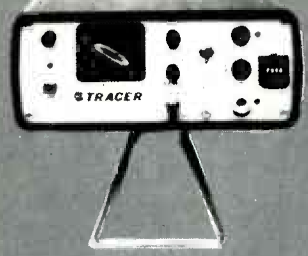
when imbedding control codes. Even BASIC sends the CHR$ function in decimal. If you get the machine, be sure to dig up a standard ASCII code chart somewhere.

Except for that operator's manual, however, the *TP-1* does a notably excellent job for the money. It has none of the bells and whistles of the super daisywheel printers, but it also doesn't cost anywhere near as much. If you're looking for something that will turn out a good-looking document and stand up to the rough handling of a typical office, be sure to look at this unit. And, if they ever come out with a retrofit to provide the symbols used in BASIC listings, this will be a dynamite all-purpose printer. **R-E**



"Hit me, Honey, I've got a system."

Non-Linear Systems Model TR-1 Signature Analyzer



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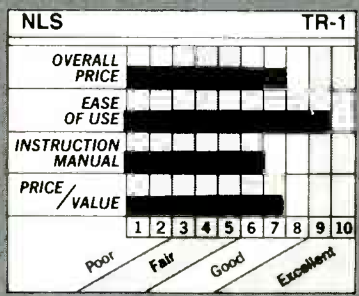


HAVE YOU EVER WISHED THAT YOU HAD an in-circuit tester that could be used to identify instantly faulty transistors, diodes, capacitors, inductors, and the like? Well, new from Non-Linear Systems, Inc. (533 Stevens Ave., Solana, CA 92075) is a compact analyzer called the model *TR-1*; that handy little unit can do just that.

The device works on the principle that if a known signal is fed to a component, the resulting waveform, called a signature, can be used to diagnose a fault in that component. For a good transistor junction, the signature is a slanting line ending in a sharp hook. If, however, the corner of the hook isn't sharp, but rounded or looped, leakage is indicated. Good diodes, on the other hand may show a small loop on the hook if they are slow-recovery types; fast-recovery types, however, must show a sharp hook like a transistor's. Good inductors and capacitors are shown as a loop. For capacitors, that loop slants to the right; for inductors it slants to the left. For all components, a straight line (no loop or hooking) indicates a short or open—shorts show up as a vertical line; opens a slanting line. After a little practice, good and bad components can be spotted almost instantly by analyzing the displayed signature.

The analyzer has two input channels; one is labeled A and the other B. Either one can be selected using a front-panel switch. That two-channel capability is useful for many applications including checking such things as stereo amplifiers.

CIRCLE 88 ON FREE INFORMATION CARD

For instance, a component in the good channel can be compared to the same component in the bad one to locate the source of the problem. Two sets of color-coded test leads are supplied with the unit.

A third position on the selector switch is labelled A/B. When the selector switch is in that position, the input channels are automatically switched at a rate set by the A/B RATE control located on the front panel; that rate can be varied from 0.25 to 0.5 seconds. Synchronization of the patterns is completely automatic; no adjustments are needed. LED indicators are used to show you which channel is being displayed.

The test signal used by the unit is a 2-kHz sinewave. Either a 2-volt or 50-volt amplitude (P–P) can be switch selected. The resulting waveform is displayed on the analyzer's small (1-inch) CRT. The very bright blue-white trace can be centered using the positioning controls that are located conveniently on either side of the CRT. The graticule is calibrated to give approximate resistance readings. Resistances from 0 to 500 ohms can be read in the LO range; resistances from 500 ohms to 500 kilohms can be read in the HI range.

There are many applications where this device should prove to be useful. Among them are checking large numbers of identical parts to weed out the bad ones or cross-checking between a known good part and one suspected to be bad. It could also be useful for testing digital devices where many identical circuits are used. With use, you're sure to find many more applications where this device can save you a considerable amount of troubleshooting time and effort.

In using the model *TR-1* we found drift to be negligible and the displayed trace to be rock steady. All-in-all this handy device worked exactly as claimed. Two models of the analyzer are available. One is a line-operated version for bench use and lists for $795. The other is battery-operated for portable and field use; it lists for $945 with battery charger. **R-E**

"He keeps reminding me he fixed his radio in 60 seconds flat. Now watch this: Helloph, Batphm, do youth reef me?"

BUILD THIS

AUTOMATIC COMMERCIAL EDITOR FOR YOUR VCR

Are commercials ruining your pleasure when you watch your favorite black-and-white classics on TV? Build this automatic commercial editor and make commercial-free tapes.

GARY McCLELLAN

ATTENTION, ALL FANS OF BLACK-AND-white movies! If you like to tape those late-night classics for viewing at a more reasonable hour, you'll love this gadget. It detects color commercials, and stops your VCR (*V*ideo *C*assette *R*ecorder) while they are running. Then, when the commercials are over and the film begins again, the VCR restarts and continues to record. As a result, all the commercials are automatically edited out of the movie, and you can enjoy it without breaks.

Using the device is simplicity itself. You just connect two cables from it to the recorder's VIDEO OUT and PAUSE jacks. Then you turn it on, and start the recorder. The rest is automatic.

Besides removing commercials from black-and-white movies, this commercial editor offers several fringe benefits. For example, by eliminating commercials, the recorder uses less tape. That means that shorter (and less expensive) tapes can be used to record longer programs. (In my area, a one-hour tape will record almost 1½ hours of movies!) Still other features are a five-minute timeout, and a jack for your remote pause control.

The five-minute timeout feature restarts the recorder if the commercials run over five minutes at a time. That feature is included because some recorder manufacturers recommend that their machines be left in the PAUSE mode for no more than five minutes. Longer than that can damage the tape, or cause excessive head wear, so the timeout feature protects both your tape and VCR. And, although the editor uses the PAUSE jack on the VCR, you can still use your remote PAUSE control as the editor contains its own jack.

You can build your own commercial editor in just a few evenings. Only four IC's are used, and there are only two easy calibration adjustments to be made. The only test equipment you need is an analog VOM and an RF signal-generator. (Don't be too concerned if you don't have the signal generator—there are ways around that, as you'll see.)

How it works

The automatic commercial editor works by detecting the presence or absence of the *color burst* signal, which accompanies all color broadcasting, but which is not transmitted (usually) when the material is in black-and-white. When that signal appears, a relay in the editor closes and switches the recorder to the PAUSE mode. When the color commercials are over, the color-burst signal disappears, and the relay opens. That switches the VCR to RUN, and recording resumes. When the next commercial appears, the cycle repeats all over again.

Note that the program being recorded must be black-and-white for the editor to work (otherwise the color-burst signal will be present at all times). If the film is in color, the first five minutes of program or commercials will not be recorded. After that time, because of the timeout feature, both commercials and program will be recorded.

Some readers, no doubt, are wondering whether this editor can be made to work with color programs. The answer is that it is not likely. The reason, we found—after extensive research—is that there is not enough difference between color commercials and color programs, which makes detecting color commercials very hard to do. So forget about an editor for color-program commercials...at least for now.

Now let's take a look at the inside of the editor. Refer first to Fig. 1. There are three main circuit-blocks: an AGC-controlled amplifier, a comparator, and a timer. We'll discuss them one at a time.

The AGC-controlled amplifier comes first. The signal from the recorder's VIDEO OUT jack is supplied to the input of the editor. That video signal consists of horizontal sync, vertical sync, video, and a color-burst signal. The only portion that we are interested in is the color-burst, which is really a few cycles—a burst—of a 3.579545-MHz signal. That signal tells the TV receiver that it is receiving a color transmission, and determines what the colors are, and how bright they are. To use it, we must amplify the color burst and filter out the rest.

Bandpass filter BPF1 separates the 3.579545-MHz (from here we'll call it 3.58 MHz for short) signal from the rest of the video, and that signal is amplified by IC1. The output from IC1 drives another bandpass filter, BPF2, which peaks the 3.58-MHz signal farther. Finally, the output from that filter is detected by D1 and converted to pulsating DC. The DC biases transistor Q1, which serves as an automatic gain control (AGC). The AGC-voltage controls the gain of IC1 via resistors R4 and R1 and, as a result, the output from D1 is at a constant amplitude whenever a color signal is present.

In our application, however, the color-burst signal itself is not used. Instead, the voltage drop across R4 is detected, which brings us to the second part of the circuit, the comparator.

The comparator circuit used here is rather unusual. To prevent false triggering, several circuit twists have been added. Resistors R6 and R7 provide a 0.26 volt hysteresis, and resistor R5 and capacitor C11 are used to introduce a short time-delay. The result of those additions to the circuit is to prevent noise—which can come from the video—from falsely triggering the device.

A color-burst signal applied to the input of the editor causes a voltage drop across resistor R4. When that voltage exceeds 0.26 volt, and lasts for at least 100 ms, comparator IC2 will be triggered, and its output will go from high to low. It will stay low for at least 100 ms after the color burst disappears, and that brings us to the third circuit block.

The last bit of circuitry is a five-minute timer, built around IC3. Whenever the output of IC2 goes low, both IC3 and the relay receive power. The relay closes immediately and, if the output of IC2 does not go high within 5 minutes, IC3 times out, removing power from the relay. The relay contacts, of course, control the VCR's PAUSE function.

Now that you have a basic understanding of how the project works, let's look at Fig. 2, the schematic diagram.

The AGC-controlled amplifier is at the top of the schematic. The video signal is input through C1. Coil L1, with capacitors C2 and C3, is peaked for the 3.58-MHz color-burst signal. The two capacitors also provide impedance matching to IC1. That IC is a differential input/output IF amplifier. It amplifies the signal by up to 60 dB, and its output appears across C6 and L2. That network is also tuned to 3.58 MHz, and provides greater selectivity. The amplified signal is detected by D1, and the color burst appears across R2 and C8. The DC component of the burst biases Q1, which draws current through R4. Capacitor C9 is included to prevent Q1 from amplifying the AC component of the color-burst signal so only a DC signal

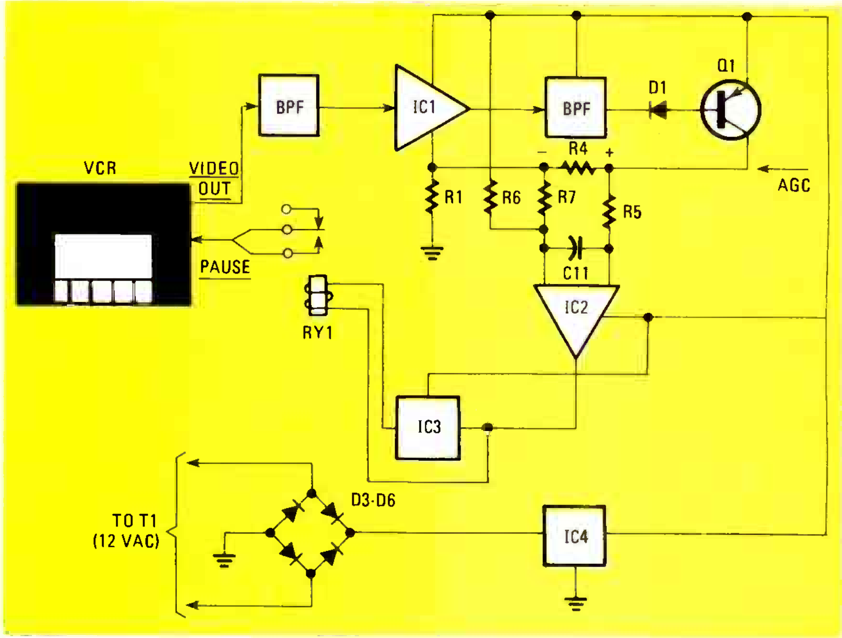


FIG. 1—BLOCK DIAGRAM OF COMMERCIAL EDITOR shows three principal sections: AGC-controlled amplifier, comparator, and timer.

is produced by Q1. From R4, that signal goes to IC1, where it controls the gain of the amplifier. In addition, IC1 also provides a 5-volt DC bias for the comparator; that 5-volt DC bias appears on pin 5 of IC1 and is necessary for the comparator to work properly.

Comparator IC2 monitors the voltage drop across R4. Resistors R6 and R7 form a voltage divider, biasing pin 2 of IC2 0.26-volt higher than the other input (pin 3). Thus, the voltage across R4 must equal or exceed the 0.26-volt hysteresis to trigger IC2. That extra circuitry was added to improve noise immunity.

With no color burst present, the output of IC2 will be high. When a color burst is present, though, there will be a voltage drop across R4. Typically, that will be 0.3 to 1.0 volt, depending upon the color intensity. When the voltage drop exceeds 0.26 volt, the comparator's output will go low. That, in turn, will trigger the timer circuitry.

In addition, the C11/R5 time-delay circuit provides a short time-delay (about 100 ms) before the comparator is triggered. That prevents noise spikes from triggering the comparator.

The output of the comparator drives a five-minute-timer circuit. Whenever pin 7 of IC2 goes low, a ground is provided for the IC3 circuitry, and that, in effect, applies power to the timer. Capacitor C14 and resistor R9 provide a trigger pulse for the timer, which causes relay RY1 to close, and C13 to charge slowly through R8. After about five minutes, the capacitor is sufficiently charged to trigger IC3, which opens RY1. Of course if the commercials last less than five minutes, the output of IC2 goes high sooner. In that case, the timer starts all over the next time it receives power. Note that the relay contacts are connected to the PAUSE jack on the recorder.

Finally, there's a simple 12-volt power supply. A wall-plug transformer supplies about 14-volts AC to D3–D6; from there the voltage is filtered by C15. It is regulated to 12-volts DC by IC4.

PARTS LIST—EDITOR

All resistors ¼-watt, 5% unless otherwise specified
R1–R3—10,000 ohms
R4—1000 ohms
R5, R6—1 megohm
R7—48,000 ohms
R8—10 megohms
R9—100,000 ohms
Capacitors
C1—10 pF, ceramic disc
C2—220 pF, ceramic disc
C3—470 pF, ceramic disc
C4, C5, C7, C8, C14, C17, C18—0.01 µF, ceramic disc
C6—150 pF
C9, C10, C12—0.1 µF, ceramic disc
C11—0.1 µF, Mylar
C13—22 µF, 16 volts, low-leakage electrolytic
C15—470 µF, 25 volts, electrolytic
C16—10 µF, 16 volts, electrolytic
Semiconductors
IC1—MC1350 IF amplifier
IC2—LM311 comparator
IC3—555 timer
IC4—78L12 12-volt regulator
Q1—2N3906 or equivalent
D1—1N6263 Schottky signal-diode *or* 1N60 germanium diode
D2–D6—1N4002
RY1—12-volt SPDT relay, 400-ohm coil (Mouser 43BC001 or equivalent)
L1, L2—10 µH adjustable shielded coil (J.W. Miller 9052 or equivalent)
P1—RCA phono plug
P2—subminiature phone plug
J1—subminiature phone jack
S1—SPST toggle switch
T1—12 VAC, 250 mA, wall-plug transformer
Miscellaneous: PC board, IC sockets, RG-174 coaxial cable, case, wire, solder, etc.

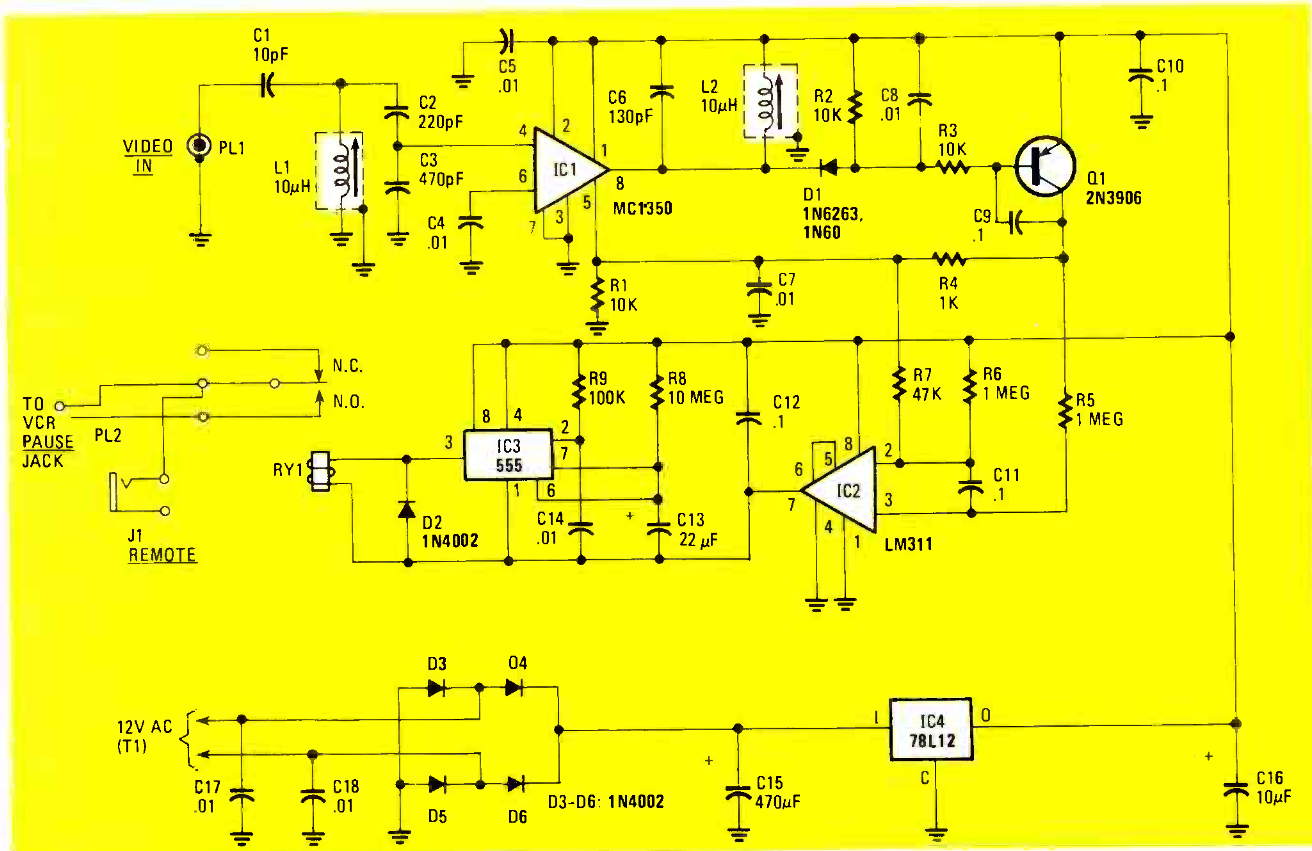


FIG. 2—AGC-CONTROLLED AMPLIFIER is preceded by two bandpass filters that isolate 3.579545-MHz color-burst signal.

Assembly

The commercial editor is intended to be built on a small PC board. In fact, you *must* use a PC board. If you don't, the AGC-controlled amplifier will probably oscillate, making it impossible to adjust the unit.

Figure 3 shows the foil pattern for the single-sided PC board, and Fig. 4 the parts-placement diagram. Start by positioning the board foil-side down so it faces the same way as the board shown in Fig. 4.

Start assembly with the IC sockets. Install 8-pin sockets at IC1, IC2, and IC3 as shown, and carefully solder them in place.

The coils and the relay are installed next. Install a coil at L1, and push it flush with the board; then solder it in place. Similarly, install L2. Finish up by installing relay RY1 in the appropriate position. Be sure to push it flush with the board before soldering.

The resistors are installed next. Start by installing R1 (10K) next to L2. Then install another 10K resistor at R2, and still another 10K resistor at R3 as shown. Move over to the IC2 socket and install R4 (1K) near it. (Be careful not to put it in the R5 position!) Then install R5 (1 megohm) between R4 and the IC2 socket. Move to the right of the IC2 socket and install R7 (47K). Again, make sure it's in the right place. After that, install R6 (1 megohm) next to R7. Move down to the IC3 socket for the remaining resistors. Install R8 (10 megohms) just to the left of the socket. Then move down and install R9 (100K). That finishes up the resistors. Check your work carefully, and correct any mistakes you may find.

Install the capacitors next. Start by mounting C1 (10 pF) next to L1. Be sure to push the part flush with the board before soldering its leads in place. Then install C2 (220 pF) next to L1 in the same manner. Similarly, install C5 (0.01 μF) as shown. After that, install C3 (470 pF) between L1 and the IC1 socket. Move to the left of the IC1 socket and install 0.01 μF capacitors at C4 and C7.

Continue by installing C10 (0.1-μF ceramic disc) next to L2. Move to the

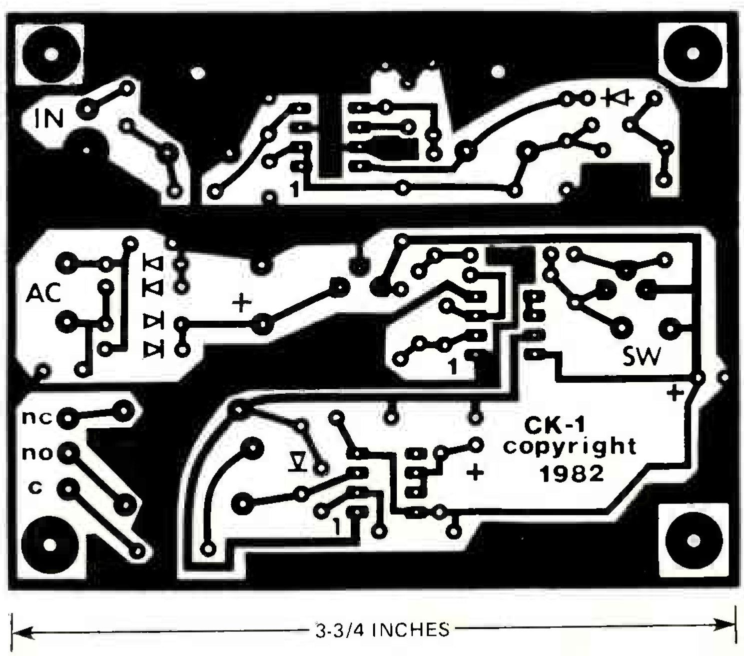


FIG. 3—FULL-SIZE foil pattern for single-sided editor PC board.

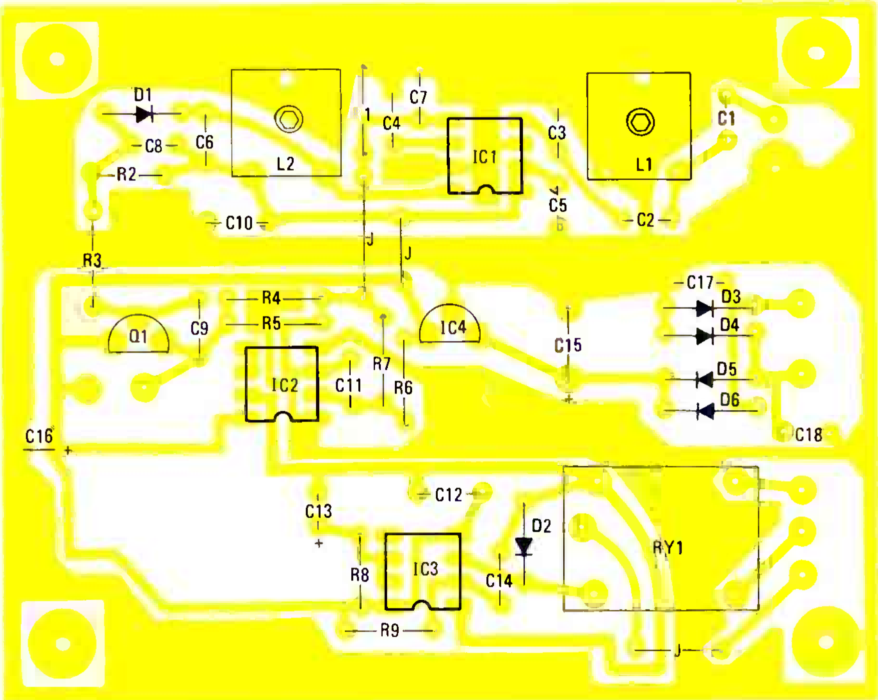


FIG. 4—BE SURE TO OBSERVE polarities of critical components. Be especially careful to install relay correctly.

other side of L2 and install C6 (150 pF). Then install C8 (0.01 μF) next to the 10K resistor. Make sure that C8 goes into the correct holes. After that, install C9 (0.1-μF ceramic disc) between the resistors.

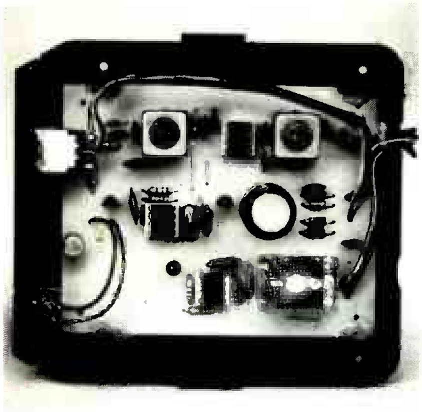


FIG. 5—COMPLETED circuit board should look like this. Board can be installed in small plastic clock-case.

Then move to the left edge of the board and install C16 (10 μF). Be careful to install this capacitor the right way; it's polarized. Similarly, install C13 (22 μF) next to the 10-megohm resistor. Then move up and install C11 (0.1-μF Mylar) between the IC2 socket and the 47K resistor. Continue by installing C12 (0.1 μF) above the IC3 socket and, after that, install C14 (0.01 μF) to the right of the IC3 socket. Move to the right center of the board and install C15 (470 μF) as shown. Be sure that this polarized part is inserted properly, then push it flush with the board and solder the leads in place. Finish up by installing C17 and C18 (0.01 μF). Carefully check your work before going any further. Be sure to check the polarities of the three electrolytics, and correct any mistakes before continuing.

Install the diodes next. Start with D3-D6. Install the four diodes as shown, then solder them in place. Move over to RY1, and install D2 as indicated. Finally, move to the top left corner of the board and install D1. Again, check your work and correct any mistakes before continuing.

The following are available from Technico Services, 1920 W. Commonwealth Ave., Box 20HC, Fullerton, CA 92633: kit of all parts, *less case*, (CK-2), $54.00 plus $3.50 postage & handling (nonrefundable); PC board only (CK-1), $10.00, postpaid; assembled and tested calibration tool (3.58-MHz signal generator) (CAL-3), $10.00, postpaid. California residents please add 6% tax.

There are three wire jumpers, identified as "J," to be installed, and they come next. Use leftover resistor leads and bend them to fit, insert them, and solder them in place. Start with the two jumpers next to L2. Before soldering them in place, be sure to position them so that they don't touch. Finish up by installing the last jumper next to RY1.

Next come the IC voltage-regulator and the transistor. Install IC4 (78L12) first. Be sure that the flat side of the case is positioned as shown before soldering the leads in place. Then install Q1. Again, make sure that the flat side of the case is positioned as shown.

As you can see, the board is essentially complete and should look almost like the one in Fig. 5. All that is left to do is install the IC's and attach the cables.

Start with the IC's and install IC1 (MC1350) first. Be sure to position it properly before you plug it in. Then install IC2 (LM311) in the same manner and, finally, IC3 (NE555). Be sure to check the IC's for proper installation before continuing.

Finish up by installing the cables (refer to Fig. 6). Start with the video-input cable. Cut a two-foot length of RG-174 coaxial cable, then strip and tin each end. Attach PL1 (RCA phono plug) to one end. Then connect the other end to the board. Note that the shield goes to the heavier ground foil on the board.

After that, connect the transformer leads. Measure about four inches from the *end* of the cable that is attached to T1 and cut *just one* of the wires at this point. Connect switch S1 at that point. Solder the free ends of the T1 cable to the appropriate pads on the circuit board.

Next, cut a two-foot piece of two-conductor wire (a short length of speaker wire will do). Attach PL2 (subminiature phone plug) to one end, and connect the other end of the cable to the board as shown.

Finish up the cable installation by wiring J1. Cut two two-inch lengths of hookup wire and solder them to J1 (subminiature phone jack). Then connect the other ends to the pads on the board.

That completes assembly of the editor's PC board. Once you've carefully checked your work, the next step is to align the device. That will be just one of the topics we'll cover in the next part of this article. **R-E**

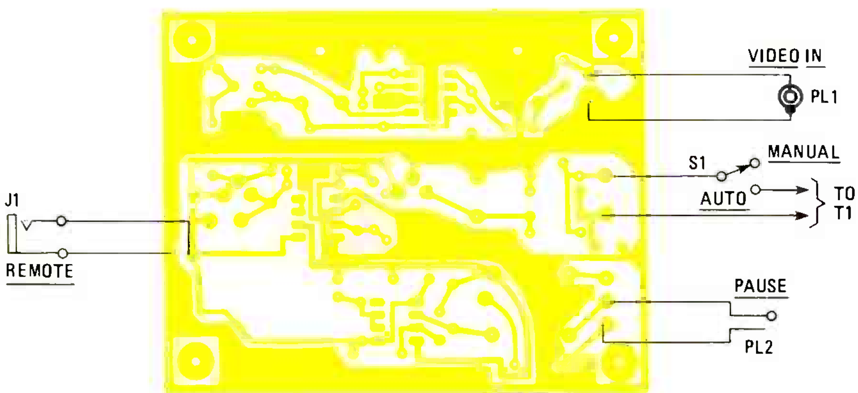
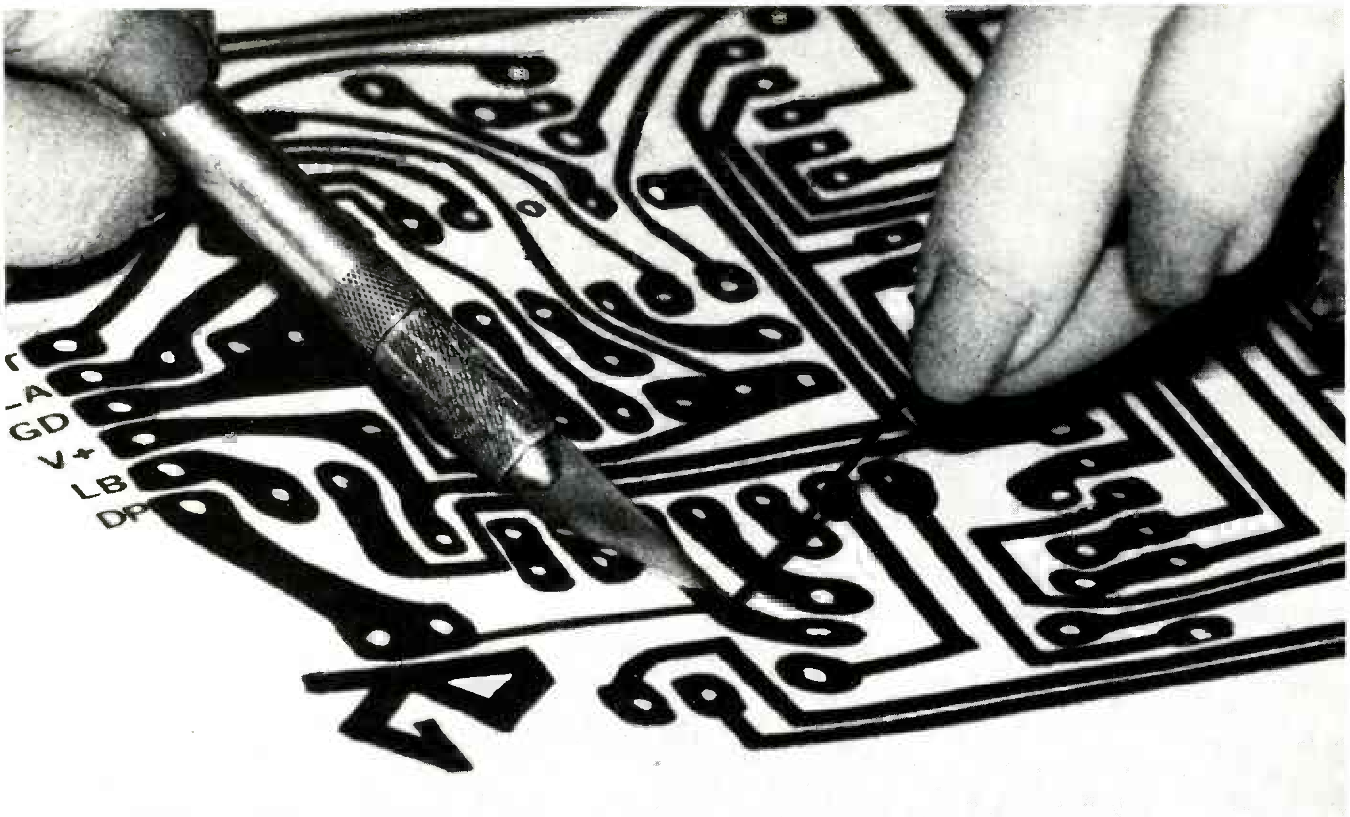


FIG. 6—OFF-THE-BOARD connections. Use RG-174 coax for VIDEO IN cable.



ETCH YOUR OWN PC BOARDS

There are lots of ways to make printed-circuit boards, but if the pattern is complicated, nothing beats doing it photographically.

ROBERT GROSSBLATT

ELECTRONICS HOBBYISTS HAVE NEVER had it as good as they do today. The modern home workshop can now be equipped with laboratory-grade instruments at consumer prices and can produce projects of industrial quality. It's rather astounding to consider that the decision whether to build or buy is more a function of convenience than complexity. Ever since the IC manufacturers discovered the profits to be made in the consumer market, the components needed for virtually any project are rarely more than a postage stamp away.

So why haven't we seen a tremendous increase in the number of sophisticated projects built and developed on a back-room bench? Obviously there's been a problem, but the biggest stumbling block to home construction doesn't have anything to do with design or complexity—nine times out of ten it's the printed-circuit board. A hobbyist who wouldn't think twice about designing a circuit for bouncing signals off Neptune often cringes when he considers producing printed-circuit boards. While electronics technology gets more sophisticated almost by the minute, the process of making PC boards has remained just about the same for the last thirty years. And the reason why it hasn't changed is that the process is really quite simple.

No kidding, it's really easy to do. There's been a big push among manufacturers to develop wire wrapping as some sort of technology all on its own. If you're into wirewrapping, don't bother reading any farther because all I think wire wrapping is good for is baling hay. But making even the most complicated double-sided board isn't difficult—it takes time and requires attention to detail, but it's not hard. Let's take a look at the basic procedure.

Copper-clad board is coated with a light-sensitive chemical and allowed to dry. A mask is made photographically (the foil pattern) and contact-printed on the board. The light in the printing process causes a change in the chemical coating so that the unmasked areas become resistant to the developer. What happens then when the board is placed in the developer is that the chemical over the unmasked areas (the traces) remains, while the chemical over the rest of the board is removed. The result is a board ready to be dumped into the etchant. That is the basic procedure for so-called negative photoresist; there's also a positive resist but the idea is the same. As you can see, there are several steps in the process and we'll go over them completely later on in this article. By the time we finish, however, you'll be wondering why you thought it was difficult in the first place.

Layout

Before we explore the mysteries of board making, there's something that comes first—laying out the pattern. By the time you're ready to consider making PC boards you've probably pulled out a lot of hair in breadboarding. You've rearranged circuitry and substituted different values to make sure everything is working exactly the way you want it. When you reach that point—when you decide that you're looking at the final design—you're ready to move on.

The first step is to draw a schematic of your breadboarded circuit. The chances are that you've already done that, but if you're anything like me the drawings are a mess. When I'm at that point, I usually have several pages filled with false starts and things that blew up. That's to say nothing about the most important sections, which I usually scribble on the back of an envelope. It's really important to stop and redraw everything. Make a clean drawing of the circuit, lay it out in a coherent fashion, assign numbers to the components, and carefully label everything on the page. Also, make sure you include the pin numbers of the IC's you are using. Use graph paper to help keep the lines straight and do as many versions as you need in order to make the drawing neat. Keep on checking your drawing against the breadboard as mistakes are easy to correct at this stage—it's much simpler to erase a line than to correct a trace. Make a couple of copies of the finished drawing in case you spill coffee on the original.

A completed drawing is a valuable tool because it will give you your first overview of your entire circuit. Don't be surpried if you wind up combining things or simplifying the design. Unused gates can be combined to eliminate whole IC's and a little reorganization can allow you to simplify complicated sections of your design. I usually wind up with several stages of "final" drawings until I get the point where any further changes are profitless. When you've reached that stage you are ready to begin the layout of the board.

At this point you have the schematic and the breadboarded circuit. **Whatever you do, don't fool around with the breadboarded circuit!** Not only will you still be checking the drawing against it, but later on, when the printed-circuit board is complete but perhaps doesn't work, you'll have something to compare it to. Remember an all-important rule of original design: the breadboarded circuit is the only one in the world that does what you designed it to do. The last step in creating a working circuit on a PC board, *the very last step*, is to pull the breadboard apart.

Special considerations

Examine the breadboard and the drawing. Are there sections of your design that have to receive special treatment? If certain sections need shielding, or have unusual power requirements, they should be physically close together on the board. Should the circuit be broken into several boards to conserve space? Is the printed-circuit board going to provide structural strength to the finished project? Does the board have to have a particular shape because of the case? Those are the sorts of questions you have to consider when you begin to do the layout. The answers will determine the materials you use, the size and number of the boards, how compact the layout has to be, and so on.

Before you start planning the printed-circuit pattern make sure that you have all the components that go on the board. Resistors, capacitors, and other components come in different shapes and sizes—and you're doing a layout for components of a particular size. If you plan on making three boards, make sure you already have three of everything you'll need. There are few things sadder than going through the trouble to make a complicated board and then finding out that certain small electrolytics aren't available any longer. It's always best to stick with standard, readily available parts.

The best way to work out your layout is to do it on graph paper, but the choice of paper is important. What you want is a light-blue grid measuring ten squares to the inch. Get a large pad of at least 20 by 24 inches and tell the people in the art supply store that you want it to be non-reproducible blue. That is a particular shade of blue that won't register on the film you'll use to photograph the final drawings. The pencils you use for the initial drawing should be the same shade of blue and can also be obtained at an art supply store. The reason you want such a large pad is that you'll be doing the drawing double size and reducing it later on. Leave yourself lots of room to work and make sure that the paper you use is at least four times larger than the intended size of your board.

Drafting

Draw a horizontal line across the middle of the graph paper. You should be able to fit a double-size outline of your board's

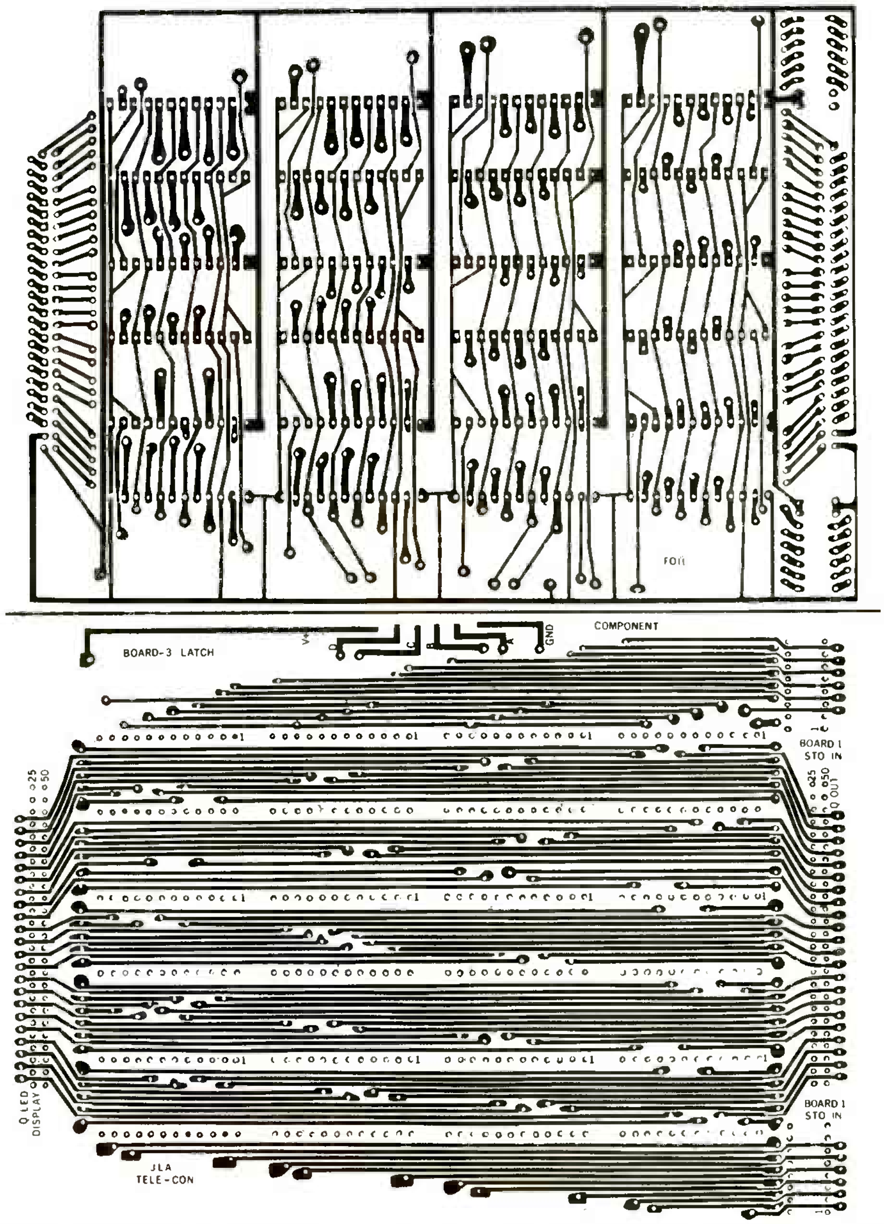


FIG. 1—DIGITAL-CIRCUIT FOIL PATTERNS often require long unbroken traces and double-sided boards with lots of interconnections. But even the most complicated patterns can be laid out and etched if you are patient and careful.

shape on both the lower and upper halves of the paper. If you can't, get larger paper. The reason for dividing it in half is that you'll be doing the foil pattern and the component layout at the same time. Not only that, but you'll be able to tell whether your board has to be single or double sided. Draw the outlines of the board in black using a fine-point magic marker. All the rest of your preliminary work will be done with blue pencils. This is the time to draw in the board extensions for edge connectors, or any other odd shape you need. Anything that has to be in a particular place on the board should be done in black. These are the "givens" around which the rest of the components have to fit. They are usually due to particular case requirements.

There are lots of schemes for doing a layout. Probably the best way to start is to draw the pins for the IC's. A good way to start the layout is to look at how the IC's were placed on your breadboard. Remember that you're working twice actual size so adjoining pins should be two squares apart. Since the physical dimensions of IC's are designed around 0.1-inch spacing, you'll find that everything fits neatly onto the paper. Place the IC's in neat rows and columns. That will make things easier when you start drawing in the traces and will make redundant connections obvious. Common connections such as power, ground, clocks, and so on will be much easier to lay in if the IC's are logically spread out on the paper. Make sure to indicate the IC pins on both halves of the graph paper and label pin number 1 on both halves to help keep everything straight in your mind.

Remember that you're not reversing anything—the bottom and top halves of the paper are being drawn as if you had laid both sides out flat and were looking down at them. Some layout schemes call for drawing the two sides of the board on top of each other in different colored inks. Not only does that cause extra steps later on, but left and right get confused and it's really easy to make mistakes.

