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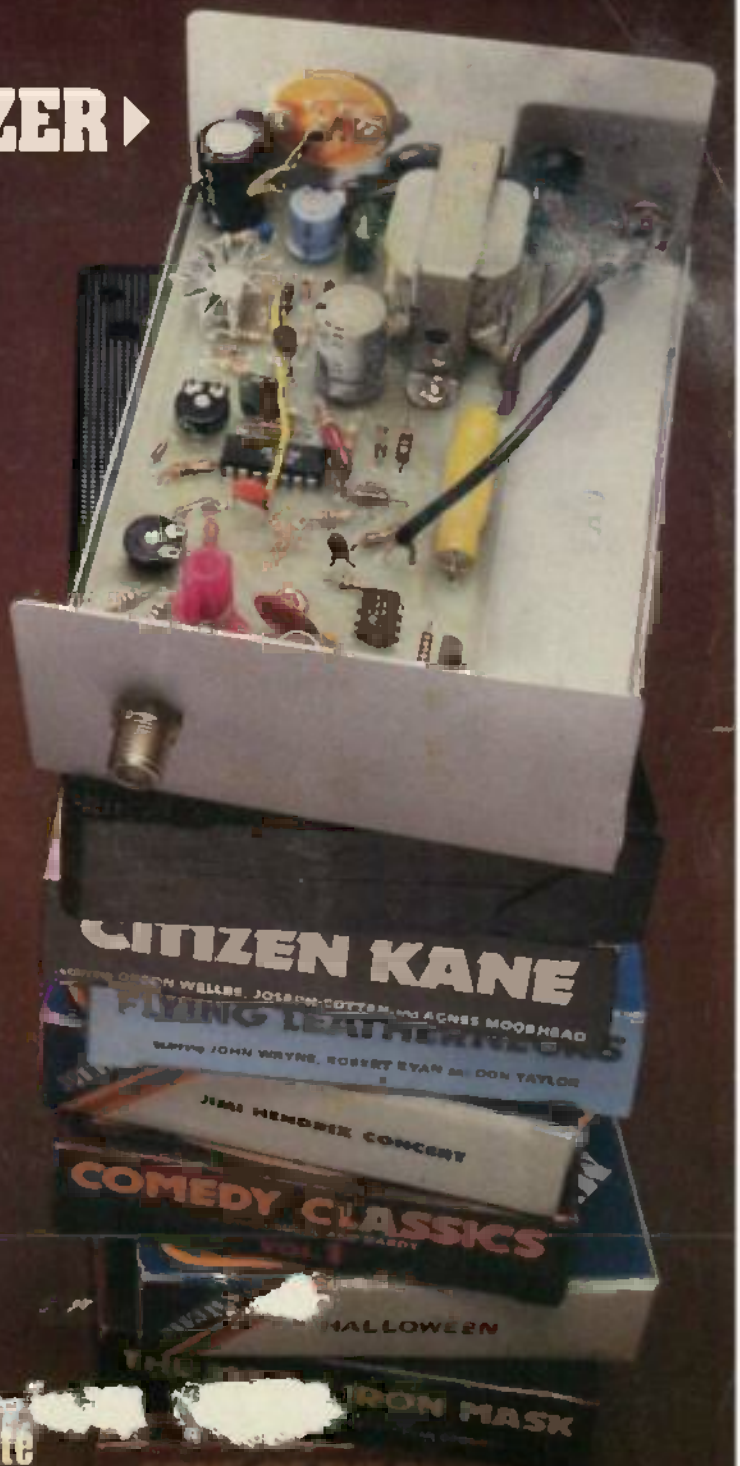

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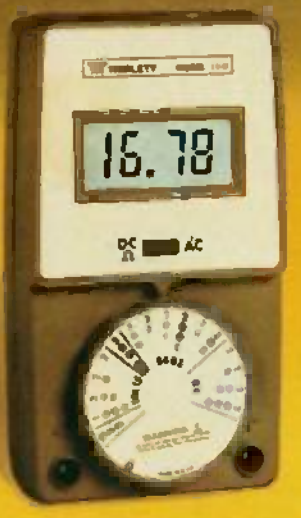

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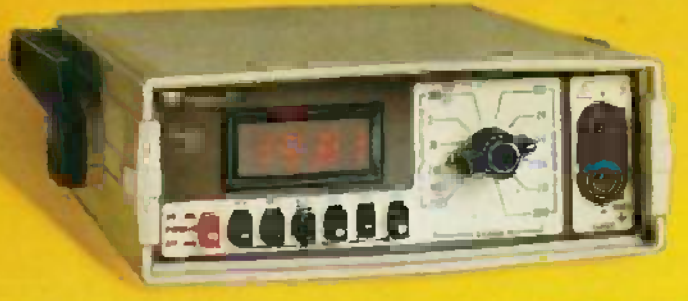

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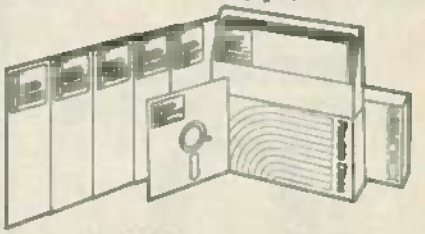

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JANUARY 1982 Vol. 53 No. 1

ON THE COVER

Here's a video accessory that you can build for your videocassette recorder. It reforms the video sync pulse and produces rock-steady pictures from pre-recorded videotapes. To get started, turn to page 45.

SPECIAL 32-PAGE SECTION covering Video Entertainment. Complete coverage of all the products that make up a video-entertainment center and what the future may bring. Story starts on page 49.

VIDEOTEX PART 3

Due to space limitations caused by the Special Video-Entertainment Section, we were unable to include the conclusion of the Videotex series. Videotex Part 3 will appear, however, in our next issue.

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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

ELECTRONIC STILL PHOTOGRAPHY

The photography field is all agog about the prospects for nonchemical snapshots. Sony was the first to demonstrate an all-electronic approach to still-picture photography with demonstrations in Tokyo and New York. Sony's *Mavica* (for "*MA*gnetic *V*ideo C*A*mera") resembles a conventional 35mm camera, but contains a CCD pickup device and a tiny floppy disk smaller than a graham cracker. (Photo shows camera, lenses, and disks.) The disk can store 50 full-color snapshots, recorded at one frame per revolution. For playback, the disk is placed in a small "viewer" which is attached to the antenna terminals of a color-TV set.

The snapshot appears on the TV screen as a full 525-line frame, even though only one field, or half-frame, actually is photographed, the remaining lines being filled in and interlaced by a processing circuit within the viewer. The disc, or *Mavipak*, may be placed in an envelope and mailed, or snapshots may be transmitted over the telephone using a special modem and slow-scan techniques. The output of the viewer may, of course, be recorded by a VCR, along with a soundtrack, for a slide show. By removing the disk and using a special cable, the camera may be used as a color video camera with any VCR. Sony says it expects to market the system at about $1,000 (complete) in the U.S. in 1983.

Sony also plans to offer a hard-copy printer, but hasn't yet demonstrated a prototype. Engineers are now working on a method to give the resultant print a resolution equivalent to that of a print made from a 35 mm negative, using the same "line-averaging" technique that the viewer uses to convert a single-field picture into a full frame. Sanyo is developing a similar electronic snapshot system, and it is believed Texas Instruments once had a high-priority project working in the same direction. Eastman Kodak also has patents in the electronic still-photography field. Now that Sony has removed the lens cap—so to speak—you can expect electronic snapshot-photography to get lots more exposure.

READY OR NOT?

TV set manufacturers call it "cable-ready" tuning, and it is designed to permit a TV set to tune to cable TV's midband, superband, and hyperband channels without a converter, by making the set's UHF channel selector do double-duty. Among the conveniences it provides is letting viewers use their wireless remote controls to tune the cable channels. So far, cable-ready tuning has also served as a can opener, and the can is full of worms. A joint engineering committee of EIA and National Cable TV Assn. (NCTA) is currently sorting out the worms in hopes of making certain that cable-ready sets will work with all cable-TV systems. For one thing, special cable channels aren't standardized, so there's no guarantee that the set will do its cable-tuning job.

Worse yet is the problem with cable pay-TV services. When a set-owner subscribes to a pay-cable service that uses a scrambled signal, the cable-ready remote control can't be used at all—not even for the non-pay cable channels. That is because cable channels must be selected on a special converter box, which includes the descrambler. Considering that some 12 million U.S. homes now subscribe to pay cable, with the number increasing every day, the committee has a real problem. The answer could be at least two or three years away.

RCA COUNTER-ATTACKS

Critics who scorn RCA's CED videodisc system because it isn't programmable, and doesn't have random access and other special effects, were answered at the Vidcom video conference in Cannes, France, when the company demonstrated a prototype designed to show the system's potential. The machine demonstrated had stereo or bilingual sound tracks, of course; a keypad remote control provided access to any segment of the disc by minute and second. (RCA said it also could be designed to access any specific field.) It can be made completely interactive by using microprocessors, the RCA spokesmen said. The disc also provided still-picture effects through use of a disc in which certain frames were repeated three times (since the system plays four frames per revolution). RCA said a solid-state memory eventually will be developed to provide still-frame from any disc. Because each field of the recorded picture is identified by code when the master disk is made, RCA said that CED could have exactly the same random-access and chapter-access features as other systems. R-E

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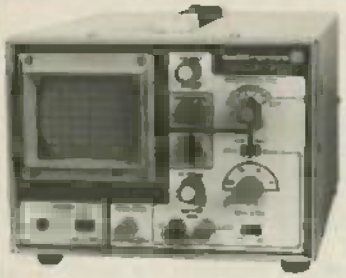

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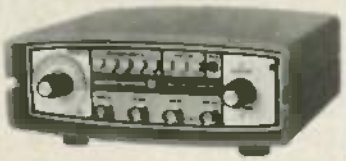
Low cost Function Generator Model 5020A



Specifications:
- Frequency range: 1Hz to 200kHz in five overlapping decade ranges.
- Waveforms: Sine wave: Distortion <1% from 1Hz to 100 kHz; <3% from 100kHz to 200kHz
- Square wave: Rise/fall time <250nsec. Symmetry <98%
- Triangle wave: Non-linearity <1% to 100kHz
- Output: Impedance: 600Ω short-circuit proof. Amplitude (continuously variable): 10V P-P open circuit; 5V P-P into 600Ω max. Low Level: -40dB of high output. TTL square wave: >10 std. TTL loads
- Sweep input: Impedance: 27kΩ. Range: >100:1. Input voltage: Up to ±10V.

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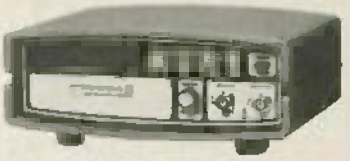
Features:
- ☆ 9-digit resolution for more precise readings
- ☆ Excellent 30mV sensitivity up to 1GHz
- ☆ 3 switch selectable gate times
- ☆ 10MHz crystal controlled time base for greater accuracy
- ☆ 2 separate inputs for added versatility
- ☆ Front panel sensitivity control

1GHz 9-digit Frequency Counter Model 8000B



Specifications:
- Frequency range: Model 8000B: 10Hz–1GHz in 3 ranges. Model 8610B: 10Hz–600MHz in 3 ranges
- Display: 9-digit 0.4" (10 mm) LED with automatic decimal point; separate LED gate activity indicator
- Resolution: 10MHz range: 0.1Hz with 10s gate time. 100MHz range: 1Hz with 10s gate time. 600MHz/1GHz range: 10Hz with 10s gate time
- Sensitivity: <20mV rms, 10Hz–100MHz; <30mV rms, 100–600MHz; <35mV rms, 600MHz–1GHz
- Input impedance: Input A–1MΩ/100pF. Input B–50Ω nominal
- Time base: Frequency: 10MHz. Selectable ±2ppm. Temperature stability: ±1ppm from 0 to 40°C
- Gate time: 0.1 second, 1 second, 10 seconds switch selectable

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**Model 8610B 600MHz for only $169.00

AUTORANGING DMM Model 2040 with 10 amps current measuring capability

This is a very sensitive, general purpose instrument which provides the facilities and quality required by today's electric/electronic technicians and engineers.

Specifications:
- Display: Numerical display: 3.5 digit LCD, maximum reading 1999. Unit and sign: mV, V, mA, A, Ω, KΩ, AUTO, BATT, ADJ, LO, –, AC
- Range selection: Autoranging on VOLT and OHM
- Polarity: Autopolarity, (–) sign when minus, (+) sign is implied and is not shown
- Battery warning: LO BATT sign
- Sampling rate: Two times per second
- Power consumption: 5mW typically
- Power supply: Two 1.5V batteries, type UM-3 or AA
- Battery life: 300 hour continuous operation
- Overload protection: One 3A 600V, BBS type fuse and one 0.3A 250V, 5x20 mm fuse for OHM and mA ranges
- Operating temperature and humidity: 0 to +40°C, less than 80%
- Zero adjustment: Zero adjustment by ZERO ADJ. Keyswitch
- Low power OHM ranges: For in-circuit resistance measurements at voltage levels below 0.33 volts

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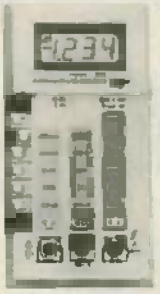
Features:
- ☆ Easiest operation: AUTORANGING SYSTEM requires no range selections
- ☆ Easiest reading: Automatic indications of units, signs, polarity, decimal point, overrange and battery warning
- ☆ Low battery consumption of 5mW: 300 hour continuous use with two 1.5V batteries, type UM-3 or AA
- ☆ Difference Measurements: This instrument can be used like a galvanometer
- ☆ Ultimate Portability: Actualized light weight and compactness in excellently designed ABS cases



Low Cost Handheld DMM Model 2038A

Features:
- ☆ 3½-digit LCD display
- ☆ 0.8% basic DCV accuracy
- ☆ DC voltage: 1000V
- ☆ AC voltage: 750V
- ☆ Input impedance: 10MΩ
- ☆ Low battery indicator
- ☆ High impact ABS case
- ☆ AC/DC current: 2 amps
- ☆ Overload protection
- ☆ 2000 hours battery life
- ☆ Auto zero

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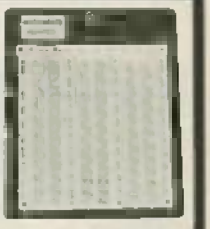
Solderless Breadboard Model 356S



Features:
- ☆ 3 terminal strips 5 distribution strips
- ☆ Aluminium plate
- ☆ Size: 200x175x8 mm actual area of breadboard
- ☆ Silver-plated contacts
- ☆ Accept all DIP size including RTL, DTL and CMOS devices
- ☆ Interconnect with any solid 20 to 29AWG (0.3–0.8 mm) wire
- ☆ Breadboard elements are mounted on ground plane, ideal for high frequency, high speed and low noise circuit

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Logic Probe Model LP-1

Features:
- ☆ Input impedance: 100KΩ
- ☆ Operating frequency: 10MHz
- ☆ Min. detectable pulse width: 50nsec
- ☆ Input overload protection: ±50V Cont.
- ☆ Power requirements: 5 to 15V less than 30mA
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WHAT'S NEWS

4-day course covers computerized robots

A four-day course, providing a comprehensive introduction to computerized robot technology and practical techniques for identifying and implementing robot applications is being offered in a new 1982 course by Integrated Computer Systems, a leading technical-education firm in Santa Monica, CA.

The course, entitled "Computerized Robots" is designed for managers whose responsibilities are in planning and designing advanced manufacturing methods, and for those who will be engaged in developing and integrating high-technology robot systems.

Topics covered include the extent of robot automation in the United States, Europe, and Japan; technical capabilities and limitations of robots; robot sensory-mechanisms, vision, touch, proximity; programming techniques for robot control; analyzing cost benefits; robot-selection methodology, and planning for advances in robot technology.

The course is priced at $845, and will be held in Washington, DC, January 19-22, 1982; Los Angeles, February 9-12; Boston, March 16-19; San Diego April 13-16, and Philadelphia, April 20-23.

For further information, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., P.O. Box 5339, Santa Monica, CA 90405. Telephone: (213) 450-2060.

Sony Corp builds new color-TV plant in SC

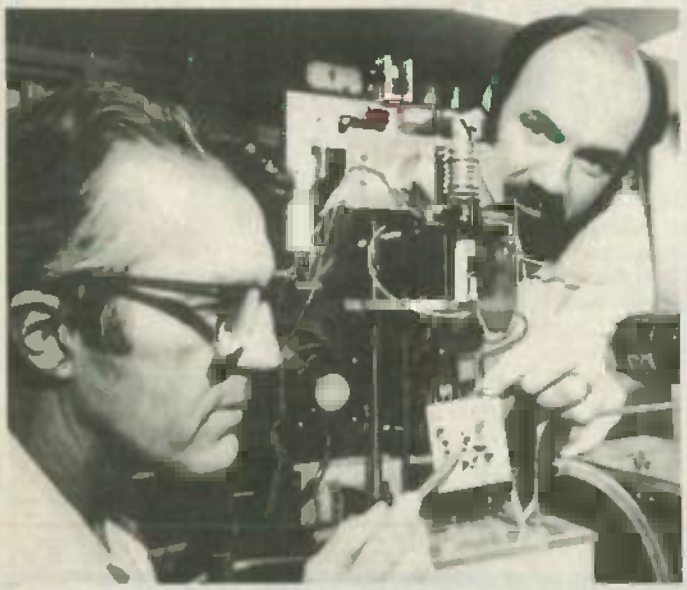
Sony Corp of America has announced plans for its second TV factory in the United States. The new 200,000-square-foot facility, where 500 people will be employed, will be located on a 330-acre site in Richland County, just outside the city limits of Columbia, SC.

The plant will assemble Trinitron television sets, with screen sizes of 17 inches and larger, at a rate of approximalley 20,000 sets a month; increases are planned to meet expected market requirements. First production is expected in late 1982.

Sony was the first Japanese-TV firm to locate in the United States, when it opened its San Diego, CA, facility in 1972. That plant now employs more than 1,800 persons. During 1981 it produced approximately 750,000 Trinitron TV receivers, with the vast majority sold in the North American market.

The Columbia facility is Sony's third major manufacturing operation in the United States. In 1977 Sony established a magnetic-tape manufacturing plant in Dothan, AL, which now employs more than 1,750 persons.

RCA DEVELOPS NEW CIRCUIT BOARD



A PORCELAIN-OVER-STEEL CIRCUIT BOARD with improved electrical and heat-resistance characteristics has been developed at the RCA Laboratories, Princeton, NJ, by Wayne M. Anderson (above, left) and Dr. Kenneth W. Hang. The new porcelain is highly crystallized—unlike most porcelains, which are glassy—and can be heated to high temperatures repeatedly without deforming. RCA believes the new boards are superior to conventional porcelain or organic plastic ones, and will be more rugged and reliable.

Hewlett-Packard helps software writers

In its newest addition to HP-PLUS, Hewlett-Packard will help qualified third-party software writers to sell their programs by promoting them through a comprehensive catalog to customers and dealers. The catalog contains descriptions and how-to-order information for all HP-41 programmable-calculator software written by HP and by outside sources.

"We want to attract high-quality software writers with proven success to this program," an HP spokesman said. "Third-party software writers, dealers, and users all will benefit from the program. Software supplies get HP's reputation and marketing force behind them; dealers get more solutions to sell, and an easy-to-use comprehensive catalog means that HP-41 users get more dependable programs."

Dalton Pritchard wins international prize

The most prestigious and richly endowed award for research in the consumer-oriented audio-visual field—the Edward Rhein Prize—has been awarded to Dalton W. Pritchard of the RCA Laboratories, for his contributions to improved picture sharpness and quality. Mr. Pritchard was the only American among the nine who were recipients of the prize for the year 1980.

He was honored for numerous contributions to video techniques, and particularly as a leader in developing the Dynamic Detail Processor used in RCA receivers. It uses a charge-coupled device (CCD) in an advanced integrated circuit. Through optimization of horizontal and vertical sharpness, the processor produces a clear and sharp picture that is free of dot crawl and cross color.

A Fellow of the IEEE and of the Society for Information Display, Mr. Pritchard received the IEEE's Vladimir Zworykin Award "for significant contributions to color-television technology" in 1977. He has written numerous technical papers and has been granted 37 U.S. patents, with others pending. Most of his 35-year career with RCA has been devoted to research in color-television systems and devices.

Journeyman CET's now number 10,000

When Kenneth G. Hill, Corvallis, OR, passed his CET test he became the 10,000th journeyman Certified Electronic Technician. Hill recently moved to Oregon from Ohio, where he worked for seven years as a technician and engineer for Ohio Nuclear, Inc., and WYSO in Yellow Springs. He took the CET test to meet the Oregon State licensing requirement as a repair technician.

The CET program is administered by the International Society of Certified Electronic Technicians. Hill passed an exam in basic electronics, which included math, transistors and semiconductors, troubleshooting, and network analysis, plus a journeyman test that covered knowledge of test equipment, troubleshooting techniques for consumer electronics equipment, transistor circuits, color TV, and some antenna theory. He was also required to have four years experience or training.

Hill is now working as a computer repair technican at Videx Corp. in Corvallis. His exam was administered by Larry Broschart, CET, of Portland, OR, and ap-

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Clean up without clog-up.