I wish I could give you some foolproof way of routing the leads but I don't know any other than trial and error. Be prepared to do a lot of erasing and redrawing because it takes a while to solve the topological problems caused by your circuit—there's no teacher other than experience. When you find that you absolutely, positively have to cross traces, break one of them and draw doughnuts at the ends. Locate the **exact same** positions on the other side of the board, draw two more doughnuts there, and draw a trace connecting them.

As you draw the connections for your circuit and put in the components, try to avoid using the component side of the board because single-sided boards are much easier to make. Unfortunately, however, digital circuitry often requires a double-sided board. If you accept that in the beginning, you can save a lot of grief by first laying out the address and data lines. The chances are that those traces will require a number of connections between both sides of the board. It's not at all unusual to have a trace jump back and forth from one side of the board to the other eight or ten times—if you can make the connection that way, do it.

The complexity of the foil pattern you generate will depend on a number of things. If the component density is high, the foil pattern will be busy. Obviously, the more connections you have to make, the more complicated the foil pattern will be. Interestingly enough, if your circuit has lots of passive components, you'll have an easier time figuring out a foil pattern. You'll wind up with lots of short traces and you'll be able to route the longer power and ground connections around them. Digital circuitry is tough because lots of direct connections have to be made between the IC's. That requires long, unbroken traces and, unfortunately, lots of connections between both sides of the board (see Fig. 1).

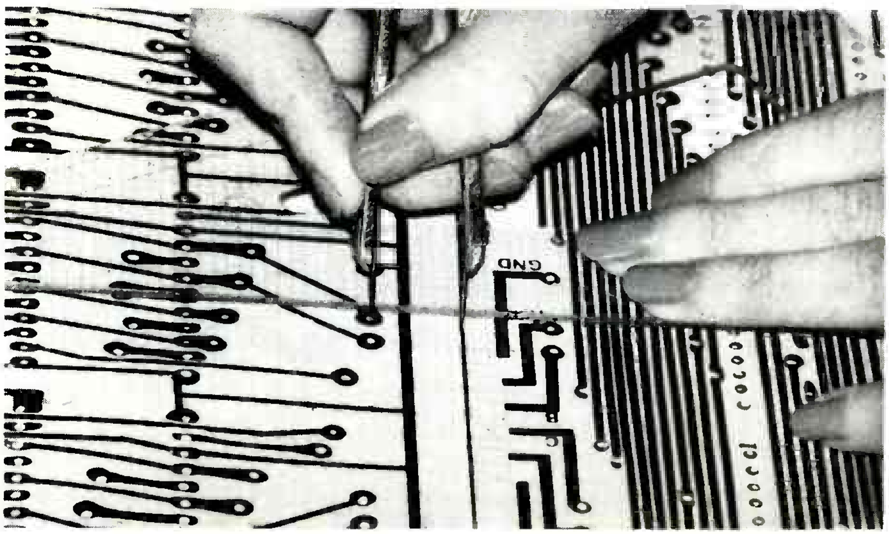


FIG. 2—WHEN LAYING OUT a double-sided pattern, one of the most important steps is to make sure that both sides line up properly.

Double-sided boards

Sometimes you can simplify things by rearranging the IC's but if you're dealing with power, ground, clock, address, and data lines, there's no way you're going to be able to get them all on a single-sided board. Don't throw in the towel, however, as double-sided boards *aren't* that much harder to make. Piggybacking components and using loads of jumpers is a poor alternative to making a double-sided board.

You have to be really careful when you're working back and forth on the two sides of the drawing—make sure that the holes and traces line up properly. Use a straightedge and calipers, as shown in Fig. 2, and don't feel silly about counting squares—I've made a lot of double-sided boards and I do it all the time.

Once you've decided to make your board double sided, take advantage of the decision. There's as much copper on the component side of the board as there is on the foil side. It's rather strange to jam as many traces as you can on the foil side and leave only a few on the component side. Not only that, but the more evenly you distribute your traces, the more likely it is that the board will etch evenly. If you have 90% of your pattern on the foil side and just a few traces on the component side, you're running a serious risk of undercutting the traces on the foil side during etching. What's more, having lots of traces on the foil side means that some of them are going to be thin. While you're waiting for a veritable sea of copper to be etched on the component side, the thin traces on the foil side will disappear.

If you plan things carefully, the connection from one side of the board to the other can be made using the leads of the components. It's a simple matter to solder the leads on both sides of the board. For those traces that wander from one side of the board to the other, you'll just have to leave doughnuts and connect them with small pieces of hookup wire soldered to both sides.

The big problem comes when you have to deal with IC's. There are a few options: For one thing, you can solder the IC's directly to the board and make the feed-through connections by soldering the IC legs on both sides—but **don't do it—** always use IC sockets. You can mount the socket so that it is raised about an eighth of an inch or so above the board and solder the the socket legs on both sides of the board; of course, you'll need wire-wrap sockets to do that. I don't like that method because wire-wrap sockets are more expensive and physically larger than others. Also, having the socket sit above the board leaves the plastic part of the socket free to move and puts an undue strain on the legs. All things considered,

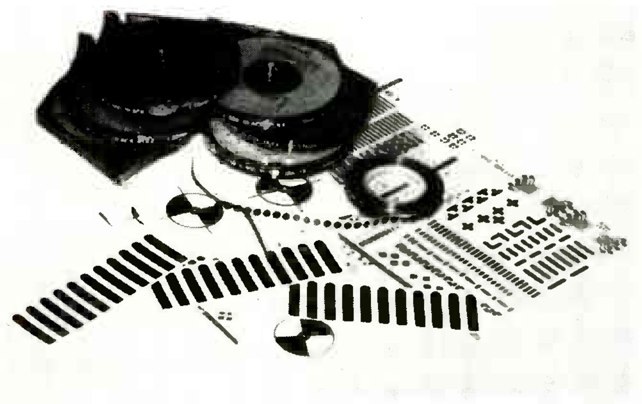


FIG. 3—DRAFTING AIDS, such as the ones shown here, can be very useful in completing your layout.

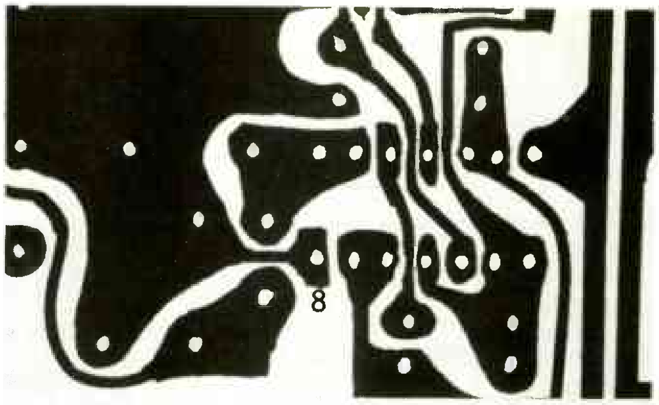


FIG. 4—IF TRACES MUST BE ROUTED between IC pads, elongate the pads to make soldering the components easier later on.

if your circuit is complex enough to require a double-sided board, you want to eliminate any potential problems, and mounting sockets above the board is a possible source of trouble.

What I do is to extend the trace on the component side and use small doughnuts on both sides of the board to make the connection from one side to the other. It's neater, and makes the board more secure and compact. After the board is etched, I thread hook-up wire through all the feedthroughs and then solder and snip them in one shot. Any other method leaves room for error and if you have a board with lots of connections, it's much too easy to forget the IC legs hidden under the sockets and then go crazy trying to figure out why the circuit won't work.

Further considerations

Whenever you add a component to your drawing, show the doughnuts on both sides of the board. Not only does that make the geography of the board easier to understand, but it will be the basis for a parts-placement diagram later on. When you have your drawing completed, draw the components in (remember you're working twice actual size) and make sure that there's enough room to fit them on the board. Count up the number of traces on the component side to see whether a double-sided board is justified. If there aren't too many, consider the idea of jumpers, instead. If you feel, though, that a double-sided board is necessary, make sure that you leave at least two squares between the traces and any component leads. That is particularly important around the IC's because you don't want the IC sockets to hide the traces on the component side. It's almost impossible to locate a small break in a trace if it's hidden under a socket, and it's even harder to correct it.

Once you have the drawing finished and have checked the hole alignment, make sure that the connections agree with the schematic. Take your time doing that because corrections are a lot easier to make at this stage than they will be later on.

Final artwork preparation

After everything has been verified, the next step is to prepare the board for photography. All that means is that you have to ink in all the doughnuts and traces you've done in blue pencil. Many of the commercially available drafting aids can come in handy here (see Fig. 3). Long runs can be made using black drafting tape and several companies sell IC pads and doughnuts in double-size patterns. When working double size, try to keep the traces at least 1/16-inch wide and separated by at least 1/32-inch. That's the absolute minimum, though—tiny traces have a nasty habit of disappearing in the etchant and small separations may not show up in the final foil pattern.

The only exception is when you find it necessary to route leads through the pins of IC's (which you should avoid like the plague—especially if you're doing a double-sided board). If you find that you absolutely have to route traces between IC pads, make the pads, rather than the trace, thinner, and elongate the pads parallel to the traces as shown in Fig. 4 to be sure you'll have enough copper to solder the pins to.

When you've finished that part of the layout make sure there aren't any breaks in the pattern. If you find any, color them in with a fine-point felt-tipped pen as shown in Fig. 5. Check the pattern carefully and if any of the traces or corners look thin, use the pen to fatten them. If you make a mistake, cover it over with typewriter correction-fluid and redraw it.

Make sure your lines are as black as possible and are completely filled in—every bit of black you add now will become copper on the board. Also, try to anticipate any special problems. Will you be soldering any nuts on the board to mount a meter or power transistor? If so, blacken in an area large enough to provide copper for the nut. There are no hard and fast rules to tell you how much copper to leave on the board and everything depends on your application, and your patience. Just remember that the more copper you keep, the less you have to etch. Once I've gotten to this stage, I thicken every trace I can to make the etching process as simple as possible. It never hurts to have spare copper on the board and wide power and ground planes are never a bad idea.

There is one place where the doughnuts should be as large as you can possibly make them. That is wherever you have feedthroughs going from one side of the board to the other. The larger the doughnuts, the more tolerance you're going to have in keeping the top and bottom of the board in register later on.

When we continue this article, we'll put the finishing touches on the layout. We'll also show you how to transfer the layout to the copper board. **R-E**

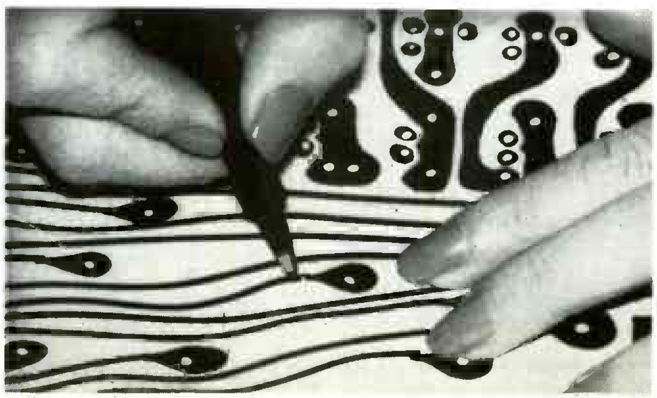


FIG. 5—REPAIR ANY BREAKS in the layout by filling them in with a felt-tipped pen.

SPECIAL SECTION

VIDEO ENTERTAINMENT

Radio-Electronics®

A GUIDE TO VIDEO ENTERTAINMENT IN THE HOME

Video Entertainment in The Home
New Video Components
Direct Broadcast Satellite Television
Video Accessories
How to Connect Video Components

VIDEO ENTERTAINMENT

The video revolution has changed the way we look at and use television. But has your set kept up, and will it keep up in the future? The following will help answer that question.

A. LEVIS

IT WAS ALL SO SIMPLE BACK IN THOSE EARLY DAYS OF VIDEO, BEFORE SONY'S *Betamax* and Atari's *Pong* began to change the way we viewed the lowly TV set. In that ancient era, which began drawing to a close in the early 1970's, video simply meant television. The only choice one faced when shopping for video equipment was whether or not to blow the entire budget on that huge 25-inch console.

Unless you've been asleep these past few years, you know that those days are most certainly gone for good. Walk into any video store or department and you are likely to see VCR's (*V*ideo*C*assette *R*ecorders), videodisc players, projection televisions, television-component systems, VCR and cable-TV accessories, and perhaps even a complete satellite-TV earth station. You're also likely to find a great many computers and video games; we'll not say much about those products in this section, but you can be certain that the next year will feature the kind of new products and exciting advancements we've all now come to expect. What we will be looking at is video—the latest developements in the field, as well as what the near future holds. But first, let's look at what our old family TV-set has grown into, and why.

Alternative programming

In the old days, television "quality" generally referred to a set's reliability rather than to the kind of image it reproduced. After all, few consumers would have been willing to lay out the extra dollars for such things as high resolution—even if the manufacturers had been capable of producing sets with such features—just to watch the generally low-quality fare offered by the networks.

That began to change with the advent of cable-TV services such as Home Box Office. That service, and others like it, offered viewers a real alternative in the form of recent movies, live sports events, and specials.

The real beginning of the so-called video revolution, however, began with the introduction of the VCR. That device gave the viewer almost complete programming control. Today, programming can be drawn from a vast array of pre-recorded videotapes, including the very latest movies (sometimes the videotape is released simultaneously with the movie's premiere); from both free (broadcast) and pay-TV services, or can be original—the video camera allows your video programming to be limited only by your imagination. For those who demand the very best, there are now video accessories that help clear up many picture, color, and stability problems; we'll take a closer look at those elsewhere in this section.

A relatively new program source is the videodisc. Although those devices lack the recording capabilities of the VCR, and have not proven as successful in the marketplace as was predicted, there is still considerable hope that it will succeed as an alternative program source. Among its advantages are its lower initial outlay, as compared with a VCR, and its potential for use with a computer.

IN THE HOME

Currently, satellite-TV reception is out of reach to all but a few. That too is about to change as an exciting new service, direct broadcast satellites, will be in place by the end of this decade. Aside from being yet another source of alternative programming, it may also offer such attractive features as high-definition TV and stereo sound.

A new kind of TV

Although TV set manufacturers were slow in responding to the explosive growth of alternative programming and video-related products, they soon realized that their product was destined to become the centerpiece of a sophisticated, highly complex, and demanding electronic home information and entertainment system. They also realized that the conventional TV-receiver was inadequate for that purpose. There were many reasons for that, but among the most important was the way a signal is fed into the receiver. Up to recently, the only signal that the TV was required to handle was a combined over-the-air audio/video RF signal; that signal was simply fed into the set through the antenna terminals. Once inside, the RF signal was demodulated, with the video information extracted and displayed on the screen. The result of that process was degradation of the signal that showed up as poor resolution, video-noise, and the like.

With some recent exceptions, that's exactly how it's still done. But now, as we pointed out before, the TV set is being called upon to handle the audio and video information from a variety of sources. Those signals are still fed in through the set's antenna terminals, and on an RF carrier. As a result, that same modulation, demodulation, and extraction process still causes significant signal degredation. And what may have been acceptable for watching your favorite soap opera certainly is not when dealing with computer-generated graphics, videotapes, videodiscs, etc.

The standard television set also fails in another important area. The audio quality of most sets is poor. And while high-quality audio may not be particularly important for getting the most out of your video game or computer, some things that should happen in the near future will make TV audio more important than it has ever been before. One of those is multichannel, or stereo, TV-audio. Such audio has been available in Japan for many years now, and last year was introduced in West Germany. In both cases, the set manufacturers were prepared and had sets on the market by the time the service was approved. In this country, three TV-stereo systems have been proposed; as this is written, though, no commitment has been made to any of them, so neither we, nor the set manufacturers can be certain of which standard(s) will eventually receive acceptance. In the meantime, however, VCR's and videodisc players with stereo-audio capability are already on the market.

But help is on the way, thanks to a new generation of TV equipment designed to meet the high requirements of new and future video technology, and to be the centerpiece of that home-entertainment/information center of the future. The age of component television is here.

The term component television is currently used to refer to a wide range of products. In the past year, many of the leading set manufacturers, and some manufacturers that previously had dealt with audio products only, have introduced at least a few models designed to solve some of the video and audio problems we've mentioned. In some cases, they've simply taken an existing TV chassis and added separate audio and video input jacks. Doing that allows direct access to both video and audio circuits, getting rid of many of the problems associated with feeding an RF signal to the set. That helps, but you're still stuck with a receiver with limited flexibility, and limited growth potential.

A better alternative is the true component approach. Systems of that type were first available last year from Sony (1 Sony Plaza, Park Ridge, NJ 07656) and Teknika (1633 Broadway, New York, NY 10019); now they are available from a variety of manufacturers. Those systems are by no means identical, and each manufacturer has its own idea as to how a component system should be configured. For instance, some offer a seperate amplifier and monitor while others offer a combined package. Also, in some the tuner doubles as a switcher while in others those functions are handled by separate components. Since you now have a bit to choose from when picking your component system, it's important to match your needs to what's available.

What's available

The *Profeel* system from Sony remains unchanged from last year except for the addition of a new 12-inch monitor to the series. Like the larger 19- and 25-inch *Profeel* monitors, this one boasts good video resolution and offers an RGB (*R*ed, *G*reen, *B*lue) input. While currently that input will only be of interest to some computer hobbyists, it is hoped that will change with the eventual availability of RGB outputs on consumer video equipment. The main advantage of an RGB input is that it allows you to bypass all of the signal processing stages in the receiver. The RGB signals are fed directly to CRT grid amplifiers. For the time being, however, such outputs are available only on professional equipment.

THE NEWEST ADDITION to the *Profeel* line, is the model *KX-121HG* shown here. Like all *Profeel* monitors, it boasts RGB inputs.

Sanyo (1200 W. Artesia Blvd., Compton, CA 90220) enters the field with their *Pro-Ponent* system. It features a 19-inch monitor with a built-in 5-watts-per-channel stereo amplifier, a separate TV-tuner with remote control, a companion stereo-audio sound system, and a pair of accessory speakers. The tuner has multiple inputs designed to accept a wide variety of sources (VCR, videodisc, etc.).

Zenith (1000 Milwaukee Ave., Glenview, IL 60025) was the first U.S. manufacturer to offer a component TV system. It includes a 19-inch monitor, TV tuner, a separate source-selector, a separate stereo-amplifer, and speakers. The monitor also has its own built-in audio amplifier and speaker and features both composite-video/audio and RGB inputs. The source selector allows the connection of up to six sources to the system. The tuner features an infra-red remote control and has 112-channel capability, including 42 for cable TV.

Several high-fidelity audio-component manufacturers have also come out with systems. Pioneer (200 West Grand Ave., Montvale, NJ 07645) is offering two screen sizes, 19- and 25-inches, with the larger monitor offering 400-line resolution, which is the highest claimed by any manufacturer. The tuner is housed separately and features 127-channel capability and an infra-red remote control; the tuner also serves as the system's source selector, handling all of the switching functions.

THIS NEW VIDEO-COMPONENT SYSTEM from Jensen offers a choice of tuners either with (shown) or without AM and FM-stereo.

Jensen (4136 N. United Parkway, Schiller Park, IL 60176) has a new entry that offers the consumer an additional choice. While many manufacturers are marketing systems with more than one monitor size, Jensen is marketing two tuners—one for AM and FM-stereo as well as TV, and one with TV capability only.

Even some smaller companies are getting into the act. NAD (675 Canton St., Norwood, MA 02062) and Proton (1431 Ocean Ave., Suite B, Santa Monica, CA 90401) are marketing systems built around the same 19-inch monitor, but will sell them through different outlets.

Component-TV systems are also available from Mitsubishi (7045 N. Ridgeway Ave., Lincolnwood, IL 60645), JVC (41 Slater Drive, Elmwood Park, NJ 07407), and others. And you can be sure that the list will grow considerably in the near future.

The future of video

Will your new video-entertainment/information system soon become obsolete? The answer to that is yes and no. No, because the U.S. is almost certainly tied to the 525-line NTSC broadcast standard for many years to come, although just about everyone involved with the technical end of the television industry—from broadcasters to set-makers—agrees that it is less than perfect. (For one thing, the resolution of current sets is not limited by technology, but by that standard.) Yes, because there are several developments that may soon result in higher definition television, with signals compatible with the NTSC standard.

Work is continuing on high-definition TV (HDTV), with much of it concentrating on developing a system that is NTSC compatible. RCA, for one, is involved in an intensive NTSC-compatible HDTV project, and believes such a system can be operational within this decade.

Another thing to look forward to is the arrival of digital TV. ITT in Europe is scheduled to begin offering set makers digital-circuit kits sometime next year, and such international companies as RCA, Sanyo, Philips of Holland, Sharp, Blaupunkt and Thomson CSF are involved in intensive research and development projects in that area.

But one of the chief advantages of a component system is its adaptibility. It's relatively easy to modify your system to keep in step with the latest changes in technology, or your needs. So, don't let what's coming tommorrow spoil your fun today. **R-E**

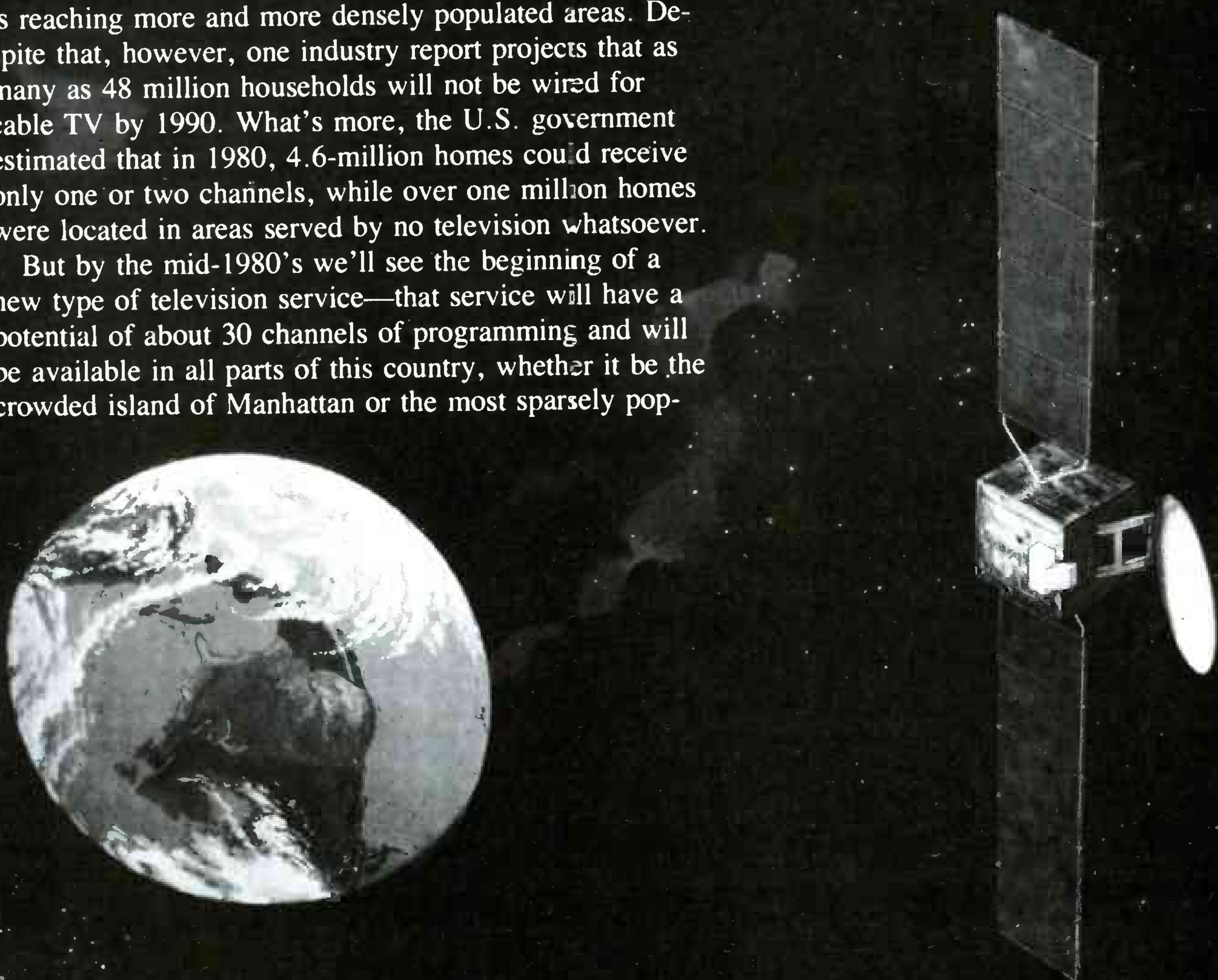
DIRECT BROADCAST SATELLITE TELEVISION

In this age of cable television, a proposed cableless system is getting quite a bit of attention. Here's a look at what DBS television is, and what it can mean to you.

DANNY GOODMAN

AS THE WIRING OF AMERICA CONTINUES, CABLE TELEVISION is reaching more and more densely populated areas. Despite that, however, one industry report projects that as many as 48 million households will not be wired for cable TV by 1990. What's more, the U.S. government estimated that in 1980, 4.6-million homes could receive only one or two channels, while over one million homes were located in areas served by no television whatsoever.

But by the mid-1980's we'll see the beginning of a new type of television service—that service will have a potential of about 30 channels of programming and will be available in all parts of this country, whether it be the crowded island of Manhattan or the most sparsely pop-



THE SMALL SIZE and relatively low cost of a DBS dish antenna will bring satellite-TV reception within reach of most families.

ulated areas of Nevada or Montana. All you'll need to receive that service is line-of-sight exposure to a satellite parked in orbit some 22,300 miles up, a 2½-foot-diameter dish antenna, a satellite receiver, and your TV set.

At least eight companies have unveiled a variety of plans for *D*irect *B*roadcast *S*atellite (DBS) services, including advertising-supported programming (free to the viewer), subscription television (pay TV), and advanced video services such as teletext and *H*igh *D*efinition *T*ele*V*ision (HDTV). The success of those plans depends on a number of technical and regulatory issues that are as yet unresolved, but substantial amounts of money are being invested in the belief that DBS services will eventually become a reality.

Mini dishes

DBS services will differ greatly from the satellite-TV services currently in operation. The present generation of TV satellites generally receive high-powered signals from Earth in the 5.9- to 6.4-GHz range (called the *uplink* frequency), and retransmit them in the 3.7- to 4.2-GHz range (called the *downlink* frequency) using low-powered transmitters. The downlink transmitters are low powered primarily because each satellite carries as many as 24 transponders and each of those must share the limited power provided by the satellite's solar panels. The transponders carry TV and radio relays, as well as two-way communications traffic.

The retransmitted signal is so weak by the time it travels through the atmosphere that the receiving antenna dish needs to be relatively large (10 to 20 feet in diameter) to collect as much signal as possible and focus it on the receiver's sensitive amplifier, which is suspended over the dish's center. Large dishes and highly advanced receiving circuitry built in small quantities make for expensive setups, ranging from under $5,000 to over $25,000 depending on your location and the number of different satellites you want to tune in. While that high cost, and the large size antennas required, may not present a problem to a cable-TV company, it does put home satellite reception out of the reach of many individuals and families.

The proposed DBS services, however, will use frequencies in the 17-GHz region for the uplink and frequencies in the 12-GHz region for the downlink. More important, however, is that the satellites will have transmitters capable of outputs of 150 watts or more. Contrast that to the satellites that are currently in service: those can only deliver outputs of about 5 watts or so. The greater power levels will allow a sensitive receiver to gather a useable signal from the smaller 2½- to 3-foot dish. At that size, a chimney-mounted satellite dish is no more cumbersome than a high-gain terrestrial-TV antenna.

Programming on the DBS channels may not be different from present satellite fare, but its intended audience will be. Currently, satellites are used primarily as a relay for broadcast and cable networks. In the original plan, retransmitted signals were to be picked up only by properly licensed ground stations for further distribution over a local terrestrial TV station or cable network. While the FCC has removed the necessity of securing a license for a TVRO (*TV R*eceive *O*nly) station, there are still some gray areas about the legality and/or ethics of individuals "eavesdropping" on relay satellites. Home Box Office, one of the more popular and outspoken satellite services has begun scrambling its signal, making it difficult for satellite afficianados to view their programs. Other satellite-distributed services may feel likewise threatened by the relatively small number of TVRO owners and scramble signals.

In contrast, DBS signals will be received by each individual subscriber, bypassing the need for an earth-based distribution system such as a cable system. Some cable systems may, however, wish to "subscribe" to a DBS service so that they can, in turn, offer the DBS services to their own subscribers.

Variety of DBS services

The proposals submitted to the FCC by the initial eight DBS applicants contained a number of different approaches. Satellite Television Corporation (STC), a subsidiary of COMSAT, was the first to submit a proposal, having done so in April 1981. Their plan (see Fig. 1) calls for a system of four active satellites, one for each of the U.S. time zones (the Pacific Time Zone satellite will also serve Hawaii and the more heavily populated areas of southern Alaska), plus two orbiting spares. The spares are intended to provide uninterrupted service in the event that one of the primary satellites fails. As early as 1985, STC hopes to have its first satellite (and one spare) in place, providing service initially to the Eastern Time Zone.

It is expected that each STC satellite will have three operating transponders (one for each channel of programming) and three spare transponders. With the high cost of each satellite and the long waiting list for room aboard a Space Shuttle or Ariane rocket, spare transponders and satellites are particularly important to prevent delays or interruptions in service due to equipment failure.

Three distinctly different program channels will be beamed from the 185-watt transponders. Only one, the so-called "Superstar" channel will run nearly 24 hours a day. Planned programming includes recent movies, popular concerts, theater, and family entertainment. The "Spectrum" channel will offer 15 hours daily of children's programming, classic films, performing arts, cultural programs, and public affairs. "Viewers Choice" will offer 15 hours of sports, educational/instructional programming, ex-

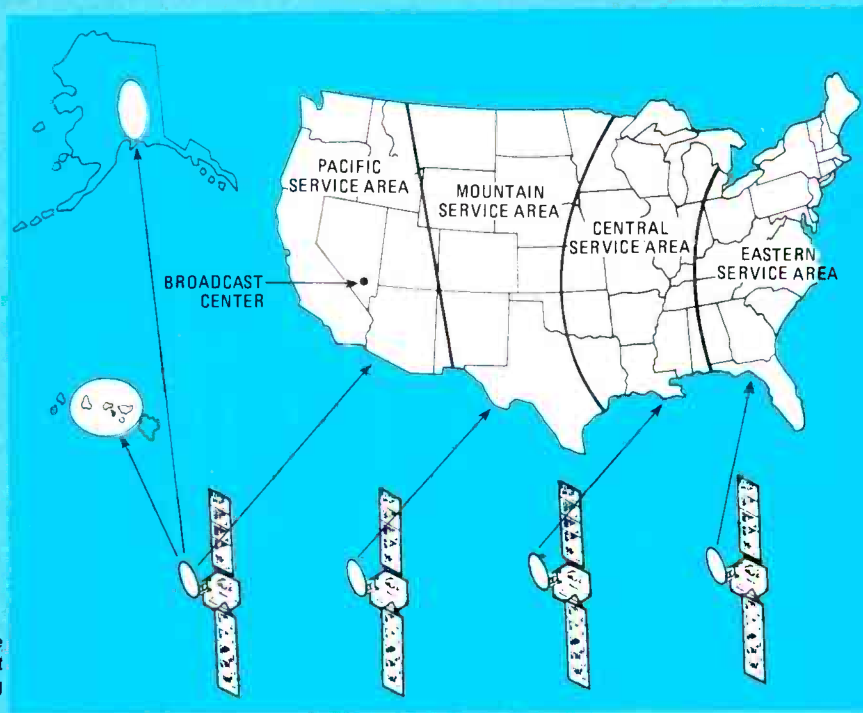


FIG. 1—STC'S PROPOSED DBS SYSTEM will cover the entire continental United States, as well as the most heavily populated regions of Alaska and Hawaii, using four operational satellites and two spares.

perimental theater, and the like. STC plans to "counter program," a scheduling method that tries to satisfy as many different viewing tastes during a given viewing period as possible. The STC satellite network will also have provisions for stereo sound for concerts, simultaneous second language transmission for minority viewers, and closed captioning for the hearing impaired. It also will present a full range of teletext information services.

All three channels will be scrambled, and TV set decoders will be individually addressable (digitally coded signals corresponding to each home decoder's serial number will engage the decoder), allowing the possibility of pay-per-view or pay-per-series specials requiring an extra subscriber fee.

Free satellite TV

United States Satellite Broadcasting (USSB) is taking a different approach. Their initial plan calls for only two satellites to cover the four time zones. Each satellite would carry six operating transponders, three for each time zone. An orbiting spare would have 12 transponders ready to fill in where needed.

But what is more striking about their proposal is that the three channels would be advertiser-supported—like our present commercial TV—and would therefore be free to any viewer equipped with a dish and satellite receiver. According to Stanley Hubbard, president of USSB, the company's DBS service will be like a fourth national commercial network, with member TV stations around the country. Local stations will act as news bureaus and will be able to sell original programming to USSB and advertisers for national broadcast. Local member stations, whether broadcast or cable TV, will be able to re-transmit the USSB programming in those areas where DBS dishes aren't practical or popular. That proposed system is shown in Fig. 2.

Planned programming on USSB's channels include a full-service TV channel (news, weather, entertainment, children's programming, etc.), a 24-hour news and information

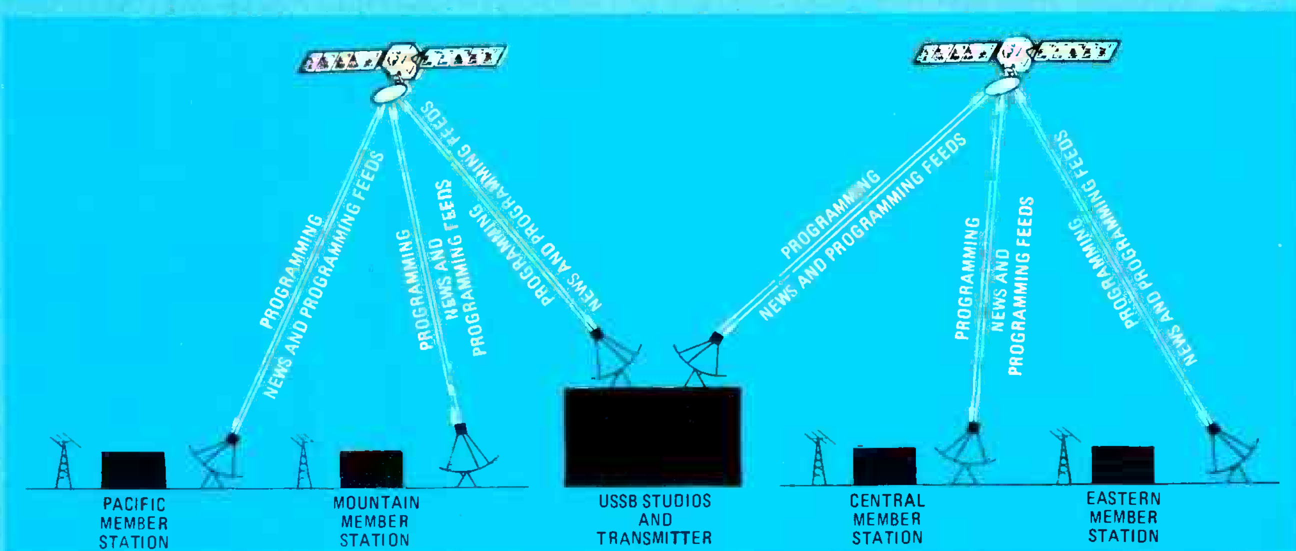


FIG. 2—IN THE USSB PROPOSAL, local member stations will feed news and original programming to the satellite "network" for national distribution. The local stations will also be able to rebroadcast the DBS services in areas where home satellite reception is either not practical on unpopular.

channel, and a third channel. Hubbard would not reveal what programming was planned for that third channel, but he did state that it will be "something original and unique."

Another way DBS satellites may be used is as common carriers. In other words, satellite companies will build, launch, and control the DBS satellites, but will lease the transponders to programmers or networks as is currently done with C-band satellites.

Pat McDougal of Direct Broadcast Satellite Corporation (DBS Corp.) foresees his company dividing the country into three zones, with one satellite covering each zone. Each satellite will have six channels, some of which could be used to transmit programming only to specific regions within the satellite's broader reception area; that reception area is often called a satellite's "footprint."

Although, as a common carrier, DBS Corp. would have no say in the programming going through its satellite, McDougal anticipates a mixture of advertiser-supported (free) and scrambled subscription or pay-per-view programming. DBS Corp., he says, is working toward a universal decoding scheme for all DBS satellites so viewers won't need a separate decoder for each service. There will also be a huge potential for FM stereo and teletext services through the DBS Corp. system.

High resolution

For its part, CBS is looking to the sky to test and implement a major video development expected in the mid- to late-80's called HDTV (*H*igh *D*efinition *T*ele*V*ision. The intent of HDTV is to improve the resolution of the video picture in the U.S. from the current NTSC standard of 525 horizontal scanning lines to 1125 lines. The aspect ratio (the ratio of horizontal to vertical measure) would also change from the present 4:3, to 5:3, which more closely resembles the aspect ratio of theatrical films. Unfortunately, HDTV signals will require a wider bandwidth than NTSC television signals because they contain much more information.

The CBS plan calls for four satellites (one per time zone), each capable of transmitting three HDTV channels. One channel would be used to feed HDTV programming to CBS affiliates for rebroadcast. A second channel would probably feature subscription and/or pay-per-view programming for individual subscribers. The third HDTV channel would be a professional service, most likely used for distributing HDTV movies to theaters, where they would be shown using a HDTV projection-television system.

As it appears now, HDTV signals will be incompatible with current TV receivers, and a report prepared for CBS indicates that HDTV sets will cost about 20% to 30% more than a standard television. But CBS is also looking at ways to make HDTV signals "transcodable," that is, to allow them to be viewed on NTSC sets also. In addition, work is being done by CBS and other HDTV developers to establish international standards to avoid the NTSC/PAL/SECAM compatibility problems broadcasters face today; work is also being done to find ways to reduce the bandwidth required for HDTV signals.

Home receiver

To receive the DBS programming, each subscriber will need a home DBS receiver. To prompt potential suppliers to develop those receivers, STC early this year issued provisional specifications for their system's home receiver, a block diagram of which receiver is shown in Fig. 3.

The eventual cost of the home receiver is difficult to predict at this time. One reason for that is that work is continuing in an effort to reduce the cost of several of the critical microwave components. The GaAs FET's used in the circuit, for instance, cost between $10 and $20 each when bought in large quantities. Among other things, ways are being sought to improve the manufacturing yield (the ratio of the good circuits or devices to the total produced) and to place as much of the circuitry as possible—including multiple GaAs FET's—on a single IC. That is turning out to be more difficult than with ordinary semiconductors, but researchers are confident that solutions will be found by the mid-1980's, when many of the DBS services are expected to begin.

Even with the uncertainties that remain, STC figures that consumers will need to pay "several hundred dollars" for the receiver electronics, or will be able to lease the receiver from the company for about $25 per month, including the subscription to the basic three-channel service. Those that chose to buy the electronics can expect to pay $14 to $18 for the subscription alone. In addition, a one-meter dish antenna will have to be bought and installed at a cost of about $100. Stanley Hubbard, of USSB, predicts that mass-produced receivers, capable of tuning all possible DBS channels in the 12-GHz range, will be available for $250 or less. **R-E**

(continued next month)

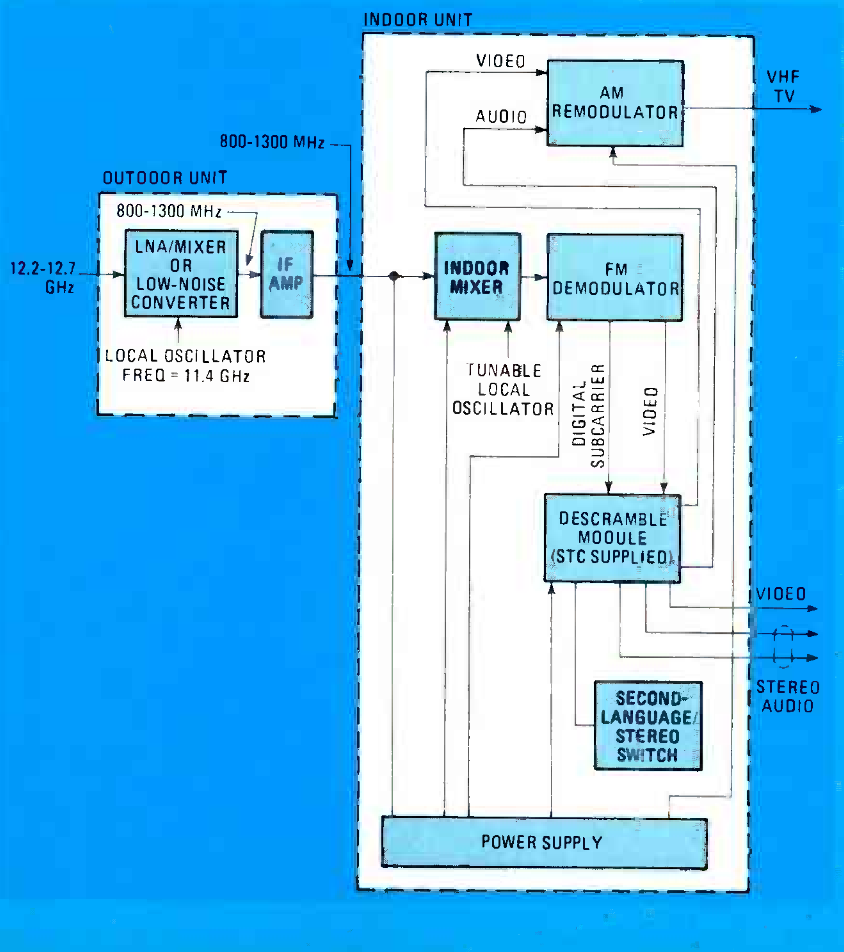


FIG. 3—BLOCK DIAGRAM of STC's proposed receiver. Descrambling will be handled by an STC-supplied module.

NEW VIDEO COMPONENTS

From the looks of things, the video revolution is nowhere near over. Here's what's new in home-entertainment equipment, and what to expect in the next couple of years.

DANNY GOODMAN

IN THE LAST FEW YEARS, WE'VE SEEN THE INTEREST AND activity in video grow at an almost explosive rate, and there is no sign of that letting up. Consider, for instance, that VCR's continue to sell briskly; pre-recorded videotape rentals are way up; and, according to an RCA estimate, those who own videodisc players also own, on the average, a library of about 30 discs. It's also expected that video camera sales in 1982 may double those of the previous year.

Manufacturers of home video equipment are very much aware of the consumer's love affair with video. They continue to produce better performing, more advanced equipment in new shapes, sizes, and concepts—all designed to lure more of us into the video picture. And, from the looks of the trend-setting video innovations already here and expected soon, they're likely to succeed.