Introducing the Philips ECG SS-200, a self-contained desoldering system that helps keep repair operations continuous and efficient.

Clogged desoldering units cost time and money. The Philips ECG SS-200 helps overcome the problem. It removes solid-state components quickly and easily from all types of PC boards.

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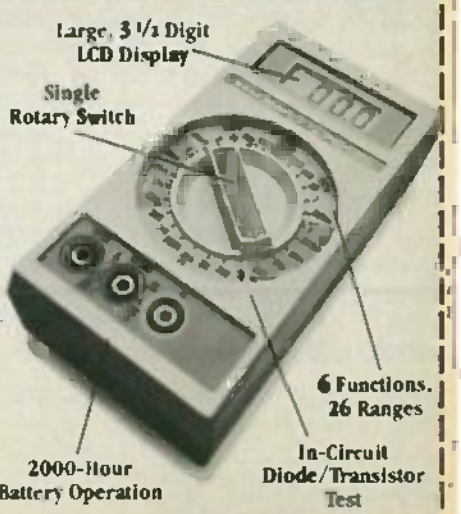
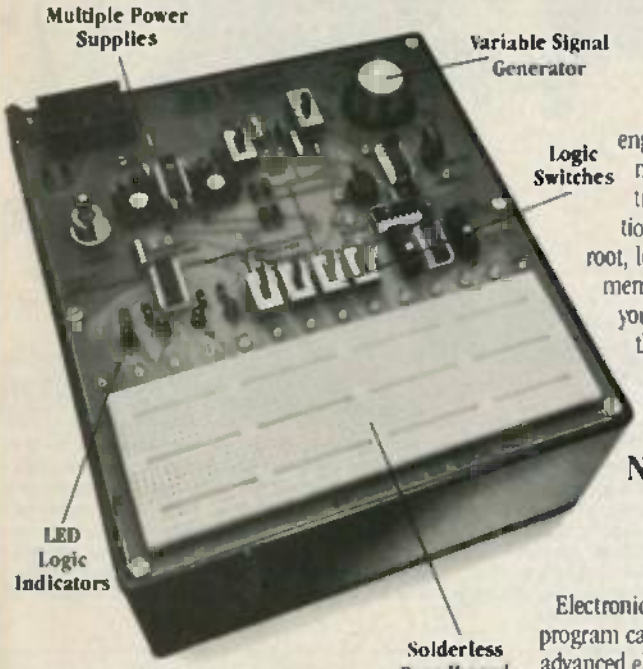
You learn by doing. No ivory-tower, strictly theoretical course here. You actually design and build modern electronic circuits, run tests, and verify specs. You learn how various systems interact, design your own circuits to perform specific tasks, learn to look for better ways and new ideas.

The NRI Circuit Designer is a totally unique instrument with full breadboarding capability, built-in multiple power supplies and a multi-function signal generator for circuit testing. Fast, simple connections let you build up prototype



.ELECTRONIC LOGY TRAINING



circuits, immediately check them out for function or faults. It handles both linear and digital integrated circuits as well as discrete components such as transistors and diodes. Six practical lab units carry you through both the theoretical and practical world of electronic circuit design.

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Your course also includes the choice of the professionals...the 6-function, 26-range Beckman digital multimeter for fast, accurate voltage, current, and resistance measurements. It features accurate LCD readout and full portability. You also get the famous Texas Instruments TI-30 scientific calculator to speed and simplify circuit analysis and design. It's a true engineering instrument that includes trigonometric functions as well as square root, logarithms, and memory. Together with your Circuit Designer, they work to give you a sound basis of practical experience.

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WHAT'S NEWS

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proved by the Television and Radio Service Advisory Board for the State of Oregon. Although Hill is the 10,000th CET, an additional 5,300 technicians have received associate certification.

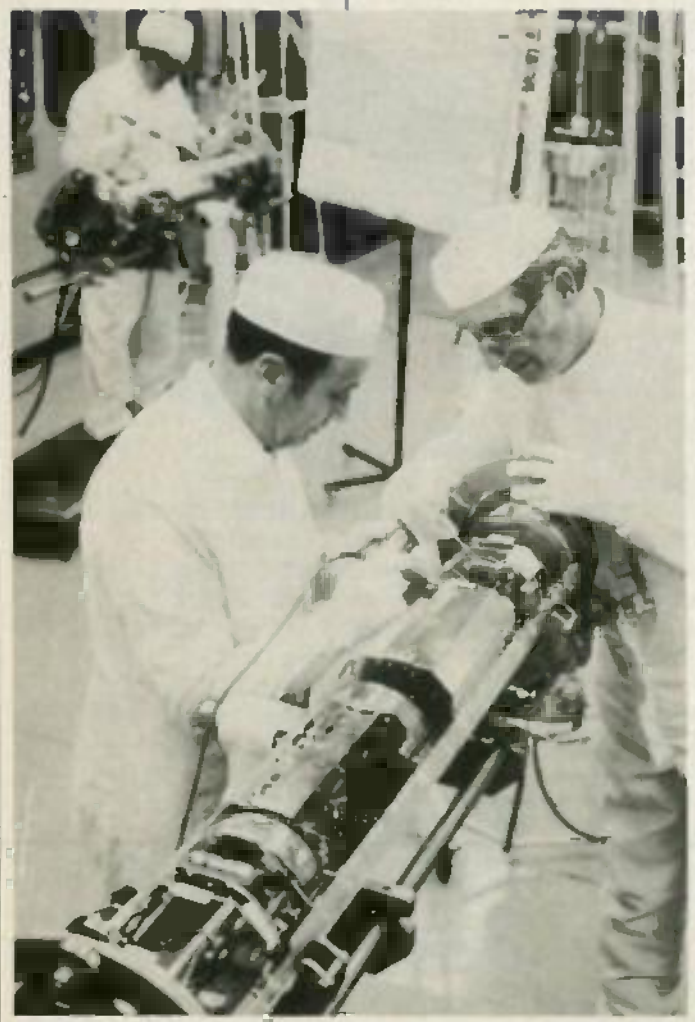
More information about the CET program may be obtained from ISCET, 2708 West Berry, Fort Worth, TX 76109.

Order is placed for longest phone cable

The largest single order ever placed for a submarine telephone cable was for "the major portion of" a new underseas cable linking Australia, New Zealand, and Canada. The contract—for $400 million—has been awarded to Standard Telephones and Cables, reports ITT, parent company of STC.

The cable, called ANZCAN, has a capacity of 1380 telephone conversations. It has been planned in five sections, running from Sydney, Australia via Norfolk Island, Fiji, and Hawaii to Vancouver, Canada. A lower-capacity segment will run betwen Auckland, Australia, Fiji, and Norfolk Island.

With a total length of 8,000 nautical miles, and with more than 1,000 repeaters (two-way amplifiers) it is the longest high-capacity undersea telephone cable ever undertaken. Voice signals will be amplified 10^{4000} times along its length.



MORE THAN 1,000 UNDERSEAS AMPLIFIERS like this will be used on the Australia-New Zealand-Canada telephone cable circuit.

The order was placed by the Overseas Telecommunications Commission of Australia, Teleglobe Canada, the New Zealand Post Office, and Fiji International Telecommunications Ltd.

Color-TV camera, VTR in a hand-held unit

RCA has demonstrated a new television camera-recorder system, which combines a broadcast-quality color-television camera and a videotape recorder in a single hand-held unit. The demonstration of the Hawkeye system was before the recent Radio and Television News Directors Association convention in New Orleans.

The Hawkeye system camera is a three-tube unit with new high-performance half-inch Saticon or lead-oxide pickup tubes. The system uses half-inch VHS cassettes as the medium for its new ChromaTrak recording format. That produces videotape quality superior to that of present three-quarter-inch tape.

The system also includes a full-feature studio videotape recorder and an edit controller for complete in-studio editing.

Rough times ahead for U.S. cable companies?

Financial and management problems, sky-rocketing interest rates, lack of programming services, rising construction costs, and competition by new services are combining to produce a critical time for U.S. cable companies and their equipment and program suppliers. That is the opinion of Strategic Services, a research organization of San Jose, CA.

The rise of new facilities: low-power local television, microwave distribution services, and direct-to-home satellite broadcasting, are new threats to the present dominant position of cable. In addition, piracy of cable and pay-TV programs is forcing companies to resort to addressable decoders or converters to prevent theft. R-E

FIRST ALL-SOLID-STATE SATELLITE

A SOLID-STATE SATELLITE POWER AMPLIFIER that will be used in the first all-solid-state communications satellite is being checked out by RCA engineer Nick Laprade. The satellite will be launched in 1982. The new solid-state amplifiers replace traveling-wave tube amplifiers (TWTA's), thereby extending the expected life of the SATCOM domestic communications satellite to ten years, as against the seven years of present satellites. Not only are they longer-lasting and more reliable than the TWTA's they replace, but are smaller and lighter, and eliminate the bulky high-voltage power supplies required by those amplifiers.

LETTERS

OOOOOOPS!

I noticed a few errors in my article, "4 Toys for the Holiday Season" (Radio-Electronics, December 1981). In Fig. 4, Q2 is incorrectly identified; it should be a 2N3904 as listed in the Parts List. Secondly, there are two D3's shown—the one in the lower right-hand corner, at the base of Q4, should be D4; it is correctly identified as a 1N914. (Also, that diode was left off of the Parts List.) Finally, R4, a 1-megohm resistor, was left off of the Parts List. That resistor is correctly shown in the schematic.

DAN TALBOT

NEW USER'S GROUP

In your "Letters" department in the September 1981 issue, Mr. Robert Smith of Michigan City, IN, writes about the *Z-80 Starter Kit* by SD Systems, a Z-80 microprocessor trainer.

I have started a user's group for owners of the *Z-80 Starter Kit*, and would like to invite those of your readers who are interested in receiving our newsletter to write to me.

CARY DAVIDS.
6000 Puffer Road,
Downers Grove, IL 60516

TEMPERATURE MEASUREMENT

In the November 1981 Radio-Electronics, Joseph J. Carr's article, "Temperature Measurement — Circuits and Components" was of special interest to me. A hobbyist concern of mine is with sensors in general (fluid-flow, wind velocity, pressure, etc.), but with a particular emphasis upon temperature sensors, because they have such wide application.

For those of us who pursue some of those elusive parameters, I feel that some expansion is called for.

In the special box entitled "Fahrenheit, Kelvin, Celsius, and Centigrade," paragraph two seems to contain more speculation than fact. Physics defines two properties very clearly:

1) Zero degrees Celsius is defined as the melting point of ice, rather than the freezing point of water. (That is because the former is well defined, while the latter is nebulous. Any stable mixture of water and ice will maintain a temperature of 0°C so long as any unmelted ice remains, while there is a range of temperature involved between the start of the formation of ice crystals and their final solidification.)

2) 100°C is defined as the boiling point of water at 760 mm (29.92 inches) of mercury barometric pressure. (While the references do not make it clear, I assume distilled water in both cases.)

That error in the box is inconsistent with the correct statements in the text relating to an "ice-point bath."

With regard to Fig. 6, the author states that the Datel VFQ-1 chip is "not generally

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PUBLISHER'S LETTER

Thank you! All you wonderful readers who responded to our two recent surveys—one on Microcomputers, the other on Video Entertainment. As a result of your cooperation, we now know a lot more about you and the reasons why you read **Radio-Electronics**, and our editors are now better equipped to keep **Radio-Electronics** packed with the kind of information you want to read.

We know that 85% of you attended or graduated from college! We know that your average age is 37; that 99.2% of you are men and that you are well paid—your median income is $33,000. We also know that both computers and video equipment are among your strongest interests. The only thing you like better is the field of electronics as a whole.

You told us that 93% of you, 107,645 readers, are interested in microcomputer technology—that's greater than the total circulation of four of the leading computer magazines. We also know that 67,643 readers personally own a computer, while 130,003 readers own or otherwise have access to a computer. We also know that our readers, as a group, own $263,599,589 worth of computer equipment. And another 93,010 readers plan to buy a microcomputer in the next year.

On top of all that, 101,465 readers made 638,214 buying recommendations each month to others who are considering buying a computer.

Your video-entertainment interests are just as strong. 71,872 readers already own a VCR and half of them bought their unit in the past year! Another 57,074 readers plan to buy a VCR during the next 12 months.

One direct result of what we have learned is the special Video-Entertainment section in this issue. However, we are not going to become a computer magazine, and we are not going to become a video magazine. We will remain as we are—an ELECTRONICS magazine that will continue to deliver all the varied and exciting information that makes electronics our field of interest.

When something new is happening, you can be sure that **Radio-Electronics** will deliver the story. Whether it's computers, satellite TV, robots, digital stereo, video recorders, or whatever—as long as it is ELECTRONICS, we will cover it. So keep reading and enjoying **Radio-Electronics**. Thanks again for your assistance; we appreciate it! Now watch how we will continue to keep your magazine—Radio-Electronics, the Number 1 Authority—your must-read electronics magazine.

Larry Steckler

LARRY STECKLER
Publisher

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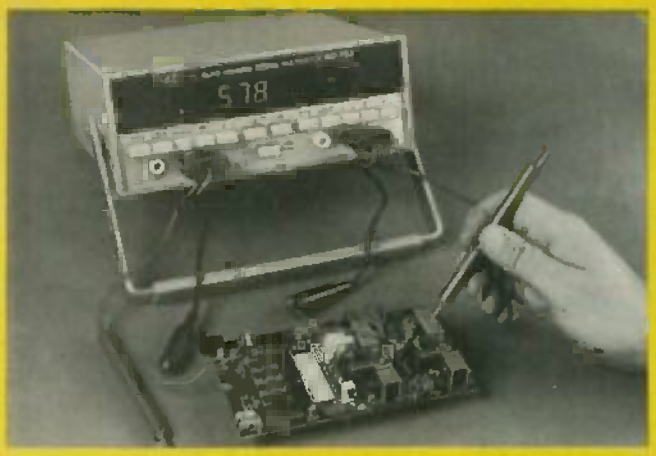

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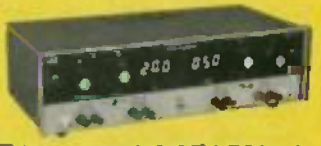

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LETTERS

continued from page 13

available through hobbyist outlets." Radio Shack would be amazed to hear that they are not considered to be a hobbyist outlet. But the author is pardoned for being unfamiliar with a Radio Shack 276-1790, which is a Teledyne 9400CJ, whose pin-out and specifications are virtually identical to those of the VFO-1. In fact, the VFO series includes the −1C, −2C, −3C, and −1R, which differ in non-linearity, temperature coefficient, and temperature range of operation primarily.

Further, the 9400CJ may be used with voltage input to pin 3 (rather than current), as presumably is also true of the VFO series. Additional points of interest about those two IC's is that a $f_o/2$ output is available at pin 10 (using the same pull-up) and that the scaling factor is moveable with C1/C2 while keeping the same approximate 5/1 ratio. A disadvantage (from my viewpoint) of the pin-8 output is that it consists of a very narrow (3 μs) negative pulse. The pin-10 output (not shown in Fig. 6), however, is a fairly symmetrical square wave, but at half the frequency. Where one's application involves measuring period rather than frequency, that output has advantages.

For those interested in similar temperature sensors, data sheets should be obtained for the Raytheon series, RC-, RM-, RV-4151/2/3 and the National series LM131/231/331, as well as the Exar XR4151, all of which are V/F converters. (Some are also F/V converters.) National also has the LM334 and LM335 series, which are of interest as constant-current devices for long-line two-wire transmission applications. For direct temperature control, they also have the LM3911. Some, if not all, of those are advertised in **Radio-Electronics**. The builder should note especially the linearity and temperature-coefficient specifications applicable to his requirements, and purchase the best he can afford, in light of those specifications.

With regard to Fig. 5 and the accompanying text, I would be cautious about permitting a water path to exist among the leads of the 2N2222. Probably they should be insulated, lest certain minerals in the water produce leakage currents, which might lead to errors.

Here are some practical notes on thermometers:

1) Check the 0°C (32°F) calibration point of your thermometer in a vacuum (thermos) bottle containing a stirred mixture of ice and water. (No correction required for barometric pressure.)

2) Check the 100°C (212°F) calibration point of your thermometer in boiling water at a time when your local barometeric pressure is 29.92 ±.03 inches and holding steady. Otherwise, a correction factor is needed. (See your library for *The Handbook of Chemistry and Physics*; it has the formula.)

3) It might be wise to use distilled water (or clean rain water, at least). Mineral content in some localities may

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LETTERS

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result in introducing errors.

4) A quality mercury thermometer uses a capillary of uniformly precise cross-sectional area. Once that is known to be true, only the end points on the thermometer have to be calibrated accurately. The remainder of the scale can be engine-divided into equal increments, with considerable assurance of accuracy at all points within the range.

I should be happy to correspond with any of your readers whose interests are similar to mine.

JOHN P. LANE,
511 Linden St.,
Roanoke, VA 24014

RADAR DETECTORS

I am concerned about the same things that Mr. Dalton Horn is, in relation to his letters about radar detectors (**Radio-Electronics**, June and December 1981), but there is one thing he's overlooked.

There are always going to be drivers who will exceed speed limits if they think they can get away with it. And, no doubt, some of them will buy radar detectors for the purpose of speeding so long as no one's watching. But what will such persons do when their detectors give them notice that they're being watched? *They'll slow down!*

It may be but for a short time, true. But nonetheless, the radar detector has forced our reckless driver to become a safe driver for awhile. That has special meaning if he's going through a populated area, where kids might dart across the street at any moment. The forced slowdown, which otherwise would not have occurred, might save a life at any time, under those conditions. And it could prevent an accident, which otherwise might have occurred, on a highway, too.

The thing is: Some people are going to get radar detectors for the purpose of seeing if they can beat the law, whether they're legal or not. A law-abiding driver, of course, does not need them. And other people are going to try to beat the speed laws without radar detectors, just as they did before the devices existed. But having radar detectors means slowdowns that might prevent accidents and save lives. So, reluctantly, I vote in favor of radar detectors.

GUS WARD,
Hoboken, NJ

R-E

Now the stars are within your reach

Movie Stars
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Your favorite stars are coming off the satellites right now in one of the greatest selections of family and adult entertainment ever offered. And now there's a new satellite receiver system that puts it all within your reach – at a price that's within reach.

The new Heathkit Earth Station

It includes a *3-meter Satellite Antenna* with a single-axis adjustable mount that lets you direct your antenna to receive signals from the entire satellite arc. It's a heavy-duty, commercial-quality antenna, made by Scientific-Atlanta and designed for long, reliable performance.

Special Low-Noise Amplifier and Down-Converter converts signals to 500 MHz band for transmission on ordinary TV cable.

The Receiver features electronically-synthesized tuning for stable, drift-free reception, and 24 channel selections for a broad variety of programming. It even includes a special Zenith Space Command Remote Control so you can change programs without leaving your easy chair.

Special Earth Foundation Kit anchors your antenna firmly to withstand winds of up to 100 mph.

Unique Site Survey Kit

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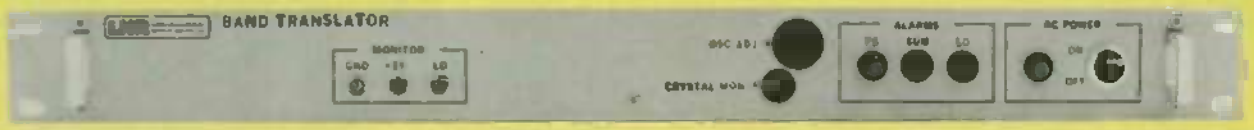
Heathkit Electronic Centers are units of Veritechnology Electronics Corporation.

Viewing of some satellite TV channels may require the customer to obtain permission from, or make payments to, the programming company. The customer is responsible for compliance with all local, state and federal governmental laws and regulations, including but not limited to construction, placement and use. For use only in Continental U.S.

Heathkit

SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR



FREQUENCY TRANSLATOR INTRODUCED

A frequency translator that can shift signals from the Ku to C band has been unveiled by LNR Communications Inc. The unit, *model DC 12/4*, (see photo) provides block down-conversion of the entire 11.7- to 12.2-GHz band to the 3.7- to 4.2-GHz range. With the unit online, C-band receiving equipment is immediately converted for Ku-band use. The unit can also be used to downconvert a Ku-band video signal to an unused channel in a 24-channel C-band TV receiver.

The frequency translator interfaces directly with a 12-GHz LNA and 4-GHz receivers or converters. LNR won't reveal the price yet, but it calls the unit an "economy" model. (LNR Communications, 180 Marcus Blvd., Hauppauge, NY 11787).

HOME INFORMATION TEST

AT&T and CBS will begin running a videotex test later this year, with the Bell System contributing communications facilities and hardware, while CBS offers software. Unlike teletext trials, this experiment will not be transmitted via TV signals; rather, the test will run via a telephone system in a community still to be chosen. The information, however, will be seen on a TV set augmented with special receiving equipment.

The software for the test will come from CBS's immense library of information, including some material from CBS News. More substantial, however, will be the information developed from the large number of magazines that are published by a CBS subsidiary, including *Field and Stream, Audio, Road and Track* and other automotive magazines, *Woman's Day*, and *World Tennis*.