Hi-Fi VCR

Stereo-audio for broadcast TV is still only in the planning stage in the U.S., but the absence of a broadcast standard isn't preventing stereo from being included in several home videocassette-recorders. For now, stereo is limited to the upper end of the VCR price scale. In the VHS format, for example, top-of-the-line models from Panasonic (*PV-1780*), JVC (*HR-7650*), Quasar (*VH5623UW*), and General Electric (*1VCR3018W*) all feature stereo-audio inputs and outputs, including Dolby noise reduction. As high-end models, costing roughly \$1500 to \$1600, those units also have the deluxe special effects features and remote control offered on last season's expensive recorders. In the Beta format, Marantz has a home deck, the model *VR200*, with stereo and *Dolby C* noise reduction. That deck lists for \$1295.

Although there are few pre-recorded stereo-videocassettes currently available, there are other possible sources for two-channel audio, including FM simulcasts of TV concerts, stereo videodisc players, and your own dubbing. But, as stereo VCR's become more popular, you can be sure that much more pre-recorded material will become available. The quality of the audio, howev-

er, may not measure up to what you might expect from a hi-fi tape recording. The audio tracks on videotape are narrow, and the tape speed relative to the fixed audio tape-heads (ranging from 1.31- to 0.44-inches-per-second depending on format and selected speed) is slower than an audio cassette's 1⅞-inches-per-second. But if the stereo is played through a hi-fi amplifier and speakers, it will provide a spatial feeling and left-right separation that you can't get from any of the TV stereo-audio adapters currently on the market. And stereo isn't just limited to the home—a new portable VHS-format VCR, the JVC *HR-2650*, lets you record your own stereo material in the field. That unit sells for about $1150.

Finding stereo in such compact recorders is not surprising considering that the trend in new portables is to equip them with as many features as the stay-at-home models. Today, the full-featured portable essentially breaks the home VCR's tape playing and tuning/timing elements into separate, mobile components. That arrangement offers the most in flexibility, since the VCR system can be a compact portable-recorder for remote taping with the addition of a camera, but can also act as a sophisticated home deck with such features as infrared remote control, multi-day/event time-shift programming, and special effects.

The lightweights

The race is on in the industry to see who can develop the smallest and the lightest VCR. Sony's *SL-2000* ($1150) and the Zenith *VR-9800*, which is sold with its companion tuner for $1425, are the lightest Beta portables, weighing just 9.5 pounds. But several lighter (8.5 pounds) VHS-portables were recently introduced; those are built on the same Matsushita chassis and carry brand names like Magnavox, Panasonic, Quasar, General Electric, and Canon. Those units range in price from about $750 to $1500. The high-end models are full-featured VCR's that include, among other things, 14-day, 4-event programmable tuner/timers.

An intriguing new portable VCR was announced this year it was developed by JVC and is called the *U*ltra *C*ompact *M*achine, or UCM for short. It is just what the name implies. Though not yet available, Sharp has demonstrated a model of that machine, the *VC220*, which weighs just 5.8 pounds, including battery, and measures approximately 7 × 2¾ × 9¼ inches. The key to the UCM is the *VHS-C* ("C" for compact) format cassette. About the size of a pack of cigarettes, a *VHS-C* cassette contains enough ½-inch videotape for about 20 minutes of recording on a UCM recorder. You can playback the tape through a TV, or edit on to a longer-playing regular-sized deck. You can also slip the VHS-C cassette into an adapter that makes the tiny tape playable on a standard VHS recorder.

SOLID-STATE IMAGE SENSORS, such as the one used in this NEC *TC-100* color camera may eventually replace the cumbersome and power-hungry image tubes of today.

Many more home video-recordists are eagerly awaiting the all in-one camera-recorders currently under development by several Japanese companies. Those companies are working toward a uniform ¼-inch videotape standard to help avoid another battle such as the one over the Beta/VHS format. But the way things are going, even if a standards agreement is reached in 1983, it may be 1985 or later before finished products reach the store shelves.

Still looking to the future, most of you are probably familiar with the ¼-inch VCR format—CVC—from Japan's Funai Electric. In the U.S., their small, five-pound portable recorder is sold by Technicolor. But an even smaller recorder, using the same CVC format, will be marketed in the U.S. in 1983 by Grundig. Grundig, a popular brand in Germany, has been selling their five-pound *VP-100* successfully in Europe. It measures only 4¼ × 2¾ × ½ inches and can be easily mistaken for a portable audio-cassette player; among its features are variable speed and freeze frame.

Lights, camera...

The producer and director in us all will appreciate the features found on advanced color cameras. General Electric's two newest cameras, for example, both feature automatic focusing, relieving the cameraman of that chore. The more expensive of the two, the model *1CVC3035E*, which sells for $1350, uses a *Newvicon*-style pick-up tube that is designed to reduce "picture lag"—the tendency of an image to persist, thus streaking when the camera pans away from it. In addition, a control panel on the camera gives the operator fingertip command of fade-in/fade-out between scenes, and a built-in character generator capable of adding titles of up to 60 characters.

An exciting bit of news is the development of advanced solid-state imaging devices. Those, it is hoped, will eventually replace the power-hungry and cumbersome image tubes found in most of today's cameras. The heart of Hitachi's *VK-C2000* color camera, for instance, is a one-IC MOS image-sensor. That sensor, which is about the size of a postage stamp, consists of wafers of color filters over an intricate grid of semiconductor material. The material appears to be impervious to the burn-in that many cameras suffer when the lens is directed at a bright light. With its electronic viewfinder, the compact camera weighs only 3¾ pounds, but carries a heavy price tag—about $2,000.

Another type of solid-state image sensor is a CCD (*C*harge *C*oupled *D*evice). NEC, for one, is currently developing a CCD color camera. The CCD in that camera will consist of a mosaic of 384 × 490 picture-elements and is expected to produce 250 horizontal lines of resolution. And, while the cost of cameras with solid-state image sensors will initially be very high, as manufacturers find ways to produce those sensors more efficiently, that cost should drop significantly.

For the do-it-yourself recordists, several new accessories can be very helpful for producing more varied programming. Although converters that let you videotape 35-mm slides for home-spun travelogues have been available for some time now, Sony has introduced a more advanced version, the *HVT-3000* ($179.95), that gives you the option of doing the same with print film negatives when used with their *model HVC-2400* ($1250) color camera. That camera converts the negative images to positives before they're recorded using a standard color video-camera.

More dramatic and professional productions can be done using Sony's new *HVS120K* special-effects kit, which consists of a model *HVS-2020* black-and-white camera, model *HVS-2000* special-effects generator, graphics aids, etc. If the kit is used with a color VCR-camera, you can superimpose either titles and graphics (from a six-color palette), or any image from the black-and-white camera, over the color-camera image. A slide-control fades titles in and out for quite a professional look. The generator also lets you alter color keying (up to six different colors), which can make for some interesting "sci-fi" footage—as does electronic black-and-white reversal. The kit, which should be available by the time you read this, is expected to sell for around $550.

Anyone with real creative talent will want to be first on the block with the *Video Scribe* electronic color-video titler ($795), from Comprehensive Video Supply Corporation. You can be a real artist, using the device's 80 letters, numbers, and graphic elements, all addressable by a flat-membrane keyboard, to draw colorful titles and animation sequences in 8 colors—red, green, yellow, blue, buff, powder blue, orange, and magenta. Graphic output goes directly to the video input of your VCR.

Videodiscs

Videodiscs aren't generating all of the excitement they did about a year ago, but the two current formats, RCA's CED and Philips' LaserVision optical format, have been making some news as more consumers are selecting videodiscs as an alternate program source.

New on the scene are stereo CED players from RCA, Toshiba, and Hitachi. RCA now offers two stereo models, both of which contain CX noise-reduction decoders (stereo CED discs are CX encoded). The top-of-the line *SGT250* sells for about $449. That model features infrared remote control and an automatic start function, which replaces the front-panel control lever. Toshiba offers a $90 accessory that allows owners of their monaural CED-players to get the full benefit of CX-encoded stereo discs.

The LaserVision group also has chosen CX noise-reduction. Two North American Philips companies (Magnavox and Sylvania) have newly styled stereo LaserVision players, featuring remote controlled random frame-access and special effects. Those players sell for about $750 and are made for N.A.P. by Pioneer.

LaserVision backers are still looking toward the future with the knowledge that their optical videodisc-players can be more than simple playback devices. North American Philips (Magnavox and Sylvania) has been demonstrating how their players can be used interactively with home computers. Interfaces exist now that allow computers like the *Apple II* and Texas Instruments *TI-99/4A* to control a videodisc player's search and frame-access functions. Soon, we're likely to see very realistic video-game-type interactive video based on such a setup. The use of a videodisc will allow for realism unmatched by any other home or arcade game.

Video separates

With all of the new video sources available, you need something to use for display. That display device is, of course, your home television set—but even it is undergoing some major changes. For one thing, more and more sets are including separate video and audio input jacks in addition to the antenna-input terminals. Previously, the video and audio signals from a VCR or other video source had to be fed into an RF modulator, with the modulator's RF-output fed to the set's antenna terminals. The set would then demodulate the RF signal to extract the audio and video information. The addition of the separate audio and video inputs skips all of those steps and eliminates the losses caused by them.

Even more significant, however, is the trend toward video separates or components. In a component TV-system, the TV set is broken up into separate units; just how it is broken up varies from manufacturer to manufacturer, but often the the system is made up of a separate video monitor, tuner, controller/switcher, and speakers. The monitors used in component TV-systems are capable of high-quality displays, but there is a premium to pay for that quality, and for the flexibility that those units can offer. For instance, Pioneer's *Foresight* 19-inch monitor lists for about $850, while their 25-inch monitor lists for $1500; the companion tuner for those lists for about $500. Also, you should bear in mind that

AMONG THE FEATURES of this *VP-500* CED videodisc player are stereo audio and CX noise reduction.

the displayed video can only be as good as what is input.

But, on the positive side, with a component approach to video you have the flexibility to build your system one piece at a time. With Sanyo's *Pro-Ponent* series, for instance, you can start with their model *AVM195* 19-inch monitor ($600) and their model *AVT95* tuner/controller ($400). The audio outputs can be fed to a separate stereo audio-amplifer and played through stereo speakers; the monitor also has its own built-in five-watt-per-channel stereo amplifier.

Zenith takes the component approach a bit farther. In its *Hi-Tech* system, all of the components feed into a central source selector, the model *CV-540*. That is one system in which the tuner and selector are separate units. The tuner here, the model *CV-510* lists for $279.95, and features an infrared remote control. Getting back to the source selector, that $169.95 component can accept up to six video and audio inputs. The video inputs and mono audio-inputs are routed by the selector to the system's model *CV-1950* 19-inch monitor, which lists for $469.95; stereo audio-inputs are routed to a 20-watt-per-channel stereo amplifer that lists for $149.95. That amplifier, the model *CV-520*, is designed specifically for the component TV-system; some manufacturers simply use one from their standard audio line. The amplifier also has phono and auxiliary inputs for adding hi-fi audio sources to your system.

Like many of the other new component-TV monitors, the Zenith monitor has an RGB (*R*ed-*G*reen-*B*lue) input. While such outputs are currently available on only a few consumer products, such as the IBM *Personal Computer*, they offer a great advantage. Unlike video-modulated RF (such as broadcast TV) or composite video signals, an RGB signal is fed directly to the video amplifiers, bypassing many stages of lossy signal conversion. With an RGB input, most component-TV monitors are capable of high-resolution displays.

A component-TV system with its stereo amplifiers, speakers, and controller functions sounds much like a stereo-audio setup. In fact, it's getting harder and harder to classify entertainment as either all video or all audio; instead, it's simpler to consider the two as part of a broader home-entertainment catagory. Consider, for instance, Jensen's model *AVS 1500* audio/video receiver; it's an AM/FM- and TV-receiver, as well as a stereo amplifier, all in one package. The AM/FM receiver section features a synthesized AM/FM-tuner and a digital frequency-readout. On the TV side, there's a 133-channel (including cable channels) TV tuner and National Semiconductor's DNR (*D*ynamic *N*oise *R*eduction) circuit. The amplifier has an output of 50-watts-per-channel. The unit lists for $990. Two companion monitors are available—the 19-inch model *AVS-3190*, which lists for $800, and the 25-inch model *AVS-3250*, which lists for $1030.

Teknika is another company that blends audio and video into the same components. Their $1200 *ATV-19* system consists of a 19-inch monitor, AM/FM/TV tuner, and 2 speakers. A 25-inch monitor is also available.

Tiny TV's

There's been a great deal of interest in small-sized TV and this year the first commercial flat screen (or pocket) TV's may become available. Sony's 2-inch diagonal screen

POCKET-SIZED TELEVISION, such as the Sony *Watchman* shown here, may finally become available this year.

Watchman uses a new picture tube design which places the electron gun below and parallel to the screen surface. The scanning electron beam is magnetically "bent" to hit the screen at a perpendicular; the result is a TV only 1¼ inches thick. The estimated retail for that set is around $300.

Sinclair, developers of another bent electron-beam flat TV-tube, may get their 3-inch TV on the U.S. market soon; its price is expected to be in the $100 range. Both the Sony and Sinclair tubes are black-and-white only.

The LCD flat-screen display is still under development, but may be still a year or two away. Seiko has been demonstrating a prototype of a wristwatch TV. Only the LCD screen is worn on the wrist. The bulk of the receiver, including an FM-stereo receiver, is housed in a vest-pocket sized unit.

Turning to small-sized color TV, Panasonic is offering what may be the world's smallest color TV/monitor; its *CT-3311* sells for $499.95 and features a screen size of just 2.6 inches. It even has separate audio and video input jacks.

Projection TV

From the very small, we turn to the "giants" of home video—projection TV. More companies are heading toward one-piece, rear-screen projection systems. They are typically more expensive than front-projection units, but recent scaling down of chassis size, as RCA has done for example, allows 40- to 45-inch screens to be placed in a cabinet that takes up no more floor space than a console TV. New for this year are many cabinet styles and sizes from General Electric, Mitsubishi, NEC, Panasonic, Quasar, Sharp, and Sony, to name a few; prices for those are in the $3,000-$4,000 range. Many like GE's new *Widescreen 40* feature built-in stereo amplifiers and twin, two-way speakers.

It may sound odd to put the words projection and portable together, but Kloss Video Corp has developed a portable (i.e. movable) projection-TV called the *Novabeam Model Two*. The unit is about the size of a 19-inch portable TV (though only 12-inches deep), and opens to project a 5-foot diagonal image on any wall. Room lighting needs to be controlled for best viewing, yet the ability to use a plain wall as a screen allows the unit to be played anywhere in the house and makes the viewing angle much less critical. Assuming that most projection-TV buyers have VCR's with TV tuners, Kloss eliminated the tuner completely from that model, which helped keep the price to about $2200.

It appears, then, that there's more available in video this year than ever before. The so-called video revolution is continuing, and it's getting easier all the time to become a part of it. **R-E**

LIST OF MANUFACTURERS

Canon U.S.A., Inc.
One Canon Plaza
Lake Success, NY 11042

Comprehensive Video Supply Corp.
148 Veterans Dr.
Northvale, NJ 07647

General Electric
Portsmouth, VA 23705

Grundig AG
Kurgartenstrabe 37
Furth, W. Germany 8510

Hitachi
401 W. Artesia Blvd.
Compton, CA 90220

Jensen Sound Laboratories
4136 N. United Parkway
Schiller Park, IL 60176

JVC
41 Slater Drive
Elmwood Park, NJ 07407

Kloss Video Corporation
145 Sidney Street
Cambridge, MA 02139

N.A.P Consumer Electronics Corporation
I-40 and Straw Plains Pike
Knoxville, TN 37914

Marantz
20525 Nordhoff St.
Chatsworth, CA 91311

Mitsubishi
7045 N. Ridgeway Ave.
Lincolnwood, IL 60645

NEC Home Electronics
1401 W. Estes Ave.
Elk Grove Village, IL 60007

Panasonic
One Panasonic Way
Secaucus, NJ 07094

Pioneer Electronics
1925 E. Dominguez St.
Long Beach, CA 90810

Quasar Co.
9401 W. Grand Ave.
Franklin Park, IL 60131

RCA
600 N. Sherman Dr.
Indianapolis, IN 46201

Sanyo Electric Inc.
1200 W. Artesia Blvd.
Compton, CA 90220

Sharp Electronics Corp.
10 Sharp Plaza
Paramus, NJ 07652

Sinclair Research, Ltd.
50 Staniford St.
Boston, MA 02114

Sony
1 Sony Dr.
Park Ridge, NJ 07656

Technicolor
299 Kalmus Dr.
Costa Mesa, CA 92626

Teknika
1633 Broadway
New York, NY 10019

Toshiba
82 Totowa Rd.
Wayne, NJ 07470

Zenith Radio Corporation
1000 Milwaukee Ave.
Glenview, IL 60025

VIDEO ACCESSORIES

With the three devices described below, there's no need to put up with poor-quality videotapes any longer. While they can't work miracles, they can make an amazing difference in the recorded image

GORDON McCOMB

THERE WAS A TIME NOT TOO LONG AGO WHEN THE AMAteur video enthusiast endured videotapes with poor or shifted colors, fuzzy details, and picture instabilities. But as the home-video industry has grown to include millions of owners of videocassette recorders (VCR's), add-on components have been introduced to help clear up the annoying color, detail, and picture problems that have plagued videophiles for years.

There are three video componenets that no top-quality video system should be without (at least not for long): a color processor, an image enhancer, and a sync stabilizer. Color processors can shift, exaggerate, even delete the color information on signals from a tape, disc, camera, or any other standard NTSC format video source. Image enhancers improve the high-frequency response and help restore clarity and sharpness to old tapes, dubs, and less than perfect video equipment. The vertical sync pulses on many pre-recorded videotapes have been altered in an attempt to prevent unauthorized VCR-to-VCR duplication. Unfortunately, the circuitry in some TV's can't handle those altered sync pulses. That results in vertical hold instability and horizontal "tearing" of the picture. To eliminate the problem, sync stabilizers are used to restore the altered sync pulses to their original shape.

Let's examine each of those components further, and discuss the ways they can be used to improve your video pictures.

Color processors

Color processors enable full manipulation of the color and brightness components of any standard NTSC video signal. Colors can be shifted so that reds become green, greens become blue, and blues become red. The intensity of the image and colors can also be modified. A videotape with washed out colors can be rejuvenated by increasing the CHROMA or COLOR controls on a color processor. Special effects such as fading from a black-and-white to a full color scene can also be created.

The main function of the color processor is to correct for errors in the brightness, color, and tint of video signals, particularly with equipment lacking color and tint controls, as when dubbing between one VCR to another.

Three important fundamentals must be considered when reviewing the operation of television signals and color processors. Those fundamentals are luminance, hue, and saturation. The luminance signal occupies a bandwidth of 0 to 4.2 MHz. and includes all the brightness information seen in a black-and-white or color-TV picture.

Hue (adjusted by the TINT control on most color-TV sets) is the actual colors (red, blue, green, etc.) seen in a picture. Saturation (adjusted by the COLOR control on most color-TV sets) is the degree to which a hue is diluted by white light, enabling differentiation between vivid and weak shades of the same color. For example, a vivid blue is a saturated hue; a pastel blue is an unsaturated hue.

A color-TV picture consists of hue and saturation information, in addition to the black-and-white luminance information. The combination of hue and saturation is called chroma. The chroma signal is transmitted as a 3.58 MHz subcarrier of the luminance signal and consists of two color-difference signals, designated I and Q. The I signal determines the saturation, and the Q signal determines the hue. The I signal is transmitted as an amplitude modulation of the 3.58 MHz subcarrier signal, and has a bandwidth of 0 to 1.5 MHz. The Q signal frequency modulates the 3.58 subcarrier, and has a bandwidth of 0 to .5 MHz. A 3.58 MHz color-burst signal is inserted after every horizontal sync pulse in the composite video signal. The color-burst signal is used to synchronize the phase of the 3.58 MHz oscillator in the TV receiver, enabling proper color demodulation.

The instantaneous phase angle of the modulated chroma signal, with respect to reference color burst, controls the hue. The variations in the amplitude of the modulated chroma signal, in relation to the corresponding brightness

THIS COLOR PROCESSOR from Showtime Video Ventures features independent chroma and burst amp controls.

or luminance level of the scene, determines the saturation of the color.

Color processors can manipulate the amplitude and phase of the chroma signal, and thus can vary the tint and saturation of any scene. Old movies, either recorded or broadcast with weak color, can be rejuvenated by boosting the amplitude (saturation) of the chroma signal. Poorly taped home movies with incorrect colors can be corrected by altering the phase angle of the modulated chroma signal. Of course, there is no way to selectively boost, retard, or shift only certain colors with this type of color processor. If skin tones are excessively yellow, shifting the scene to normalize the skin color may also change the color of blue swimsuits to green. But those side effects, usually slight, are more than compensated for by the overall improvement of the video image.

A TRUE PROCESSING AMPLIFIER, this unit from Vidicraft allows full control over both the color and sync of the video image.

Operating a color processor, like the one manufactured by Showtime Video Ventures (2715 Fifth Street, Tillamook, OR 97141), is relatively easy. Showtime's color processor, model *VV-777P*, sells for $377 and uses a MODE switch along with four front-panel controls for manipulation of the brightness, color saturation, and tint of a TV picture.

The LUMA control determines the relative amplitude of the luminance signal being processed. Decreasing the LUMA control darkens the scene; increasing the control brightens the scene. Color saturation is determined by the CHROMA and BURST AMP controls. The CHROMA control adjusts the amplitude of the color subcarrier with respect to luminance (hence the LUMA and CHROMA controls are interactive), and so alters the degree of color intensity. A BURST AMP control, unique to the *VV-777P*, adjusts the color-burst amplitude without actually affecting the subcarrier level itself, and is used as a fine adjustment for resolution and proper skin tone. Rotating the BURST PHASE control counter-clockwise a quarter-turn shifts reds toward blue, blues toward green, and green toward red. Rotating the BURST PHASE a quarter-turn clockwise will have the reverse effect. Secondary and complementary colors undergo a similar change. Switching the MODE switch to MONOCHROME squelches the color-burst signal, rendering a black-and-white picture.

Showtime's *VV-777P* color processor, like nearly all video components made by Showtime and others, operates with a demodulated composite video signal. To use the color processor with an RF signal (from the RF output of a VCR or from an antenna downlead, for example) the signal must first be demodulated by use of an RF demodulator. An RF modulator or converter is then used to remodulate the processed video to a suitable RF channel (usually Channel 3 or 4) for reception on a standard TV set. Most VCR's have separate RF IN/OUT and VIDEO IN/OUT connections, and in some instances, an RF demodulator and RF modulator may not be required.

AN RF CONVERTER or modulator is used to modulate separate audio and video signals for viewing on a standard TV.

SYNC STABILIZERS, such as this one from Vidicraft, are used to eliminate side effects caused by tape-duplication prevention schemes.

Image enhancers

Image enhancers are used to improve the detail and sharpness of programs viewed off-the-air, while recording or playing videotapes, and during tape-to-tape duplication. Image enhancement involves boosting or accentuating high-frequency video signals, thus increasing overall detail.

The picture displayed on a TV screen is produced by varying the intensity of an electron beam (or three beams in the case of a color TV) as the beam sweeps across from left to right, and from top to bottom on the face of the picture tube. Extremely fine detail and outlines require the beam to vary its intensity more often—up to several million times per second. The smaller the detail in the image, the higher the frequency required to produce it. Likewise, the sharper the outline of an object, the faster the beam must cycle from light to dark or vice versa. Again, high frequencies are involved.

The bandwidth of the TV luminance (brightness) channel is from 0 to 4.32 MHz. However, high frequencies are often distorted and rolled off by the less than perfect circuitry used in most home VCR's and TV sets. That combined with the maximum bandwidth of most VCR's of about 2.0 MHz, leaves only a 0 to 2 MHz bandwidth for all the picture detail and information displayed in any given video frame. Reduplication of a videotape—three of four generations from the original—will yield a muddy, hardly discernable image

THE SHARPNESS AND DETAIL of both recorded and broadcast video can be improved by using an image enhancer.

where only the largest objects can be recognized

The easiest way to think of an image enhancer is to look at it as a video version of an audio-frequency equalizer. But instead of dealing with audio frequencies, video image enhancers handle frequencies of 1.0 MHz and beyond. By boosting high-frequency signals, much in the same way as an equalizer or treble control boosts audio high frequencies, sharpness and detail can be improved. Low-freqency signals (0 to .5 MHz) are ignored by the image enhancer as they do not contain any detail or sharpness information.

Most image enhancers split the high-frequency signals into separate bands by using a comb filter, then selectively amplify the signals giving them an extra boost. Preshoots and aftershoots are added to the signal, driving the signal transitions (dark-to-light and light-to-dark) at a steeper amplitude than normal. That helps eliminate the soft edges in light-to-dark and dark-to-light transitions in the picture.

Of course, an image enhancer cannot produce something that isn't there in the first place. If the delineation of each blade of grass no longer exists in the image recorded on a videotape, no enhancer—no matter how well designed or made—will restore the lost detail.

Boosting the high-frequency content of a video signal also brings out noise, seen as snow. Most enhancers incorporate noise-reduction circuitry in addition to the main enhancement circuitry. The noise-reduction circuit reduces the level of enhancement to compensate for the introduction of snow, and usually works in direct opposition to the enhancement circuit. Noise, usually of high-frequency content, has a lower amplitude than most desired signals. Noise reduction circuitry is designed primarily to suppress low-amplitude, high-frequency signals.

For example, Vidicraft's (Box 13374, Portland, OR 97213) *Detailer I* (selling for approx. $149) and *Detailer II* (selling for approx. $295) incorporate a VNX control that suppresses noise. It performs the opposite function of the DETAIL control, but uses a different set of amplitude thresholds, thus removing a majority of the increased noise and a smaller portion of the enhanced signal. There are trade-offs to be considered when using an image enhancer, as excessive noise cancellation can totally counteract all efforts to enhance detail. The proper enhancement level for any given program, with relation to detail and snow, is performed by interactive adjustment of both the enhancement and noise-reduction controls.

Connecting an image enhancer to a video system is similar to the hook-up procedures for the color processor, in that all units on the market can accept demodulated video signals only. Depending on the installation, RF modulators and/or RF demodulators may be required.

The operation of an image enhancer, such as the *Detailer II* from Vidicraft, uses several knobs for enhancement control. The DETAIL control is used to compensate for detail loss encountered in VCR recording and playback. It can be used to exaggerate detail before the signal is recorded (and so precompensating for high frequency roll-off inherent in home VCR's) or to help restore a VCR signal on playback. The SHARPNESS control increases the overall sharpness of the picture whether the signal be from a tape, camera, videodisc, or off-the-air. The SHARPNESS control is adjusted for maximum edge detail without creating false, black outlines. The VNX control (also called CORE, NOISE SUPPRESS, or NOISE CANCEL on some other models and brands) helps reduce snow and other low-amplitude, high-frequency interference—however, at the expense of detail. It's function is very much opposite that of the DETAIL control and is most helpful when sharpness-only enhancement is used. Normally, fine adjustments of all three controls must be made to obtain the best results, and the settings must be optimized for each program.

It should be noted that image enhancers improve the horizontal resolution of a video image—that is, fine details that occur from left to right in a TV picture. Image enhancers, unfortunately, aren't tested for any given horizontal resolution standard or minimum, since the quality of the original program will determine the results achieved by the enhancer.

Sync stabilizers

Many pre-recorded videotape program distributors, to protect against unauthorized duplication of their product, have altered the vertical sync pulses recorded on their videotapes. That technique, most often called *Copyguard*, (although similar systems with different tradenames are available) disables the sync circuits in a VCR. However, several side effects of sync alteration can appear on the screen of a standard television receiver. *Copyguarded* tapes have a tendency to make the picture on a TV screen roll and shake, as well as "tear" at the uppermost portion of the picture. Adjusting the vertical-hold control on the TV can correct for most of the problems, but many of the newer sets often have the vertical-hold control mounted inconveniently on the back of the chassis, or may even lack a vertical-hold control altogether.

Sync stabilizers restore the vertical sync pulses and provide sync stability to TV's and VCR's. In the NTSC broadcast standard used throughout the United States (as well as Canada, Mexico, and Japan), an electron beam scans 525 horizontal lines 30 times each second. Every picture then consists of 30 frames composed of 525 vertically stacked lines. The scanning process is actually done in a 2:1 interlace pattern, so 262.5 lines are scanned in one pass over the tube, and the second 262.5 lines in a second pass. The scan lines of the first pass or field is comprised of all the odd-numbered lines; the second field is comprised of all the even-numbered lines.

When the beam reaches the bottom of the screen after each field, it is then directed to retrace back to the top of the screen, and repeat the scanning process again. The synchronization pulses required for the circuit to direct the beam to the top of the screen are contained in the vertical blanking interval.

Within that vertical blanking interval, six vertical sync pulses, bracketed on both sides by equalization pulses, are used to trigger the vertical sync circuits in the receiver (those pulses are at one-half the normal horizontal line rate). Vertical sync pulses have extremely long duty cycles of 87% (the longest duty cycle involved in TV sync timing). In most TV's, only one vertical sync pulse is required to trigger the vertical-sweep circuits. In VCR's, however, nearly all of the vertical-timing pulses are required to ensure full sync stability while recording.

Sync-alteration techniques, (again, there are numerous types currently in use), normally pass just one pulse—the remaining five pulses are changed or distorted.

Nearly all sync stabilizers currently on the market, such as MFJ Enterprise's (921 Louisville Rd., Starkville MS 39759) model *1400* (selling for approx. $80), reshape the vertical sync interval to the point where a stubborn TV or VCR will trigger properly. A timing circuit is normally used that triggers when the circuitry in the stabilizer detects the first vertical sync pulse. The stabilizer circuit then generates a single long pulse equal to the normal vertical sync interval (three horizontal lines long), overriding the altered signal produced by the tape. The sync stabilizer has a frequency adjustment to allow the unit to match its frequency with that of the incoming vertical sync pulses.

The actual half-line equalizing pulses of the vertical blanking interval are lost by use of most sync stabilizers, meaning that the horizontal sync circuits in the TV lack a timing reference for three lines in each field, which can cause horizontal sync loss during the vertical blanking interval. This can create some picture instabilities as well as horizontal tearing at the top of the screen. Only one sync stabilizer, the Showtime Video Ventures' model *VV-170P*, recreates the pulses contained in the vertical interval. Usually, however, simply adding one long pulse to the vertical interval compensates for most of the serious side effects caused by *Copyguard* or similar encoding, and produces a relatively stable, jitterless picture.

Sync stabilizers work only with demodulated video signals, although some units are now available with built-in RF modulators. To use a video-only stabilizer, the VIDEO OUT jack on the VCR is connected to the VIDEO IN on the stabilizer. An RF modulator is then used at the output of the stabilizer. It should also be noted that video processor components can be combined in one installation along with a sync stabilizer. Normally, there are no restrictions as to the order in which the components should be placed in the signal path. Be certain, however, that a sufficient video level (1 volt peak-to-peak) is supplied to the input of each component. Many video accessories incorporate distribution amplifiers (some with adjustable gain) that can be used to overcome excessive signal loss when passing the signal through several components. Video distribution amplifiers are available separately as well.

Quite a few video components have provisions whereby more than one input source can be connected to the unit at one time. A front-panel switch is used to select the desired input. Additionally, many units have several outputs allowing for multi-point signal distribution.

Operating a stabilizer requires the user to adjust one knob, the STABILIZE control. The control is usually readjusted for each tape viewed. **R-E**

NEARLY ALL of the sync stabilizers on the market, including the one from MFJ enterprises shown above, reshape the vertical sync interval.

HOW TO CONNECT VIDEO COMPONENTS

Watching TV is no longer a matter of simply turning on the set and sitting back. Here's a look at some devices and ways to take the nuisance out of what should be a pleasure.

GARY McCLELLAN

THANKS TO CABLE AND SUBSCRIPTION TV, TV GAMES, AND personal computers, television is becoming more interesting and useful than ever before—not to mention a lot more fun. Furthermore, VCR's (*V*ideo *C*assette *R*ecorders) and videodisc players are making available to us an even wider range of entertainment. And, on the horizon, there is the promise of interactive videotex, which can allow us to shop and be informed from the comfort of our living rooms.

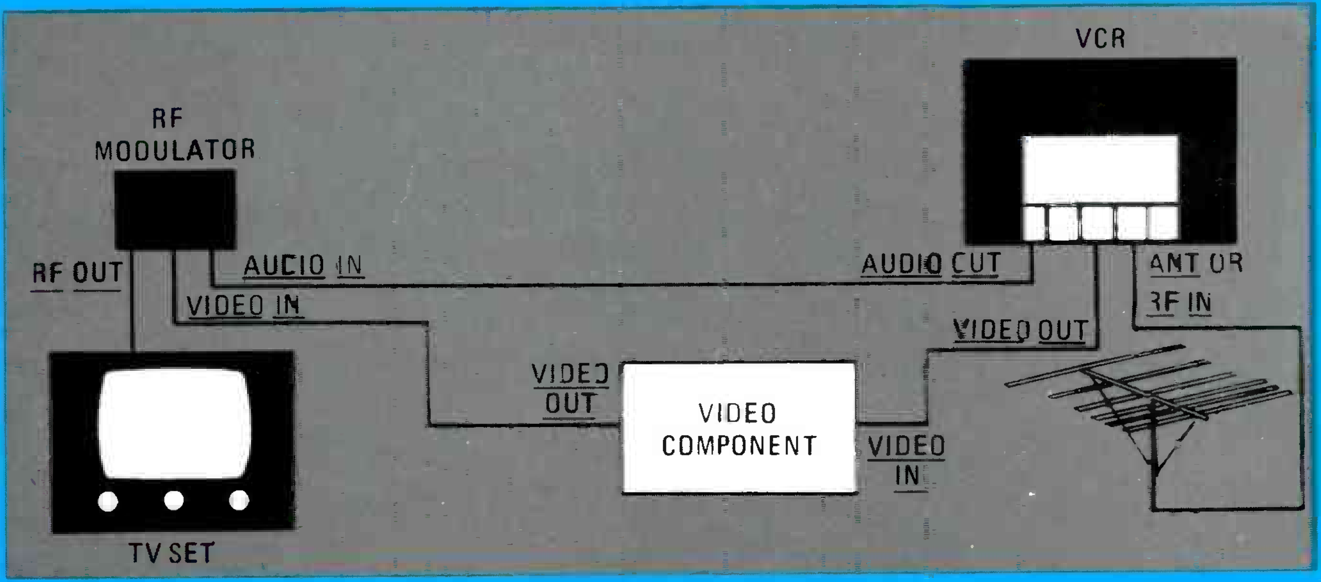
Hooking up all the equipment needed to an existing TV set can become a bit confusing, especially if several devices are involved; this situation is becoming more and more common these days. Most people start out with a VCR, and over a period of time add other equipment, turning a TV set into a video system. Perhaps there's a cable box with a decoder for sports and movies; then a programmable TV-game for the kids, a personal computer for Dad, and so on.

The result is often a rat's nest of wiring centered around a complicated switching arrangement. And, while *you* may understand it, it can make life very difficult for other people who use the system, especially if they have to change cables! Also of concern is the fact that every connection in that maze of cables causes signal losses that can degrade picture quality. What's needed is an easy and simple way to mate all that new equipment with the TV set, creating a true integrated video-system that's easy to use and provides the highest quality possible.

In this article we'll discuss how to connect additional equipment to your TV set. We'll start with the simple addition of a VCR and build up to a "full house" video system featuring almost every device you are likely to want. We'll finish up by adding useful accessories such as cameras, enhancer/stabilizers, commercial editors, and others.

The hookups described will bring many benefits. For example, your video system will be easier for the family to use (no cable swapping), and there will be fewer connections and less signal loss. All you have to do is to read through the article to find the descriptions that best match your equipment, and then follow the diagrams to hook it up. It's as easy as that!

Of course, it isn't possible to cover every possible combination in this short space; there are just too many variations. Instead, we'll concentrate on the ones that most people are likely to use. With a little thought you should be able to adapt those ideas to your particular situation.



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Basics

Before you do anything, there are few simple rules to remember when making these hookups, and they boil down to one thing—*go first class, inside and out*. Lots of people will spend a thousand dollars or more for a VCR, $15 and up per month for subscription-TV service...and then use a 15-year-old antenna and rotten cables. Naturally, they get angry when their expensive equipment performs poorly. The moral is to save a little extra cash for a new antenna and lead-in. If you don't, you'll wind up paying for your "economy" with poor reception. Read the following basics, and apply them to your own situation. Make any improvements required.

Start outside with the TV antenna and lead-in, if you use them. They are often overlooked because rooftop mounting makes antenna inspection an unpleasant chore. Yet, if your antenna and lead-in have been up 4–5 years or longer, you may not be getting the best picture possible. Why? To begin with, the sun's heat and ultraviolet radiation degrade the insulators and lead-in, which means increased signal-losses. Also, soot deposits and humidity will cause breakdown of the cable insulation, and wreak havoc with connections. The result is predictable; more losses and noisy pictures! And, in extreme cases, corroded connections, combined with a near-by CB or ham transmitter, will invite interference. So if your antenna and lead-in are four years old or more, check them out carefully, and replace them if necessary. The same goes for lightning arrestors and guy wires.

If you are going to replace your lead-in, you should use coaxial cable, rather than twin lead. For one thing, it tends to reduce noise pickup, and for another, it is more compatable with the newer equipment. In my own case, using coaxial cable cut ignition-noise pickup noticeably and reduced ghosting; the extra cost was worthwhile.

Once the antenna and lead-in have been taken care of, the antenna should be carefully oriented for the best picture-quality on all channels. Often that requires a compromise, but with patience, things can be worked out. Of course if you have a rotator, antenna positioning will be no problem!

Go first-class inside the house, too. The lead-in cable should be routed to the area where the video equipment is located, and F-type connectors used. If necessary, use a VHF/UHF signal-splitter between the cable and TV set.

Now turn your attention to the TV set you will be using. It should be in good condition and provide a good color picture. Adjust the fine-tuning control for the best sound and picture quality. If you don't get a good picture and sound, repairs or adjustments may be required; have them made. You should then be getting first-rate results, and will be ready to add other equipment.

You are going to need baluns (impedance-matching transformers), short lengths of cable with F-type connectors on each end, and other parts. Refer to Table 1 for a list of parts of this sort that you will probably require.

Adding a VCR

Video cassette recorders (VCR's) are very popular, and thanks to decreasing prices, are becoming quite widespread. Figure 1 shows a simple VCR/TV hookup. The antenna cable connects to a VHF/UHF splitter that goes to the VHF and UHF inputs of the VCR. From the VCR, separate cables are connected to the antenna inputs on the TV set.

Several remarks concerning that arrangement are in order. First, many older TV sets have balanced 300-ohm antenna inputs. To use the cable hookup shown, a 75–300-ohm matching transformer (balun) will be needed between the 75-ohm RG-59 cable and the TV set's VHF terminals. Don't try to do without the transformer or you may get a noisy picture. Second, some early VCR's don't have UHF output-terminals. If that's so in your case, run a short length of 300-ohm twin-lead from the VCR's UHF input-terminals to the UHF antenna-input on the TV set.

Adding CATV/MATV

In some parts of the country, cable TV (CATV) or master-antenna TV (MATV) takes the place of an outside antenna. Figure 2 shows a hookup for such systems. Note that the switch box is not required if just one of those services is available.

Your setup may differ somewhat from the one shown, but can probably be handled in a similar fashion. For example, your area may have CATV and still permit outside antennas. If that's the case, just substitute the antenna cable for the MATV connection to the switch box.

Subscription-TV service has become popular, thanks to its uncut, no-commercials, format of movies and sporting events and the fact that the programming is sent over the air and no cable-service is required. Figure 3 shows two simple ways to connect a subscription-TV decoder to your VCR and TV set.

The hookup shown in Fig. 3-a will work well except for one thing: when the decoder is turned on, the VCR or TV will receive *only* the decoder! That can be a problem if there are two good programs broadcast at the same time on subscription- and free TV.

The solution is shown in Fig. 3-b. By adding the a device like the *Channelizer* (made by Energy Video Corporation, 20371 Prairie St., Chatsworth, Ca. 91311), it is possible to receive all channels without any switching. You can tape one program for viewing later, and watch the other program right now. Special circuitry inside the unit makes that possible without interference, and the decoder output appears on a channel unused in your area (channel 3 in mine).

There may be an unused input on the subscription-TV decoder that can be used to connect the output from any other video equipment (game, computer, videodisc player, etc.) to it, and you can then use those devices without throwing any

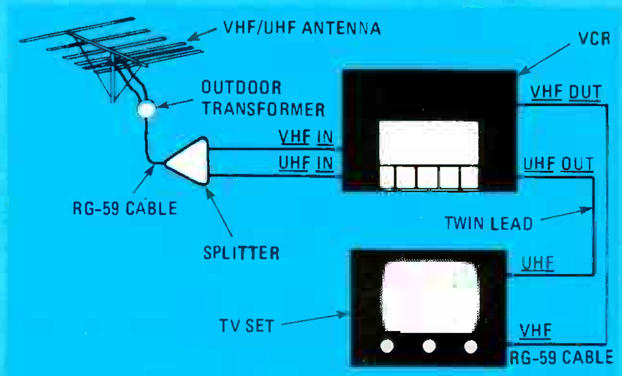


FIG. 1—CONNECT THE TV ANTENNA to your VCR, and then connect the recorder to your TV set. Keep the VHF and UHF signals separate.

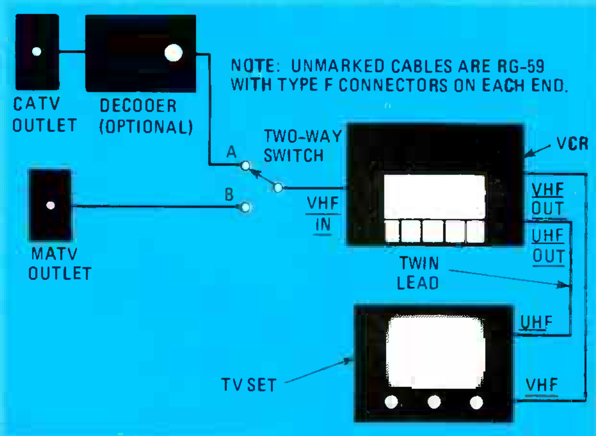
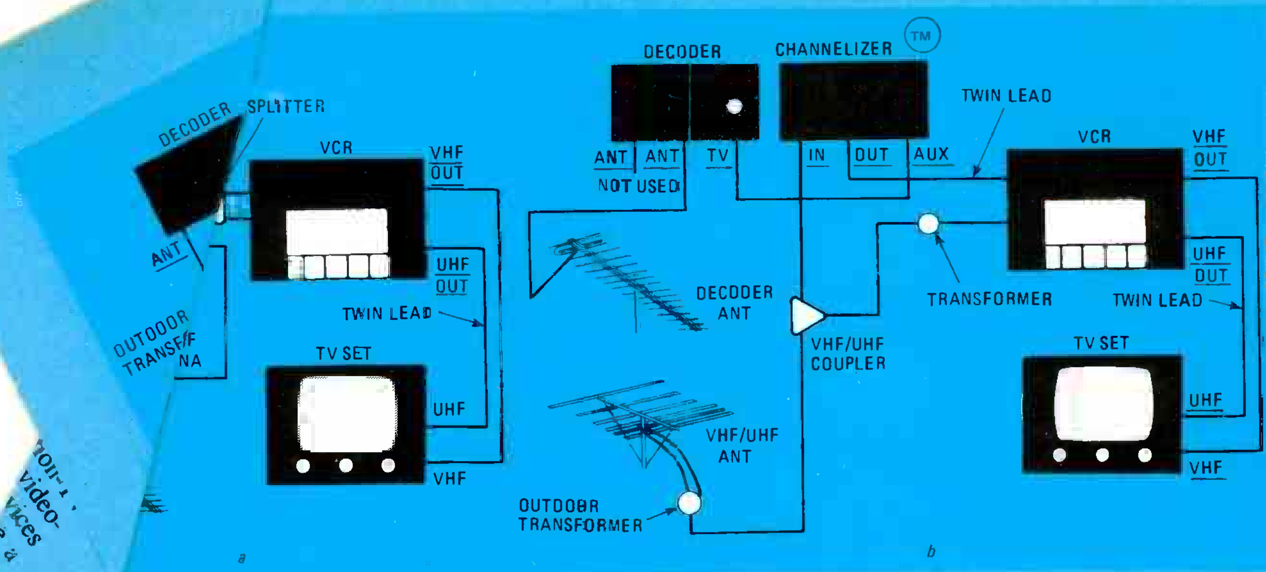


FIG. 2—A SIMPLE 2-WAY SWITCH will allow you to select between two TV-signal sources like CATV and MATV.