The test will probably also give participants the opportunity to shop at home. CBS also owns Columbia House, a direct-marketing company best known for its book and record clubs. By using those facilities, test households could order items just by pushing some buttons attached to the retrieval equipment.

The test with CBS marks AT&T's second major activity in home information retrieval. Last year, AT&T hooked up with Knight Ridder Newspapers for an experiment in suburban Miami. That test will be expanded in 1983 to a full commercial service in Florida, offering customers the opportunity to link their TV sets and telephones into a sophisticated information and tele-shopping service.

SATELLITE PROGRAMMING

Programmers continue to find new shows and projects to beam aloft. Among the latest services heading skyward are:

National Consumer Electronics Showcase, a series of eight hour-long shows featuring product demonstrations from various consumer electronics makers. The shows will run on Satcom I transponder 21, with each program highlighting different types of products, such as personal communications devices (telephones, CB radio), audio equipment, electronic games, video and TV devices, and home computers.

Cable News Network CNN2 is adding a "headline" channel, which will feed brief highlights of news stories on a more rapid basis than the current CNN service. The abbrievated version will be transmitted aboard a Warner-Amex Satellite transponder.

ESPN, the all-sports channel, and ABC have worked up a deal which would mean that some of the sporting events carried by ad-supported ESPN will become pay-TV shows. That could mean the shows will be scrambled.

Post-Newsweek Productions will produce two new programs, a children's series called "Jungleton Junior High" and a late-night satirical variety show, "The George Frankie Half-a-Comedy Hour."

Home Theater Network has moved back to Satcom I Transponder 21, and is again transmitting from 8 p.m to 2 a.m. (eastern time) every day of the week. However, by late Spring 1982, the last three hours of the feed will again be moved to another transponder to make way for the Weather Channel, due to start up in the next few months. **R-E**

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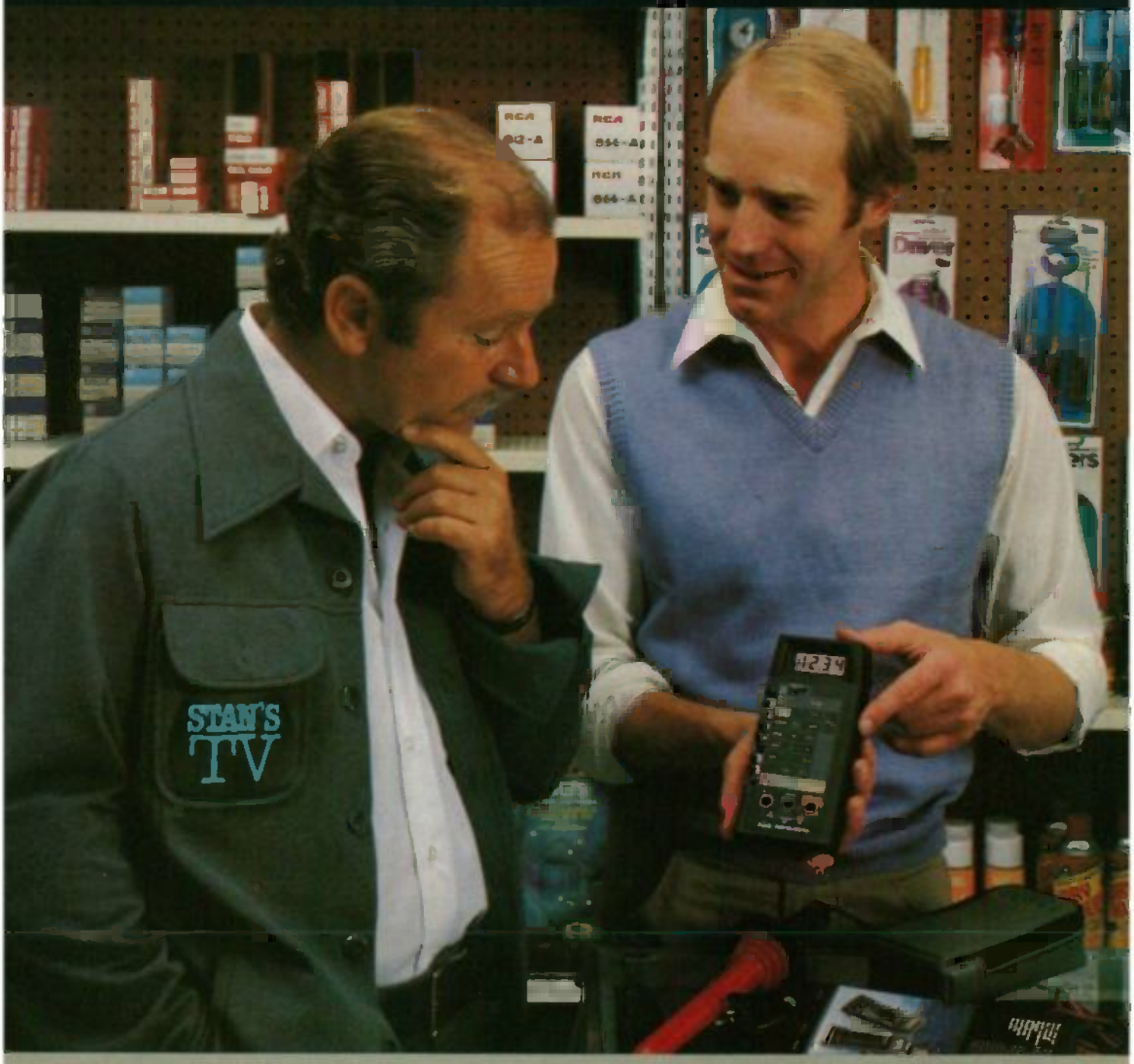

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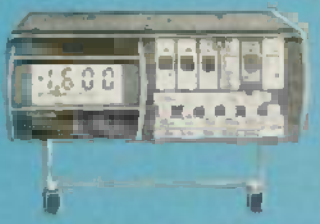
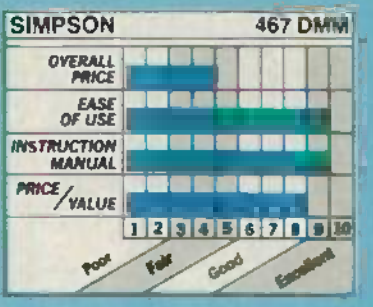
EQUIPMENT REPORTS

Simpson Model 467 DMM





CIRCLE 101 ON FREE INFORMATION CARD

THE SIMPSON ELECTRIC COMPANY (853 Dundee Ave., Elgin, IL 60120) is familiar to most electronics technicians. That company, long a manufacturer of high-quality test instruments, has introduced a new DMM—the *model 467*. The unit is loaded with useful features.

The meter is housed in a rugged plastic case. The readout is a 3½-digit LCD display; it has a few special features, which we'll discuss later. Pushbuttons, which are used for all but one of the controls, are large enough, and spaced far enough apart, to allow for easy use. The panel is color-coded, making it easy to find the function you want. The test leads connect to the right side of the case—where they are out of the way.

The instrument meets every specification of the Underwriters Laboratories: there is no exposed metal anywhere. The test leads have recessed jacks, protective collars near the test probes, and are made of heavy wire. The probes themselves have sharp points. Alligator clips can also be attached; they screw on so that they won't fall off at the wrong time. Power for the meter is supplied by a single 9-volt battery. Battery life is claimed to be 300

continued on page 26

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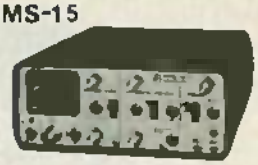

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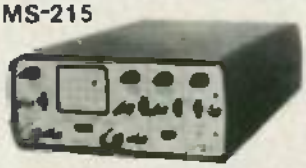
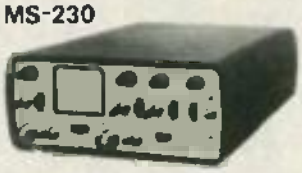


Dual Trace 15 MHz

MS-230



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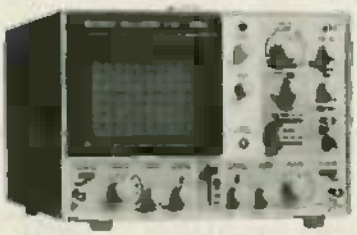

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EQUIPMENT REPORTS

continued from page 24

hours with alkaline batteries.

The meter has all of the standard DMM functions and will give true RMS voltage readings. It measures AC and DC voltages in five ranges from 200 millivolts to 1000 volts full-scale. Current (AC and DC) is measured in five ranges from 200 microamps to 2000 milliamps full-scale. Resistance is measured in six ranges from 200 ohms to 20 megohms full-scale.

Accuracies for the functions are 0.1% for DC volts; 0.5% to 5%, depending on range, for AC volts; 1.5%, up to 1 kHz, for AC current, and 0.5% for DC current. For AC inputs, the frequency response of the meter is 20 Hz to 5 kHz. All inputs are protected against overloads, with a dual-fuse system (a 2-amp fuse and 3-amp fuse in series) used for the current ranges.

Now for some of the features that set this meter apart from others: One of the problems with DMM's is that they are almost useless for making adjustments that require finding a peak or a null. That's easy to do with an analog meter—you just watch the needle swing. Simpson's solution is the addition of a bar-graph display to the readout. Located just below the 3½-digit numeric display, the LCD bar-graph display reacts instantly to changes. To find a peak, for instance, just adjust for the longest bar display. If the reading goes off scale, an indicator will appear to the right of the display. In that case, simply switch to a higher range. To find a null, simply look for the shortest bar.

Another of this meter's features is the PEAK HOLD function. That is used to display the values of sudden peaks or surges of voltage or current that might be too short in duration for you to notice. In complex waveforms, either positive or negative peaks can be read simply by setting the polarity switch (located under the PEAK HOLD button) to the appropriate polarity. That feature can be invaluable when troubleshooting circuits with transient problems.

There is an audible tone for resistance and continuity tests. That speeds up continuity testing, since you don't even have to look at the meter. The display also gives you a visual indication of continuity, as well as a readout of the actual resistance. The tone is activated by pushing in the OHMS (indicated by a Greek omega) and the AC buttons at the same time. The buttons providing audible indications are indicated by a musical note on the front panel.

The *model 467* can also be used to determine the absolute value of a pulse. Set the meter up to read resistances, using the 200K range, and connect the probes across the circuit. Any pulse of more than 50 microseconds duration, with an amplitude of more than 0.4-volts DC, will be detected; the audible indicator can be used with this function also. A reading, as well as the polarity of the pulse will be shown on the display. The amplitude of the pulse can be found by using a chart in the manual.

The bar-graph display is useful for more than reading peaks. You can use it to find the voltage of a very-low-frequency signal, say the output of a slowly turning servo-motor. Set the meter up for DC volts and connect the leads across the servo-motor's output. The bar-graph will fluctuate between the positive and negative peaks, with voltage and polarity shown by the readout. To get the peak voltage, just push the PEAK HOLD button. The peak reading, with its polarity, will be held on the numeric display, but the bar-graph display will continue to follow the signal.

The meter can also be used as a logic probe for use with digital circuits. There are indicators on the display for that purpose. A chart in the manual tells you what the various indicators mean.

To test a circuit for a suspected transient problem, set the meter to read resistance, using the 200 OHM range; also set the polarity switch to "+." Attach

continued on page 32

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EQUIPMENT REPORTS

continued from page 26

the leads across the circuit, and with continuity indicated, push in the PEAK HOLD button. Note the reading on the meter, and leave it alone for a while. Check the meter later; a higher reading means that a transient has occurred.

While the meter's current range is more than adequate for most applications, it can be extended to 200 amps using an accessory "amp clamp." One of the uses for that accessory is measuring the current surge drawn by a piece of line-operated equipment at turn-on. Without the accessory, that measurement would be beyond the capabilities of this, or almost any other instrument.

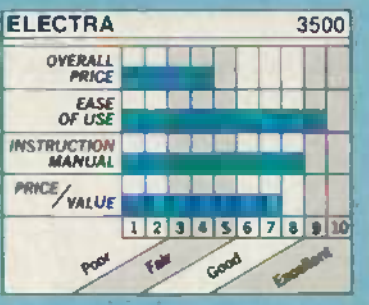
A small, but very complete, instruction manual is included with the instrument. It gives complete details on everything we've discussed, plus a lot more. Included are a full circuit description and servicing information. Various functions are illustrated by charts, making them very easy to use.

This is a typical Simpson instrument, featuring high-quality construction, good accuracy, and easy use, both in the field and on the bench. The *model 467* sells for $257.00. R-E

CIRCLE 101 ON FREE INFORMATION CARD

Electra Freedom Phone 3500 Cordless Telephone

CIRCLE 102 ON FREE INFORMATION CARD



GREATER OPERATING RANGE AND SMALLER size seems to be the trend at Electra Company, well-known for its scanner radios, and now a line of cordless telephones. The newly introduced *Freedom Phone 3500* is the smallest cordless phone that I've seen to date. It measures a mere 2¾ × 5 × 1 inches.

The unit is extremely easy to use. Operation is controlled by a convenient thumb switch on the handset. That switch has three positions—OFF, ON and TALK. When the switch is in the ON position, the unit is in a standby mode, awaiting incoming calls. When it is in the TALK position, full-duplex operation (just as with a standard telephone) is possible.

Dialing out is done using a 12-key, *Touch-Tone*-type keypad. A unique feature of that keypad is the RE-DIAL key. Pushing that key automatically re-dials the last telephone number entered. The only other control on the handset is the three-position volume control. That lets you set the handset's volume to accommodate the ambient noise conditions. Two LED indicators on the handset let you know when the unit is in the TALK mode, and inform you of a low-battery condition: the handset uses nickel-cadmium batteries. A collapsible whip antenna on the handset measures 10½ inches long when fully extended.

The only control on the base unit is a CALL button, which is used to signal the

continued on page 97

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NEW IDEAS

Measuring Voltage with a Frequency Counter

AMONG THE REASONS FOR THE POPULARITY of the 555 IC are its capabilities for being used as an inexpensive free-running astable multivibrator, square-wave generator, or signal source. The frequency of the output from pin 3 of that IC is determined by the voltage input to pin 6. It can be shown experimentally that the relationship between the voltage input and the frequency of the output is linear, provided that the input resistance is large enough (at least 500,000 ohms). Because of those characteristics, it is possible to use a 555 IC to build a voltage-to-frequency converter, such as the one shown in Fig. 1. With that converter, a standard frequency counter can be used to measure voltages directly over a limited range of from 0 to 5 volts. (The range is limited by the 5-volt power supply to the oscillator.)

In the circuit, the 555 is wired as an astable multivibrator. Resistor R2 is used to determine the output frequency when the input to the circuit (the voltage measured by the voltage probes) is zero. Resistor R4 is a scaling resistor and is used to adjust the output frequency so that a change in the input voltage of 1 volt will result in a change in the output frequency of 10 Hz. That will happen when the combined resistance of R3 and R4 adds up to 1.2 megohms.

The circuit is fairly simple, and it can be built using any construction technique. For best stability, locate resistors R1-R4 and capacitor C1 as close to the 555 as possible. If stability is still a problem, bypass pin 5 to ground using a 0.1 μF capacitor.

To calibrate the circuit, connect the output to a frequency counter, short the voltage probes together, and adjust R2 until the reading on the frequency counter just changes to 00 Hz. Then, use the voltage probes to measure an accurate 5-volt source and adjust R4 until the frequency counter reads 50 Hz. Repeat those adjustments until the frequency counter reads 00 with a 0-volt input and 50 with a 5-volt input. To read voltages greater than 5 volts, a voltage-divider network or attenuator will have to be used. When measuring very low voltages, remember that the circuit sources a few microamperes; that may throw off some readings slightly.

—Burjor T. Santoke

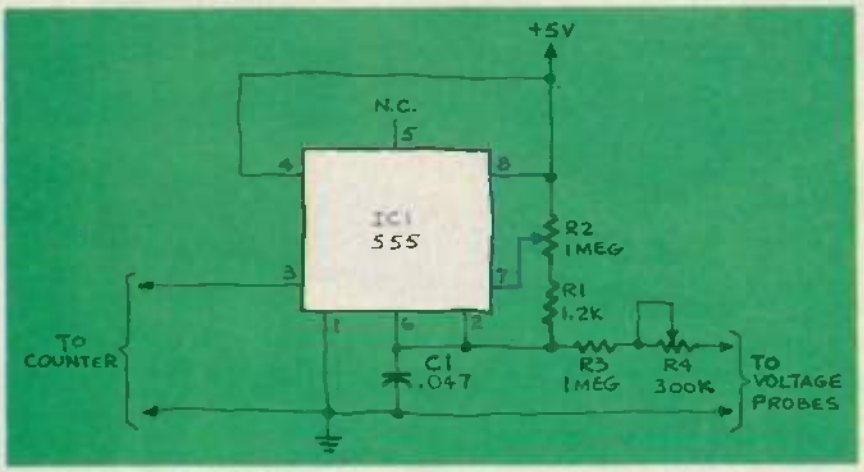

FIG. 1

"I had my home computer do my taxes. It cheated the government out of ten thousand bucks and set me up as the fall guy."

NEW IDEAS

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

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

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- Horizontal deflection
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  - TV synchronization — TV sync-separator circuit
    - Internal — Over 1 div (V sync-signal)
    - External — Over 1 Vp-p (V sync-signal)
  - Trigger sensitivity

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

  - Trigger slope — +
  - Sweep time — 0.2μs/div - 0.2s/div ± 5%, 19 calibrated steps
  - Sweep-time magnifier — 10 times (± 7%)
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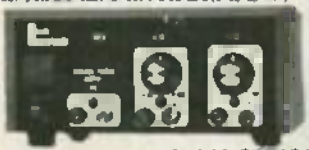

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CIRCLE 32 ON FREE INFORMATION CARD

HOBBY CORNER

How one hobby can benefit another

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

ONE REASON FOR THE WIDESPREAD interest in electronics is that it touches almost every aspect of modern life. It comes close to being the universal ingredient in all our activities, whether it's work or play.

Over the years, we have presented electronics projects relating to many areas of interest. We have never, however, talked about how electronics can be applied to what is probably the most popular hobby of them all—stamp collecting. This month's project will correct that omission.

Recently, I moved into a new house. During the move, I went through—and at least partially sorted—the accumulation of treasure and junk that one acquires over many years. One of the things I came across was a small box with a window, several knobs, and a trailing AC cord.

It took me a few moments to remember what it was—an electronic watermark-detector that I had built long ago. For the benefit of those who have never collected stamps, let me say that the presence (or absence) of a particular watermark can be quite significant. It can be the crucial factor in identifying a particular stamp that has one or more look-alikes, and can determine whether a stamp is worth fifty cents or fifty dollars.

Holding a stamp up to the light will seldom, if ever, show a watermark because of the presence of the colored ink used to print the stamp. The usual method for detecting a watermark is to place the stamp in a black container and cover it with carbon tetrachloride. It's a messy procedure—you have to avoid inhaling the fumes; you have to wait for the stamp to dry, and you have to be careful not to knock over the bottle of fluid. You can avoid all those problems with an electronic watermark-detector.

The instrument described here is quite simple. It operates on the principle that light of the proper color and intensity will reveal watermarks even on printed and cancelled stamps. The detector produces light of adjustable brightness and color.

The detector is built inside a 5 × 7 × 2-inch case; the 5 × 7-inch top serves as both the control panel and working surface, as shown in Fig. 1.

Let's take a look at the simple circuit (Fig. 2). Depending upon the positions of switches S2 and S3, a voltage of up to 6.3-volts AC is applied to the bulb. The circuit can supply six voltages in all; switch S2 is used to select one of three voltages, and D1 is used to divide each of those when it is switched into the circuit by S3. Thus you can select one of six intensity-levels for the light.

The bulb is mounted on the bottom of the box directly under the "window" that is described below. A reflector made of aluminum foil is placed behind the bulb.

Changing the color of the light is a little more difficult because it involves an optical/mechanical arrangement. The method I used was to mount wedge-shaped segments of colored plastic on the top of a plastic disc. A sketch of the disk is shown in Fig. 3.

That disk is mounted on a shaft and turned by the knob in the center of the panel. As the colored wedges pass over the bulb, the light changes color.