.PTION-TV DECODER in the line usually restricts you to receiving only one channel . device like the Channelizer (*b*) removes that restriction.

..ies. Just set the TV set to your local "vacant channel," ..m on the equipment, and go. That's great for the non-technical members of the family who hate to figure out switches!

Adding other equipment

Add-on devices like video games, personal computers, and videodisc players are rapidly increasing in popularity, and making one part of your video system is easy—just use a two-position switch as shown in Fig. 4.

That arrangement does have a drawback; it allows you to connect only one device at a time. If you're lucky enough, however, to have a device with a VHF antenna-input (perhaps a videodisc player), you can "daisy chain" it with another device. Figure 5 shows how that kind of hookup can be made. You might be able to connect the output of your video game to the antenna input of the videodisc player, and the output of the player to the switch. Often that method will work well, and will eliminate a second switch. However, since not all video equipment has an antenna input, that hookup may not be practical for you! The solution, then, may be a video switch, our next topic.

Getting sophisticated

All the hookups described so far have assumed that you would be adding just one device to your video system but the chances are that, with time, you will be adding several pieces of equipment. That can complicate things greatly if you are not careful, and you can end up with a rat's nest of cables. But take heart; there's a way around that problem.

This solution is simple enough: Use a multi-position video switch to select the output of a particular device for viewing on the TV set or for recording.

Actually, the term "video switch" is a misnomer. Those devices actually switch VHF/UHF RF signals, *not* low-frequency video, as their name would imply. However, since most manufacturers refer to their products as "video" switches, we'll do so, too.

The switches are sold under various names: *Bambi Electronic Video Switch* from Simple Simon Electronics (3871 S. Valley View No. 12, Las Vegas, NV 89103), *Video Organizer* from Zenith (1000 Milwaukee Ave., Glenview, IL 60025), and many others. All those products have one purpose: to switch in or out a number of program sources with a minimum of loss and crosstalk. They neatly replace the array of 2-position switches that are often used, and eliminate cable swapping. So, once your video system reaches the point where a 2-position switch won't be enough, or where cable swapping is required, a video switch would be a wise investment.

To really appreciate how neatly a video switch simplifies cabling, suppose you add a video game, personal computer, and a videodisc player to your system. You could make the whole thing work by using the scheme shown in Fig. 4 and using three 2-position switches. Or, you could daisy-chain the devices as shown in Fig. 5. A better way, though, is shown in Fig. 6. There, a single video-switch takes care of everything and fewer cables and connections are required. That means less fuss in hooking the devices up, and less signal loss. But, best of all, using the switch is easy—all that you need to do is press the appropriate button to get what you want.

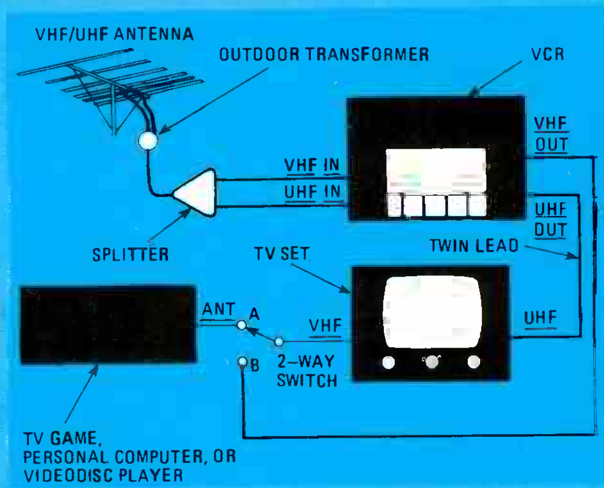


FIG. 4—USE A 2-POSITION switch to select between off-the-air TV reception and using an add-on video device.

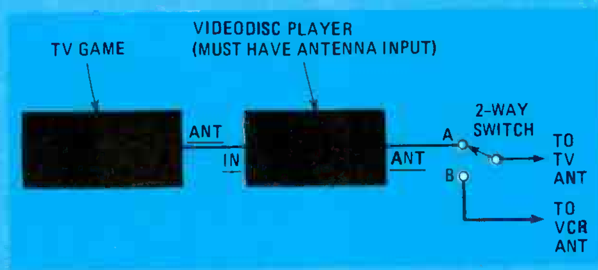


FIG. 5—"DAISY CHAINING," when you can do it, can reduce or eliminate the need for switches.

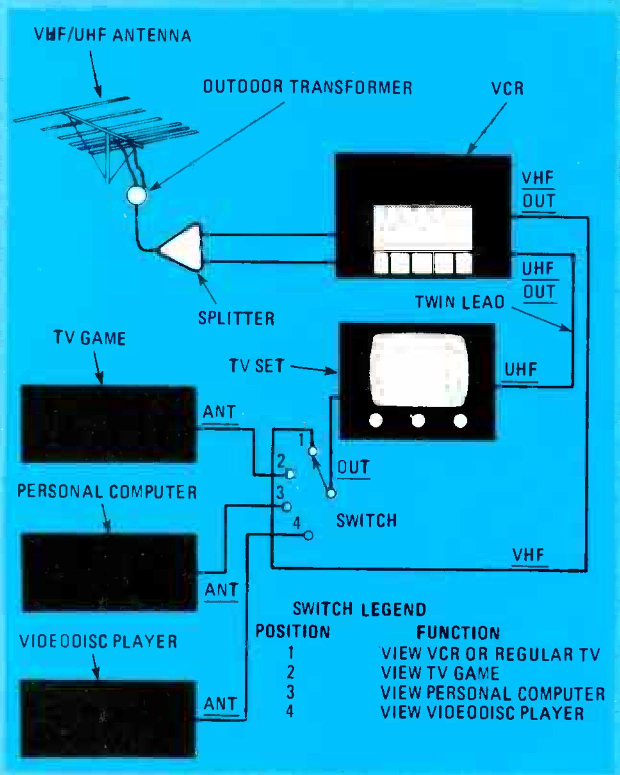


FIG. 6—A MULTI-POSITION switch will allow you to hook up several pieces of equipment to a single receiver easily.

A full-house system

There are many people who take video very seriously, and, as a new item is introduced, they will add it to their systems. With each addition, the switching becomes more complicated, until most video switches become inadequate.

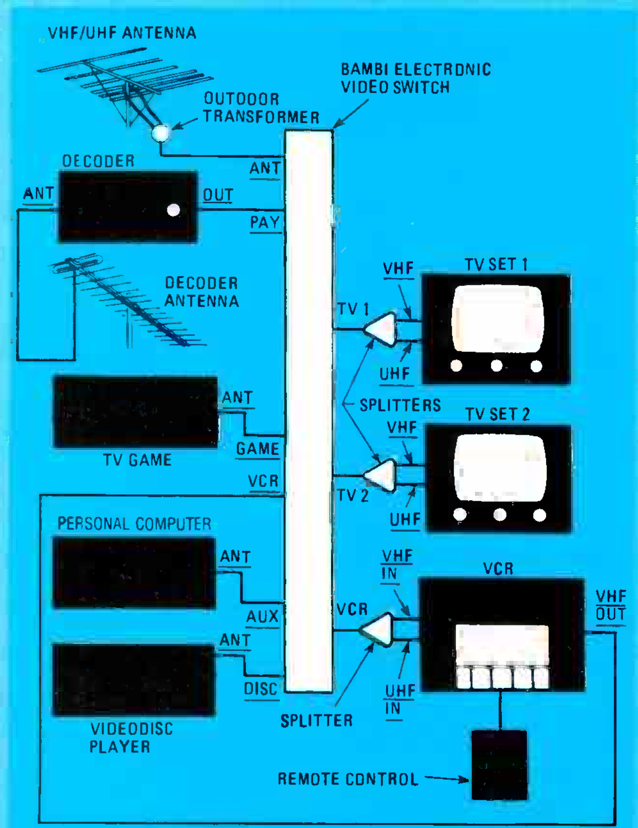


FIG. 7—"FULL HOUSE" VIDEO SYSTEM is easy with an electronic video switch. Any input can feed any output.

The solution to that problem i... video switch.

A setup for those who have "eve... 7. That particular arrangement is... *Electronic Video Switch*. It can hand... can route the signals from any of those... outputs.

select a more versatile
is shown in Fig.
the Bambi
inputs, and
three

The manufacturer quotes an especia... figure (65 dB) for the unit, which is impo... reduces interference among sources. Interf... because most inputs to a video switch are... channel (typically channel 3), and that can c... pictures and interference lines to appear on you... The solution is to use a switch with a high isola... indicated in dB. Watch for that specification when...

As shown in Fig. 7, an outdoor antenna, subscrip... decoder, VCR, videogame, personal computer and a... disc player provide inputs to the video switch. Those de... can be switched independently, and the VCR can ta... program while the kids use the TV game and you wa... another program off the air. A video switch makes it easy; i... the case of Bambi, just press two buttons and go!

Selecting a "full-house" video-switch is easy. First, figure out how many devices you will be hooking up to your system. You will need a video switch with *at least* that many inputs, and—I would recommend—a spare or two. If you buy a switch without allowing for future expansion, you'll soon regret it.

There are plenty of video switches on the market, with a wide number of inputs and outputs, so scan the ads when you get ready to buy a switch. When you have narrowed your choice down to a few units, select the one with the greatest isolation figure, if those numbers are available to you. Once you have a video switch, just hook it into your system as shown in Fig. 7.

Copying

There are times when it becomes necessary to copy material recorded on one VCR onto another. For example, I recently replaced my Beta-1 machine with a newer VHS model and had to re-record my old lectures and family outings onto VHS-format tapes as the new machine couldn't handle Beta-format tapes.

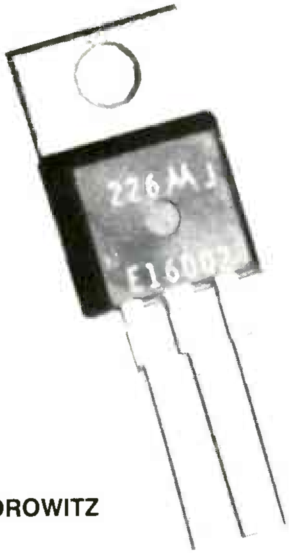
There are two methods that can be used for dubbing videotapes. You could use an RF hookup to the antenna terminals of the second recorder, but that would put a lot of signal-processing circuitry between the two machines and cause a reduction in picture quality. A direct-video/audio hookup using separate audio and video cables is preferred.

You may have to make the cables if you can't buy them locally. The audio cable can be standard audio or microphone cable with RCA phono plugs, or miniature phone plugs on the ends. The video cable should be RG-174 coax with RCA phono plugs on each end. The reason for for using coaxial cable is to reduce losses. While a very short length of microphone cable could be used, it is very lossy and will reduce picture definition.

In some cases you may want to make a copy of an old tape that is of poor quality. Sometimes a video enhancer/stabilizer can make improvements in the quality, if the tape isn't too bad.

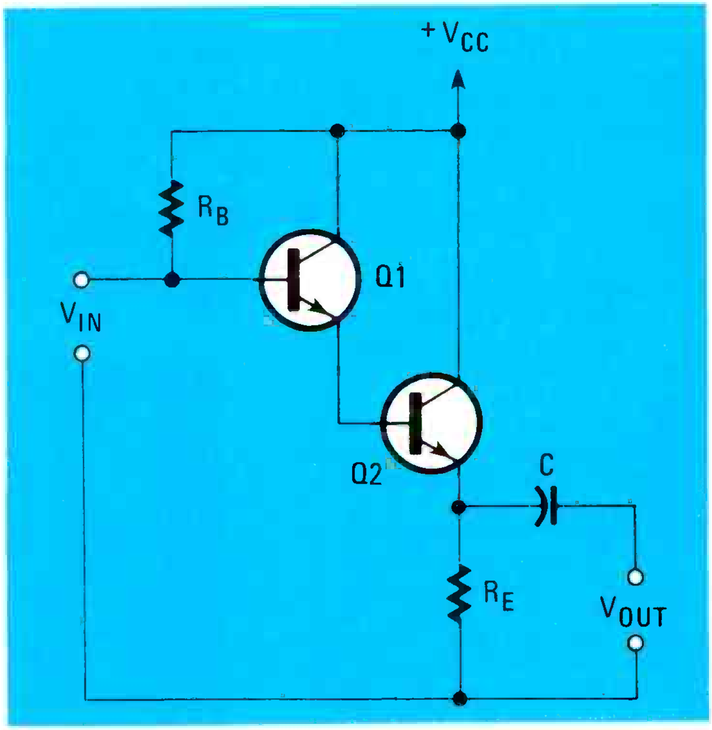
Enhancer/stabilizers are available from a wide range of suppliers (many of whom advertise in **Radio-Electronics**), and are very useful. The enhancer section of the device boosts—or peaks—the high-frequency portion of the video, which makes the picture look better. The stabilizer portion is used to stop vertical roll when some commercially available tapes are viewed on certain TV sets—especially some of the newer ones. Thus, the enhancer/stabilizer can be is a valuable tool when it becomes necessary to copy tapes. **R-E**

How to Design Analog Circuits —Multi-Stage Amplifiers



MANNIE HOROWITZ

For most applications, you'll need more gain than you can get from a one-stage amplifer. This month, we'll show you how to combine one or more amplifer stages to get a more useful circuit.



A SINGLE STAGE OF AMPLIFICATION MAY provide enough gain for some applications, but rarely, if ever, is the gain from a single-stage amplifier sufficient for audio or RF circuits. For those applications, the output from one amplifier stage must be fed to one or more subsequent stages to obtain enough gain. If that is done, the voltage gain of the first stage is multiplied by the voltage gain of the succeeding stages to determine the overall gain of the entire circuit.

Let's look at some of the methods that are often used to connect several amplifier stages together. Transformer coupling was, at one time, used quite often with audio amplifiers—especially in the power-output stages. Although it is still used for that, transformer coupling is now used mainly in IF and RF circuits.

Another method of coupling is through an R-C network. In that type of circuit, the output of one stage is connected to the input of another through a capacitor. In the previous article in this series (see the November 1982 issue of **Radio-Electronics**), we indicated that a capacitor is used to couple a signal from its source to the input of an amplifier to isolate the source from the bias circuit. If the signal source and the bias circuit were not isolated in that fashion, the bias on the transistor would be altered by the signal source. That will also occur in a two-stage (or more) coupled circuit, but with an additional factor—in a circuit of that type, the collector voltage at the first transistor would affect the base current of the second. In turn, the current demanded by the base circuit of the second would affect the collector voltage of the first.

But that interaction can be accounted for and the circuit can be designed so that the use of a capacitor between the two stages is not required. That type of circuit is referred to as a direct-coupled amplifier and there are a number of advantages to using that arrangement, including better low-frequency response.

The circuits we will describe in this article all use bipolar transistors. Many of the problems encountered are not as severe in FET circuits. Thus, once you have mastered the design procedures for bipolar-transistor circuits, applying what you've learned to FET circuits is relatively easy.

Transformer-coupled circuits

The transformer has characteristics that make it useful as a coupling device. As you know, a simple transformer is made up of two coils of wire wound around a common magnetic-core. For the rest of this discussion, we will assume that one coil, called the primary, consists of N1 turns of wire, while the other coil, called the secondary, consists of N2 turns of wire. If a DC current were fed to the primary, a steady magnetic field would be induced in the primary and coupled through the core to the secondary, but no current would be induced in the secondary. If an AC current were fed to the primary, however, an AC current would be induced in the secondary. The signal in the secondary would have the same frequency and vary identically to the signal fed to the primary (assuming an ideal transformer, of course). If there were perfect magnetic coupling between the two coils, the current appearing in the secondary (I2) due to the input current (I1) would be inversely proportional to the ratio of the turns in the coils, or:

$$\frac{I2}{I1} = \frac{N1}{N2}$$

The ratio of the voltages across the two coils is directly proportional to the turns ratio, or:

$$\frac{V1}{V2} = \frac{N1}{N2}$$

Since impedance, Z, is equal to the product of V and I, by multiplying equation 1 by equation 2, we come up with the fact that the impedance ratio is proportional to the turns ratio squared, or:

$$\frac{Z1}{Z2} = \frac{(N1)^2}{(N2)^2} = \left(\frac{N1}{N2}\right)^2$$

That equation states that an impedance in the secondary, Z2, will appear reflected into the primary as an impedance, Z1′, equal to Z2 multiplied by $(N1/N2)^2$, the square of the turns ratio.

Now, let's turn to a practical design example. Let us say that we have a ceramic phonograph cartridge that must see a resistance of at least 22,000 ohms. The average output voltage from the cartridge is 0.25 volt. After amplification, however, ½-watt must be delivered to an 8-ohm loudspeaker at the output. Transformer coupling is to be used between the amplifier stages and between the output stage and the loudspeaker. To do that, we'll use the circuit shown in Fig. 1. Assume that the beta of both Q1 and Q2 is 100.

If the transformer is 60% efficient, at least 0.5/0.6 = 0.833 watt must be available from Q2. However, there are other factors such as transistor leakage, losses due to the emitter resistor, and so on. Considering those potential losses, we should be safe if we design the circuit to deliver 1 watt.

To start our design, we must first draw the load lines for output transistor Q2. When we draw the load lines, we must take into account the effect of the transformer in the collector circuit of Q2. Since the primary of the transformer is an inductor, it will present a DC resistance, equal to the resistance of the wire in the coil, but a different AC impedance. Because of that, two load lines, one DC and one AC, must be plotted on the same graph. The supply voltage is specified to be 9 volts.

Let's assume that the resistance of the primary winding of T2 is very low and just about equal to zero. We will also assume that R_{E2} is very small and let it equal zero. Making those assumptions, the vertical line in Fig. 2 is the DC load line. (To make the graph clearer, the transistor's characteristic curves have been omitted here.) That is, of course, determined by the equation for the load line, $V_{CC} = I_C(R_P + R_{E2}) + V_{CE}$. Since R_P, the resistance of the primary winding of the transformer, and R_{E2} were both assumed to be zero, $V_{CC} = V_{CE}$ for all values of collector current I_C. That, of course, is the equation of a straight line.

The AC impedance is R_L reflected into the primary of T2 as a resistance R_L'. Before we go any further, let's take another look at Q2's collector circuit because something interesting happens here. First, as we said before, the primary of the transformer is an inductor. Just as a capacitor opposes sudden changes in voltage, an inductor opposes sudden changes in current. We will show how the quiescent collector current, I_{CQ}, is chosen shortly, but for now let's just say that it will be chosen to allow for equal swings between 0 and I_{Cmax}. With no input-signal applied to the transistor's base, I_{CQ} (the quiescent collector current) flows through Q2's collector circuit and through the primary of T2. When an AC signal is applied to the transistor, however, things begin to change.

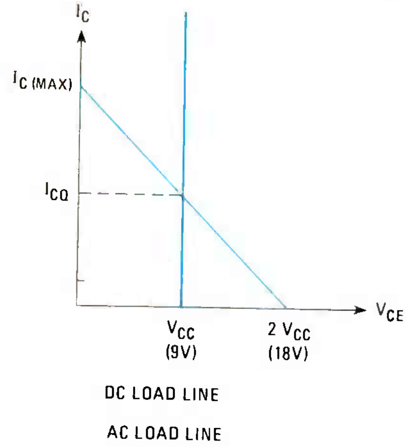


FIG. 2—THE LOAD LINES for the transistors of the circuit shown in Fig. 1 are shown here.

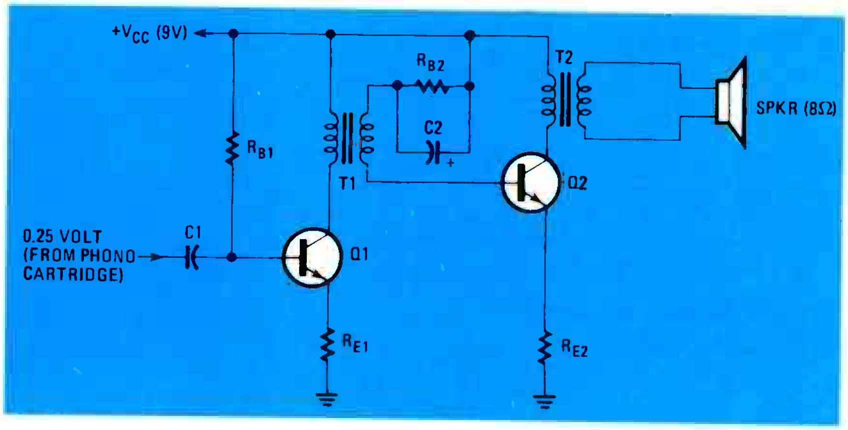


FIG. 1—THIS BASIC TRANSFORMER-COUPLED CIRCUIT uses transformers to couple the two amplifier stages, and to couple the entire circuit to the load, in this case a loudspeaker.

Let's first consider what happens when the AC-input swings negative. When that happens, the transistor tries to decrease the collector current by increasing its collector-to-emitter resistance. The inductance of T2's primary, however, opposes the change in I_C and tries to maintain the flow of current at I_{CQ}. The result is that I_{CQ} now flows through a higher collector-to-emitter resistance, and the transistor's collector-to-emitter voltage *increases* to a level higher than the power-supply potential. That same phenomenon occurs when the input signal starts swinging positive. In that case, however, the collector-to-emitter voltage subtracts from the power-supply voltage. As a result, the transistor should be biased so that V_{CEQ} is higher than $V_{CC}/2$. We will design the circuit in Fig. 1 so that the collector-to-emitter voltage of Q2 will swing between 0 and 18 volts. Plot 18 volts on the V_{CE} axis; that determines V_{Cmax} on the load line.

The amount of power delivered from the transistor, 1 watt, determines the I_{Cmax} point on the load line. Because the signal swings from the transistor's quiescent current point, I_{CQ}, to a peak current of I_{Cmax}, and then to a minimum current of 0, the RMS current delivered by the transistor is $I_{Cmax}/2\sqrt{2}$. Similarly, the RMS voltage due to the 0- to 18-volt swing is $V_{Cmax}/2\sqrt{2} = 18/2\sqrt{2} = 6.36$ volts. The product of the RMS voltage and the RMS current must be equal to the required 1 watt needed from Q2, so $6.36(I_{Cmax}/2\sqrt{2}) = 1$, and $I_{Cmax} = 0.44$ amps. Plot that point on the I_C axis and draw the AC load line. Idling current, I_{CQ}, is half of I_{Cmax}, or 0.22 amps.

The slope of the AC load line is the negative of the load resistance as seen by Q2, or (18 − 0)/(0.44 − 0) = 41 ohms. Because the load that the loudspeaker presents to the secondary is 8 ohms, the impedance ratio of the primary to secondary is 41/8 = 5.13. The turns ratio of T2 is the square root of the impedance ratio, or 2.3:1.

For stability's sake, we want to make R_{E2} as large as possible. But we are limited because of gain. Let us assume, for the moment, that we can accept a gain of 8.2. Then the sum of R_{E2} and r_e, the AC emitter resistance of the transistor, can be 41/8.2 = 5 ohms. (That is so because the gain of a stage of amplification is equal to the ratio of the output impedance to the resistance in the emitter circuit. Here it is 41/5 = 8.2.) Because the idling current is 0.22 amps, or 220 mA, r_e = 26/220 = 0.12 ohms. Resistor R_{E2} can be a maximum of 5 − 0.12 = 4.88 ohms. Thus, a standard 4.7-ohm resistor can be used for R_{E2}. Now the actual gain of that circuit is 41/(4.7 + 0.12) = 8.33. That is just a bit above our minimum desired gain of 8.2.

If the transistor is to idle at 0.22 amperes, the base current is I_{CQ}/β = 0.22/100 = 0.0022 amp. That current is determined from the circuit consisting of V_{CC}, R_{B2}, the resistance of the secondary of T1 (assumed to be 0 ohms), the base-emitter voltage of Q2, and the resistance R_{E2} multiplied by β. Knowing everything but R_{B2}, we can determine it from the equation relating all these factors, $0.0022 = (V_{CC} - V_{BE})/(R_{B2} + \beta R_{E2}) = (9 - 0.6)/[R_{B2} + 100(4.7)]$; solving for R_{B2}, we find it is equal to 3348 ohms. A standard 3300-ohm resistor can be used. If that resistor is only to affect the DC bias, no signal voltage must appear across it. For that to happen, R_{B2} must be bypassed by a capacitor. The reactance of that capacitor, X_C, should be about .01 of the resistance of R_{E2}, or 330 ohms at the lowest frequency, f_L, to be amplified. The value of the required capacitor can be found from $C = 1/(2\pi f_L X_C) = 1/2072.4 f_L$.

Because the gain of the circuit is 8.33 and the RMS voltage at the collector of Q2 is 6.3 volts, the voltage at the secondary of T1 must be at least 6.3/8.33, or 0.76 volts RMS to drive the output circuit to its desired level. The resistance across the secondary winding of T1 is the 3300 ohms of R_{B2} in parallel with βR_{E2} (r_e is negligible), or 3300 ohms in parallel with 470 ohms. That is equal to 411 ohms.

A reasonable load for T1 to present to the collector of Q1 is 2000 ohms. As the secondary of the transformer sees 411 ohms, and as the turns ratio of T1 is equal to the square root of the resistance ratio, that turns ratio is equal to $\sqrt{2000/411}$, or 2.2:1. That, of course, is also the voltage ratio. So if 0.76 volt must be across the secondary of T1 for T2 to deliver ½ watt, 2.2 × 0.76 = 1.67 volts must be across the primary of T1. As the cartridge delivers 0.25 volt, the gain of the Q1 amplifier must be at least 1.67/0.25 = 6.68. Hence R_{E1} + r_e of Q_1 must be equal to or less than 2000/6.68 = 300 ohms. We can now plot a load line for Q1, and find its quiescent operating point, as shown in Fig. 2.

When we worked around Q2, we did not decide just what the AC load resistance should be. Now, we know it—it is 2000 ohms plus the 300-ohm resistance of the emitter, or a total of 2300 ohms. Thus, I_{Cmax} is equal to 18-volts/2300-ohms, or 7.8 mA. The quiescent operating point, I_{CQ} is one half of that for Q1, or 3.9 mA. That makes r_e for the Q1 stage equal to 26/3.9, or 6.7 ohms. Resistor R_{E1} must then be a maximum of 300 ohms less 6.7 ohms, or less than 293.3 ohms. Use a standard 270-ohm resistor for that.

Since the idling collector current is 3.9 mA and β is 100, the base current is 3.9/100, or 0.039 mA. Using that, R_B can be determined from the base current circuit; i.e., $(V_{CC} - V_{BE})/(R_B + \beta R_E) = (9 - 0.6)/[R_B + 100(270)]$. Solving for R_B, it is equal to 188,000 ohms and a standard 180,000-ohm resistor can be used.

Transformer coupling is used quite often in radios where one IF stage is coupled to the other in a circuit similar to that shown in Fig. 1. In those circuits, however, a capacitor shunts the coil windings to form a resonant circuit so that only the IF frequency will pass through the amplifier circuit and all other frequencies will be rejected.

Resistor-capacitor coupling

Transformers are fine when you are working with RF frequenes. But at AF frequencies, transformers can get quite expensive and bulky. That's why R-C coupling is now being used for many applications, although transformer-coupling is still common in RF circuits.

Let's look at the circuit shown in Fig. 3. This time, let us say that the input signal comes from a low-impedance magnetic-type phonograph cartridge with an output of 4 millivolts. Assume we want to build that voltage up to a sufficient level to drive the power amplifier of Fig. 1. Thus the circuit in Fig. 1 would be driven by an amplifier circuit rather than by a ceramic cartridge. In this case, 0.25 volt is required at the output of the R-C circuit of Fig. 3 and that output must drive a load equal to the input impedance of the transformer amplifier, or 180,000 ohms in parallel with β multiplied by 276.7 ohms (the emitter resistance of Q1), or 24,000 ohms. The overall voltage gain of the amplifier must then be 0.25-volt/4-millivolt = 62.5. Theoretically, the voltage gains of the two stages can be made identical. If that were done, the gain of each stage would be $\sqrt{62.5}$, or 7.9.

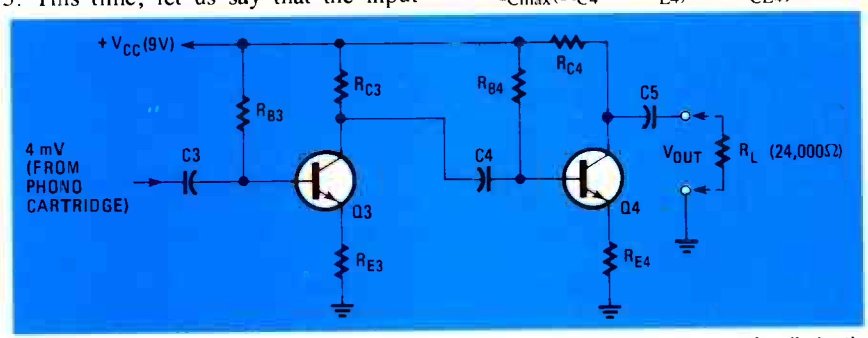


FIG. 3—AMONG THE ADVANTAGES of using R-C coupled circuits such as this one are the elimination of bulky and expensive transformers, and increased voltage gain.

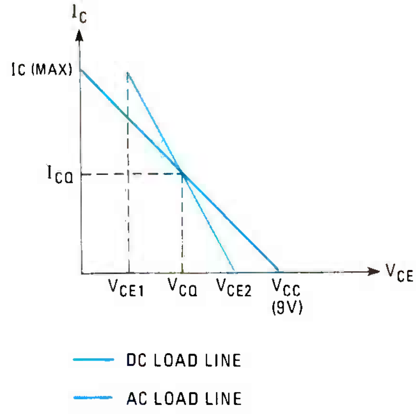


FIG. 4—THE LOAD LINES for the transistors in the circuit shown in Fig. 3.

Usually, however, the voltage gain of the second stage is made lower than that of the first stage because the output load of the second stage generally has a lower impedance.

Let's start the design by considering the second stage. Resistor R_{C4} should be chosen so that its value is between 10% to 20% of R_L; let's make it 3300 ohms. Now the DC load on Q4 is 3300 ohms and the AC load is 3300 ohms in parallel with the 24,000 ohm load, or 2933 ohms. To have a gain of somewhat more than 5, make R_{E4} equal to about 20% of 2933 ohms, or about 470 ohms.

The DC load line (see Fig. 4) extends from V_{CC} to a point on the I_C axis equal to I_{Cmax}. From the load-line equation, $V_{CC} = I_{Cmax}(R_{C4} + R_{E4}) + V_{CE4}$, we find that I_{Cmax} = 2.4 mA when V_{CE4} = 0 and V_{CC} = 9. And, as I_C must swing between 2.4 mA and 0, I_{CQ} = 1.2 mA and V_{CQ} = 4.5 volts.

The AC load line must pass through that point. We can determine V_{CE1} from the negative of the equation for the slope of the AC load line, or $(V_{CE2} - V_{CQ})/(I_{CQ} - 0) = (2933 + 470) = 3403$ ohms. Substituting V_{CQ} = 4.5 volts and I_{CQ} = 1.2 mA into the equation, V_{CE2} = 8.6 volts. As V_{CE1} is the same distance below V_{CQ} as V_{CE2} is above it, and because $(V_{CE2} - V_{CQ}) = (8.6 - 4.5) = 4.1$ volts, then $V_{CE} = (4.5 - 4.1) = 0.4$ volts when I_C is equal to 2.4 mA.

The output must be able to swing the full 0.25 volt RMS, or $2\sqrt{2}(0.25)$ = 0.707 volt peak-to-peak in order to be able to drive the amplifier in Fig. 1 sufficiently. The maximum peak-to-peak swing of the transistor is $(V_{CE2} - V_{CE1}) = (8.6 - 0.4) = 8.2$ volts. Thus a 0.707-volt swing is well within the capabilities of this amplifier stage.

The actual gain of this stage can be determined after we find just what r_{e4} is in the Q4 circuit. It is equal to $26/1.2 = 21.7$ ohms. Thus, the total resistance in the emitter circuit is $470 + 21.7 = 491.7$ ohms. and the gain is just about equal to $2933/491.7 = 6$. Because the total gain must be at least equal to 62.5, the gain of the first stage, Q3, must be greater than 62.5/6, or 10.42.

We will now determine R_{B4} in a manner similar to that used for determining R_{B2} in the circuit of Fig. 1. Use the equation $V_{CC} = I_B R_{B4} + V_{BE} + \beta I_B R_{E4}$. Note that $\beta = 100$ and $I_B = I_{CQ}/\beta = 1.2/100 = 1.2 \times 10^{-5}$ amps. After substituting into the equation, we can calculate that R_{B4} is equal to 653,000 ohms and a standard 620,000-ohm resistor can be used.

The load on the output of the Q_3 circuit is 620,000 ohms in parallel with $\beta(R_{E4} + r_e)$, or 45,291 ohms. As R_{C3} should be less than 10% of that, use a 4300-ohm resistor for that. Now the DC load on the transistor is 4300 ohms and the AC load is that resistor in parallel with 45,291 ohms, or 3927 ohms.

Following the procedure used to find R_{E4}, we can determine that R_{E3} should be 330 ohms if we are to get a gain of more than the required minimum of 10.42. To check the gain, we must first determine I_{Cmax}. It is $(9 - 0.6)/(3927 + 330) = 1.97$ mA, and I_{CQ} is one-half of I_{Cmax}, or about 1 mA. That makes r_e equal to 26/1, or 26 ohms. The total emitter resistance is $330 + 26$, or 356 ohms. Consequently, the actual gain of the Q3 circuit is about 3927/356, or 11. As that is more than the required minimum of 10.42, the circuit fulfills our requirements.

The value of R_{B3} can be found from the equation $V_{CC} = I_B R_{B3} + V_{BE} + \beta I_B R_{E3}$. When we note that $I_B = \beta I_{CQ}$, we can determine that R_{B3} is equal to about 897,000 ohms, and you can use a standard 910,000-ohm resistor.

The resistance the magnetic cartridge sees is 35,600 ohms (the resistor in the emitter circuit of Q_3, multiplied by the beta of that transistor) in parallel with 910,000 ohms, or just about 35,000 ohms. That is pretty close to the resistance most cartridges must see. If the resistance the cartridge must see is specified to be less than 35,000 ohms by the manufacturer, an additional shunting resistor must be wired across the cartridge. The shunting resistor can be calculated by using the equation for resistors in parallel and substituting 35,000 ohms and the resistance that the cartridge must see into the equation. Place that calculated resistor directly across the cartridge, not on the circuit side of C3. The reason it must be placed that way is to keep it from upset-

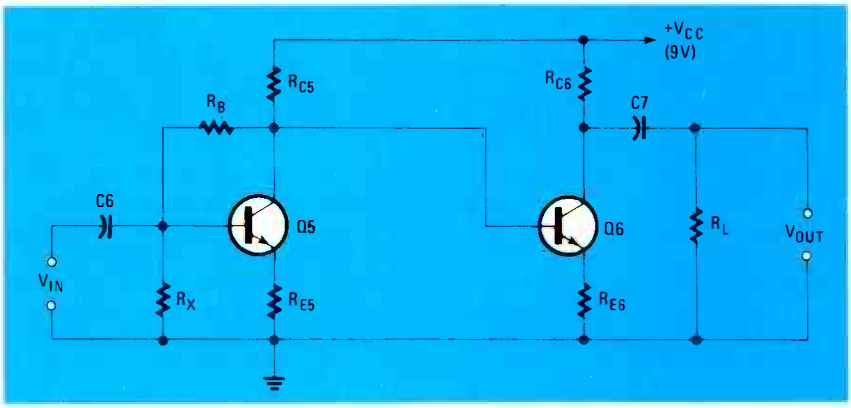


FIG. 5—DIRECT-COUPLED CIRCUIT. Those circuits have been developed to overcome the drawbacks of using capacitors as coupling devices.

ting the bias voltage established by the other components in the circuit. The function of the isolating capacitor has been detailed in the previous article on audio-amplifier circuits.

Direct-coupled amplifiers

Using capacitors to couple transistor amplifers does have some important drawbacks. For one thing, capacitors do not pass low frequencies very readily. Besides, capacitor-resistor circuits introduce phase shifts, are not linear, and add distortion. As a result, circuits have been developed that do not use coupling capacitors. An example of one such circuit is shown in Fig. 5. While that circuit does not appear to be much different than the one you see in Fig. 3, the differences that do exist are significant. Note primarily that the coupling capacitor between the collector of Q5 and the base of Q6 has been omitted. The overall gain is still the product of the gains of the two transistor circuits.

The circuit around Q6 can be designed in a fashion similar to that used for the design of the circuit around Q4 in Fig. 3. But here, we must also consider that the base voltage of Q6 is the same as the collector voltage of Q5. Voltage at the collector of Q5 must not be upset if Q6's base voltage is low, as it tends to be. To compensate for that, a parallel R-C network may be wired in series with R_{E6}. Considering the DC current that flows through the series resistor circuit, the DC voltage developed across the combination is much greater than it would have been had only R_{E6} been in the circuit. Voltage at the base of Q6 is the voltage across the series combination of resistors added to the V_{BE} of the transistor. The capacitor across the added series resistor is there to bypass the AC signal so that the new resistor will not affect the AC gain of Q6. The reactance of that bypass capacitor should be less than 10% of the value of the resistor it is bypassing at the lowest frequency to be amplified.

Note the R_B and R_X resistors in the base circuit of Q5. If you look back at the bias circuits described in a previous article, you will find that the circuit involving those resistors is essential for stablizing transistor collector-current to withstand variations of temperature. It is used here because the effect of any increase in leakage current in Q5 is multiplied in magnitude due to the DC amplification of the direct-coupled circuit. So if the leakage current in Q5 is multiplied in that transistor by a factor of 10 due to the increase in temperature, it can be multiplied further by the beta of Q6 before it appears in its collector circuit. Excellent stability is an important consideration when designing direct-coupled amplifier circuits.

More than just the collector current of Q5 flows through R_{C5}. When determining the voltage drop across that resistor, be sure to add other currents that flow through that resistor to the I_C normally expected. Bias current for Q5 flows through R_{C5} (and R_B) along with the base bias-current for Q6. The sum of those currents may, at times, be a substantial factor in determining the quiescent conditions around the circuit, along with the expected I_C.

Special direct-coupled circuits

Last time, we described the emitter-follower or common-collector circuit. Its characteristics were a high input impedance and a low output impedance; its power gain was equal to beta. The Darlington circuit goes one step farther and improves even on those excellent characteristics by a factor of beta.

Darlington amplifiers consist of two cascaded emitter followers, as shown in Fig. 6. If the beta of Q1 is β_1, and the beta of Q2 is β_2, the current and power gains of the overall circuit are $\beta_1 \times \beta_2$. But the voltage gain still remains slightly less than 1, as it did for the emitter follower.

The input impedance is R_E multiplied by the product of the betas, in parallel with R_B. The value of R_B can be quite large in that circuit as there is only a small amount of base current in Q1. That Q1 base current must equal $(V_{CC} - 2V_{BE})/(\beta_1\beta_2 R_E + R_B)$ for a substantial amount of emitter current to flow in Q2.

The output impedance of that circuit is $R_B/\beta_1\beta_2$ in parallel with R_E. The values

continued on page 102

COMPUTER CORNER

Selecting an accounting package

LES SPINDLE*

OFFICE AUTOMATION PERFORMS A VARIety of useful functions that can greatly increase the cost-effectiveness of each employee. In previous columns, we have examined such sophisticated business-software innovations as database management systems (DBMS) and financial-planning programs (like *VisiCalc*). Those state-of-the-art programs offer creative solutions to everyday office problems. Perhaps less ostentatious—but no less useful—are the software packages available for everyday bookkeeping tasks, one of which is shown in Fig. 1.

FIG. 1

General ledger, accounts payable, accounts receivable, inventory, and payroll form what are commonly referred to as the "Big 5" accounting programs. The bookkeeper who works with quality programs in each of those categories—or opts for a complete interactive "Big 5" package—will benefit from greatly increased productivity from his accounting staff.

Careful planning and selective shopping—as always—are the keys to finding the software that will be best suited to your purposes. It is important to select software that offers enough features and options to make the conversion of your bookkeeping records relatively simple. At the same time, it is wise to select packages that allow enough flexibility for you to fine-tune the program to your own special requirements. Let's take a look at a few criteria to keep in mind when choosing various accounting programs for your office.

In planning to computerize your general-ledger system, begin by defining your needs. Can that system operate independently, or is it preferable to have one that interacts with other "Big-5" programs? Will it be restricted to the financial activities of one office, or must the reports from various branch offices or subsidiaries be integrated as well? What is the volume of transactions? It is important that your computer system have the memory capacity to support the necessary functions. How educated is your office staff in computer functions? That is important in choosing between a general-ledger package that uses a step-by-step format to guide the novice user through the program, or a more sophisticated offering.

It is important to chart out all of your requirements before even beginning to shop. The salesman demonstrating the software will only be able to direct you to the package best suited to your purposes if he has a good idea of the quantity of data that has to be processed and the specific requirements of your bookkeeping methods.

A general ledger is essentially a financial history of a specific accounting period that lets management analyze a company's profile to determine appropriate planning strategies. The primary functions are to keep a record of financial transactions and the resulting balances, and to generate regular balance-sheets and profit/loss statements.

It is vital for a general-ledger program to use a double-entry accounting system. (That means that for every dollar of debit, there is a corresponding credit entry of equal amount, and vice versa.) Double-entry bookkeeping is a safeguard to insure that all accounts are in balance.

Another point to look for is the system's ability to set up a proper chart of accounts. That is a crucial part of the general-ledger framework, for it can provide rapid departmental profiles, as well as a perspective on the financial status of the entire company. Since the allowable number of accounts varies from package to package, the prospective buyer should select a package that can handle the current number of accounts, and is flexible enough to expand as the company does.