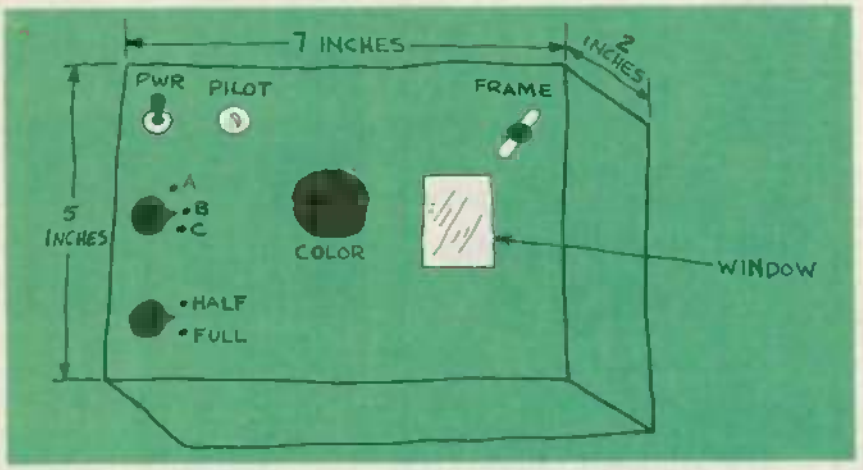

FIG. 1

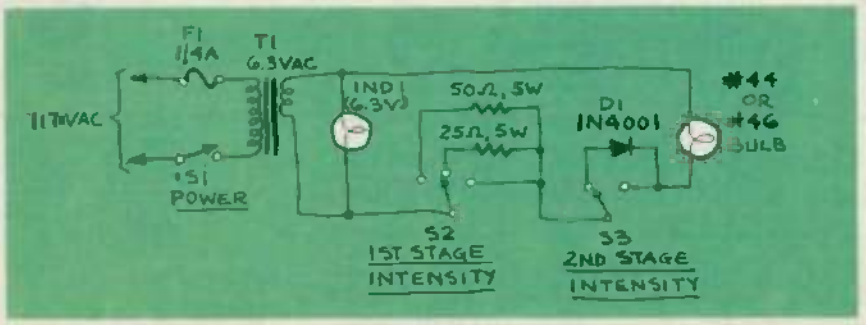

FIG. 2

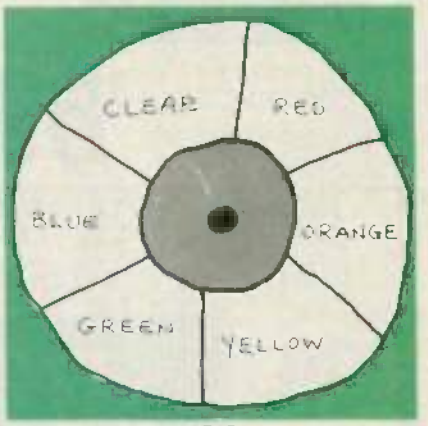

FIG. 3

The light shines through a "window" in the panel on which the stamps are placed. The window is a piece of ground glass, or it can be made from clear glass backed with waxed paper from the kitchen. It should measure about 1½ × 2 inches, to accommodate larger stamps.

Unfortunately, you'll find that there

continued on page 42

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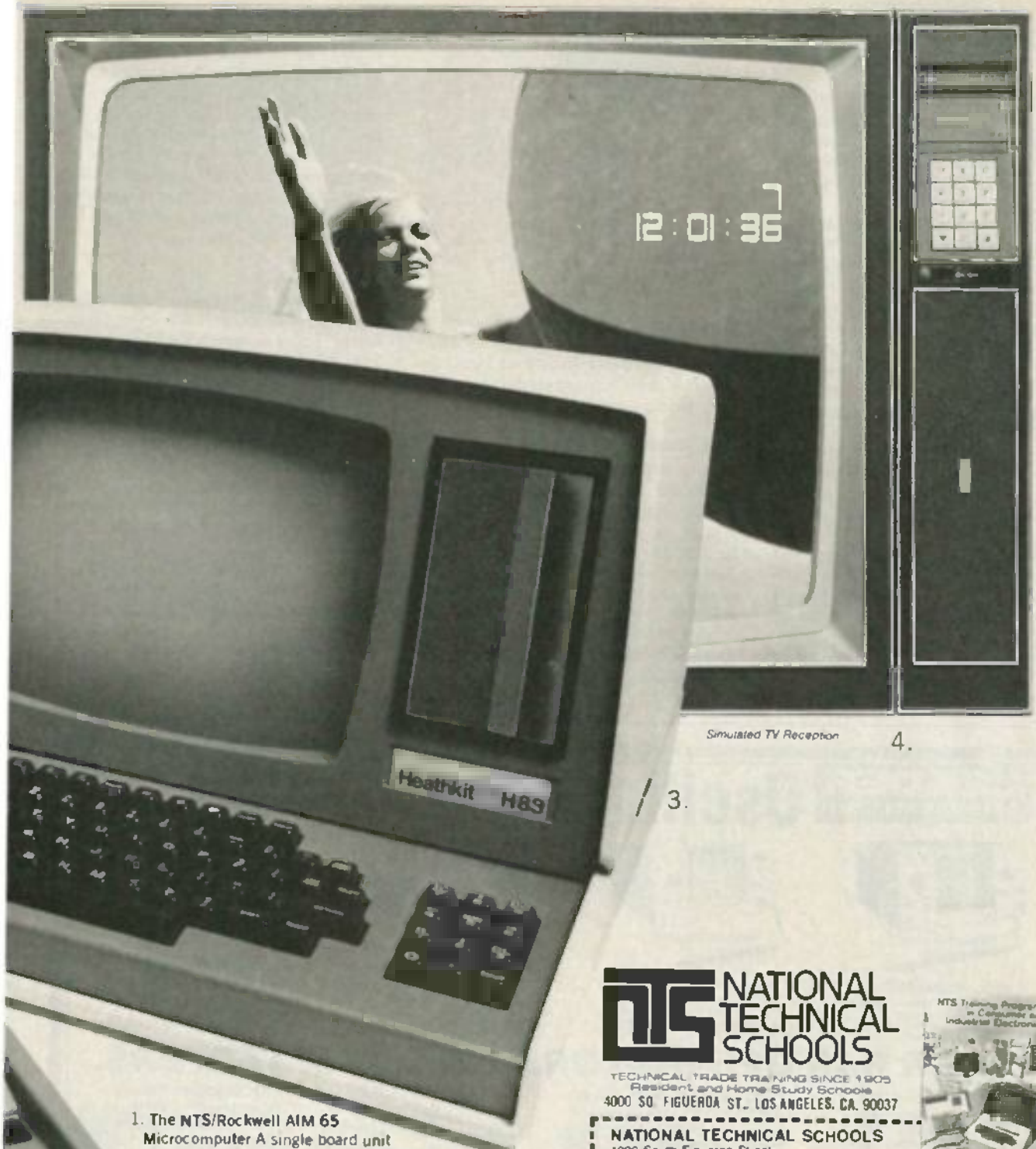

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HOBBY CORNER

continued from page 36

is a problem with a window of that size—it is larger than *most* stamps and the extra light around the edges will often make the watermarks difficult to see. There are two ways to overcome that problem.

The easiest solution is to use an "L"-shaped piece of thin carboard. When it is placed over a corner of the window, it will block out the extra light. A better way is shown in Fig. 4. In that case, an "L"-shaped piece of metal is mounted below the window in such a manner that it can be positioned to block out the unwanted light. Moving the knob one way or the other in the slot controls the size of the window.

The watermark detector is an interesting project to build. You'll find that it saves a lot of time and trouble in identifying some of those "rare" stamps in your collection.

Incidentally, my detector was built quite a few years ago. With the developments in electronics since that time, I am sure there are better ways to design the circuit. My parts, instruments, breadboards, and so on, are still in dozens of boxes (because of the move) and I have not been able to try out the

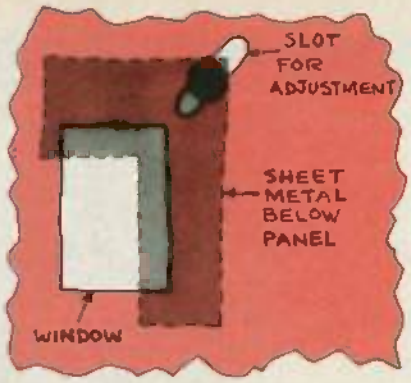

FIG. 4

improvements that have occurred to me.

If you have any ideas for a better design, try them out and let me know how they work.

Red faces department

It is embarrassing (but not unheard of) to ask a question here and be told that the answer appeared in this magazine in the past. That happened recently and the only saving aspect of the situation was that the reader had to go pretty far back to come up with the reference. Well, it proves at least a couple of things: I can't catch them all, and **Radio-Electronics** has covered most topics at one time or another.

In the July 1981 issue, I relayed Tom Grove's request for a circuit to check his camera's shutter speeds. First, John Thorne of Burlington, NC sent me a copy of an article in the May 1965 issue of **Radio-Electronics**. It describes a very simple circuit that is connected to the input of a VTVM (I see no reason why an FET-VOM or a DMM could not be used instead). John reports that the device works quite well with between-the-lens shutters, but he cannot comment on focal-plane shutters because he has not used it with them.

More Inquiries

Jim Kreter of Augusta, GA is looking for sources of information about underwater voice-communication systems. J.W. Lee of North Bay, Ontario, Canada is looking for a circuit that will read temperature differences. He is building a home heat-exchange system and needs a way to measure the difference in temperature of the air in two ducts. L.E. McHenry of Phoenix, AZ needs help in designing a clock that will provide a simultaneous readout of the time, day of the week, and date. Marcel Robitaille of Beauport, Quebec, Canada wants to build a device to locate a break in a heating element buried in concrete at his home.

If you have any ideas that may help those readers, send them to me so we can share them. R-E

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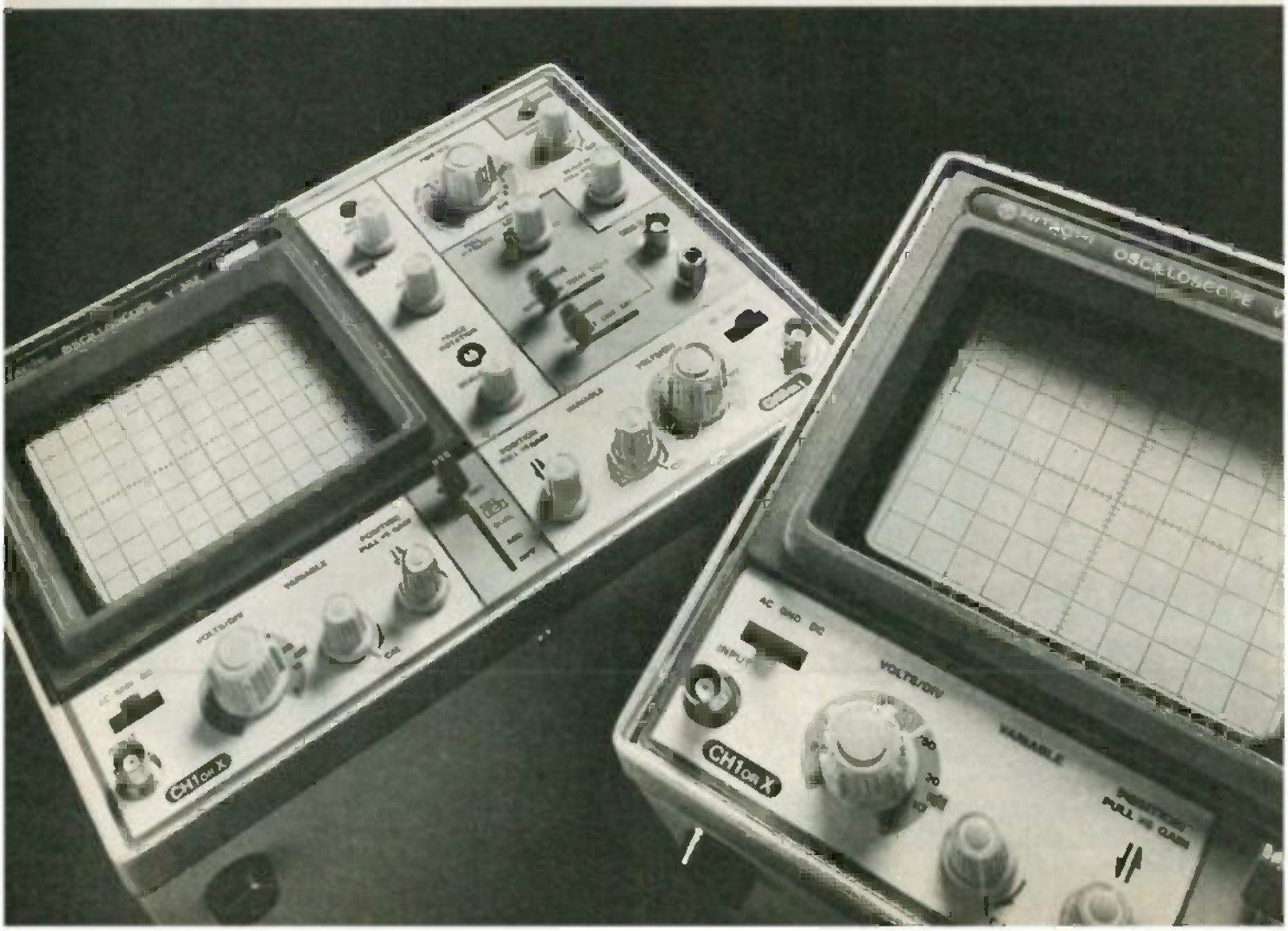