Accounts payable/receivable

An accounts-payable or -receivable package has five primary functions. It must: create master files for customers and vendors; record sales and purchases; index all sales/purchase data with the appropriate master files; manipulate the data, and prepare summary reports by master file account, date, or some other reference.

As with general-ledger programs, your particular needs will determine the appropriate checklist of required features that you should prepare.

One of the important criteria is the ability to produce audit trails—especially for companies that require a certified audit. A good program will automatically prepare a transaction listing immediately after the data is input.

Most accounts-payable systems will require more detailed record-keeping. For example, a check may have to be coded to multiple accounts (for example, when a single check pays a bill that covers different accounts).

Job-costing is another important feature, as many manufacturers will need to access accumulated costs by job. An accounts-payable system set up to handle job-costing can accept job codes as well as account numbers.

Among other items to keep in mind are: commission accounting (some companies don't pay commissions to the salesman until after the company is paid) and finance charges. The better accounting packages are able to compute and assign finance charges rapidly and efficiently. Most accounts-receivable systems will print statements and invoices, and good ones will automatically print checks—both functions are useful and time-saving for the accountant.

Inventory control

There are several benefits in managing the flow of merchandise to be gained from an inventory-control program. Overstocks can be reduced and out-of-stock situations can be avoided. The average small business pays 25–50% of the value of its inventory just in inventory carrying-costs.

The two most common approaches to automating inventory control are invoicing and order entry. With the invoicing approach, the program won't accept invoicing data until after the order is filled—generating an invoice only upon completion of the order. That system has the drawback of not being able to list

*Managing Editor, *Interface Age* magazine

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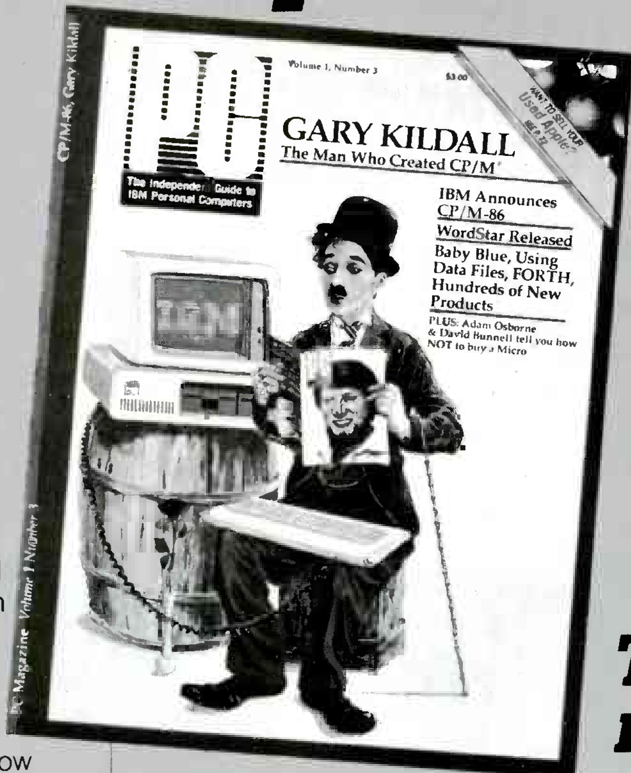

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backorders and open-orders.

An order-entry system will accept the data at any time, separating order-placement and invoicing into two different steps. Also, open-orders may be altered in any way called for, prior to billing. Most businesses will benefit from that approach, as opposed to the more limiting invoicing setup.

An obvious, but critical, consideration in the selection process is knowing the system's ability to handle the current volume of items—as well as knowing its capability for coping with future growth. That often involves hardware decisions such as whether your disk capacity is sufficient to handle the data involved. Most inventory packages on the market will handle at least 1000 items of stock, which should be adequate for most small businesses.

The allowable size of data fields is also very important. Basic specifications for items in stock must be supplemented with other information. Make sure that the package you select allows for that. Such data as product class or code, average cost, previous cost, and product description are often required, so your data fields must be structured with enough space to enter the necessary information.

Payroll

A payroll system is set up primarily to compute and print payroll checks, distribute labor costs to the proper files, and compile the information required for government reports.

The most common features one can expect in a package are: computing FICA, state unemployment, and federal and state taxes; reporting of employee earnings by category (such as department); generating quarterly and annual government tax filings; and handling of miscellaneous items (non-taxable items, overtime pay, savings and dental plans.)

There are a myriad of other features to be found in various accounting packages. Among them are: reports on hours worked as well as dollar amounts by department and job; union reports; earnings history for each employee; employee files (hire, review, and termination dates), and data on earned-income credits.

More than any other accounting program, a good payroll program can save weeks of employee labor per year. But because of the confidentiality, timeliness, and accuracy required, choosing the right one is an especially crucial step in putting together a computerized bookkeeping system.

Sample the brochures from many different vendors and ask as many questions as you have to to satisfy yourself before deciding which package has the features that will work best in your accounting organization. R-E

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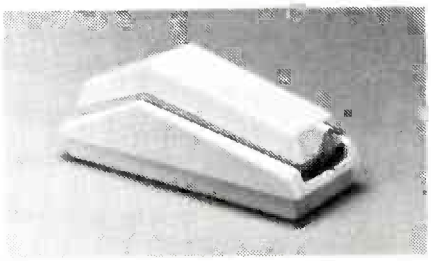

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NEW IDEAS

Low-battery indicator

TODAY MANY HOBBYISTS BUILD BATTERY-operated projects using highly efficient solid-state devices that ensure long battery-life. Even with those circuits, though, a need occasionally arises to make certain that the battery—which may have been in use for some time—is still in good condition. I use the low-battery indicator shown in Fig. 1 in several battery-powered special-effects devices for the theater, where it is crucial that everything operate when it's supposed to.

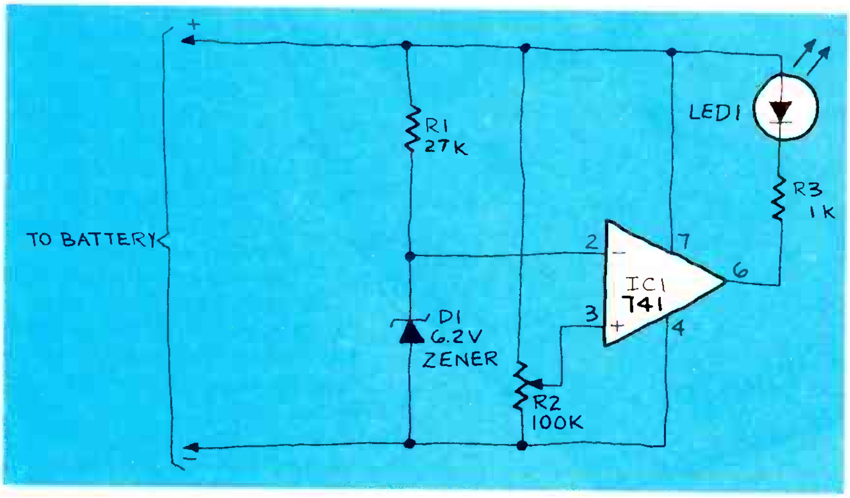


FIG. 1

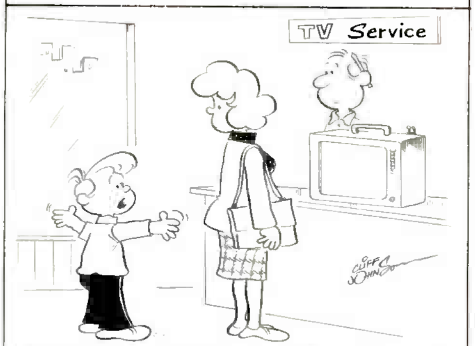
The low-battery indicator uses an LED to signal when the battery voltage has dropped below a pre-selected level. It is easy to build, reliable, and inexpensive, and can be adapted for a wide range of voltages. The device shown is intended to operate in a 9-volt circuit.

The sensing circuit consists of a 741 op-amp set up as a voltage comparator, using a Zener diode as a voltage reference. The op-amp is inserted as a bridge between two resistance ladders, one containing the Zener reference, and the other a high-value linear potentiometer. The Zener is connected to the inverting input of the op-amp, and the wiper of the potentiometer is connected to the non-inverting input. The top and bottom of the bridge are connected to V_{CC} and ground, respectively.

When the voltage at the wiper of the potentiometer drops below the voltage set by the Zener, the output of the op-amp goes low; that turns on the LED connected between it and V_{CC}. The LED turn-on voltage is selected by the potentiometer; the device can be adjusted most easily by applying to it the voltage at which you want the LED to turn on and adjusting the potentiometer until it just does so.

The indicator uses only six parts: R1 is 27K; R2 is a 100K linear potentiometer; R3 is 1K, and Zener diode D1 is rated at 6.2 volts; IC1 is a 741, and just about any LED will work. The device is easy to build and doesn't present much of a load to the battery it monitors—the version I use draws only about one milliamp when idling, and about 20 milliamps when the LED is lit.

The circuit can be adapted to work with battery-powered circuits requiring between 6 and 18 volts; the only changes needed would be a lower-voltage Zener and smaller current-limiting resistor in the case of voltages below nine volts, and a larger resistor for higher voltages.—*Donald F. Ricklies*

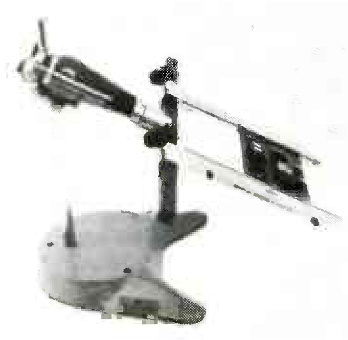


"*But, Mom, I liked the green faces—they were scary.*"

NEW IDEAS

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

All published entries, upon publication, will earn $25. In addition, Panavise will donate their *model 333*—The Rapid Assembly Circuit Board Holder, having a retail price of $39.95. It features an eight-position rotating adjustment, indexing at 45-degree increments, and six positive lock positions in the vertical plane, giving you a full ten-inch height adjustment for comfortable working. (See photo below.)



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NEW LIT

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MICROCOMPUTER GAMES is a color 2-page letter-sized flyer describing 19 computer games. The games range from solitaire layouts (Voyager, Computer Football Strategy, Controller), 1 - 4 players (Computer Stocks and Bonds), 2 - 4 players (Computer Foreign Exchange), up to as many as 20 players seeking to conquer the universe (Galaxy). Free from **The Avalon Hill Game Company,** 4517 Hartford Road, Baltimore, MD 21214.

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HEX-TOOL CATALOG, *No. SD-267*, is 4-color, 8 pages, and contains complete descriptions and photographs of Vaco's newly expanded line of unique ball-end hex tools.

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The catalog also illustrates the unique features and benefits of Vaco's ball-end hex tools. They allow easy access even in restricted or hard-to-reach areas, set or remove screws at angles up to 30°, and drive fasteners quicker and easier, saving time and labor. The *No. SD-267* Ball End Hex Tool Catalog is free upon request from **Vaco Products Company,** 1510 Skokie Blvd., Northbrook, IL 60062.

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TV/VIDEO SYNC, Primer and Product Note Opt. 005-1 is a 16-page primer, with 13 drawings and 3 photographs; the special sections include the United States NTSC broadcast standards and nomenclature, a discussion of PAL and SECAM systems of color transmissions, and a glossary of TV and video terms.

Other sections cover theory of operation, typical setup, specifications, and the features and applications possible when a TV/video sync option is added to any currently-manufactured *HP 1700*-series oscilloscope. Applications described are relevant to such industries as medical imaging, consumer video products, and television broadcasting.

Copes are free from **Hewlett-Packard,** Inquiries Manager, 1820 Embarcadero Road, Palo Alto, CA 94303.

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STATE OF SOLID STATE

Measuring relative humidity

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

A KNOWLEDGE OF THE RELATIVE HUMIDity at any given time can permit us, or others around us, to make decisions that can affect our health, comfort and personal safety. In addition, the measurement of relative humidity (abbreviated RH) is vital in such areas as food processing, air conditioning, packing, photography, paper and lumber production, and chemical manufacturing. Knowing the RH—along with the temperature—can allow airport operators to predict fog and runway icing. Similarly, farmers and nurserymen can predict dew and frost; and highway safety authorities can forecast dangerous fog and icing on bridges.

Electronic circuits for humidity measurement have rarely appeared in the press because humidity-sensitive transducers have been expensive and seldom available to the electronics constructor and hobbyist. Now, for about ten-dollars-worth of semiconductors and discrete components, and less than sixty dollars for the humidity sensor, you can build a direct-reading electronic hygrometer. The device, described in National Semiconductor's Application Note AP 256, is designed around the PCRC-55 humidity sensor, from Phys-Chemical Research, and a linear 0 to 10-volt DC meter.

The sensor

The electro-humidity sensor has a hygrometric element whose impedance changes with changes in relative humidity. The hygrometric portion of the sensor is on the surface of a chemically treated styrene copolymer plastic wafer. Water vapor is sorbed or desorbed by means of adsorption (the adhesion of molecules to a surface; not the same as *ab*sorption). That

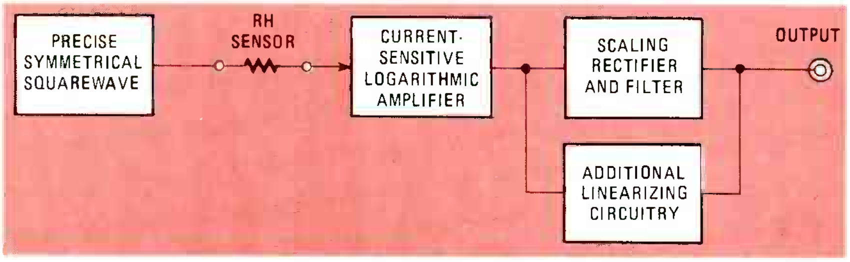

FIG. 1

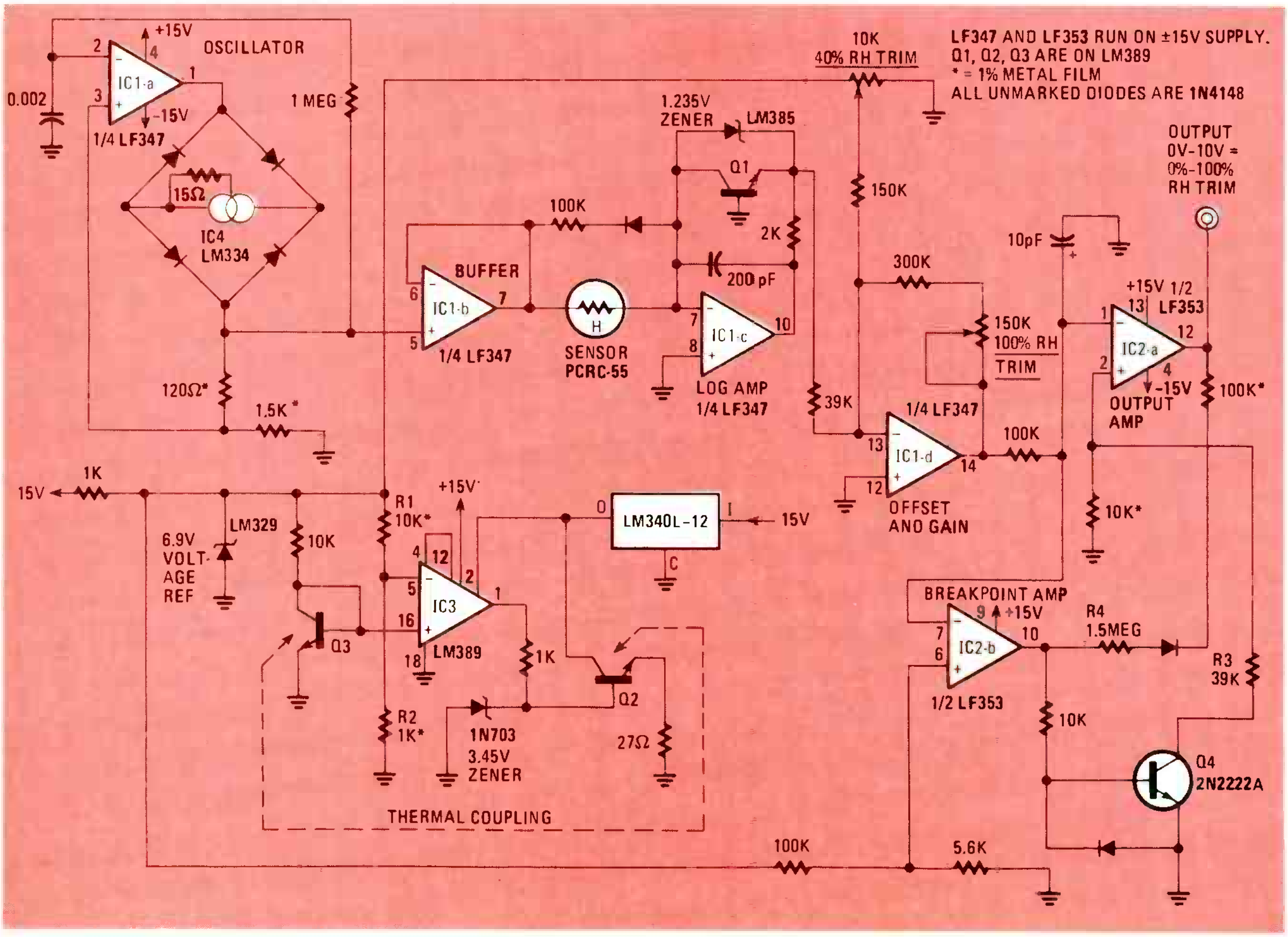

FIG. 2

results in the sensor's having a very rapid response to changes in relative humidity. A single sensor covers the complete range of relative humidity—from 0 to 100%.

The sensor should be excited only by AC voltages (preferably sinusoidal waveforms) of at least 20 Hz with no DC component. Sustained operation with a DC voltage, or AC with a DC component, causes a shift in calibration. The maximum allowable current is one mA.

Figure 1 is a block diagram of the electronic hygrometer. An amplitude-stabilized squarewave drives a precise alternating current through the sensor. The sensor's output current feeds a current-sensitive logarithmic amplifier to linearize the response. The output of the log amplifier is scaled, rectified, and filtered to provide a 0–10-volt DC-output representing RH's from 0 to 100%.

A practical circuit

In Fig. 2, a symmetrical squarewave is generated by IC1-a, an op-amp with positive feedback applied to cause it to oscillate. The combination of constant-current source IC4 and its associated diode-bridge clamps the squarewave output of IC1-a at +8 volts. IC4 has a positive temperature coefficient of 0.033%/°C, which almost completely compensates for the negative 0.036%/°C temperature coefficient of the PCRC-55 sensor. (Mount IC4 close to the sensor so they will be at the same ambient temperature; that way the temperature coefficient of the complete instrument will approach zero.)

The squarewave is buffered, and then fed through the sensor into the summing junction of IC1-c. On negative-going halves of the squarewave, the V_{BE}/I_C characteristic of Q1, in the IC1-c feedback loop, gives the amplifier a logarithmic amplitude-response. On positive-going half-cycles of the squarewave, feedback through the diode to the summing junction ensures that this point remains at a virtual ground so the sensor always "sees" the required symmetrical drive-waveform.

The output of the log amplifier goes to IC1-d, an op-amp used to sum-in the calibration at the 40% RH point, and to provide adjustable gain for trimming the output to the proper level for a 100% RH reading. The output of IC1-d is filtered to DC by the 100K resistor and 10 μF capacitor and then fed to IC2-a, the output amplifier

IC2-b compensates for the sensor's departure from linear response below 40% RH. It does that by altering the gain of the output amplifier when its input drops to about 0.36 volt—corresponding to 40% RH. The inverting input of IC2-b, the breakpoint amplifier, is tied to the non-inverting input of the output amplifier. When the input to those paralleled gates drops below 0.36 volt, the output of IC2-b swings positive; that turns on transistor Q4 to produce the required change in the output amplifier. Transistor Q4 is turned off for RH values above 40%, so linearity is then determined solely by the log amplifier.

Transistor Q1, in the log-amplifier feedback loop, is extremely temperature sensitive and can adversely affect the performance of the amplifier. To compensate for that, the designers at National Semiconductor came up with a unique circuit application. Transistors Q1, Q2, and Q3 are discrete NPN devices on the same substrate as the audio power-amplifier in IC3, an LM389. Transistor Q3 serves as the on-chip temperature sensor while Q2 is used as the on-chip heater. The audio amplifier senses the temperature-dependent V_{BE} of Q3 and uses it to drive Q2 and heat the chip to a temperature (typically 50°C) set by the reference voltage at the junction of R1 and R2. That circuit stabilizes Q1's temperature and makes it immune to changes in ambient temperature.

To adjust the temperature-stabilizing circuit, ground Q2's base, apply power and then measure Q3's collector voltage. Make a note of the ambient room temperature. Now, calculate what Q3's collector voltage will be at 50°C; allowing -2.2mV/°C. Adjust the value of R2 to develop a voltage close to the calculated 50°C potential at IC3's inverting (−) input. The range of values for R2 can be fairly wide because the exact chip temperature is not important as long as it is stable. Finally, remove the ground from Q2's base and the chip should reach the predetermined stable operating temperature within 100 ms. You can check temperature stability by reading Q3's collector voltage while blowing on IC3. The measured voltage should remain constant within 100 μV (0.05°C).

Calibration

To calibrate the electronic hygrometer, connect a 35K resistor in place of the sensor and adjust the 150K 100% RH TRIM pot for 10 volts output. Now, substitute an 80-megohm resistor for the sensor and set the 40% RH TRIM pot for 4 volts at the output terminal. Repeat the 100% RH TRIM and 40% RH TRIM adjustments until they no longer interact with each other. Finally, substitute a 60-megohm resistor for the sensor and select a 39K resistor for R3; that will develop a 2.4-volt output corresponding to 24% RH. It may be necessary to select a particular 1.5-megohm resistor for R4 to minimize jitter in the meter reading around the 24% RH point.

As this is written, the sensor is priced at $57.00, $54.00, and $51.50 each, in lots of 1 to 24, for devices with RH deviations of ±1%, ±1.5%, and ±3%, respective-

UNDERSTANDING ATMOSPHERIC MOISTURE

Water covers over three-fourths of the Earth's surface, and there is always some moisture in the Earth's atmosphere—even over the driest desert. At times, as much as 4–5% of a portion of the atmosphere is water vapor or water in a gaseous state. The variation of the amount of moisture in the air (*humidity*) is influenced by geographic location, temperature, and wind currents. The most important of those is *temperature*. Heat causes some of the molecules of the Earth's surface water to escape into the astmosphere.

Saturation occurs when, at some temperature, the rates of evaporation and condensation balance. The space above the liquid contains all the water vapor it can hold. When that happens, the air is *saturated*. The amount of vapor a volume of air can hold before becoming saturated depends on the temperature; the higher the temperature, the more moisture the air can hold. Air can hold four times more moisture at 70°F than it can at 32°F.

Absolute humidity is a measure of the actual amount of moisture in the air at a given temperature. It is expressed either as the number of *grains* (one seven-thousandth of a pound) per cubic foot of air, or in terms of pressure in millibars or in inches of mercury.

Relative humidity is the moisture content of the air *expressed as a percentage*. It is the ratio of the absolute humidity to the greatest amount of moisture the air is capable of holding at the same temperature. As an analogy, consider a quart bottle that is half full of liquid. The ratio of its actual contents (one pint) to its capacity (one quart) is 50% Similarly, a mass of air that is holding half the moisture possible at a given temperature has a relative humidity (RH) of 50%

When the relative humidity is high (60% to 85%) we say the weather is muggy. Evaporation of perspiration is slow and we feel overheated. We are uncomfortable as it accumulates on our skin and clothing.

When the relative humidity is too low, perspiration evaporates too rapidly and we are uncomfortably chilly. Prolonged exposure causes our throat and nasal passages to become dry. When it comes to personal comfort, temperature and relative humidity are closely related. We enjoy relative humidities in the range of 45% to 55%.

Indoors in the winter when relative humidity is low, the comfort range is around 68°–74°F. Warm-air heating systems dry out the air and we often use humidifiers to raise the moisture content to a comfortable level. On a muggy summer day, we may use a dehumidifier to make indoor air drier. An air conditioner dehumidifies as it cools.

Dew point is the temperature at which air, as it cools, becomes saturated (RH is 100%) and water droplets condense on cool surfaces such as grass and plants. If the dew point is above 32°F, the condensate is dew. When the dew point is 32°F or lower, the condensate forms ice crystals that we call frost. R-E ly. To obtain the latest pricing and data on the humidity sensor, write to Phys-Chemical Research Corp., 36 W. 20th St., New York, NY 10011. Be sure to specify the PCRC-555 because the company has other sensors whose characteristics are not suitable for the circuit that has been described here.

Semiconductor catalog

SGS Shortform '82 is a 72-page catalog listing pertinent application information and technical data on the SGS line of small-signal and power transistors; and linear, low-power Schottky TTL, MOS, and CMOS 4000/4500 logic-series IC's. Also included in a list of SGS data books, technical notes, design notes, and the names and addresses of distributors and reps throughout the U.S.—**SGS Semiconductor Corp.,** 7070 E. 3rd Ave., Scottsdale, AZ 85251.

Instrumentation Amplifier IC

The standard three-op-amp instrumentation amplifier with its more than a half-dozen discrete external components has been replaced by National's LM363. A low-cost, high-performance monolithic instrumentation amplifier, the LM363 (and the LM163 military version) comes in an 8-pin TO-5 package. It requires no external resistors for accurate fixed gains of either 10, 100, or 500 (one gain per package). The device has a super-beta bipolar input stage that yields a very low input-voltage noise, and a high common-mode rejection ratio (CMRR). For added versatility, the internally set gains can be increased by adding external resistors. A 16-pin DIP-packaged device, which should soon be available, will feature pin-strappable gain options of 10, 100, and 1000. The LM363 is priced as low as $9.60 in 100-piece lots.—**National Semiconductor,** PO Box 70818, Sunnyvale, CA 94086.

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The Harris HA-2539 op-amp features a 600V/μs slew rate and a 600-MHz gain-bandwidth product, making it an ideal device for use in pulse- and video-amplifiers, wideband amplifiers, high-speed sample-and-hold circuits, and RF oscillators. Full $\pm$10-volt output swing and high open-loop gain make this Harris device useful in high-speed data-acquisition systems.

Power bandwidth is 9.6 MHz, offset voltage is 3 mV, and input-voltage noise is 15 nV/Hz. The device is packaged in a 14-pin ceramic DIP. The HA-2539-2, manufactured for military use, operates in the $-55°$ to $+125°C$ temperature-range. The HA-2539-5, intended for commercial applications, operates in the 0°C to +75°C temperature-range.—**Harris Corp.,** Analog Products Div., PO Box 883, Melbourne, FL 32901. **R-E**

SERVICE CLINIC

A common cause

JACK DARR, SERVICE EDITOR

THIS MONTH'S TITLE HAS NOTHING TO DO with any political organization. It refers to a problem in TV sets that can be puzzling if you don't know about it. If you've been with me for a long time, you'll soon realize that I've covered this ground before. However, I've noted of late that I'm getting quite a few letters in the mailbag concerning what is obviously this particular problem so I thought it would be a good idea to discuss it once again.

The problem in question has one characteristic symptom—the set suddenly develops *many* symptoms at the same time! It may have poor sync, weak video, poor- or off-color, and so on. Common sense tells us that it's unlikely for many parts or circuits to all go bad at the same time. (Unlikely, but definitely not impossible!) So, what we should look for is a common cause—something that's common to all stages (and that's where the title comes from, at least in part).

In every TV set ever made, there's one circuit that fits that description—the DC power-supply. The DC supply has two functions; one, of course, is to supply the operating voltages to all the stages of the set. The other is the cause of the problem. The B+ supply also serves as the *common return* path for signals from every stage. Figure 1 will give you an idea of what I mean. The large filter-capacitors in the B+ supply provide a very-low-impedance path to ground or common (there's the rest of the title) for AC only; the impedance is a decimal point followed by about ten zeros and a 1.

If one of the filter capacitors develops a defect such as high power factor, or even opens, that raises the impedance in the common return-path and all the signals returning to ground develop signal voltages across that impedance. Those signals float around the B+ network, and "back-up" into the other stages, where they immediately cause trouble by beating with the normal signal. That is plain old-fashioned feedback, and you know what that causes—oscillation, regeneration, beats, and other various and sundry problems.

Fortunately, there's a simple way to determine whether a bad B+ capacitor is at the root of your problem(s). Just touch a scope probe to a DC-voltage supply point on any of the circuits that are acting up. The normal response should be absolutely nothing; just a nice straight green line, even with a high vertical-gain. (Incidentally, that is the best possible test for either filter or bypass capacitors.) If you see any sign of a signal on the bypassed end of a circuit, you know that the filter or bypass capacitor is bad.

Try bridging a good capacitor across the suspect one. If the signals disappear and the problem clears up, you've found the cause (and cure). Replace the original capacitor with a good one.

Caution: perform this test with the power on *only in tube sets*. In all solid-state sets, turn the power off, connect the bridging capacitor, and then turn the set back on. The charging surge causes transients that can damage transistors, IC's, and other components.

That "common" problem causes some of the oddball symptoms we've all seen—the dark horizontal bar crawling up through the picture, bending or weaving at the sides of the raster, beats in the picture or color, AGC problems, etc.

One of the more unusual situations I ran across was a set with absolutely no vertical sync; the horizontal sync was steady as a rock. Scoping the composite-sync waveform at the output of the sync separator showed what looked like a normal pattern. A normal pattern will show the vertical sync as thin lines every so often along the "bar" made up of the horizontal-sync pulses. I finally noticed that they weren't there (I hadn't looked close enough at first)! When I scoped the DC power-supply for the stage, I found that there was a small sharp spike at the vertical frequency.

That spike was feeding back into the sync-separator output, opposite in polarity to the sync pulses, and neatly punching out the vertical sync! The cause turned out to be a bad electrolytic capacitor in DC power supply.

So, there you are. If you find multiple symptoms, start looking for a common cause. Only one thing in the set fits that, and it is the DC power-supply. Solid-state sets, too, can suffer from the problem. In sets with low-voltage DC supplies derived from the flyback, look for pulses and hash on the DC at the horizontal frequency. Each supply has a rectifier diode *and* a filter capacitor. Check to make sure it is not open, leaky, or suffering from a high power-factor.

Your scope is the only instrument that will positively locate and identify the cause of that sort of trouble, so, if you suspect it, grab the scope probe and start looking; it can save you a whole lot of time. **R-E**

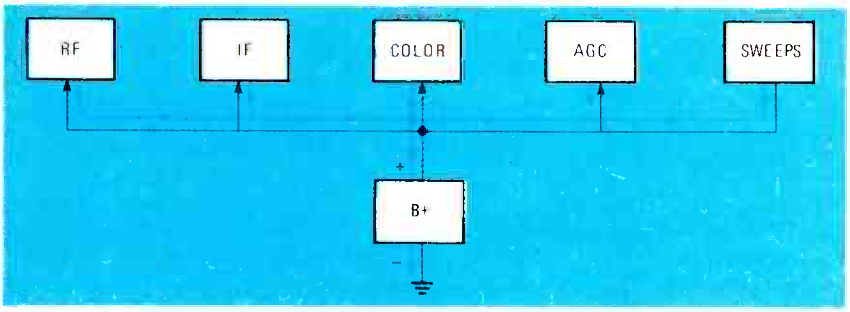

FIG. 1

SERVICE QUESTIONS

LOW VOLTAGE

I've got a raster on this Sharp 3W77, but it is about an inch short on either side. All of the DC voltages (out of the flyback) are too low. There are also three pictures, side-by-side, on the screen.—J.C., West New York, NJ

I think that the last symptom is the key to the entire problem. If your horizontal oscillator is that far off, it will upset the voltage from the flyback, and just about everything else. Fortunately, that is more or less a standard oscillator/AFC circuit. Ground the top of the AFC diode. That will kill the AFC and let the oscillator free-wheel. Now, tune the coil until you get just a single picture, with straight sides, floating back and forth. That indicates that the oscillator is back on fre-

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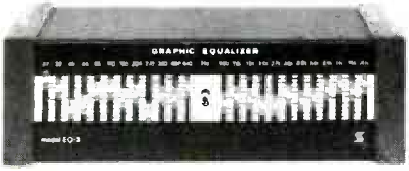

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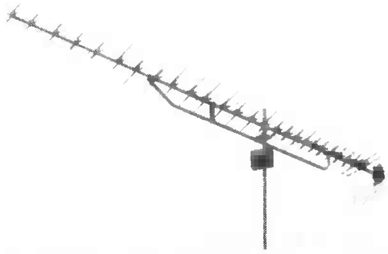

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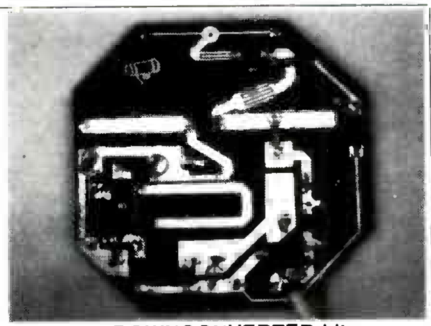

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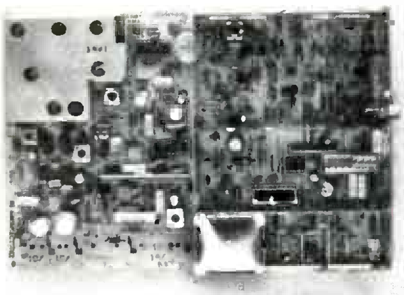

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quency. Remove the short from the AFC diode and the picture should lock in; if not, your AFC diodes may be bad—check and replace them if necessary.

NO COLOR

I wasn't getting any color from a KE-chassis GE set. I made the tests you suggested and found the 2700-ohm plate resistor of the 6BW11 open. Thanks for the help.—*G.M., Walled Lake, MI*

THERMAL PROBLEM

I've got a thermal problem in a Sampo M-12B. The vertical lock is poor and, when it does lock, retrace lines are visible. I froze C604 and the problem disappeared until it warmed up. I replaced the capacitor, and the same thing happened. I also froze C505 and the problem disappeared...temporarily. A new C505 didn't help; nor did a new vertical IC and sync-separator transistor. Any ideas?—D.B., Selah, WA

You obviously have a thermal problem—the question is where! Try cooling some of the *resistors*. While I tend to agree that the little low-voltage electrolytics are a likely cause, in your case they seem to be OK (installing new ones isn't a bad idea, though).

Resistors are subject to thermal drift, and that could easily account for the far-off DC voltages you found at the sync separator. As a last resort, check all the solder joints in the area you were cooling; cold-solder joints can be responsible for some weird problems. **R-E**

JUST A FEW OHMS OFF

This Zenith 23GC45 suffered from poor vertical-height. I subbed the 9-92 module, but that didn't help. It finally turned out that R203—a 4.7-ohm resistor from pin 9 to ground—had increased in value to 6.5 ohms. I replaced the resistor and that took care of the problem. A good low-resistance scale on your meter is a handy tool!—*D.H., Vacaville, CA*

Amen!

FULL-WAVE BRIDGE QUESTION

I'm puzzled about something I found while fooling around. If I feed an audio signal into a full-wave bridge rectifier, the resulting sound is badly garbled. If I add a DC bias to the rectifier's AC inputs, the audio sounds normal. Can you tell me what's going on?—J.G., Morgan Hill, CA

I hope so. When you feed AC to a full-wave bridge rectifier, there are always two paths that conduct, and two that are blocked. That gives a DC voltage, with some ripple at the input frequency. That would be the equivalent of very severe clipping in an audio amplifier. The normal audio-signal at the output is AC *floating* on a DC signal; it can go either positive or negative, adding to or subtracting from the DC voltage.

When you added DC bias, you raised

your audio signal above the DC level, which let it vary normally, and the audio came through.

MISLEADING SYMPTOM

The raster in this Magnavox T982 took on a trapezoidal shape; usually that means a shorted yoke-winding. If you're wondering whether we tried changing the yoke, yes, we did.

Later, we found that the values of the filter capacitors in the power supply had decreased in value, allowing the vertical circuit to be "pumped" at the horizontal rate. Replacing the capacitors brought things back to normal. Watch out for this—not only in that chassis, but also in the T981 and T987.

Thanks to C.T., of Adelphi, MD, for the warning.

NEGATIVE VOLTAGE

There is no high-voltage, etc., on this J.C. Penney 685-4827. The B+ voltages seem to be OK and the horizontal oscillator seems to be working. When I checked around the output stage, I found a negative voltage on the plate of 40KD6 and the cathode of the 34CE3 damper tube. What is going on?—M.B., Newport News, VA

Try this: Hook a DC voltmeter to the cathode of the damper tube and turn the power on. Watch the meter—if it comes up to full B+, disconnect the meter quickly. If it shows zero, or, as you found, a small negative voltage, the cathode of the damper is probably open inside the tube. Check the continuity from the damper cathode to the plate of the 40KD6; that checks the primary winding of the flyback. Also, try a new damper tube—that is rarely the problem, but it is possible.

NON-STARTING VERTICAL OSCILLATOR

I've checked all the parts in the vertical circuit of this RCA KCS204A, but the oscillator simply won't start. I don't get it.—C.A.S., Snellville, GA

Oscillators that won't start, even though all the parts check out OK, have been a common problem for years. Just remember that if a circuit won't work, there almost always has to be a bad part! In your case, I'd suspect an open capacitor in the feedback loop—if there's no feedback, there's no oscillation.

Double check: feed a 60-Hz signal to the input of the first stage of the oscillator. If you now get deflection, the amplifier part of the circuit is OK. (All vertical oscillators of this type are really just two-stage amplifiers with very heavy feedback from input to output.) If the amplifier is working, then the problem is in the feedback loop, and very likely to be an open capacitor. Check C609 and the others to see whether they're good. **R-E**

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CB TRANSCEIVER SYSTEM, Realistic *model TRC-429,* has 40 channels and has been designed for easy, one-hand operation. The speaker, microphone, and all operating controls are in the handset, including the volume and squelch controls, push-to-talk switch, and a rotary channel selector with

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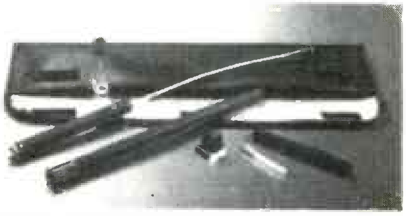

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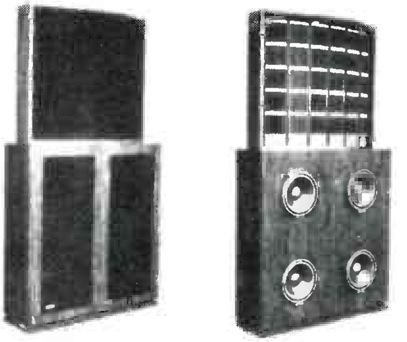

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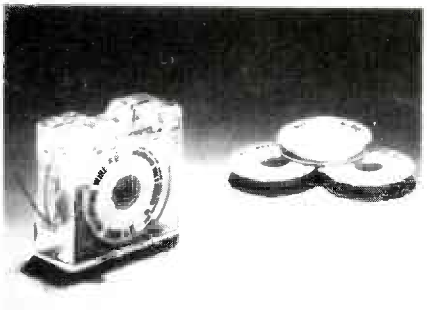
capabilities and dispersion characteristics, the *model ZS 30-4* has a new electrostatic diaphragm with the lowest mass of any material used heretofore, offers failure-proof electrostatic elements (nine thousands of one percent field-rejection rate), and has four 1-inch fiber carbon die-cast low-frequency transducers. High frequency is produced by thirty 5-inch electrostatic elements.

The *model ZS 30-4* is priced at $4500.00 a pair.—**JansZen Electrostatic**, Division of Soundmates, 796 29th Avenue Southeast, Minneapolis, MN 55414.

WIRE DISPENSER, *model WD-30-TRI*, holds three colors of wire and features built-in cutting and stripping mechanism. The refillable dispenser holds 50 feet each of red, white, and blue Kynar insulated, silver-plated, solid copper wire. To operate the cut-



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strip mechanism, the wire is first drawn out to desired length; then a built-in plunger cuts the length free from the roll, while a gentle pull through the stripping blade removes the insulation. The *model WD-30-TRI* is priced at $9.17; the three-color refill, *model R-30-TRI*, is priced at $7.01.—**OK Machine and Tool Corporation**, 3455 Conner Street, Bronx, NY 10475.

R-E

HOBBY CORNER

Help from our readers

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

THIS MONTH SEEMS TO BE A GOOD TIME TO pause and thank those of you who have written to offer help to others. Your answers and suggestions are appreciated. It is a good time, too, to pass along some of your helpful hints to those who may have experienced similar problems.

Little shocker

Ernest Worley of Irvine, CA went to the trouble of analyzing the "Little Shocker" circuit that appeared in the this column in the August 1981 issue. Among several improvements he suggested are two of special interest.

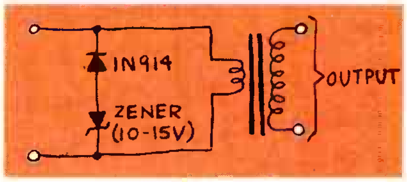

FIG. 1

The most significant change is shown in Fig. 1. If you compare it with the original circuit, you will see that Ernest has added a 12-volt Zener diode in series with the 1N914 across the primary of the output transformer. The Zener allows the transformer to make a more complete recovery with each pulse while still protecting the transistor from breakdown.

In addition, Ernest adjusted the values of the capacitor and resistors to increase the frequency to about 350 Hz and to bring the duty cycle to 50%. The end result is to give the shocker a bit more "zing" and, more importantly, to conserve battery life. You may recall that short battery-life was a characteristic of the original circuit, and the changes help get rid of that problem.

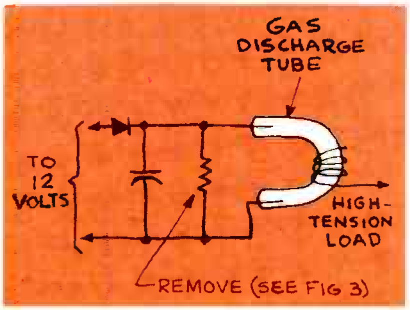

FIG. 2

I am not calling Ernest's changes to your attention so much because the shocker circuit is especially deserving, but rather because the addition of the Zener diode across the primary of the transformer can be applied to other situations.

Often you will run across designs that couple transistor outputs through a transformer. If it is not a circuit like an audio amplifier, where fidelity is important, give the Zener a try. It may improve circuit efficiency and conserve battery power.

Thanks, Ernest, for sharing the battery-saving-Zener with us.

Induction timing-light

David Reading of Marshfield, WI offers a good solution to James McDaniel's desire to change his timing light to the induction pick-up variety (April 1982). Careful selection of the few extra parts required—especially the triggering transformer—will allow you to fit it all into the original light case.

Figure 2 shows a basic high-tension timing-light circuit. Figure 3 shows a circuit with David's added parts (note that the resistor shown in Fig. 2 has been removed). He says any 4-kV trigger transformer will work fine and suggests one sold by Mouser Electronics (11433 Woodside Ave., Santee, CA 92071) as their stock number 42FM401.

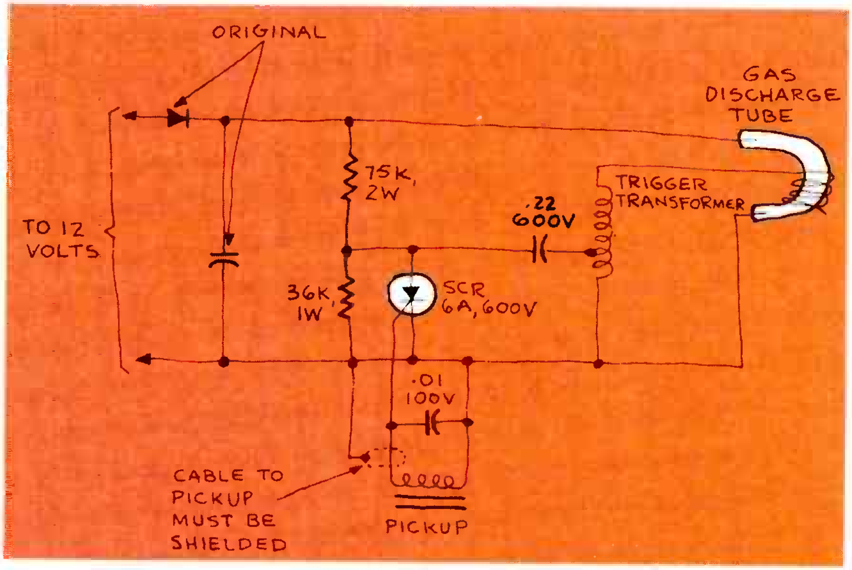

FIG. 3

David has tried several different styles of induction pickups. All had three to five turns of wire around the core and they all worked fine. He cautions that the SCR must not be rated any lower than six amps at 600 volts.

Many thanks, David. Now all of us can give new life to those old timing lights.

AN INVITATION

To better meet your needs, "Hobby Corner" will undergo a change in direction. It will be changed to a question-and-answer form in the near future. You are invited to send us questions about general electronics and its applications. We'll do what we can to come up with an answer or, at least, suggest where you might find one.

If you need a basic circuit for some purpose, or want to know how or why one works, let us know. We'll print those of greatest interest here in "Hobby Corner." Please keep in mind that we cannot become a circuit-design service for esoteric applications; circuits must be as general and as simple as possible. Please address your correspondence to:

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Bullet velocity

Randolph Richter (Schenectady, NY), J.A. Keys (Long Beach, CA) and others were quite helpful with the problem of measuring bullet velocity (December 1981). The solution, of course, is to measure the time it takes the bullet to travel over a known distance as accurately as possible.

The usual approach is to place two wires a given distance apart and then break them with the bullet. I acknowledge that the most difficult part of that procedure, at least to me, would be to hit the two wires! The experts tell me, however, that it isn't too hard to do provided that the wires are close and the rifle (or pistol) is supported by sand bags.

In any case, it is easy enough to measure the distance between the wires. Now, if you only knew the length of time between the breaking of the first wire and the breaking of the second one, finding the velocity would be easy.

Everyone seemed to go about timing the breaks in just about the same way. A counter circuit counts the pulses from a fast clock. The clock is triggered by the breaking of the wires—the first one starts it when broken, and the second one stops it. Knowing the clock rate and the number of counts, it is simple to figure the time that has elapsed between the breaking of the two wires.

After you know both the distance and the time, you can divide the first by the second to get the velocity. Let's now look at the actual techniques our readers used.

J.A. and Randolph use different circuits to measure the time. J.A. uses an internally triggered commercial counter that's enabled by an EXCLUSIVE-OR gate. The two wires are, of course, connected to the gate inputs. When one is broken the counter starts; it stops when the second wire is broken.

Randolph, on the other hand, built his gear from designs in Radio Shack's *Engineer's Notebook*. His circuit also consists of counters and a clock, but the triggering setup he uses is a little different. In that setup, he has the clock running before he fires and uses the breaking of the first wire to start the counter.

Breaking the second wire stops the clock by turning off its power. When the clock stops, there are no more pulses for the counter to count and the display freezes, showing the number of pulses that were counted between the wire breaks. Neat!

If you are thinking of measuring bullet velocities, I should tell you that almost every response to this problem that I received included one piece of advice: OBSERVE FIREARM SAFETY PROCEDURES! That is very important and only a fool thinks it is "silly" to repeatedly go through a safety checklist when conducting tests like this.

Forgetting about guns for the moment, you can measure the speed of almost anything with the system described here. It will completely eliminate errors due to human reaction-time, as well as errors (real or imagined) that might be due to favoritism.

Certainly, anything slower than a bullet will present no difficulty. All you have to do is to slow down the clock to a rate that is appropriate to the event you are measuring.

Mosquitoes again

Summer is an interesting time of the year. Many of you become involved in warm-weather activities and electronics experimenting receives less attention than it does in other seasons. Your outside activities bring to mind (and body) the problem of mosquitoes, and what can be done about them.

Last summer was no exception. Several readers wrote to ask for information or a circuit for a mosquito repeller. If you have a problem with those infernal pests, you may wish to refer to "Hobby Corner" in the March 1980 and February 1981 issues of **Radio-Electronics.** There you will find a circuit and some comments about its value.

It may be helpful to summarize the comments I have received over the last couple of years. Before you plunge into building a repeller, you should know that the number of readers who think it is great is about equalled by the number who think it is of no value at all! Until there is more information, I wouldn't recommend that you build one except on an experimental basis.

I am beginning to think that the effectiveness of a mosquito repeller is, like beauty, in the eye of the beholder. Certainly, there is no consensus of opinion on the question.

It occurs to me that, in addition to the psychological aspects of your reactions, there is the probability that certain components in the circuitry are critical. The speaker, for instance, could make a considerable difference in the unit's effectiveness. (Has anyone tried using one of those inexpensive piezo-element tweeters?) In addition, I have been led to believe that the frequency of the oscillator is critical.

It would be nice to resolve the question once and for all. If you have any information on the effect of sound on mosquitoes (or other insects), how about sharing it with the rest of us? If you have built a repeller that seems to work, let us know the exact parts you used and the oscillator frequency, as close as you can measure it. If you have done any actual experimenting with sound and the little beasties, tell us about your results.

Because of the continuing interest, I'll start a "mosquito" file and share its contents from time to time. If you have anything to contribute to that file please write in and share it with us. R-E

ANALOG CIRCUIT

continued from page 78

of r_e and r_b are negligible when compared to R_E and R_B and can therefore be ignored. The load across R_E can be very small, but should be no less than ten times the calculated output impedance.

In addition to the direct-coupled Darlington arrangement, transistors can be connected in series or in parallel. When connected in parallel, a two-transistor combination can theoretically deliver twice the current each individual device is capable of suppling. For that to be true, the current they must pass must divide evenly between the two devices. That of course, never happens. Actually, the current rating of each transistor should be reduced by at least 20% to keep the devices in the circuit from being destroyed. One method of equalizing the currents in the transistors is to place a small resistor in series with the emitters of each one. That, however, reduces the amount of power the circuit can deliver for a given power-supply voltage. As for the series circuit, ideally the supply voltage divides evenly between the two devices, as shown in Fig. 7.

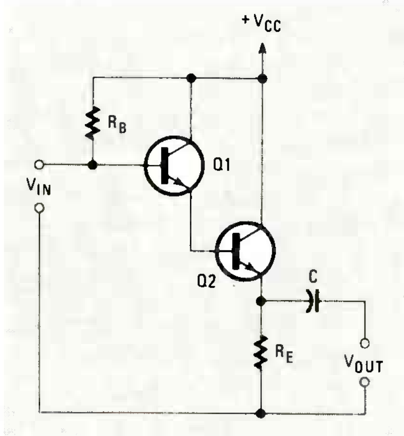

FIG. 6—THE DARLINGTON AMPLIFIER consists of two cascaded emitter-follower circuits.

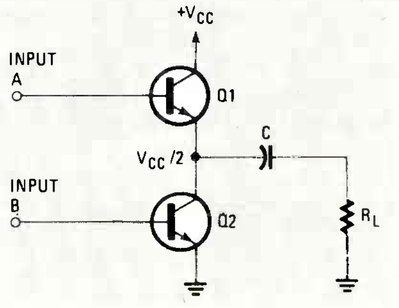

FIG. 7—WHEN TWO TRANSISTORS ARE connected in series, the supply voltage ideally will be split evenly between the two devices.

Complementary pairs are used quite frequently in direct-coupled circuits. One common use for that type of arrangement is in a push-pull audio-amplifier circuit, such as the one shown in Fig. 8-*a*. In that amplifier, the positive half of the input signal's cycle is fed to one transistor, in this case Q2, while the negative half is fed to the other, in this case Q1. The two halves of the signal combine across R_L to reproduce the full cycle. In a practical application, R_L could be a loudspeaker.

The complementary-pair circuit shown in Fig. 8-*b* can be modified depending on the requirements of the circuit. In the circuit as shown, the current gain is the product of the betas of the two transistors, the voltage gain is $1 + (R4/R3)$, and the power gain is the product of the voltage and current gains. The input impedance is approximately equal to R1 while the output impedance is $R4R6/(R4 + \beta_2 R6)$, where β_2 is the beta of Q2.

Two variations of the circuit shown in Fig. 8-*b* are frequently used. In one, R4 is omitted while R3 and R5 are shorted. Now, voltage gain drops to 1 and the output impedance becomes equal to R6.

In the second variation, R2 and R3 are omitted while R4 and R5 are shorted. Now the characteristics are the same as for the first variation except that the output impedance drops to near zero.

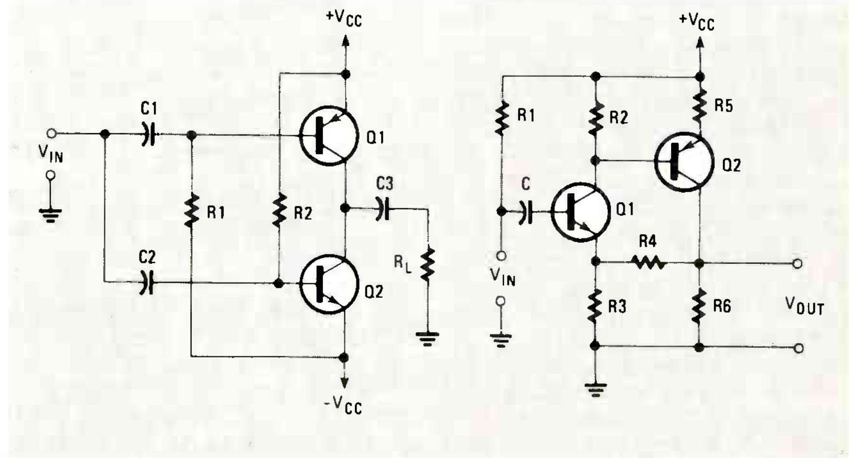

FIG. 8—COMPLEMENTARY TRANSISTOR CIRCUITS. The one shown in *a* is a push-pull audio amplifier. The one shown in *b* can be modified to meet a variety of circuit requirements.

Another form of direct-coupled circuit is the differential amplifier. That extremely useful circuit will be the subject of the next part of this article. **R-E**

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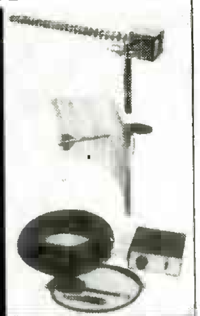

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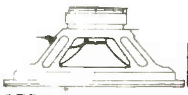

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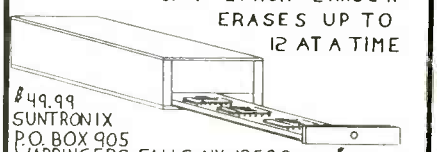

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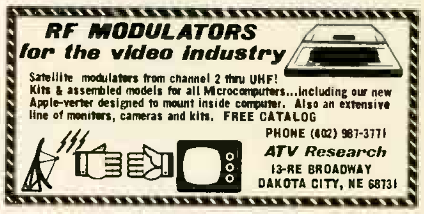

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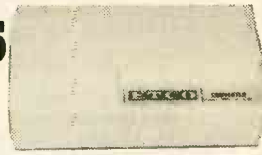

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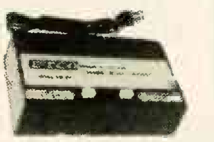

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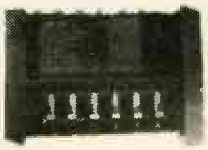

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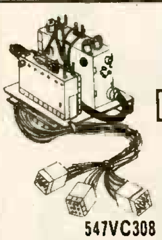

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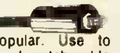

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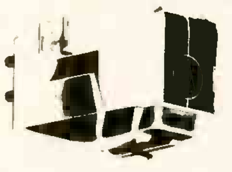

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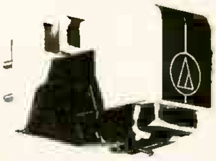
- Output: 4.8 mV



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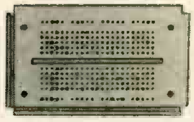
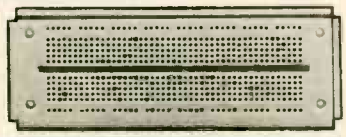
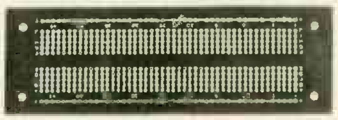


Design and Debug Your Circuit on a Socket. Transfer It to Matching PC Board—It's Easy!

A 

B 

C

A Experimenter's PC Board. Layout matches that of sockets (below) for quick and easy transfer of your finalized circuit. Features 550 pre-drilled connection points. 2¹⁄₁₆ x 5⁷⁄₁₆ x ¹⁄₁₆".
276-170 .... 3.29

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C Modular IC Breadboard Socket. Smaller version of above has two bus strips, 270 indexed connection points. 2⅛ x 3⅝".
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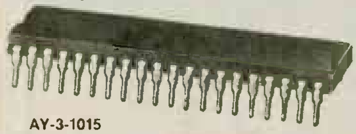
Computer Communication



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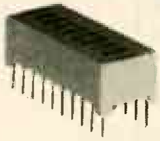

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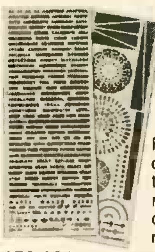

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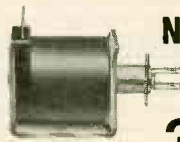

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SN74167N	16	2.79
SN74170N	16	1.29
SN74172N	24	4.95
SN74173N	16	.69
SN74174N	16	.69
SN74175N	16	.69
SN74176N	14	.69
SN74177N	14	.69
SN74179N	16	1.49
SN74180N	14	.69
SN74181N	24	1.95
SN74182N	16	.89
SN74184N	16	1.95
SN74185N	16	1.95
SN74190N	16	.69
SN74191N	16	.69
SN74192N	16	.69
SN74193N	16	.69
SN74194N	16	.69
SN74195N	16	.69
SN74196N	14	.89
SN74197N	14	.89
SN74198N	24	1.19
SN74199N	24	1.19
SN74221N	16	1.19
SN74251N	16	.79
SN74276N	20	1.95
SN74279N	16	.79
SN74283N	16	1.49
SN74284N	16	2.95
SN74285N	16	2.95
SN74365N	16	.55
SN74366N	16	.55
SN74367N	16	.55
SN74368N	16	.55
SN74390N	16	1.49
SN74393N	14	1.49

74LS

74LS00	14	.25
74LS01	14	.25
74LS02	14	.25
74LS03	14	.25
74LS04	14	.29
74LS05	14	.29
74LS08	14	.29
74LS09	14	.29
74LS10	14	.29
74LS11	14	.35
74LS12	14	.35
74LS13	14	.39
74LS14	14	.59
74LS15	14	.35
74LS20	14	.29
74LS21	14	.29
74LS22	14	.29
74LS26	14	.29
74LS27	14	.29
74LS28	14	.35
74LS30	14	.29
74LS32	14	.35
74LS33	14	.55
74LS37	14	.35
74LS38	14	.35
74LS40	14	.29
74LS42	16	.55
74LS47	16	.75
74LS48	16	.75
74LS49	16	.75
74LS51	14	.25
74LS54	14	.29
74LS55	14	.29
74LS73	14	.39
74LS74	14	.39
74LS75	16	.39
74LS76	16	.39
74LS78	16	.39
74LS83	16	.65
74LS85	16	.69
74LS86	14	.39
74LS90	14	.55
74LS92	14	.55
74LS93	14	.55
74LS95	14	.79
74LS96	16	.89
74LS107	14	.39
74LS109	16	.39
74LS112	16	.39
74LS113	14	.39
74LS114	14	.39
74LS122	14	.49
74LS123	16	.79
74LS125	14	.49
74LS126	14	.49
74LS132	14	.59
74LS133	16	.59
74LS136	14	.39
74LS138	16	.59
74LS139	16	.59
74LS151	16	.59
74LS153	16	.59
74LS154	24	.99
74LS155	16	.69
74LS156	16	.69
74LS157	16	.65
74LS158	16	.59
74LS160	16	.69
74LS161	16	.65
74LS162	16	.69
74LS163	16	.65
74LS164	14	.69
74LS165	16	1.19
74LS166	16	1.19
74LS169	16	1.19
74LS170	16	1.49
74LS173	16	.69
74LS174	16	.59
74LS175	16	.59
74LS181	24	2.49
74LS190	16	.89
74LS191	16	.89
74LS192	16	.79
74LS193	16	.79
74LS194	16	.69
74LS195	16	.69
74LS197	14	.79
74LS221	16	.89
74LS240	20	1.09
74LS241	20	1.09
74LS242	14	1.09
74LS243	14	1.09
74LS244	20	1.09
74LS245	20	1.49
74LS247	16	1.09
74LS248	16	1.09
74LS249	16	1.09
74LS251	16	.59
74LS253	16	.59
74LS257	16	.59
74LS258	16	.59
74LS260	14	.59
74LS266	14	.69
74LS273	20	1.49
74LS279	16	.49
74LS283	16	.69
74LS290	14	.89
74LS293	14	.79
74LS298	16	.89
74LS352	16	1.29
74LS353	16	1.29
74LS365	16	.49
74LS366	16	.49
74LS367	16	.49
74LS368	16	.49
74LS373	20	1.29
74LS374	20	1.29
74LS375	16	.69
74LS386	14	.45
74LS393	14	1.19
74LS399	16	1.49
74LS670	16	1.49
81LS95	20	1.49
81LS97	20	1.49

74S/PROMS*

74S00	14	.35
74S02	14	.35
74S03	14	.35
74S04	14	.45
74S05	14	.45
74S08	14	.39
74S09	14	.39
74S10	14	.35
74S11	14	.35
74S15	14	.35
74S20	14	.35
74S22	14	.35
74S30	14	.35
74S32	14	.45
74S38	14	.89
74S40	14	.39
74S51	14	.35
74S64	14	.39
74S65	14	.39
74S74	14	.55
74S86	14	.55
74S112	16	.55
74S113	14	.55
74S114	14	.55
74S124	16	2.95
74S133	16	.45
74S134	16	.50
74S135	16	.69
74S136	14	1.39
74S138	16	.89
74S139	16	.89
74S140	14	.55
74S151	16	.99
74S153	16	.99
74S157	16	.99
74S158	16	.99
74S160	16	2.49
74S174	16	.99
74S175	16	.99
74S188*	16	1.49
74S194	16	1.49
74S195	16	1.49
74S196	14	1.49
74S240	20	2.25
74S241	20	2.25
74S242	14	2.49
74S243	14	2.49
74S244	20	2.49
74S251	16	1.19
74S253	16	1.19
74S257	16	1.19
74S258	16	1.19
74S260	14	.79
74S280	14	1.95
74S287*	16	1.95
74S288*	16	1.95
74S373	20	2.49
74S374	20	2.49
74S387*	16	1.95
74S471*	20	5.95
74S472*	20	4.95
74S473*	20	4.95
74S474*	24	4.95
74S475*	24	4.95
74S570*	16	2.95
74S571*	16	2.95
74S572*	18	4.95
74S573*	18	4.95
74S940	20	2.49
74S941	20	2.49

CA—LINEAR

CA3010H		.99
CA3013H		2.15
CA3023H		3.25
CA3035H		5.95
CA3039H		1.35
CA3046N	14	.89
CA3059N	14	3.25
CA3060N	16	3.25
CA3080E	8	.89
CA3081N	16	1.49
CA3082N	16	1.49
CA3083N	16	1.49
CA3086N	14	.69
CA3089N	16	1.69
CA3096N	16	2.95
CA3130E	8	1.39
CA3140E	8	.99
CA3160H		1.19
CA3401N	14	.59
CA3600N	14	3.95

CD—CMOS

CD4000	14	.29
CD4001	14	.29
CD4002	14	.29
CD4006	14	.89
CD4007	14	.29
CD4009	16	.39
CD4010	16	.39
CD4011	14	.29
CD4012	14	.15
CD4013	14	.39
CD4014	16	.79
CD4015	16	.39
CD4016	14	.39
CD4017	16	.75
CD4018	16	.79
CD4019	16	.39
CD4020	16	.75
CD4021	16	.79
CD4022	16	.79
CD4023	14	.29
CD4024	14	.69
CD4025	14	.23
CD4026	16	2.49
CD4027	16	.45
CD4028	16	.69
CD4029	16	.79
CD4030	14	.39
CD4034	24	1.95
CD4035	16	.89
CD4040	16	.79
CD4041	14	.79
CD4042	16	.69
CD4043	16	.79
CD4044	16	.79
CD4046	16	.89
CD4047	14	.89
CD4048	16	.39
CD4049	16	.39
CD4050	16	.35
CD4051	16	.79
CD4052	16	.79
CD4053	16	.79
CD4056	16	2.95
CD4059	24	7.95
CD4060	16	.89
CD4066	14	.39
CD4068	14	.39
CD4069	14	.29
CD4070	14	.39
CD4071	14	.29
CD4072	14	.29
CD4073	14	.29
CD4075	14	.29
CD4076	16	.79
CD4078	14	.49
CD4081	14	.29
CD4082	14	.29
CD4093	14	.49
CD4098	16	1.95
CD4506	16	1.19
CD4507	14	.39
CD4508	24	3.95
CD4510	16	.89
CD4511	16	.89
CD4512	16	.89
CD4514	24	1.79
CD4515	24	1.79
CD4516	16	.99
CD4518	16	.99
CD4519	16	.99
CD4520	16	.79
CD4526	16	1.19
CD4528	16	1.19
CD4529	16	1.19
CD4543	16	1.19
CD4562	14	6.95
CD4566	16	1.39
CD4583	16	2.49
CD4584	14	.59
CD4723	16	1.19
CD4724	16	1.19
MC14409	16	13.95
MC14410	16	13.95
MC14411	24	11.95
MC14412	16	13.95
MC14419	16	7.95
MC14433	24	13.95
MC14538	16	1.19
MC14541	14	1.19

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MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$9.95
2650	40	MPU	14.95
IDM2901ADC	40	CPU—4-bit slice (Com. Temp. Gr.)	19.95
MCS6502	40	MPU w/Clock (65K bytes mem.)	9.95
MC6802CP	40	MPU w/Clock and RAM	7.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N-6	40	CPU-Sgl. chip 8-bit (128 bts. Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	5.95
INS8070N	40	CPU (64 bytes RAM)	11.95
INS8073N	40	CPU w/Basic Micro Interpreter	14.95
P8085A	40	CPU	5.95

Z80, Z80A, Z80B, Z8000 SERIES

Z80	40	CPU (MK3880N)(780C) 2MHz	$4.95
Z80-CTC	28	Counter Timer Circuit	5.95
Z80-DART	40	Dual Asynchronous Rec./Trans	11.95
Z80-DMA	40	Direct Memory Access Circuit	15.95
Z80-PIO	40	Parallel I/O Interface Controller	5.95
Z80-SIO/0	40	Serial I/O (TxCB and RxCB Bonded)	15.95
Z80-SIO/1	40	Serial I/O (Lacks DTRB)	15.95
Z80-SIO/2	40	Serial I/O (Lacks SYNCB)	15.95
Z80-SIO/9	40	Serial I/O	15.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	5.95
Z80A-CTC	28	Counter Timer Circuit	5.95
Z80A-DART	40	Dual Asynchronous Rec./Trans	11.95
Z80A-DMA	40	Direct Memory Access Circuit	17.95
Z80A-PIO	40	Parallel I/O Interface Controller	5.95
Z80A-SIO/0	40	Serial I/O (TxCB and RxCB bonded)	16.95
Z80A-SIO/1	40	Serial I/O (Lacks DTRB)	16.95
Z80A-SIO/2	40	Serial I/O (Lacks SYNCB)	16.95
Z80A-SIO/9	40	Serial I/O	16.95
Z80B	40	CPU (MK3880N-6) 6MHz	11.95
Z80B-CTC	28	Counter Timer Circuit	13.95
Z80B-PIO	40	Parallel I/O Interface Controller	13.95
Z8001	48	CPU Segmented	51.95
Z8002	40	CPU Non-Segmented	55.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6800/68000 SERIES

MC6800	40	MPU	4.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6810API	24	128x8 Static RAM	3.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	4.95
MC6828	24	Priority Interrupt Controller	15.95
MC6830L8	24	1024x8-bit ROM (MC68A30-8)	10.95
MC6850	24	Asynchronous Comm. Adapter	4.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	9.95
MC6862	24	2400bps Modulator	12.95
MC6880A	16	Quad 3-state bus. trans. (MC8T26)	2.25
MC68000L8	64	MPU 16-Bit (8MHz)	69.95
MC68488P	40	General Purpose Int. Adapter	8.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	8.95

8080A SERIES

INS8080A	40	CPU	3.95
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	3.95
DP8216	16	Bi-Directional Bus Driver	2.25
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	5.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element (INS8250)	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	7.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	6.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.49
DP8304	20	8-bit Bi-Directional Receiver	2.49
DP8307	20	8-bit Bi-Directional Receiver	2.49
DP8308	20	8-bit Bi-Directional Receiver	2.49
DP8310	20	Octal Latched Peripheral Driver	4.95
DP8311	20	Octal Latched Peripheral Driver	4.95

MICROPROCESSOR MANUALS & DATA BOOKS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00
10400	1982 Intel Data Book (1405 pg.)	14.95
30001	1981 Nat. CMOS Book (628 pg.)	6.95
30002	1980 Nat. Interface Book (840 pg.)	6.95
30003	1982 Nat. Linear Book (1952 pg.)	11.95
30005	1981 Nat. TTL Book (624 pg.)	9.95
30008	1980 Nat. Memory Data Book (464 pg.)	6.95
30011	1980 Nat. Linear Applications (736 pg.)	15.95
30013	1983 Zilog Data Book (641 pg.)	7.95
205610	1981 Intel Peripheral Design (828 pg.)	9.95

DYNAMIC RAMS

Part No.	**Pins		Price
1103	18	1024x1 (300ns)	.99
4027	16	4096x1 (250ns)	2.49
4116N-2	16	16,384x1 (150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1 (200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1 (250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1 (150ns)	7.95 - 8/59.95
4164N-200	16	65,536x1 (200ns)	7.49 - 8/54.95
MM5261	18	1024x1 (300ns)	49 - 8/1.95
MM5262	22	2048x1 (365ns)	49 - 8/1.95
MM5270	18	4096x1 (250ns) MK4096	4.95
MM5280	22	4096x1 (200ns) 2107	3.95
MM5290-2	16	16,384x1 (150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1 (200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1 (250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1 (200ns)	1.69

STATIC RAMS

1101	16	256x1 (650ns)	1.49
2101	22	256x4 (450ns) 8101	2.49
2102	16	1024x1 (350ns)	.89
21L02	16	1024x1 (450ns) L.P.	1.49
2111	18	256x4 (450ns) 8111	2.95
2112	16	256x4 (450ns) MOS	2.95
2114	18	1024x4 (450ns)	1.95 - 8/13.95
2114L	18	1024x4 (450ns) L.P.	2.25 - 8/15.95
2114-2	18	1024x4 (200ns)	2.25 - 8/15.95
2114L-2	18	1024x4 (200ns) L.P.	2.49 - 8/17.95
2141-3	18	4096x1 (150ns)	3.95
2147	18	4096x1 (70ns)	4.95
2148	18	1024x4 (70ns)	8.95
TMS4044	18	4096x1 (450ns)	3.95
TMS4045	18	1024x4 (450ns)	3.95
5101	22	256x4 (450ns) CMOS	4.95
MK5257	18	4096x1 (450ns) 4044	4.95
HM6116P-3	24	2048x8 (150ns) CMOS	7.95
HM6116-4	24	2048x8 (200ns) CMOS	6.95
HM6116LP-4	24	2048x8 (200ns) L.P. CMOS	7.95
7489	16	16x4 (50ns) 3101	2.25
74C920	22	256x4 (250ns) CMOS (6551)	3.95
74C921	18	256x4 (250ns) CMOS	3.95
74C929	16	1024x1 (250ns) CMOS (6501)	3.95
74C930	18	1024x1 (250ns) CMOS (6518)	3.95
74S189	16	16x4 (35ns) 93405	1.95
74S200	16	256x1 (80ns) 93410	3.95
74S206	16	256x1 (60ns) 93411	3.95
74S289	16	16x4 (35ns) 3101	2.25
82S10	16	1024x1 (50ns) O.C. (93415)	3.95
82S25	16	16x4 (50ns) O.C. (74S289)	2.25

EPROMS

1702A	24	256x8 (1us)	4.95
2708	24	1024x8 (450ns)	3.95
2708-5	24	1024x8 (550ns) SM00246	2.95
TMS2516	24	2048x8 (450ns) 2716	6.95
TMS2532	24	4096x8 (450ns) NMC2532	9.95
TMS2564	28	8192x8 (450ns)	19.95
TMS2716	24	2048x8 (450ns) 3 voltage	7.95
2716	24	2048x8 (450ns)	4.95
2716-1	24	2048x8 (350ns)	6.95
2732	24	4096x8 (450ns)	9.95
2758Q	24	1024x8 (450ns) single +5V	2.95
MM2764	28	8192x8 (450ns)	16.95
MM2764-3	28	8192x8 (300ns)	19.95

PROMS

74S188	16	32x8 PROM O.C. (6330-1)	1.49
74S287	16	256x4 PROM T.S. (6301-1)	1.95
74S288	16	32x8 PROM T.S. (6331-1)	1.95
74S387	16	256x4 PROM O.C. (6300-1)	1.95
74S471	20	256x8 PROM T.S. (6309-1)	5.95
74S472	20	512x8 PROM T.S. (6349-1)	4.95
74S473	20	512x8 PROM O.C. (6348)	4.95
74S474	24	512x8 PROM T.S. (DM87S296N)	4.95
74S475	24	512x8 PROM O.C. (6340)	4.95
74S478	24	1024x8 PROM T.S. (TBP28S86)	8.95
74S570	16	512x4 PROM O.C. (6305)	2.95
74S571	16	512x4 PROM T.S. (6306)	2.95
74S572	18	1024x4 PROM O.C. (6352)	4.95
74S573	18	1024x4 PROM T.S. (82S137)	4.95
82S23	16	32x8 PROM O.C. (27S18)	2.95
82S115	24	512x8 PROM T.S. (27S15)	2.95
82S123	16	32x8 PROM T.S. (27S19)	2.95
82S126	16	256x4 PROM O.C. (27S20)	3.95
82S129	16	256x4 PROM T.S. (27S21)	3.95
82S130	16	512x4 PROM O.C. (27S12)	5.95
82S185	18	2048x4 PROM T.S. (TBP24S81)	9.95
DM87S180N	24	1024x8 PROM O.C. (82S180)	9.95
DM87S181N	24	1024x8 PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4 PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4 PROM T.S. (82S185)	9.95
DM87S190N	24	2048x8 PROM O.C. (82S190)	19.95
DM87S191N	24	2048x8 PROM T.S. (82S191)	19.95

DATA ACQUISITION

DC10		Mostek DC/DC Convert. +5V to -9V	2.95
MC3470P	18	Floppy Disk Read AMP System	4.95
MC1408L7	16	7-bit D/A Converter (DAC0807LCN)	2.49
MC1408L8	16	8-bit D/A Converter (DAC0808LCN)	2.95
ADC0804	20	8-bit A/D Converter (1 LSB)	3.49
DAC0806	16	8-bit D/A Converter (0.78% Lin.)	1.95
ADC0809	28	8-bit A/D Converter (8-Ch. Multi.)	4.49
AY-5-1013A	40	30K BAUD UART (TR1602)	4.95

INTERSIL

*Evaluation Kits

Part No.	**Pins	Function	Price
7045IPI	28	CMOS Precision Timer	14.95
7045EV/Kit*	28	Stopwatch Chip, XTL	19.95
7106CPL	40	3½ Digit A/D (LCD Drive)	9.95
7106EV/Kit*	40	IC, Circuit Board, Display	34.95
7107CPL	40	3½ Digit A/D (LED Drive)	11.95
7107EV/Kit*	40	IC, Circuit Board, Display	29.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD.	16.95
7117CPL	40	3½ Digit A/D LED Dis. HLD.	15.95
7201IUS		Low Battery Volt Indicator	2.25
7205IPG	24	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	24	Stopwatch Chip, XTL	14.95
7206CJPE	16	Tone Generator	4.95
7206CEV/Kit*	16	Tone Generator Chip, XTL	7.95
7207AIPD	14	Oscillator Controller	5.95
7207AEV/Kit*	14	Freq. Counter Chip, XTL	7.95
7208IPI	28	Seven Decade Counter	15.95
7209IPA	8	Clock Generator	3.95
7215IPG	24	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	24	4 Func. Stopwatch Chip, XTL	14.95
7216AIJI	28	8 Digit Univ. Counter C.A.	29.95
7216CIJI	28	8 Digit Freq. Counter C.A.	24.95
7216DIPI	28	8 Digit Freq. Counter C.C.	19.95
7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
7224IPL	40	LCD 4½ Digit Up Counter DRI	10.95
7226AIJL	40	8 Digit Univ. Counter	29.95
7226AEV/Kit*	40	5 Function Counter Chip, XTL	74.95
7240IJE	16	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	8	CMOS Divide-by-256 RC Timer	2.25
7250IJE	16	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	16	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	8	CMOS 555 Timer	1.45
7556IPD	14	CMOS 556 Timer	2.20
7611BCPA	8	CMOS Op Amp Comparator .5MV	2.25
7612BCPA	8	CMOS Op Amp Ext. Cmvr. .5MV	2.95
7621BCPA	8	CMOS Dual Op Amp Comp. .5MV	3.95
7631CCPE	16	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	14	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	14	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	8	Voltage Converter	2.95
8038CCPD	14	Waveform Generator	3.95
8048CCPE	16	Monolithic Logarithmic Amp	16.95
8069CCQ		50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	8	Volt Ref/Indicator	2.95
8212CPA	24	Volt Ref/Indicator	2.95
30009		1983 Intersil Data Book (1356 pages)	$9.95

74C—C/MOS

74C00	14	.35
74C02	14	.35
74C04	14	.29
74C08	14	.35
74C10	14	.35
74C14	14	.59
74C20	14	.35
74C30	14	.35
74C32	14	.39
74C42	16	1.39
74C48	16	1.95
74C73	14	.79
74C74	14	.69
74C85	16	1.95
74C86	14	.39
74C89	16	5.95
74C90	14	1.19
74C93	14	1.19
[illegible]	14	1.39
74C107	14	.89
74C151	16	2.49
74C154	24	3.49
74C157	16	2.25
74C160	16	1.19
74C161	16	1.19
74C162	16	1.19
74C163	16	1.19
74C164	14	1.49
74C173	16	.79
74C174	16	1.19
74C175	16	1.19
74C192	16	1.49
74C193	16	1.69
74C195	16	1.39
74C221	16	1.95
74C240	20	1.95
74C244	20	1.95
74C373	20	2.49
74C374	20	2.49
74C901	14	.59
74C903	14	.59
74C906	14	.59
74C911	28	8.95
74C912	28	8.95
74C915	18	1.19
74C917	28	8.95
74C922	18	4.49
74C923	20	4.95
74C925	16	5.95
74C926	18	5.95
80C95	16	.39
80C97	16	.39

NEW PRODUCT! 74HC High Speed CMOS

74HC00	14	.75
74HC02	14	.75
*74HCU04	14	.75
74HC08	14	.75
74HC10	14	.75
74HC20	14	.75
74HC27	14	.75
74HC74	14	.99
74HC75	16	.99
74HC86	14	.99
74HC109	16	1.39
74HC138	16	1.49
74HC139	16	1.49
74HC147	16	1.19
74HC151	16	1.19
74HC157	16	1.19
74HC160	16	1.79
74HC161	16	1.79
74HC164	14	1.79
74HC174	16	1.39
74HC175	16	1.39
74HC242	14	2.79
74HC243	14	2.79
74HC251	16	1.19
74HC266	14	.99
74HC280	14	4.95
74HC373	20	3.95
74HC374	20	3.95
74HC533	20	3.95
74HC534	20	3.95
74HC4075	14	.75
74HC4538	16	2.95
74HC4543	16	4.95

*74HCU04 is unbuffered. All others are buffered. Send $.30 for Data Sheet.

NEW Programmable Array Logic (PALS)

Part No.	**Pins	Function	Price
PAL10H8	20	Octal 10-Input AND-OR Gate Array (High Output)	$5.95
PAL12H6	20	Hex 12-Input AND-OR Gate Array (High Output)	5.95
PAL14H4	20	Quad 14-Input AND-OR Gate Array (High Output)	5.95
PAL10L8	20	Octal 10-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL12L6	20	Hex 12-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL14L4	20	Quad 14-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL16L8	20	Octal 16-Input AND-OR-Invert Gate Array (Low Output)	9.95
PAL16R8	20	Octal 16-Input Register AND-OR Gate Array	9.95
PAL16R6	20	Hex 16-Input Register AND-OR Gate Array	9.95
PAL16R4	20	Quad 16-Input Register AND-OR Gate Array	9.95
30012		1982 National PAL Data Book (176 pages)	$5.95

LINEAR

TL071CP	8	.79
TL072CP	8	1.39
TL074CN	14	1.95
TL081CP	8	.59
TL082CP	8	1.19
TL084CN	14	1.95
LM301CN	8	.35
LM302H		1.95
LM304H		1.95
LM305H		.99
LM307CN	8	.45
LM308CN	8	.69
LM309K		1.25
LM310CN	8	1.75
LM311CN	8	.69
LM312H		2.49
LM317T		1.19
LM317K		3.95
LM318CN	8	1.95
LM319N	14	1.95
LM320K-5		1.35
LM320K-12		1.35
LM320K-15		1.35
LM320T-5		.89
LM320T-12		.89
LM320T-15		.89
LM323K		5.95
LM324N	14	.59
LM337T		1.95
LM338K		6.95
LM339N	14	.69
LM340K-5		1.35
LM340K-12		1.35
LM340K-15		1.35
LM340T-5		.79
LM340T-12		.79
LM340T-15		.79
LM348N	14	.99
LM350K		4.95
LF355N	8	1.10
LF356N	8	1.10
LM370N	14	4.49
LM373N	14	3.95
LM377N	14	1.95
LM380N	14	.89
LM381N	14	1.79
LM382N	14	1.39
LM384N	14	1.79
LM386N-3	8	.89
TL494CN	16	2.95
TL496CP	8	1.19
NE510A	14	4.95
NE529A	14	2.95
NE531V	8	2.95
NE536H		8.95
NE540H		4.95
NE544N	14	2.95
NE550A	14	1.95
NE555V	8	.35
LM556N	14	.69
NE564N	16	2.95
LM565N	14	1.19
LM566CN	8	1.49
LM567V	8	.89
NE570N	16	3.95
LM703CN	8	1.19
LM709N	14	.49
LM710N	14	.69
LM711N	14	.79
LM723N	14	.55
LM733N	14	1.00
LM739N	14	1.95
LM741CN	8	.35
LM747N	14	.69
LM748N	8	.59
LM1310N	14	1.49
LM1458CN	8	.59
LM1488N	14	.69
LM1489N	14	.69
LM1496N	14	1.95
LM1800N	16	1.49
LM1889N	18	1.95
LM1896N	14	2.95
LM2002T		1.49
LM3189N	16	1.59
LM3900N	14	.59
LM3905CN	8	1.19
LM3909N	8	.99
LM3914N	18	3.49
LM3915N	18	3.49
LM3916N	18	3.49
RC4136N	14	1.25
RC4151NB	8	1.95
ICL8038B	14	3.95
LM13080N	8	1.19
LM13600N	16	1.19

MORE AVAILABLE

CONNECTORS

DB25 — D Subminiature (meets RS232)

Part No.	Description	Price
DE9P	9 Pin Plug	$1.79
DE9S	9 Pin Socket	1.95
DA15P	15 Pin Plug	1.95
DA15S	15 Pin Socket	2.95
DB25P	**25 Pin Plug (Meets RS232)**	**2.49**
DB25S	**25 Pin Socket (Meets RS232)**	**3.25**
DB25P-631	25 Pin Right Angle Plug	4.95
DB25S-631	25 Pin Right Angle Socket	5.25
DC37P	37 Pin Plug	4.95
DC37S	37 Pin Socket	5.95
DD50P	50 Pin Plug	5.95
DD50S	50 Pin Socket	6.95

Accessories

DE-9H	Hood for DE-9 Series Connectors	$1.19
DA-15H	Hood for DA-15 Series Connectors	1.29
DB25H	Hood for DB25 Series Connectors	1.25
DC37H	Hood for DC37 Series Connectors	1.39
DD50H	Hood for DD50 Series Connectors	1.49
D20418-2	2 screws for mtg. connectors to a panel	.79

Solder Eyelet/Wire Wrap Edge Card

Part No.	Cnts.	Sp.	Description	Price
15/30SE	15/30	.156	Solder Eyelet	$1.79
18/36SE	18/36	.156	Solder Eyelet	1.95
22/44SE	22/44	.156	Solder Eyelet	2.49
22/44PC	22/44	.156	PC type (no mtg. ears)	.99
50/100SE	50/100	.125	Solder Eyelet	9.95
22/44WW	22/44	.156	Wire Wrap - Level 3	4.95
67031-5	22/44	.156	WW (Pins .0625a.03x.75)	3.95
R-681-1	50/100	.125	Wire Wrap - Level 3	7.95
R-681-2	50/100	.125	Wire Wrap - Level 1	6.95

RF Coaxial Connectors

Part No.	Description	Price
PL259	UHF Plug	$.89
SO239	UHF Panel Receptacle	.69
PL258	UHF Straight Adapter	.89
UG175/U	UHF Reducing Adapter	.49
UG88/U	BNC Plug	1.49
UG89/U	BNC Jack	1.69
UG306/U	BNC Angle Adapter	2.49
UG260/U	BNC Plug	1.49
UG1094/U	BNC Bulkhead Receptacle	.89

IC SOCKETS

For Socket Required, See Column After The IC Part No.

LOW PROFILE (TIN) SOCKETS

	1-9	10-99	100-999
8 pin LP	.16	.14	.13
14 pin LP	.17	.15	.14
16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.26
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
36 pin LP	.46	.42	.39
40 pin LP	.49	.46	.43

— Soldertail Standard Tin & Gold Also Available —

WIRE WRAP (GOLD) SOCKETS LEVEL #3

	1-9	10-99	100-999
8 pin WW	.49	.45	.42
10 pin WW	.65	.62	.59
14 pin WW	.65	.62	.59
16 pin WW	.69	.65	.61
18 pin WW	.89	.85	.79
20 pin WW	1.09	1.05	.99
22 pin WW	1.25	1.19	1.15
24 pin WW	1.29	1.23	1.18
28 pin WW	1.59	1.50	1.45
36 pin WW	1.85	1.75	1.69
40 pin WW	1.99	1.89	1.79

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

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	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.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	.16	.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

$10.00 Minimum Order — U.S. Funds Only
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Postage — Add 5% plus $1.50 Insurance
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12/82

CIRCLE 47 ON FREE INFORMATION CARD

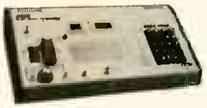
2708,2716,2732 & 2764 EPROM Programmer

JE664 EPROM PROGRAMMER

8K TO 64K EPROMS — 24 AND 28 PIN PACKAGES

Self-Contained — Requires No Additional Systems for Operation

NEW!



• Programs, validates, and checks for properly erased EPROMs • Emulates PROMs or EPROMs • RS232C Computer Interface for editing/program loading • Loads data into RAM by keyboard • Changes data in RAM by keyboard • Loads RAM from an EPROM • Compares EPROMs for content differences • Copies EPROMs • Power input: 115VAC, 60Hz, ◄ 10W power consumption • Enclosure: Color-coordinated, light tan panels w/molded mocha brown end pieces • Size: 15-5/8"L x 8¾"D x 3½"H • Wt.: 5¾ lbs.

JE664-A EPROM Programmer **$995.00**
Assembled & Tested (Includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The JE665 RS232C Interface Option implements computer access to the JE664's RAM. Sample software written in BASIC provided for TRS-80® Model I, Level II Computer. Baud rate: 9600. Word Lgth: 8 bits - odd parity. Stop bits: 2. Option may be adapted to other computers.

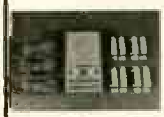
JE664-ARS EPROM Prog. w/JE665 Option **$1195.00**
Assembled and Tested (Includes JM16A Module)

EPROM JUMPER MODULES — The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets JE664 for proper programming pulses to the EPROM & configures EPROM socket connections for that particular EPROM.

Part No.	EPROM	EPROM MANUFACTURER	PRICE
JM08A	2708	AMD, Motorola, National, Intel, TI	$14.95
JM16A	2716, TMS2516	Intel, Motorola, National, NEC, TI	$14.95
JM16B	TMS2716	Motorola, TI (+5,-12,+12)	$14.95
JM32A	TMS2532	Motorola, TI	$14.95
JM32B	2732	AMD, Fujitsu, NEC, Hitachi, Intel	$14.95
JM64A	MCM68764, MCM68L764	Motorola	$14.95
JM64B	2764	Intel	$14.95
JM64C	TMS2564	TI	$14.95

CONSUMER PRODUCTS

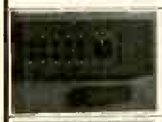
SECURITY ALARM SYSTEMS



Home Alarm System

• Self-Installation • Presettable w/individual 3-digit code — no key nec. • Instant or 10-sec. delayed warning system • Alarm system incl. window & door contacts • One 9V battery required (not incl.) Low power consumption (0.01mA) • Loud audible alarm (90db) • Delayed exit feature • System complete w/one control station with built-in siren and test button; 4 magnetic contact sets & connecting wires for entire system

ST-05 Home Alarm System **$59.95**



Door Security System

• Coded door alarm. • Instant or 7-second delay system. • Alarm activated as door is opened • Can be de-activated by pressing personal code. • Power: One 9V battery (not incl.). • System includes one personal coded keyboard and one magnetic sensor.

ES-07 Door Alarm **$29.95**

Anti-Theft Auto Alarm System

• Audible horn is activated when door or trunk is opened • Alarm sounds for 3 min. — unless turned off by secret 3-digit code • Wire cutting will not deactivate alarm. • Code set by owner. • Uses only 0.01mA power. • System complete w/one black-box control unit: one personal coded keyboard, 2 sets of sensors; one audible horn, & wiring (incl. one 10A fuse).

CA-06 Auto Alarm **$59.95**

DIGITAL QUARTZ TIME PEN

• 5-Function: Hours, Minutes, Seconds, Month, Day • Liquid Crystal Display • 1/8" digits • Battery included • Uses standard Parker ink refills • Ultra-slim design (5½" x ⅜")

77ILK	Black/Gold Trim	$9.95 each
77ISG	Stainless Steel/Gold Trim	$9.95 each
77ILR	Red/Gold Trim	$9.95 each

STICK-ON CLOCK

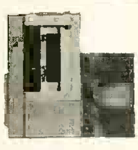
5-Function LCD Quartz Digital

• Hours • Minutes • Seconds • Month • Day • Flashing Colon • Ideal for car, kitchen, bathroom, office, etc. • 1/4" digits • Runs 2 years on 1 battery (incl.) • Size: 1½" Round. Specify color: Red/ST-001R; White/ST-001W; Black/ST-001B

#ST-001____ (Specify letter) .... $4.95 each or 2/$8.95

Stereo Cassette Player

with FM Stereo Tuner Pack

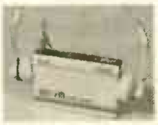


• Lightweight Headphones
• Cr02/Metal/Normal Tape Selector
• Anti-Rolling Mechanism

FEATURES: • Blue carrying case, shoulder strap, belt strap, lightweight headphones, FM stereo tuner pack & instruction manual • Talkline • Tone selector • Cr02/Metal/Normal tape selector • LED operation indicator • Built-in microphone • Stop/eject, play, rewind/review, fast forward/cue, tape/radio selector functions • Vol. control • Ext. power input jack • Headphone jack • Auto-stop mechanism (shuts off player when tape ends) • Anti-rolling mechanism (prevents sound from quivering when walking, jogging, etc.) • Weight: 13 oz. • Requires 4 AA batteries (not included) • Size: 6"L x 4"W x 1-1/8"H

Model TWF-802 .... **$69.95**

AM3-4 AA Alkaline Batteries .... 4/$3.95



UTIC

Mini Stereo AM/FM Receiver

WITH HEADPHONES

For Joggers, Cyclists, Skaters & Sports Events

FEATURES: Lightweight headphones. Left/right balance control. Full fidelity stereo sound. Additional black soft carrying case and shoulder strap. Belt clip (hands free). Operates on 3 AA cell batteries (not incl. - see below). Compact size: 3-1/8"H x 4-7/8"L x 1"D. Wt. 6 oz.

Model 2830 .... **$29.95**

AM3-3 AA Alkaline Batteries .... 3/$2.95

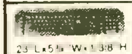
KEYBOARDS — POWER SUPPLIES

16½ L x 5¾ W x 1½ H

MICRO SWITCH 69-KEY KEYBOARD

Data Entry Keyboard, Encoded Output: 8-bit Parallel EBC DIC, Switching: Hall Effect, 24-pin Edge Card Connection. Complete w/Pin Connection. Can easily be modified to ASCII code.

Part No. KB69S012-2 (Fits into DTE-20 Enclosure) .... $19.95 each



23 L x 5¾ W x 1⅜ H

MICRO SWITCH 85-KEY KEYBOARD

Word Processing Keyboard, 26 Pin Edge Card Connection. Supply Voltage +5VDC. Main Keyboard is QWERTY. Additional Key Pads for Cursor and word processing functions.

Part No. 85SD18-1 .... $29.95 each

18¾ L x 5¾ W x 1½ H

MICRO SWITCH 88-KEY KEYBOARD (PARALLEL)

Data Entry Keyboard used in a Diablo 1640 Terminal. Supply Voltage: +5V, -12V. Switching: Hall Effect — 10-pin Edge Card Connection. Schematic Included. Uses 8048 Encoder Chip.

Part No. 88SD22 (Fits into DTE-20 Enclosure) .... $69.95 each

POWER SUPPLY +5VDC @ 1 AMP REGULATED — *Transaction Tech*

Output +5VDC @ 1A (also +30VDC) reg. Input 115VAC 60Hz. 2-tone (black/beige) self-enclosed case. 6 ft., 3 cond. black power cord. 6½"W x 7"D x 2¼"H. Wt. 3 lbs. Data sheet incl.

Part No. PS51194 .... $19.95 each

POWER SUPPLY +5VDC @ 1 AMP REGULATED — *B Industries*

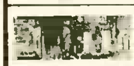
Output +5VDC @ 1 amp, +36-42VDC adj. 400mA or less, 30VAC (isol.) @ 1.5 amp. Input 115VAC 60Hz. Circ. brkr, re-set button. Blk. self-encl. case w/4 rubber feet. 6 ft., 3 cond. blk. pow. cord. On/off switch. 6¼"W x 7⅝"D x 3-7/8"H - wt. 7 lbs. Data sheet included.

Part No. PS4070 .... $24.95 each

POWER SUPPLY +5VDC @ 3 AMP REGULATED — *Deltron*

Input: 115VAC, 47-440Hz. Output: 5VDC Adjustable @ 3 amp, 6VDC @ 2.5 amp. Adjustable current limit. Ripple & Noise: 1MV rms, 5MV p-p — 2 mounting surfaces. UL recognized. Size: 4"W x 4½"L x 2-7/16"H - wt. 2 lbs. Data sheet included.

Part No. QPS-1 .... $29.95 each



MULTI-VOLTAGE POWER SUPPLY +5,+12,−12VDC REGULATED

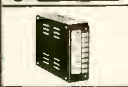
Input: 105-125VAC, 47-63Hz/205-250VAC, 47-63Hz. Output: +5VDC @ 2 amps Adj., 5VDC @ 50mA Fixed, +12VDC @ 1 amp Adj., −12V @ 2 amp adj. Overvoltage protection. Size: 12⅛"L x 4-7/8"W x 3¾"D. Data sheet included.

Part No. RAD250 .... $39.95 each

POWER SUPPLY +5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING

Input: 115VAC, 50-60Hz @ 3 amp/230VAC, 50Hz @ 1.5 amp. Fan volt./power supply select switches (115/230VAC). Output: 5VDC @ 7.5 amp, 12VDC @ 1.5 amp. 8 ft. blk. pow. cord. 11⅞"W x 13¼"D x 3¾"H. Wt. 6 lbs.

Part No. PS94V0 .... $49.95 each



POWER SUPPLY 4-Channel Switching Power Supply

Microprocessor, mini-computer, terminal, medical equipment and process control applications. Input: 90-130VAC 47-440Hz. Output: +5VDC @ 5A, -5VDC @ 1A; +12VDC @ 1A, -12VDC @ 1A. Line reg.: ±0.2%. Ripple: 30mV p-p. Load reg.: ±1%. Overcurrent protection. Adj: 5V main output ±10%. 6-3/8"L x 1-7/8"W x 4-15/16"H. Wt. 1½ lbs.

Part No. FCS-604A .... $69.95 each

POWER SUPPLY Adjustable Switching 4-24VDC to 5 Amps

Adj. 4-24VDC; 5VDC @ 5A, 6VDC @ 4.8A, 9VDC @ 4.1A, 12VDC @ 3.3A, 18VDC @ 1.9A, 24VDC @ .5A. Overvoltage Protection. Input: 115VAC 50/60Hz. Output variations within 20mV. 8.25"L x 4.25"W x 2.25"H. Wt. 3.25 lbs.

JE224 Kit .... $79.95 each
JE224A Assembled & Tested .... $99.95 each

SORENSEN Regulated Power Supplies

SOC 2-6 (Pictured)

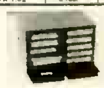
Sorensen's open construction (SOC) power supplies are series-regulated solid-state systems, designed to provide reg. DC voltages at 6 levels (2-28 v/range). These units are open-framed on sturdy black anodized aluminum for excellent mounting.

FEATURES: 115/208/230VAC Input @ 50-63Hz. Low Ripple: 1.5mVrms, 5mV P-P maximum. Adjustable current limit. Voltage adjustment control. All schematics and specifications supplied with unit. Series A,B,C,E have three mounting surfaces (Series F, bottom mounting only).

Part No.	Series	Output Voltage Adjustment Range		Output Current amps (Adc)			Size (Inches)	Weight	Price
		min.	max.	@40°C	@50°C	@60°C			
SOC 2-6	B	1.9	2.1	6.0	4.9	3.6	5.62 x 4.88 x 2.50	4.3 lbs.	$18.95
SOC 2-25	F	1.9	2.1	25.0	21.5	17.5	16.00 x 4.88 x 4.88	16 lbs.	29.95
SOC 5-18	E	4.25	5.25	18.0	15.0	12.0	14.00 x 4.88 x 2.75	12 lbs.	39.95
SOC 5-25	F	4.25	5.25	25.0	21.5	17.5	16.00 x 4.88 x 4.88	16 lbs.	49.95
SOC 12-11	E	11.4	12.6	11.0	9.2	6.8	14.00 x 4.88 x 1.62	12 lbs.	44.95
SOC15-6	C	14.25	15.75	5.0	4.2	3.5	7.00 x 4.88 x 3.37	6.5 lbs.	39.95
SOC 15-9.5	E	14.25	15.75	9.5	7.6	5.8	14.00 x 4.88 x 1.62	12 lbs.	44.95
SOC 15-13	F	14.25	15.75	13.0	10.5	8.0	16.00 x 4.88 x 4.88	16 lbs.	49.95
SOC 28-0.8	A	26.6	29.4	0.8	.64	.45	4.00 x 4.88 x 1.62	2 lbs.	24.95

BUG BOX™ — 30 individual compartments • Stores 60 8-pin or 30 14- or 16-pin DIPs • Heavy duty injection molded plastic • Clear plastic cover slides & locks • Cover marked w/numbers 1-30 • Compartment size: 1" x 3.75" x .5" deep • Box size: 4.9" x 3.3" x .6" • Weight: 1.75 oz.

BUG BOX™ STORAGE SYSTEMS



BUG CAGE™ (BGC-001-____) with Bug Boxes

BUG BOX™

Please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

Part No./Color Code	QTY	PRICE
BGX-001-( )	1	$ 2.29
BGX-010-( )	10	19.99
ANTI-STATIC		
BGX-001-( )AS	1	$ 3.29
BGX-010-( )AS	10	28.89

BUG CAGE™ — 12 locations store Bug Boxes, Big Bug Boxes or Bug Trays • Modular and interlocking • Heavy duty injection molded plastic • Each cage has 6 slip-on locations • 2 cages per pkg. • Cage size: 5-1/8" x 5" x 3-7/8" • 4 colors available — please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

Part No./Color Code	Price
BGC-001-( ) 2 Cages (6 loc. ea.)	$11.95/pkg.

BUG TRAY™ — Stores in Bug Cage • Molded plastic • Three styles: Open (1 compartment 3.05" x 4.5" x .6"); Vertical (5 compartments .5" x 4.5" x .6"); and Horizontal (8 compartments .4" x 3.95" x .6") • Ideal for tools, hardware, components, etc. • Tray size: 3.55" x 5.05" x .6" • Black color only

PART NO.	DESCRIPTION	PRICE
BTH-001	Horizontal Bug Tray	$1.95
BTV-001	Vertical Bug Tray	1.95
BTO-001	Open Bug Tray	1.95
BTX-003	1 of each Bug Tray (3)	4.98

LSI BIG BUG BOX™ — Designed to store large IC's, Resistors, Capacitors and Diodes • Divided into three compartments measuring 1" x 4.15" x .5" deep • Three vertical and three horizontal dividers included • Heavy duty injection molded plastic • Box size: 4.9" x 3.3" x .8" • Weight: 1.75 oz.

LSI BIG BUG BOX™

Please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

PART NO./COLOR CODE	QTY	PRICE
BLX-001-( )	1	$ 3.29
BLX-010-( )	10	28.79
ANTI-STATIC		
BLX-001-( )AS	1	$ 4.29
BLX-010-( )AS	10	37.89

BACK PACK™ — Self-adhesive labels for the back of ICs • Shows exact internal logic in relation to IC pins • 532 labels in each package (including several blank labels) • Each package for 8, 14, 16, 24, 28 and 40 pin ICs • Combo package includes 1,068 labels for TTL and CMOS ICs • Microprocessor package contains 744 labels

Part No.	Description	Price
BPT-012	TTL	$7.95
BPC-012	CMOS	8.95
BPM-012	Combo	14.95
BPU-012	Microprocessor	9.95

JUMPER AND CABLE ASSEMBLIES

Custom Jumpers! *Custom Cables!*

STANDARD DIP JUMPERS

All jumpers use low profile dip plugs with heavy duty pins for repeated disconnect applications.

JAMECO Part No.	AP Cross Reference	No. Pins	Description	Wire Length	Price
DJ14-1	924102-12	14	single end	12"	$1.79
DJ14-2	924102-24	14	single end	24"	2.05
DJ14-3	924102-36	14	single end	36"	2.35
DJ14-1-14	924106-12	14	double end	12"	2.95
DJ14-2-24	924106-24	14	double end	24"	3.19
DJ14-3-14	924106-36	14	double end	36"	3.49
DJ16-1	924112-12	16	single end	12"	1.89
DJ16-2	924112-24	16	single end	24"	2.19
DJ16-3	924112-36	16	single end	36"	2.59
DJ16-1-16	924116-12	16	double end	12"	2.95
DJ16-2-16	924116-24	16	double end	24"	3.29
DJ16-3-16	924116-36	16	double end	36"	3.59
DJ24-1	924122-12	24	single end	12"	2.69
DJ24-2	924122-24	24	single end	24"	3.19
DJ24-3	924122-36	24	single end	36"	3.59
DJ24-1-24	924126-12	24	double end	12"	4.49
DJ24-2-24	924126-24	24	double end	24"	4.95
DJ24-3-24	924126-36	24	double end	36"	5.39
DJ40-1	924132-12	40	single end	12"	5.39
DJ40-2	924132-24	40	single end	24"	6.19
DJ40-3	924132-36	40	single end	36"	6.89
DJ40-1-40	924136-12	40	double end	12"	9.49
DJ40-2-40	924136-24	40	double end	24"	10.29
DJ40-3-40	924136-36	40	double end	36"	10.95

STANDARD DB25 SERIES CABLES

Now you can order DB25 P or S connectors with the cable necessary to fit your application. Choose from our standard flat cable in 4-foot lengths. **Call today.**

STANDARD CABLES

Part No.	Cable Length	Connectors	Price
DB25P-4	4 feet	1-DB25P	$7.95
DB25S-4	4 feet	1-DB25S	8.49
DB25P-4-P	4 feet	2-DB25P	13.49
DB25P-4-S	4 feet	1-DB25P/1-DB25S	13.75
DB25S-4-S	4 feet	2-DB25S	13.95

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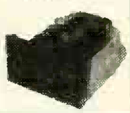
5¼" Mini-Floppy Disc Drive

FOR TRS-80 MODEL I (Industry Standard)

Pertec Computer Corp.



Features single or double density. Recording mode: FM single, MFM double density. Power: +12VDC (±0.6V) 1.6 amps max., 5VDC (±0.25V) 0.8 amps max. Unit as pictured at left (does not incl. case, power supply or cables). 30-page data book included. Weighs 3½ pounds. Size: 5¾"W x 8"D x 3¼"H

Limited Quantity!

Part No.	Price
FD200	$179.95
Single-sided, 40 tracks, 250K bytes capacity	
FD250	$199.95
Double-sided, 35 tracks, 438K bytes capacity	

EXPAND YOUR TRS-80

to 16K, 32K, or 48K

**Model 1 = From 4K to 16K Requires (1) One Kit
Model 3 = From 4K to 48K Requires (3) Three Kits
Color = From 4K to 16K Requires (1) One Kit

**Model 1 equipped with Expansion Board up to 48K Two Kits Required — One Kit Required for each 16K of Expansion —

TRS-80 16K Conversion Kit

Kit comes complete with 8 each MM5290 (UPD416/4116) 16K Dynamic RAM (*ns) and documentation for conversion.

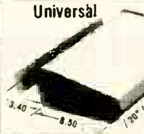
TRS-16K2 *150ns $14.95
TRS-16K3 *200ns $12.95
TRS-16K4 *250ns $10.95

TRS-80 Color 32K or 64K Conversion Kit

Kit comes complete with 8 ea. 4164-2 (200ns). 64K Dyn. RAMs & conversion documentation. Converts TRS-80 color computers from 4K-32K Memory or 16K-64K Memory.

TRS-64K2 (200ns) $54.95

Universal Computer Keyboard Enclosure



"DTE" Blank Desk-Top Enclosures are designed for easy modification. High strength epoxy molded end pieces in mocha brown finish. Sliding rear/bottom panel for service/component access. Top/bott. panels .080" thick alum, alodine type 1200 finish (gold tint color) for best paint adhesion after modification. Vented top & bottom panels for cooling efficiency.

DTE-20 Panel width 20" $34.95

Sprite-style Fan

• 36cfm free air delivery
• 3.125" sq. x 1.665" depth
• 10 yrs. cont. duty at 20°C
• 115V 50/60Hz
• For Apple users

Metal Frame

PWS2107U Cleaned & tested (used) .... $ 9.95 ea.
*PWS2107F New .... $14.95 ea.

Muffin-style Fan

• 105cfm free air delivery
• 4.68" sq. x 1.50" depth.
• 10 yrs. cont. duty at 20°C
• Impedance protected, ambients to 70°C
• 115V 50/60Hz 14W Wt. 17 oz.

Metal Frame

MU2A1-U Cleaned & tested (used) .... $9.95 ea.
*MU2A-1N New .... $14.95 ea.

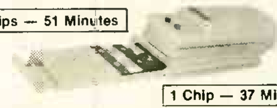
JOYSTICKS

JS-5K (Pictured)

JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JS-150K	150K Linear Taper Pots	$4.75
JVC-40	40K (2) Video Controller in Case	$4.95

UV-EPROM Eraser

8 Chips — 51 Minutes



1 Chip — 37 Minutes

Erases 2708, 2716, 2732, 2764, 2516, 2532, 2564. Erases up to 8 chips within 51 minutes (1 chip in 37 minutes). Maintains constant exposure distance of one inch. Special conductive foam liner eliminates static build-up. Built-in safety lock to prevent UV exposure. Compact — only 9.00" x 3.70" x 2.60". Complete with holding tray for 8 chips.

UVS-11EL Replacement Bulb **$16.95**

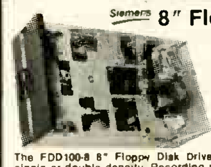
DE-4 UV-EPROM Eraser **$79.95**

Wall Transformers AC and DC Types

AC250 (Pictured)

Part No.	Input	Output	Price
AC 250 (above)	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC9004	117V/60Hz	9.2VAC 2.5 amp	$3.95
DC 800	120V/60Hz	8VDC 400mA	$1.95
DC6912	120V/60Hz	6,9,12VDC 300mA	$8.95
DC5490	117V/60Hz	9.5VDC 275mA	$2.95
DC900	120V/60Hz	9VDC 500mA	$3.95
DC1200	120V/60Hz	12VDC 300mA	$2.95
DV9200	117V/60Hz	9VAC 200mA	$3.25

Siemens 8" Floppy Disk Drive



• Single-Sided
• 77 Tracks
• 400/800K Bytes Capacity
• Industry Standard

The FDD100-8 8" Floppy Disk Drive (Industry Standard) features single or double density. Recording mode: FM single, MFM double density. Transfer rate: 250K bits/sec. single density; 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette 1, or eq. disk cartridge. Hard-sectored option available. Power: 115/230VAC @ 50-60Hz, +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs. Incl. 96-pg. manual.

Part No.		Price
FDD100-8	Buy 1 for	$269.95 each
FDD100-8	Buy 2 for	$259.95 each
FDD100-8	Buy 10 for	$249.95 each

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828 9-Volt Power Supply
830 Multi-purpose Power Supply
834 Color Organ 3-channel, 1-control
836 3-channel, 4-control Color Organ
840 Variable Strobe Light
842 12-volt Color Organ
844 T.V. Jammer
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850 Whooper Alarm
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856 Electronic Tennis
858 Digital Roulette
860 5-24 Volt Regulated Power Supply
861 Big Sound Portable Organ
862 Full-wave Motor Speed Control
866 Digital Slot Machine
868 Digital Dice
870 Nerve Tester
876 6-digit Digital Clock
878 Digital Bird
880 12-volt, 2-amp Regulated Power Supply
882 Musical Horn
884 Sound Activated Color Organ, 1-channel
886 Audio Amp/Intercom
888 Librarian Tormentor
890 Step-action Timing Tester
892 Telephone Hold Button
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898 Binary Clock

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4164	200ns	6.50
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4116	150ns	1.75
4116	200ns	1.50
STATIC RAMS		
2016P 1	100ns	7.00
2016P	150ns	6.00
6116P-3	150ns	6.50
6116LP-3	150ns	7.75
2114LC-3	200ns	2.00
2114LC-1	300ns	1.50
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2716	450ns	3.75
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2732	450ns	5.75
2732A-2	200ns	11.00
2764K	250ns	15.00
2764-4	450ns	13.00
2764-3	300ns	14.00
2532	450ns	6.50
2564	450ns	13.00

Z80A	Unit Price
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Z80A SIO/0	20.00
Z80A SIO/1	20.00
Z80A SIO/2	20.00
8000	
8035	5.50
8039	6.00
8080	6.00
8080-9	5.00
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SNAP-IN SOCKET FITS BAYONET BASE LAMPS (SEE B-2576, BELOW) SNAPS INTO A 5/8" HOLE, HAS 6" LONG WIRE LEADS B-2575
15¢ 10/$1.20 WT 4 OZ 100/$10. WT 1-1/2 LB

BAYONET 13V BULBS
#RH GE 1816 330 mA T-3¼
LIST PRICE IS 10/$2.70
10/75¢ WT 3/4 LB 100/$6.50
WT 2 OZ B-2576 1000/$55 7-1/2 LB

2-1/4" 8Ω SPEAKER
MINIATURE UNIT MFD BY QUAM IN USA, HAS 5/8" VOICE COIL IS IDEAL FOR BEEPING, SQUEEKING OR VOICE PROJECT 1" DEEP
3 OZ B-1445 99¢

$11.95 VHF/UHF CHANNEL A-I MIDBAND Varactor TUNER
HI-GAIN, BRAND NEW, FOR UPGRADE OR CONVERTER USE. IF OUTPUT, USES +12V AND +24V SUPPLY. T-1195 WT 1/2 LB

Brand New 115 VAC 8 Track TAPE DECK WITH PLAYBACK AMP
3 LB X-6950 $6.95
COMPLETE 8 TRACK TRANSPORT
QUALITY BUILT BY MOTOROLA WITH AUTO TURN ON, END OF TAPE SENSOR, AUTO TRACK CHANGE, 115 VAC CAPACITOR START MOTOR, STEREO R/P HEAD AND +12 VDC PLAY BACK ELECTRONICS GREAT FOR HOMEBREW PHONE ANSWERERS, ROBOTS, ETC.

OUTSIDE USA SEND $1 FOR CATALOG

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18 PIN 25¢ S-1800
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40 PIN 55¢ S-4000

BCD Thumbwheel SWITCH WITH COMPLIMENT 0-9
B 2124 GOLD CONTACTS STD SIZE CAN BE STACKED TO ANY WIDTH
$1.25
OUTPUT IS 1-2-4-8 WITH COMPLIMENT

B-1181 2 OZ CARLING **Heavy Duty Momentary 10 Amp ROCKER** $1
SNAPS INTO 3/4" X 1-3/8" CUTOUT SPECIFY YOUR CHOICE OF RED, WHITE OR BLACK ROCKER

3 AG FUSES
F-0102 WT 1 OZ 35 A 32 V MFD BY LITTLEFUSE
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ANY QUANTITY 10¢ EACH YOUR CHOICE

99¢ 2 OZ MFD BY VIKING * GOLD * BIFURCATED CONTACTS
28/56 EDGE Connector
* GOLD WW 3-LEVEL PINS *
C-0356 10/$9. 1 LB
6 LB 100/$80.
1000/$750. 60 LB

B-5020 3 LB $9.50 WOW!
6 VOLT 5 AMP-HR
RECHARGEABLE SEALED LEAD ACID **BATTERY**
SIZE: 5-3/8" X 3-1/8" X 1-7/8"

MARINE TOGGLE SWITCH HEAVY DUTY SPST CAST ALUMINUM CASE
$1.50 B-1195 (6 OZ) GOOD FOR A FEW DOZEN AMPS

PILOT LIGHTS
14V OPERATION SNAP-IN DESIGN LOOKS GREAT IN CAR OR BOAT FITS 1/2 X 1" HOLE
3 OZ 50¢ EA B-1193 RED B-1194 BLUE

.068 mfd 250 V Molded CAP
C-1015 .4 X .3 X .1"
25/$1 WT 2 OZ
4 OZ 250/$8
1000/$30 1 2 LB

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6 LB X-0995
5 x 7 x 12" INSTRUMENT CASE
LOCAL MFR NEEDS LEADER 'SCOPES BUT DOESN'T NEED THE CASES! SO, HE SELLS 'EM TO US!! THE FRONT PANELS ARE PUNCHED, BUT REPLACES WITH 2 SCREWS. BACK HAS BANANNA JACKS AND CORD WINDER TWO TONE BLUE COLOR. GREAT FOR HOMEBREW PROJECTS

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DUAL 13V 350 mA
13 V 13 V
T-1350 6 OZ
$1.50 1-5/8" X 1-1/4" X 1-1/4"

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TAPESWITCH MODEL CVP 623 IS UL APPROVED MEASURES 6" X 23" OUTPUT IS 2 PIN MOLEX
1/2 LB X-7950 $7.95

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$7 MINIMUM ORDER $15 CREDIT CARD

CIRCLE 72 ON FREE INFORMATION CARD

Lowest Prices Video and Electronic Components

COAXIAL A/B SWITCHES
Select from two inputs to VCR or TV

A-CS75/75 75 ohm inputs/75 ohm output $2.75 ea. 10/$22.00
A-CS75/75P Professional version of above $7.50 ea. 10/$60.00
A-CS75/300 75 ohm inputs/300 ohm output $2.75 ea. 10/$22.00

REPLACEMENT TV GAME/COMPUTER SWITCH
A-STVC STD RCA INPUT/300 ohm output $2.50 ea. 10/$20.00

UHF/VHF/FM MATCHING TRANSFORMERS
Converts 75 ohm to 300 ohm inputs

A-MT75-300 Indoor universal 69¢ ea. 10/$5.50
A-MT75-300B Outdoor with boot 99¢ ea. 10/$8.00

UHF/VHF/FM HYBRID SIGNAL SPLITTERS
Splits one input to multiple outputs

A-CMS2-M 2-way splitter (75 ohm) $1.65 ea. 10/$13.00
A-CMS3 3-way splitter (75 ohm) $2.25 ea. 10/$18.00
A-ACP4 4-way splitter (300 ohm) $2.25 ea. 10/$18.00

UNIVERSAL REPLACEMENT ANTENNAS
A-AR6 SONY Trinitron type antenna $7.99 ea 10/$64.
A-ABS-U Back-of-set VHF/FM antenna $4.25 ea. 10/$34.00

POPULAR VIDEO CONNECTORS/ADAPTORS
A-F81C F to F female splice 50¢ ea. 10/$4.00
A-VA9 F jack to RCA plug adaptor $1.49 ea. 10/$12.00
A-VA10 RCA jack to F plug adaptor $1.49 ea. 10/$12.00
A-VA5 RCA jack to BNC plug adaptor $1.69 ea. 10/$13.50
A-VA2 Double female BNC adaptor $1.99 ea. 10/$16.00
A-VA14 Quick connect F plug adaptor 89¢ ea. 10/$7.00

POPULAR VIDEO HOOK-UP/DUBBING COAXIAL CABLES
(Molded heavy-duty construction)

A-VC106 RCA plug to mini plug (6 ft.) $2.75 ea. 10/$22.00
A-VC306 RCA plug to RCA plug (6 ft.) $2.75 ea. 10/$22.00
A-VC406 Quick F plug to quick F plug (6 ft.) $2.99 ea. 10/$24.00
A-VC612 BNC plug to BNC plug (12 ft.) $5.99 ea. 10/$48.00

VHF/FM SIGNAL BOOSTERS/ DISTRIBUTION AMPLIFIERS (75 ohm)
A-CMA1 One output booster (10dB Gain) $9.50 ea. 10/$76.00
A-CMA4 Four output booster (3dB Gain) $11.95 ea. 10/$95.00

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EXPERIMENTER/TECHNICIAN ELECTRONIC COMPONENT KITS
Each kit in reusable compartmentalized storage cabinet

SK-CD 5Pf to .1Mf (150 pcs)
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SK-RM50 10 ohms to 10 meg (350 pcs)

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30 watt soldering iron with each kit ordered ($4.99 value)

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$50 order receive free auto fm signal booster ($12.50 value)
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Over $1000.00	12.50
C.O.D.'s extra	

CIRCLE 75 ON FREE INFORMATION CARD

CPU'S & SUPPORT CHIPS

8080A	2.75	8251	5.75
8085A	6.75	8255	6.95
AMD 2901	8.95	8259	6.95
8202	19.95	8257 (AM9517)	7.95
8212	2.25	BX300	15.00
8214	3.60	6502	6.00
8216	2.90	Z80A CPU	3.75
8224	3.25	Z80A SIO	12.95
MM5307	9.95	Z80A PIO	3.75
8226	2.75	Z80 CTC A	3.75
8228	4.80	TMS 9927 NL	9.95
8155	9.00	8275	16.95
8237	14.00	6845	13.95
3242	6.00	6810	2.50

RAM's		ROM's	
21L02-3	.70	2708	2.95
93L422	5.95	2716 + 5V	4.25
2101-1	2.45	2732	8.95
2111AL	1.95	2532	7.95
2114L-3	1.65	2764 25	18.95
2147-3	4.95	82S23	1.95
TMS3409	1.75	82S115	4.00
MK4008P	1.96	82S123	1.95
MK4027-3	1.95	82S129	1.95
TMS4050NL	2.95	82S130	1.95
MK4096-11	1.95	3628A-3	3.00
4116-2	1.60	AM9214C	2.95
4116-3	1.30	8256-5 (74188A)	1.25
4116-15	1.95	74S474	6.95
MK4802 J3	10.95		
5101E	2.95		
Z6104-4	2.50		
6116-3	6.50		
8264 (4164-2)	7.25		

INTERFACE & DRIVERS		SHIFT REGISTERS	
1488	.80	MM1402	1.75
1489	.90	MM1403	1.75
8130	2.50	MM1404	1.75
8830	2.50	MM5013	2.50
8131	2.50	MM5055	2.50
8833	2.50	MM5056	2.50
8834	2.00	MM5057	2.50
8837	2.00	MM5058	2.50
MM5321	9.50	MM5060	2.50
MM5369	2.50		

UART's

TR1602B	3.95	M8868A	8.95
PT1482B	3.25	COM2017	3.75

14 PIN HEADERS .... 3/$1.00
24 PIN HEADERS .... .75
40 PIN HEADERS 1.10
50 PIN EDGEBOARD CONN. 3.95
26 PIN EDGEBOARD CONN. 2.50
50 PIN RIGHT ANGLE CONN. 3.95
20 PIN RIGHT ANGLE CONN. 2.25

50 PIN RIBBON CONNECTORS $3.25
40 PIN RIBBON CABLE CONN. $2.75
34 PIN RIBBON CABLE CONN. $3.00
20 PIN RIBBON CABLE CONN. $2.25
10 PIN RIBBON CABLE CONN. $1.50

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

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

CRYSTALS — 2.95 ea.

1.000	4.000	6.144	18.000
2.000	5.000	8.000	18.432
3.000	6.000	10.000	20.000
3.579			

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
2N5457 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

.22UF 35V	5/$1.00	10UF 20V	— $ .40
.47UF 35V	5/$1.00	22UF 10V	— $ .30
.68UF 35V	5/$1.00	15UF 16V	3/$1.00
1UF 20V	5/$1.00	30UF 6V	5/$1.00
2.2UF 20V	5/$1.00	33UF 10V	$ .40
3.3UF 20V	4/$1.00	47UF 20V	$ .85
4.7UF 35V	4/$1.00	68UF 10V	$1.00
6.8UF 35V	3/$1.00	120UF 6V	$ .75
		200UF 20V	$1.75

DIP SOCKETS

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

RS232 CONNECTORS
DB 25P male $2.75
DB 25S female 3.75
HOODS 1.25

C/MOS

4001	.25	4028	.55	4081	.20	74C32	.46
4002	.25	4029	.75	4082	.20	74C42	1.00
4006	.65	4030	.35	4093	.80	74C73	.76
4007	.27	4034	1.75	4098	1.75	74C74	.60
4008	.70	4035	.65	4501	.95	74C76	.70
4009	.45	4040	.65	4510	.85	74C85	1.40
4010	.45	4042	.55	4511	.65	74C86	.50
4011	.22	4043	.65	4514	1.40	74C90	.90
4012	.22	4044	.55	4515	1.60	74C83	.95
4013	.35	4046	.60	4516	.75	74C154	2.50
4014	.70	4047	1.25	4518	1.25	74C157	1.75
4015	.70	4049	.40	4520	.70	74C160	1.20
4016	.30	4050	.40	4539	1.25	74C161	1.15
4017	.60	4051	.80	4553	2.75	74C163	1.15
4018	.50	4052	.75	4583	.90	74C173	1.15
4019	.45	4053	.75	4585	.85	74C174	1.30
4020	.70	4066	.50	74C00	.27	74C175	1.20
4021	.65	4068	.36	74C02	.27	74C192	1.30
4022	.80	4069	.20	74C04	.50	74C801	.50
4023	.22	4070	.35	74C08	.30	74C902	.70
4024	.45	4071	.25	74C10	.27	74C914	1.75
4025	.25	4072	.20	74C14	1.20	74C921	3.96
4026	.95	4076	.65	74C20	.27		
4027	.40	4077	.75				

DOUBLE SIDED DIP RIBBON CABLE JUMPER ASSEMBLIES
16 PIN 4" LONG .... $ 2.00
14 PIN 12" LONG .... $ 2.50

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'.
Add 10% postage for orders over 100'.

SPECIALS

CPU's		CRT Controllers	
6502	$6.00	TMS9927NL	$ 9.95
8080A	2.75	6845	13.95
Z80A	3.75	8275	16.95

ROM's
2732 .... $ 7.95
2716 .... 4.00

RAM's		DISC Controllers	
2114L-4	$1.35		
4116-2	1.60		
MK4802-J3-2KX8	8.95		
93L422 BIPOLAR	5.95	1791	25.00
4164-2-64K	7.95	1793	35.00
2147 J3	4.95	1795	45.00
4118-4	6.95	1797	45.00
		D765C	25.00

68000L8 .... $70.00

SPECIALS GOOD THRU DEC. 1982

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

DIP SWITCHES
CTS 206 4 — 4 POSITION 1.25
CTS 206 7 — 7 POSITION 1.40
CTS 206 8 — 8 POSITION 1.50
CTS 206 10 — 10 POSITION 1.95

TOGGLE SWITCHES
106D — SPDT — 1.10
206D — DPDT — 1.50
206P — DPDT — CENTER OFF $1.75

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

L1411-IR DETECTOR .... 3/$1.00
FP 100 PHOTO TRANS. .... $ .50
RED, YELLOW, GREEN or AMBER LARGE LED's .2" .... 6/$1.00
MLED92 IR LED .... $ .75
MRD14B PHOTO DARL. XTOR .... $ .50
TIL 1190PTO ISOLATOR .... $ .60
IL-5 OPTO ISOLATOR .... $ .45
1 WATT ZENERS: 3.3, 4.7, 5.1, 5.6, 6.8, 8.2, 9.1, 10, 12, 15, 18, or 22V .... 6/$1.00

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

FLAT RIBBON CABLE GRAY, 28 gauge
26 conductor .. .60/ft — 40 conductor .. .90/ft
50 conductor 1.00

.5V at 800ma SOLAR CELLS 3" diameter $4.35

7 SEGMENT DISPLAYS

FSC8024-4 digit C.C. 8" display	$5.95	DL-707 C.A. .3"	$ .75
FND 359	$ .75	FND810 .8" CA	$1.95
FND 503 C.C. .5"	$ .85	FND803 .8" CC	$1.95
DL-704 .3" C.C.	$ .85	MAN 54 C.C. Green	$ .75
		MAN 82 C.A. Yellow	$ .75

TRANSISTOR SPECIALS
2N1307 PNP GE TO-5 .... $ .40
2N4044 PNP GE TO-5 .... 3/$1.00
HEP C6014 — PNP GE TO-3 .... $ .85
TIP 111 .... $ .50 — TIP 145 .... $1.35
2N6233 NPN SWITCHING POWER $1.95
MRF 8004 CB RF TRANSISTOR NPN .... $ .75
2N3772 NPN Si TO-3 .... $1.00
2N4908 PNP Si TO-3 .... $1.00
TIP 295 PNP Si .... $ .90
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 .... $ .50
TIP 32B PNP Si TO 220 .... $ .55
TIP 34 PNP Si .... $ .95
TIP 120 PNP Si U84 .... $ .60
TIP 141 NPN Si U97 .... $1.00
MJE 3055 .... $ .60
BU208 .... $1.75

TTL IC SERIES

7400	.17	7472	.35	74162	.60
7401	.17	7473	.35	74163	.60
7402	.17	7474	.40	74164	.60
7403	.17	7475	.40	74165	.60
7404	.24	7476	.40	74166	.70
7405	.24	7480	.45	74170	1.60
7406	.33	7483	.50	74173	.75
7407	.35	7485	.65	74174	.65
7408	.27	7486	.42	74175	.60
7409	.24	7489	1.80	74176	.75
7410	.17	7490	.45	74180	.75
7411	.22	7491	.45	74181	1.90
7412	.30	7492	.45	74182	.45
7413	.42	7493	.45	74190	.70
7414	.50	7494	.60	74191	.75
7416	.33	7495	.60	74192	.70
7417	.37	7496	.60	74193	.79
7420	.17	74107	.35	74194	.85
7425	.30	74116	1.50	74195	.45
7426	.33	74121	.35	74196	.75
7427	.30	74122	.39	74197	.75
7430	.17	74123	.42	74221	1.00
7432	.27	74125	.45	74273	.85
7437	.27	74126	.45	74279	.60
7438	.27	74145	.75	74298	.65
7440	.17	74148	1.25	74365	.65
7441	.75	74150	1.10	74367	.65
7442	.45	74151	.50	74390	.90
7445	.70	74153	.40	75324	1.75
7446	.75	75154	1.10	75325	1.50
7447	.85	74155	.50	75492	1.05
7448	.65	74157	.50	9601	.75
7450	.17	74160	.85	9602	.75
		74161	.65	DS0056H	1.50

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

74LS SERIES

74LS00	.20	74LS107	.36	74LS197	.85
74LS01	.20	74LS109	.38	74LS221	.75
74LS02	.23	74LS112	.38	74LS240	.90
74LS03	.23	74LS113	.46	74LS241	.90
74LS04	.23	74LS114	.55	74LS242	1.20
74LS05	.23	74LS123	.80	74LS243	1.20
74LS08	.23	74LS124	1.25	74LS244	.80
74LS09	.25	74LS125	.46	74LS245	1.50
74LS10	.23	74LS126	.46	74LS247	.75
74LS11	.25	74LS132	.55	74LS248	1.10
74LS12	.25	74LS136	.45	74LS251	.68
74LS13	.45	74LS137	.96	74LS253	.68
74LS14	.40	74LS138	.50	74LS257	.68
74LS15	.35	74LS139	.52	74LS258	.68
74LS20	.23	74LS151	.38	74LS259	1.40
74LS21	.25	74LS153	.40	74LS266	.80
74LS22	.25	74LS155	.80	74LS273	1.16
74LS26	.35	74LS156	.80	74LS279	.48
74LS27	.23	74LS157	.45	74LS280	1.80
74LS28	.46	74LS158	.48	74LS283	.85
74LS30	.22	74LS160	.70	74LS290	.75
74LS32	.27	74LS161	.70	74LS293	.95
74LS37	.30	74LS162	.80	74LS298	1.00
74LS38	.30	74LS163	.65	74LS320	2.00
74LS40	.40	74LS164	.80	74LS365	.80
74LS42	.44	74LS165	.80	74LS366	.80
74LS47	.65	74LS166	.80	74LS367	.58
74LS51	.22	74LS169	1.75	74LS368	.58
74LS54	.25	74LS170	1.50	74LS373	1.25
74LS73	.35	74LS173	.70	74LS374	1.25
74LS74	.36	74LS174	.46	74LS377	1.25
74LS75	.35	74LS175	.40	74LS386	.65
74LS76	.45	74LS181	1.95	74LS390	1.30
74LS83	.68	74LS190	.80	74LS393	1.30
74LS85	.80	74LS191	.80	74LS398	2.50
74LS86	.40	74LS192	.65	74LS670	1.60
74LS90	.39	74LS193	.65	74LS682	3.00
74LS92	.50	74LS194	.75	81LS97	1.10
74LS93	.60	74LS195	.90	81LS98	1.10
74LS96	.70	74LS196	.85	8T26	1.25
		25LS2539	1.50	8T97	.95
		25LS2569	1.50		

LINEAR CIRCUITS

DAC08ED	4.95	LM361	1.75	747	.50
TL082 CP	.95	LM377	1.60	CA758	1.75
TL084 CN	1.60	LM380	.85	LM1310	1.75
TL084	1.50	LM382	.80	1456	.80
LM201	.75	LM383	2.50	1458	.50
LM301/748	.30	LM386	1.40	LM1808	1.75
LM307	.30	LM387	1.25	LM2901	.95
LM308	.75	LM393	1.00	CA3018	1.95
LM310	1.10	LM555	.46	CA3078	1.60
LM311	.50	LM556	.85	CA3086	.95
LM318	.75	564B	3.50	AD2700LD	4.95
LM319	.96	565	1.40	AD521KD	9.95
LM324	.65	567	.85	CA3140	1.20
LM339	.65	708	.25	3900	.45
LM348	.90	710	.45	4136	.85
LF351	.75	711CH	.40	NE566A	1.50
LF353	1.25	741C	.35	DS3038	1.75
LF355	1.25	741CV	.25	8038CC	3.90
LF356	1.35				
LM358	.50				

REGULATORS
LM317T $1.75
78L05, 78L12 .... $ .40
4194D .... $ .95
723 .... $ .50
320T 5, 12, 15 or 24 .... $ .90
78M05 .... $ .35
LM305G .... $ .75
340T-5, 6, 8, 9, 12, 15, 18 or 24V .... $ .85
LAS1412 - 12V 3A $3.95

POSTAGE RATES
ADD 10% FOR ORDERS UNDER $25.00
ADD 5% FOR ORDERS BETWEEN $25.00 AND $50.00
ADD 3% FOR ORDERS ABOVE $50.00

TERMS: FOB CAMBRIDGE, MASS. SEND CHECK OR MONEY ORDER. MINIMUM TELEPHONE, C.O.D. PURCHASE ORDER OR CHARGE $20.00 MINIMUM MAIL ORDER $5.00.

SEND $.25 FOR OUR CATALOG FEATURING TRANSISTORS & RECTIFIERS. 145 HAMPSHIRE ST., CAMBRIDGE, MASS. 02139

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WE SHIP OVER 95% OF OUR ORDERS WITHIN 24 HOURS OF RECEIPT
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CIRCLE 57 ON FREE INFORMATION CARD

4164 64K DYNAMIC 200 NS $6.25

TMM2016 2KX8 STATIC 200 NS $4.15

ALL MERCHANDISE 100% GUARANTEED!

CALL US FOR VOLUME QUOTES

STATIC RAMS

2101	256 x 4 (450ns)	1.95
5101	256 x 4 (450ns) (cmos)	3.95
2102-1	1024 x 1 (450ns)	.89
2102L-4	1024 x 1 (450ns) (LP)	1.29
2102L-2	1024 x 1 (250ns) (LP)	1.69
2111	256 x 4 (450ns)	2.99
2112	256 x 4 (450ns)	2.99
2114	1024 x 4 (450ns)	8/14.95
2114L-4	1024 x 4 (450ns) (LP)	8/15.25
2114L-3	1024 x 4 (300ns) (LP)	8/15.45
2114L-2	1024 x 4 (200ns) (LP)	8/15.95
2147	4096 x 1 (55ns)	4.95
TMS4044-4	4096 x 1 (450ns)	3.49
TMS4044-3	4096 x 1 (300ns)	3.99
TMS4044-2	4096 x 1 (200ns)	4.49
MK4118	1024 x 8 (250ns)	9.95
TMM2016-200	2048 x 8 (200ns)	4.15
TMM2016-150	2048 x 8 (150ns)	4.95
TMM2016-100	2048 x 8 (100ns)	6.15
HM6116-4	2048 x 8 (200ns) (cmos)	4.95
HM6116-3	2048 x 8 (150ns) (cmos)	5.95
HM6116-2	2048 x 8 (120ns) (cmos)	8.95
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	6.95
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	8.95
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8 (300ns) (Qstat)	34.95

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1 (250ns)	1.99
MK4108	8192 x 1 (200ns)	1.95
MM5298	8192 x 1 (250ns)	1.85
4116-300	16384 x 1 (300ns)	8/11.75
4116-250	16384 x 1 (250ns)	8/11.95
4116-200	16384 x 1 (200ns)	8/13.95
4116-150	16384 x 1 (150ns)	8/15.95
4116-120	16384 x 1 (120ns)	8/29.95
2118	16384 x 1 (150ns) (5v)	4.95
MK4816	2048 x 8 (300ns) (5v)	24.95
4164-200	65536 x 1 (200ns) (5v)	6.25
4164-150	65536 x 1 (150ns) (5v)	7.25

5V = single 5 volt supply

EPROMS

1702	256 x 8 (1us)	4.50
2708	1024 x 8 (450ns)	3.95
2758	1024 x 8 (450ns) (5v)	5.95
2716	2048 x 8 (450ns) (5v)	3.95
2716-1	2048 x 8 (350ns) (5v)	6.25
TMS2716	2048 x 8 (450ns)	7.95
TMS2532	4096 x 8 (450ns) (5v)	7.95
2732	4096 x 8 (450ns) (5v)	4.95
2732-250	4096 x 8 (250ns) (5v)	12.95
2732-200	4096 x 8 (200ns) (5v)	16.95
2764	8192 x 8 (450ns) (5v)	16.95
2764-250	8192 x 8 (250ns) (5v)	18.95
2764-200	8192 x 8 (200ns) (5v)	19.95
TMS2564	8192 x 8 (450ns) (5v)	24.95
MC68764	8192 x 8 (450ns) (5v)(24 pin)	call

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320	X	32	15,000	595.00

DISC CONTROLLERS

1771	16.95
1791	29.95
1793	38.95
1795	54.95
1797	54.95
6843	34.95
8272	39.95
UPD765	39.95
1691	18.95
2143	18.95

INTERFACE

8T26	1.69
8T28	2.49
8T95	.99
8T96	.99
8T97	.99
8T98	.99
DM8131	2.95
DP8304	2.29
DS8835	1.99
DS8836	.99

MISC.

3242	7.95
3341	4.95
MC3470	4.95
MC3480	9.00
11C90	13.95
95H90	7.95
2513-001 UP	9.95
2513-002 LOW	9.95

SOUND CHIPS

76477	3.95
76489	8.95
AY3-8910	12.95
MC3340	1.49

CRT CONTROLLERS

6845	14.95
68B45	35.95
HD46505SP	15.95
6847	12.25
68047	24.95
8275	29.95
7220	99.95
CRT5027	39.95
CRT5037	49.95
TMS9918A	39.95

BIT-RATE GENERATORS

MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
TMS6011	5.95
IM6402	7.95
IM6403	8.95
INS8250	14.95

KEYBOARD CHIPS

AY5-2376	11.95
AY5-3600	11.95
74C922	See 74C00
74C923	Series Prices

CLOCK CIRCUITS

MM5314	4.95
MM5369	3.95
MM5375	4.95
MM58167	8.95
MM58174	11.95
MSM5832	6.95

Z-80

2.5 Mhz

Z80-CPU	3.95
Z80-CTC	5.95
Z80-DART	15.25
Z80-DMA	17.50
Z80-PIO	5.75
Z80-SIO/0	18.50
Z80-SIO/1	18.50
Z80-SIO/2	18.50
Z80-SIO/9	16.95

4.0 Mhz

Z80A-CPU	6.00
Z80A-CTC	8.65
Z80A-DART	18.75
Z80A-DMA	27.50
Z80A-PIO	6.00
Z80A-SIO/0	22.50
Z80A-SIO/1	22.50
Z80A-SIO/2	22.50
Z80A-SIO/9	19.95

6.0 Mhz

Z80B-CPU	17.95
Z80B-CTC	15.50
Z80B-PIO	15.50

ZILOG

Z6132	34.95
Z8671	39.95

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32.768 khz	1.95
1.0 mhz	4.95
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2.0	3.95
2.097152	3.95
2.4576	3.95
3.2768	3.95
3.579535	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.7836	3.95
14.31818	3.95
15.0	3.95
16.0	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

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ADC0804	3.49
ADC0809	4.49
ADC0817	9.95
DAC0800	4.95
DAC0806	1.95
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DAC1020	8.25
DAC1022	5.95
MC1408L6	1.95
MC1408L8	2.95

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8085A-2	11.95
8086	29.95
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8088	39.95
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8156	8.95
8185	29.95
8185-2	39.95
8741	39.95
8748	29.95
8755	32.00

8200

8202	29.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	39.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
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8288	25.00
8289	49.95

FUNCTION GENERATORS

MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

INTERSIL

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ICL7106	9.95
ICL7107	12.95
ICL8038	3.95
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6800

68000	99.95
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6808	13.90
6809E	19.95
6809	12.95
6810	2.95
6820	4.95
6821	3.25
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	12.25
6850	3.45
6852	5.75
6860	9.95
6862	11.95
6875	6.95
6880	2.25
6883	24.95
68047	24.95
68488	19.95

6800 1MHZ

68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	7.95
68B21	12.95
68B45	35.95
68B50	12.95

68B00 2 MHZ

6500

1 MHZ

6502	5.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	8.75
6532	11.25
6545	22.50
6551	11.85

2 MHZ

6502A	9.95
6522A	11.70
6532A	12.40
6545A	28.50
6551A	12.95

3 MHZ

6502B	14.95

EXAR

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XR 2240	3.25

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9334	2.50
9368	3.95
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9601	.75
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74LS01	.25	74LS90	.55	74LS170	1.49	74LS324	1.75
74LS02	.25	74LS91	.89	74LS173	.69	74LS352	1.29
74LS03	.25	74LS92	.55	74LS174	.55	74LS353	1.29
74LS04	.24	74LS93	.55	74LS175	.55	74LS363	1.35
74LS05	.25	74LS95	.75	74LS181	2.15	74LS364	1.95
74LS08	.28	74LS96	.89	74LS189	8.95	74LS365	.49
74LS09	.29	74LS107	.39	74LS190	.89	74LS366	.49
74LS10	.25	74LS109	.39	74LS191	.89	74LS367	.45
74LS11	.35	74LS112	.39	74LS192	.79	74LS368	.45
74LS12	.35	74LS113	.39	74LS193	.79	74LS373	.99
74LS13	.45	74LS114	.39	74LS194	.69	74LS374	.99
74LS14	.59	74LS122	.45	74LS195	.69	74LS377	1.39
74LS15	.35	74LS123	.79	74LS196	.79	74LS378	1.18
74LS20	.25	74LS124	2.90	74LS197	.79	74LS379	1.35
74LS21	.29	74LS125	.49	74LS221	.89	74LS385	1.90
74LS22	.25	74LS126	.49	74LS240	.95	74LS386	.45
74LS26	.29	74LS132	.59	74LS241	.99	74LS390	1.19
74LS27	.29	74LS133	.59	74LS242	.99	74LS393	1.19
74LS28	.35	74LS136	.39	74LS243	.99	74LS395	1.19
74LS30	.25	74LS137	.99	74LS244	.99	74LS399	1.49
74LS32	.29	74LS138	.55	74LS245	1.49	74LS424	2.95
74LS33	.55	74LS139	.55	74LS247	.75	74LS447	.37
74LS37	.35	74LS145	1.20	74LS248	.99	74LS490	1.95
74LS38	.35	74LS147	2.49	74LS249	.99	74LS624	3.99
74LS40	.25	74LS148	1.35	74LS251	.59	74LS668	1.69
74LS42	.49	74LS151	.55	74LS253	.59	74LS669	1.89
74LS47	.75	74LS153	.55	74LS257	.59	74LS670	1.49
74LS48	.75	74LS154	1.90	74LS258	.59	74LS674	9.65
74LS49	.75	74LS155	.69	74LS259	2.75	74LS682	3.20
74LS51	.25	74LS156	.69	74LS260	.59	74LS683	3.20
74LS54	.29	74LS157	.65	74LS266	.55	74LS684	3.20
74LS55	.29	74LS158	.59	74LS273	1.49	74LS685	3.20
74LS63	1.25	74LS160	.69	74LS275	3.35	74LS688	2.40
74LS73	.39	74LS161	.65	74LS279	.49	74LS689	3.20
74LS74	.35	74LS162	.69	74LS280	1.98	74LS783	24.95
74LS75	.39	74LS163	.65	74LS283	.69	81LS95	1.49
74LS76	.39	74LS164	.69	74LS290	.89	81LS96	1.49
74LS78	.49	74LS165	.95	74LS293	.89	81LS97	1.49
74LS83	.60	74LS166	1.95	74LS295	.99	81LS98	1.49
74LS85	.69	74LS168	1.75	74LS298	.89	25LS2521	2.80
						25LS2569	4.25

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
ST SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW WIREWRAP		
16 pin ZIF	6.75	call
24 pin ZIF	9.95	call
ZIF TEXTOOL (Zero Insertion Force)		

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RS232 MALE	2.95
RS232 FEMALE	3.50
RS232 FEMALE RIGHT ANGLE	5.25
RS232 HOOD	1.25
S-100 ST	3.95
S-100 WW	4.95

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4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

7400

7400	.19	74132	.45
7401	.19	74136	.50
7402	.19	74141	.65
7403	.19	74142	2.95
7404	.19	74143	2.95
7405	.25	74145	.60
7406	.29	74147	1.75
7407	.29	74148	1.20
7408	.24	74150	1.35
7409	.19	74151	.55
7410	.19	74152	.65
7411	.25	74153	.55
7412	.30	74154	1.25
7413	.35	74155	.75
7414	.49	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7422	.35	74162	.85
7423	.29	74163	.69
7425	.29	74164	.85
7426	.29	74165	.85
7427	.29	74166	1.00
7428	.45	74167	2.95
7430	.19	74170	1.65
7432	.29	74172	5.95
7433	.45	74173	.75
7437	.29	74174	.89
7438	.29	74175	.89
7440	.19	74176	.89
7442	.49	74177	.75
7443	.65	74178	1.15
7444	.69	74179	1.75
7445	.69	74180	.75
7446	.69	74181	2.25
7447	.69	74182	.75
7448	.69	74184	2.00
7450	.19	74185	2.00
7451	.23	74186	18.50
7453	.23	74190	1.15
7454	.23	74191	1.15
7460	.23	74192	.79
7470	.35	74193	.79
7472	.29	74194	.85
7473	.34	74195	.85
7474	.33	74196	.79
7475	.45	74197	.75
7476	.35	74198	1.35
7480	.59	74199	1.35
7481	1.10	74221	1.35
7482	.95	74246	1.35
7483	.50	74247	1.25
7485	.59	74248	1.85
7486	.35	74249	1.95
7489	2.15	74251	.75
7490	.35	74259	2.25
7491	.40	74265	1.35
7492	.50	74273	1.95
7493	.35	74276	1.25
7494	.65	74279	.75
7495	.55	74283	2.00
7496	.70	74284	3.75
7497	2.75	74285	3.75
74100	1.75	74290	.95
74107	.30	74293	.75
74109	.45	74298	.85
74110	.45	74351	2.25
74111	.55	74365	.65
74116	1.55	74366	.65
74120	1.20	74367	.65
74121	.29	74368	.65
74122	.45	74376	2.20
74123	.49	74390	1.75
74125	.45	74393	1.35
74126	.45	74425	3.15
74128	.55	74426	.85
		74490	2.55

CMOS

4000	.29	4528	1.19
4001	.25	4531	.95
4002	.25	4532	1.95
4006	.89	4538	1.95
4007	.29	4539	1.95
4008	.95	4543	1.19
4009	.39	4555	.95
4010	.45	4556	.95
4011	.25	4581	1.95
4012	.25	4582	1.95
4013	.38	4584	.75
4014	.79	4585	.75
4015	.39	4702	12.95
4016	.39	74C00	.35
4017	.69	74C02	.35
4018	.79	74C04	.35
4019	.39	74C08	.35
4020	.75	74C10	.35
4021	.79	74C14	.59
4022	.79	74C20	.35
4023	.29	74C30	.35
4024	.65	74C32	.39
4025	.29	74C42	1.29
4026	1.65	74C48	1.99
4027	.45	74C73	.65
4028	.69	74C74	.65
4029	.79	74C76	.80
4030	.39	74C83	1.95
4034	1.95	74C85	1.95
4035	.85	74C86	.39
4040	.75	74C89	4.50
4041	.75	74C90	1.19
4042	.69	74C93	1.75
4043	.85	74C95	.99
4044	.79	74C107	.89
4046	.85	74C150	5.75
4047	.95	74C151	2.25
4049	.35	74C154	3.25
4050	.35	74C157	1.75
4051	.79	74C160	1.19
4053	.79	74C161	1.19
4060	.89	74C162	1.19
4066	.39	74C163	1.19
4068	.39	74C164	1.39
4069	.29	74C165	2.00
4070	.35	74C173	.79
4071	.29	74C174	1.19
4072	.29	74C175	1.19
4073	.29	74C192	1.49
4075	.29	74C193	1.49
4076	.79	74C195	1.39
4078	.29	74C200	5.75
4081	.29	74C221	1.75
4082	.29	74C373	2.45
4085	.95	74C374	2.45
4086	.95	74C901	.39
4093	.49	74C902	.85
4098	2.49	74C903	.85
4099	1.95	74C905	10.95
14409	12.95	74C906	.95
14410	12.95	74C907	1.00
14411	11.95	74C908	2.00
14412	12.95	74C909	2.75
14419	7.95	74C910	9.95
4502	.95	74C911	8.95
4503	.65	74C912	8.95
4508	1.95	74C914	1.95
4510	.85	74C915	1.19
4511	.85	74C918	2.75
4512	.85	74C920	17.95
4514	1.25	74C921	15.95
4515	1.79	74C922	4.49
4516	1.55	74C923	4.95
4518	.89	74C925	5.95
4519	.39	74C926	7.95
4520	.79	74C927	7.95
4522	1.25	74C928	7.95
4526	1.25	74C929	19.95
4527	1.95	74C930	19.95

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74S03	.35	74S169	3.95
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74S05	.35	74S175	.95
74S08	.35	74S181	3.95
74S09	.40	74S182	2.95
74S10	.35	74S188	1.95
74S11	.35	74S189	6.95
74S15	.35	74S194	1.49
74S20	.35	74S195	1.49
74S22	.35	74S196	1.49
74S30	.35	74S197	1.49
74S32	.40	74S201	6.95
74S37	.88	74S225	7.95
74S38	.85	74S240	2.20
74S40	.35	74S241	2.20
74S51	.35	74S244	2.20
74S64	.40	74S251	.95
74S65	.40	74S253	.95
74S74	.50	74S257	.95
74S85	1.99	74S258	.95
74S86	.50	74S260	.79
74S112	.50	74S274	19.95
74S113	.50	74S275	19.95
74S114	.55	74S280	1.95
74S124	2.75	74S287	1.90
74S132	1.24	74S288	1.90
74S133	.45	74S289	6.89
74S134	.50	74S301	6.95
74S135	.89	74S373	2.45
74S138	.85	74S374	2.45
74S139	.85	74S381	7.95
74S140	.55	74S387	1.95
74S151	.95	74S412	2.98
74S153	.95	74S471	4.95
74S157	.95	74S472	4.95
74S158	.95	74S474	4.95
74S161	1.95	74S482	15.25
74S162	1.95	74S570	2.95
		74S571	2.95

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LM301H	.79	LM382	1.60	MC1330	1.69
LM307	.45	LM383	1.95	MC1349	1.89
LM308	.69	LM384	1.95	MC1350	1.19
LM308H	1.15	LM386	.89	MC1358	1.69
LM309H	1.95	LM387	1.40	LM1414	1.59
LM309K	1.25	LM389	1.35	LM1458	.59
LM310	1.75	LM390	1.95	LM1488	.69
LM311	.64	LM392	.69	LM1489	.69
LM311H	.89	LM394H	4.60	LM1496	.85
LM312H	1.75	LM399H	5.00	LM1558H	3.10
LM317K	3.95	NE531	2.95	LM1800	2.37
LM317T	1.19	NE536	6.00	LM1812	8.25
LM318	1.49	NE555	.34	LM1815	5.20
LM318H	1.59	NE556	.65	LM1818	2.90
LM319H	1.25	NE558	1.50	LM1820	3.50
LM319	1.25	NE561	19.95	LM1830	3.50
LM320	(see 7900)	NE562	6.00	LM1871	5.49
LM322	1.65	NE564	2.95	LM1872	5.49
LM323K	4.95	LM565	.99	LM1877	3.25
LM324	.59	LM566	1.49	LM1889	1.95
LM329	.65	LM567	.89	LM1896	1.75
LM331	3.95	NE570	3.95	LM2877	2.05
LM334	1.19	NE571	2.95	LM2878	2.25
LM335	1.40	NE592	2.75	LM2900	.85
LM336	1.75	LM703	.89	LM2901	1.00
LM337K	3.95	LM709	.59	LM3900	.59
LM337T	1.95	LM710	.75	LM3905	1.25
LM338K	6.95	LM711	.79	LM3909	.98
LM339	.99	LM723	.49	LM3911	2.25
LM340	(see 7800)	LM723H	.55	LM3914	3.95
LM348	.99	LM733	.98	LM3915	3.95
LM350K	4.95	LM741N-8	.35	LM3916	3.95
LM350T	4.60	LM741N-14	.35	MC4024	3.95
LM358	.69	LM741H	.40	MC4044	4.50
LM359	1.79	LM747	.69	RC4136	1.25
LM376	3.75	LM748	.59	RC4151	3.95
LM377	1.95	LM1014	1.19	LM4250	1.75
LM378	2.50	LM1303	1.95	LM4500	3.25
LM379	4.50	LM1304	1.19	LM13080	1.29
LM380	.89	LM1305	1.49	LM13600	1.49
LM380N-8	1.10	LM1307	.85	LM13700	1.49

H = TO-5 CAN T = TO-220 K = TO-3

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HP 5082-7760	.6"	CC	1.29
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MAN 74	.3"	CC	.99
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FND-500 (503)	.5"	CC	.99
FND-507 (510)	.5"	CA	.99

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Jumbo Green	.18	.15
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7808T	.89	78L12	.69	7912K	1.49
7812T	.89	78L15	.69	7915K	1.49
7815T	.89	78H05K	9.95	7924K	1.49
7824T	.89	78H12K	9.95	79L05	.79
7805K	1.39	7905T	.99	79L12	.79
7812K	1.39	7908T	.99	79L15	.79
7815K	1.39	7912T	.99	LM323K	4.95
7824K	1.39	7915T	.99	UA78S40	1.95
		7924T	.99		

T TO-220 K TO-3 L TO-92

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PN2222	NPN SWITCH	TO-92	10/1.00	100/8.99
PN2907	PNP SWITCH	TO-92	10/1.25	100/10.99
2N2222	NPN SWITCH	TO-18	.25	50/10.99
2N2907	PNP SWITCH	TO-18	.25	50/10.99
2N3055	NPN POWER	TO-3	.79	10/6.99
3055T	NPN POWER	TO-220	.69	10/5.99
2N3904	NPN SWITCH	TO-92	10/1.00	100/8.99
2N3906	NPN SWITCH	TO-92	10/1.00	100/8.99
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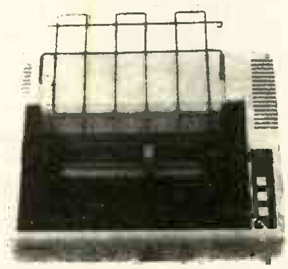

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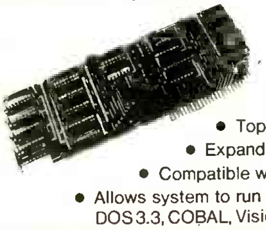

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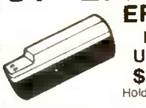

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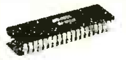

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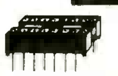

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14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.29	.27	.24
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28 pin LP	.45	.44	.43
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16 pin WW	.80	.77	.70
18 pin WW	.95	.90	.81
20 pin WW	1.15	1.08	.99
22 pin WW	1.45	1.35	1.23
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LM304H	1.98	LM1820N	.95
LM305H	1.89	LM1850N	.95
LM306H	3.25	LM1889N	3.10
LM307CN	.29	LM2111N	1.75
LM308CN	.98	LM2900N	.99
LM309K	1.49	LM2901N	2.50
LM310CN	1.25	LM2917N	2.95
LM311D/CN	.89	CA3013T	2.19
LM312H	1.75	CA3018T	1.99
LM317T	1.70	CA3021T	3.49
LM318CN	1.49	CA3023T	2.99
LM319N/H	1.25	CA3035T	2.75
LM320K-XX*	1.35	CA3039T	1.29
LM320T-XX*	1.39	CA3046N	1.29
LM320H-XX*	1.25	LM3053N	1.49
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LM324N	.95	CA3060N	3.19
LM337K	5.95	CA3062N	4.95
LM338K	6.95	LM3065N	1.49
LM339N	.95	CA3080T	1.29
LM340K-XX*	1.75	CA3081N	1.69
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LM350K	5.60	CA3096N	3.49
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LM741CN/H	.33	SN75453N	.49
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74S10	.42	74S140	.73	74S287	2.99
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74S20	.42	74S157	1.29	74S374	3.10
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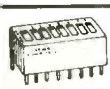

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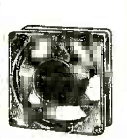

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7403	.22	7480	.49	74164	.87
7404	.22	7482	.95	74165	.87
7405	.23	7483	.55	74166	1.20
7406	.35	7485	.65	74167	1.95
7407	.35	7486	.35	74170	1.89
7408	.26	7489	1.75	74172	4.75
7409	.23	7490	.39	74173	.79
7410	.22	7491	.57	74174	.89
7411	.29	7492	.45	74175	.85
7412	.29	7493	.45	74176	.75
7413	.39	7494	.69	74177	.75
7414	.59	7495	.65	74179	1.34
7416	.29	7496	.69	74180	.75
7417	.29	7497	2.90	74181	1.75
7420	.22	74100	2.90	74182	.75
7421	.35	74107	.32	74184	2.25
7422	.29	74109	.37	74185	2.25
7423	.29	74116	1.95	74186	9.95
7425	.29	74121	.29	74188	3.90
7426	.29	74122	.39	74190	1.15
7427	.25	74123	.59	74191	1.15
7429	.45	74125	.39	74192	.85
7430	.23	74126	.44	74193	.85
7432	.29	74128	.59	74194	.85
7437	.25	74132	.69	74195	.68
7438	.29	74136	.75	74196	.85
7439	.29	74139	.95	74197	.85
7440	.19	74141	.79	74198	1.39
7441	.79	74142	2.95	74199	1.39
7442	.57	74143	2.95	74221	1.19
7443	.95	74144	2.95	74251	.95
7444	.95	74145	.62	74273	1.05
7445	.79	74147	1.95	74276	1.89
7446	.79	74148	1.20	74279	.75
7447	.65	74150	1.09	74283	1.40
7448	.79	74151	.67	74284	3.90
7450	.19	74152	.67	74285	3.90
7451	.19	74153	.87	74290	1.25
7453	.19	74154	1.19	74298	.95
7454	.19	74155	.78	74365	.68
7459	.25	74156	.78	74366	.68
7460	.23	74157	.69	74367	.68
7470	.29	74158	1.65	74368	.68
7472	.29	74159	2.49	74390	1.45
7473	.34	74160	.88	74393	1.90
7474	.34			74490	1.90

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74LS04	.35	74LS124	1.35	74LS251	1.40
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4022	1.15	4069	.35	4511	1.19
4023	.29	4070	.49	4512	1.39
4024	.75	4071	.35	4515	2.75
4025	.25	4072	.35	4516	1.45
4027	.65	4073	.35	4518	1.39
4028	.85	4075	.35	4520	1.25
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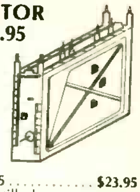

MODEL ELC 1045
FREQ. RANGE
UHF 470-889 MHZ
CHANNEL 14-83
OUTPUT CHANNEL 3
75 OHM INPUT

Part No.		
DSW10	Philips UHF Tuner ELC 1045	$23.95
DSW20	Printed Circuit Board, Predrilled Glass Epoxy	$15.00
DSW30	P.C.B. Potentiometers 5-10K, 1-5K	$5.95
DSW40	Resistor Kit 1/4 watt 5% Carbon Resistors 32 pcs.	$4.95
DSW50	Panel Mount Potentiometers 2-10K and Knobs	$2.95
DSW60	IC's 7 pcs., 1 Rectifier, 2 Regulators & 1 Heat Sink	$15.95
DSW70	Electrolytic Cap Kit, 8 pcs.	$4.95
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DSW90	Variable Trimmer Kit, 4 pcs.	$3.95
DSW100	Coil Kit, 2-18 uh, 1 variable 33 uh + 1 - + 37-12 Torold + 26 wire	$1.95
DSW110	I.C. Sockets 5-8 pins, 2-14 pin	$4.95
DSW120	Power Transformer PRI-117Vac, SEC 24Vac, 1 amp	$5.95
DSW130	Speaker, Oval 8 ohm	$3.00
DSW140	Misc. Parts, Hardware & Hookwire Ant. Term, Switch Dpdt, Fuse, Fuseholder, Line Cord, etc.	$7.95

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- Kit

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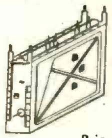

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PWD30	P.C.B. Pots, 4-20K, 2-1K, 2-10K, 2-100K	$9.95
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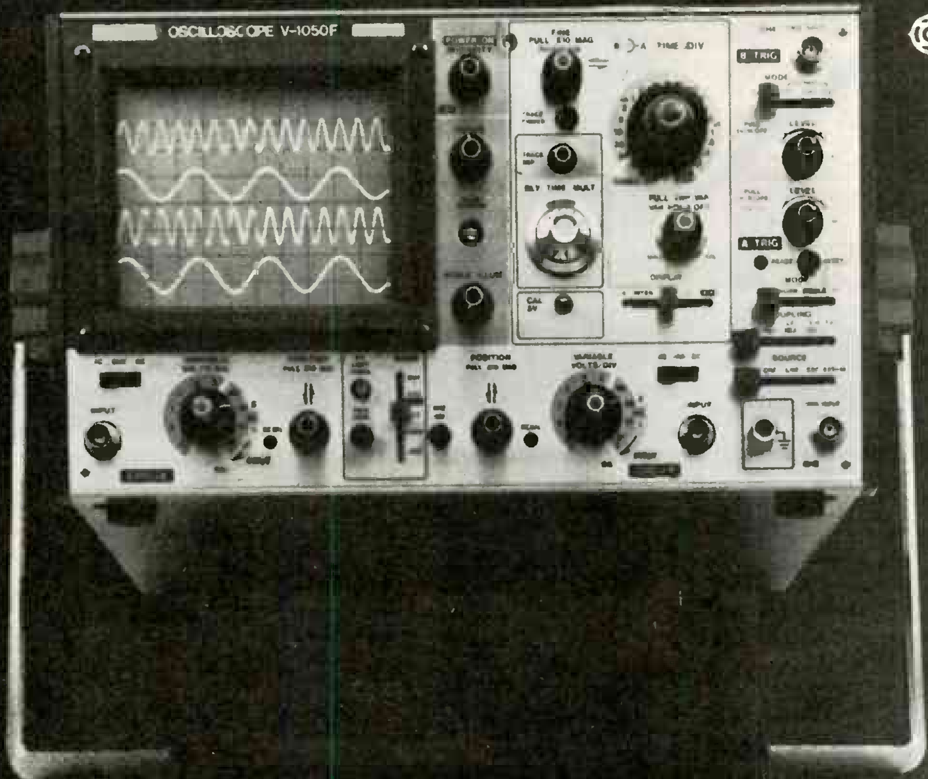

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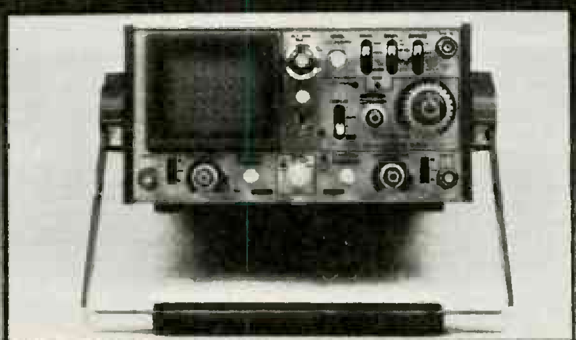

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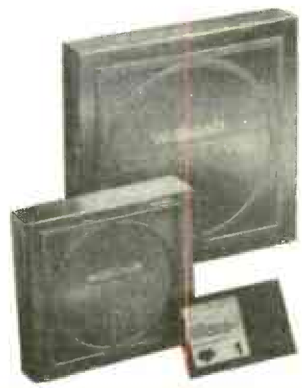

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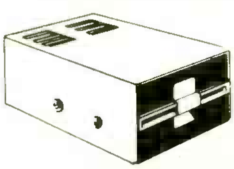

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$310.00 Each

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Kit includes: High Quality P.C. Board • 8 ea. 4116 (200ns) • All the IC's & parts • 16-pin Dip wire • Easy to assemble. You can do it in less than 30 minutes!

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ramsey the first name in Counters !

9 DIGITS 600 MHz $129.95 WIRED

PRICES

CT-90 wired, 1 year warranty	$129.95
CT-90 Kit, 90 day parts warranty	109.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC Adapter/Charger	12.95
OV-1, Micro-power Oven time base	49.95
External time base input	14.95

The CT-90 is the most versatile, feature packed counter available for less than $300.00! Advanced design features include; three selectable gate times, nine digits, gate indicator and a unique display hold function which holds the displayed count after the input signal is removed! Also, a 10mHz TCXO time base is used which enables easy zero beat calibration checks against WWV. Optionally, an internal nicad battery pack, external time base input and Micro-power high stability crystal oven time base are available. The CT-90, performance you can count on!

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 10 MV to 150 MHz Less than 50 MV to 500 MHz
Resolution:	0.1 Hz (10 MHz range) 1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	9 digits 0.4" LED
Time base:	Standard-10.000 mHz, 1.0 ppm 20-40°C. Optional Micro-power oven-0.1 ppm 20-40°C
Power:	8-15 VAC @ 250 ma

7 DIGITS 525 MHz $99.95 WIRED

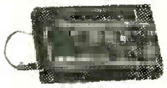
SPECIFICATIONS:

Range:	20 Hz to 525 MHz
Sensitivity:	Less than 50 MV to 150 MHz Less than 150 MV to 500 MHz
Resolution:	1.0 Hz (5 MHz range) 10.0 Hz (50 MHz range) 100.0 Hz (500 MHz range)
Display:	7 digits 0.4" LED
Time base:	1.0 ppm TCXO 20-40°C
Power:	12 VAC @ 250 ma

The CT-70 breaks the price barrier on lab quality frequency counters. Deluxe features such as; three frequency ranges - each with pre-amplification, dual selectable gate times, and gate activity indication make measurements a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1.0 ppm accuracy - that's .0001%! The CT-70 is the answer to all your measurement needs, in the field, lab or ham shack.

PRICES:

CT-70 wired, 1 year warranty	$99.95
CT-70 Kit, 90 day parts warranty	84.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC adapter/charger	12.95



7 DIGITS 500 MHz $79.95 WIRED

PRICES:

MINI-100 wired, 1 year warranty	$79.95
AC-Z Ac adapter for MINI-100	3.95
BP-Z Nicad pack and AC adapter/charger	12.95

Here's a handy, general purpose counter that provides most counter functions at an unbelievable price. The MINI-100 doesn't have the full frequency range or input impedance qualities found in higher price units, but for basic RF signal measurements, it can't be beat! Accurate measurements can be made from 1 MHz all the way up to 500 MHz with excellent sensitivity throughout the range, and the two gate times let you select the resolution desired. Add the nicad pack option and the MINI-100 makes an ideal addition to your tool box for "in-the-field" frequency checks and repairs.

SPECIFICATIONS:

Range:	1 MHz to 500 MHz
Sensitivity:	Less than 25 MV
Resolution:	100 Hz (slow gate) 1.0 KHz (fast gate)
Display:	7 digits, 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	5 VDC @ 200 ma

8 DIGITS 600 MHz $159.95 WIRED

NEW READ RECEIVER FREQUENCY

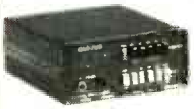
SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double-duty!

PRICES:

CT-50 wired, 1 year warranty	$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95



DIGITAL MULTIMETER $99.95 WIRED

PRICES:

DM-700 wired, 1 year warranty	$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack + AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include; 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts:	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

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For high resolution audio measurements, multiplies UP in frequency.

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

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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
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- Great for sniffing RF with pick-up loop

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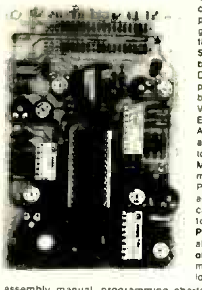
Sound Effects Kit $18.50



The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477 Sound Chip**, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3¼" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains**, or almost an infinite number of **other sounds**. The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included). **76477 is Included.** Available separately for **$3.15 each.**

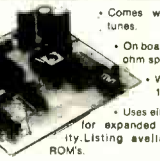
The Super Music Maker

REVISION 2

$24.95

(Basic Kit)

SEE SPECIAL OFFER BELOW



- Comes with 25 pre-programmed tunes.
- On board 7 watt amplifier drives 8 ohm speaker directly.
- Works on 12VAC or 12 VDC.
- Uses either 2708 or 2716 EPROM for expanded tune playing capability. Listing available pre-programmed ROM's.

A true electronic music maker based on a microprocessor chip. The Super Music Maker is the only kit that allows easy addition of pre-programmed tunes by plugging in one memory chip (ROM). Over 20 different ROM's with over 500 tunes are available. Use the kit for a **Car Horn, Doorbell, Door Announcer,** etc. If you have an EPROM programmer our manual tells you how to program your own tunes. Kit includes quality plated and drilled PC Board and all components.

OPTIONAL ACCESSORIES

DIP SWITCHES One 8 pos., one 5 pos., for tune address **2.00/set**
WALLPLUG TRANSFORMER For operation on 117VAC house current **3.00**
INJECTION MOLDED PLASTIC CASE w/custom front & rear panels, hardware and 2 five pos. rotary switches (replaces DIP switches) **8.00**
HORN SPEAKER 8 watt, 8 Ohm with mounting bracket **6.25**

SPECIAL OFFER

Buy a Super Music Maker kit for $24.95 and get **FREE**, a 2708 ROM pre-programmed with 35 popular tunes. This offer gives you over 60 songs to choose from!

7 Watt Audio Amp Kit $6.95

SMALL, SINGLE HYBRID IC AND COMPONENTS FIT ON A 2" x 3" PC BOARD (INCLUDED). RUNS ON 12VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 5 WATTS. COMPATIBLE WITH SE-01 SOUND KIT.

Doomsday Alarm Kit $9.95

If you have trouble sleeping and you would like the rest of the neighborhood to share your misery then this little kit will be for you! There is no way to accurately describe the unearthly howls, screams and tones that come out of this kit. Four separate tone oscillators are mixed, cancelled and stepped at a varying rate. 10 Watts of crazy sounds. A great fun kit or a practical burglar alarm. Complete with PC board and all necessary components less speaker. For 6-12 VDC. ORDER DA-02

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After taking one look at the TRIPUT POWER SUPPLY our engineer declared that the units were worth several hundred dollars each. He pointed out the engineering, high quality construction and state-of-the-art intergrated design in support of his position. The President of **BEC** more pragmatically pointed out the already full warehouse and the two trailer truck loads of power supplies waiting in the parking lot, and set the price to move them **QUICKLY!**

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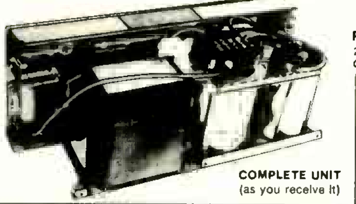
12V @ 8A (12A Int.)
5V @ 10A
-12V @ .5A

INPUT 105 - 125VAC



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Plus $5.00 Freight
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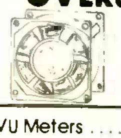

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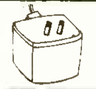

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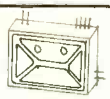

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KIT	$160.95, A & T	$199.95
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KIT	$299.95, A & T	$339.95

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LS20	.25	1.23	LS153	.75	3.56	LS258	.85	4.04
LS26	.35	1.66	LS155	.90	4.28	LS260	.65	-
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LS37	.55	2.50	LS160	.90	4.28	LS293	.80	3.80
LS38	.35	1.66	LS161	.95	4.51	LS295	1.05	4.99
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LS74	.45	2.14	LS163	.95	4.51	LS368	.70	3.33
LS75	.50	2.38	LS164	.95	4.51	LS373	1.85	8.79
LS85	1.15	5.46	LS166	1.75	8.31	LS374	1.80	8.55
LS86	.40	1.90	LS173	.80	3.80	LS377	1.45	6.89
LS90	.60	2.85	LS174	.95	4.51	LS378	1.18	5.61
LS92	.60	2.85	LS175	.95	4.51	LS620	2.25	-
LS93	.60	2.85	LS190	1.00	4.75	LS626	2.25	-
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