BUILD THIS

VIDEO SYNC STABILIZER

Some VCR's and TV sets have difficulty in playing back certain videotapes. This sync corrector will eliminate that problem.

GENE ROSETH

THE LAST FEW YEARS HAVE SEEN A REVOlution in home-TV entertainment as video cassette recorders (VCR's) and the program material available for them have proliferated.

A problem that has plagued many VCR users has been picture instability, in the form of vertical roll. It afflicts many of the older VCR's and *newer* TV receivers—the ones without external vertical or horizontal-hold controls. This can also occur when viewing prerecorded videocassettes that have been recorded using a system to prevent tape duplication. The instability is generally caused by a distortion of the vertical-sync pulse and, to say the least, is an annoyance.

The device described here will reconstitute distorted vertical-sync pulses and eliminate the vertical-roll problem. It can be built in two different versions: The first is a baseband-video unit that performs the sync-correction and outputs a video signal. It can be used only in video-to-video applications—it does not provide an RF signal.

The second version incorporates an RF modulator and outputs the corrected video (and the audio, as well) on VHF Channel 3 or 4. Feed the RF signal to your TV and glitch-free viewing is yours. Furthermore, this version can be used with a TV camera or computer to turn your TV set into a monitor.

Construction of the stabilizer is simple, and alignment can be done with only a voltmeter (although an oscilloscope is helpful).

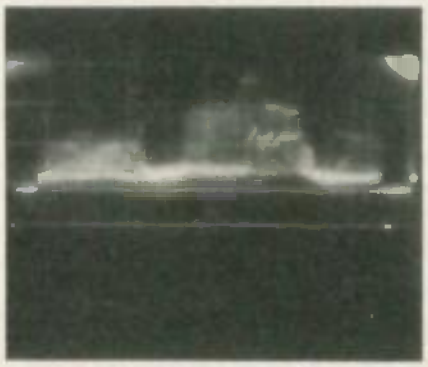


FIG. 1—ONE VIDEO FIELD. Vertical blanking-intervals are visible to right and left of video "fuzz."

A little background

Let's begin with a look at a video signal. Figure 1 shows one field of video (our system uses 60 fields per second). Most of what can be seen (the "fuzz") is picture information and will be different for each field. At 60 fields per second, the individual fields blend into a continuous, smoothly changing display on the screen. There is one element of the field, though, that does not change—the sync pulses.

At the left and right ends of the scope trace there is a short, flat area that contains no picture information, but just a short negative-going pulse. That portion of the signal is termed the vertical blanking-interval. We'll talk more about it momentarily. There are also other sync pulses (called horizontal sync pulses, and occurring 15,734 times per second) in addition to the vertical blanking-intervals. Since they are of very short duration, they do not show up well in Fig. 1. The purpose of the sync pulses is to match the timing of a TV receiver to that of a video source (VCR, camera, off-the-air signal, etc.).

The vertical blanking-interval can be seen more clearly in Fig. 2. It is at the center of the screen, with picture information to its right and left. The horizontal sync pulses can now be seen as well—their tips appear as two rows of dots below the picture information and the vertical blanking-interval. The negative-going pulse within the blanking interval is the vertical-sync pulse, and it is this that can cause picture instability if it is not recorded properly.

Circuit description

A circuit to correct distorted vertical-sync pulses is shown in Fig. 3. It contains two isolated video buffer/amplifier stages, Q1 and Q2, and a vertical-sync detection and regeneration subsection that adds a stable vertical-sync pulse to the composite-video signal through diode D6.

In operation, the clamped video (with the sync tips at +5 volts) is passed through buffer/amplifier Q1-Q2 and is

simultaneously applied to pin 5 of IC1-a (one-fourth of a CA339 quad comparator). Pin 4 of that comparator is biased a few tenths of volt above the clamp level: that causes a positive-going pulse to appear at pin 2 every time a sync pulse occurs.

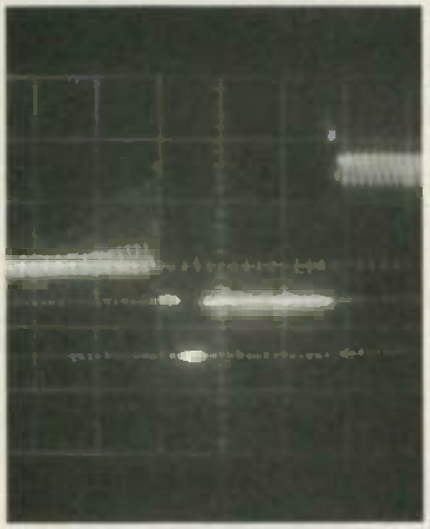


FIG. 2—EXPANDED VIEW of vertical blanking-interval showing vertical-sync pulse. Blips indicate tips of horizontal-sync pulses.

Resistor R5, R6, and capacitor C2 form an integrator circuit that allows the horizontal and vertical sync pulses to be distinguished from one another. The bias at pin 7 of IC1-b sets the level at which that will take place and a negative-going pulse occurs at pin 1 of that IC only when a vertical-sync pulse is present.

Another section of the quad comparator, IC1-c, is configured as a one-shot with a time constant of about 180 microseconds (the same as the vertical-sync pulse interval). The pulse generated is inverted by IC1-d and its amplitude adjusted by R14, after which it is mixed with the original video signal through D6. The result is a signal with a vertical-sync pulse of the proper strength and duration that "fills in" any gaps in the original signal.

RF modulator

The modulator shown in Fig. 4 will allow you to combine the audio and corrected video from the VCR and display them on your TV set using channel 3 or channel 4.

Most of the work is done by IC3. All that has to be added is an RF tank-circuit to determine the RF-carrier frequency, an audio tank-circuit for the FM audio-subcarrier, and a bias circuit. The RF tank-circuit is made up of L1 and C10; adjusting L1 allows the carrier to be tuned to either Channel 3 or Channel 4.

The audio tank-circuit uses L2 and C7 to generate a subcarrier 4.5 MHz above

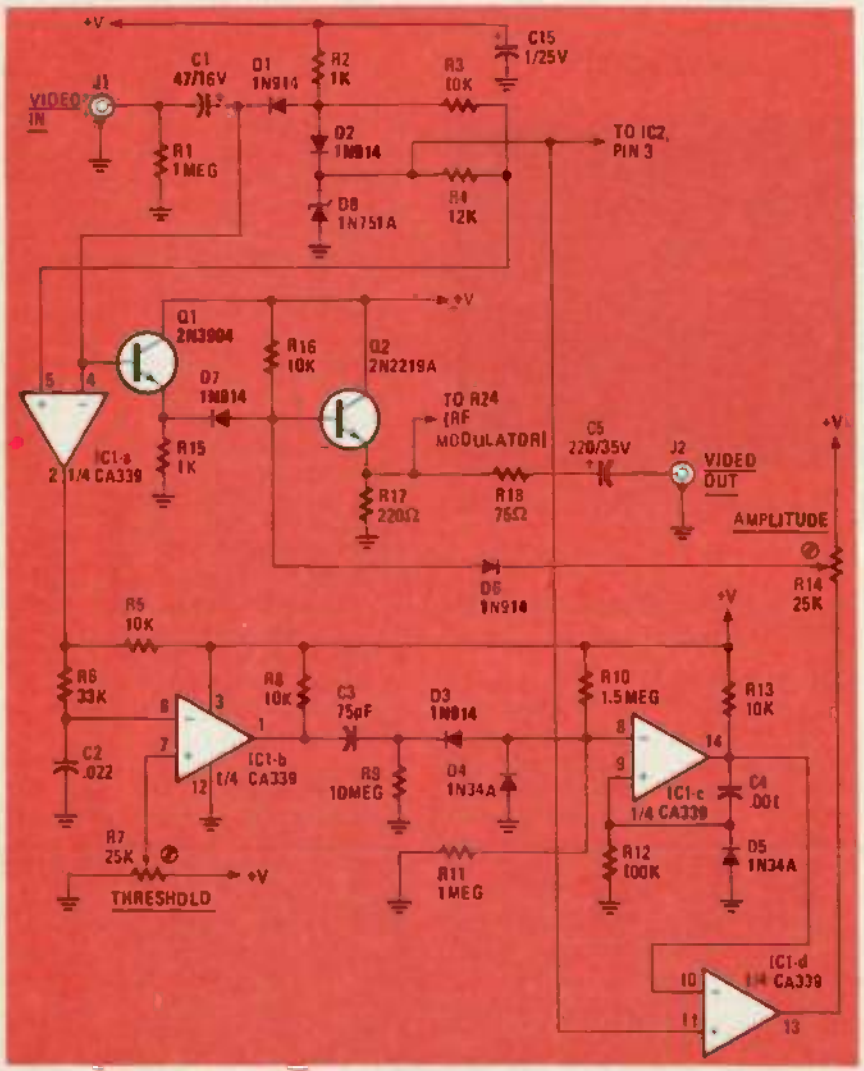


FIG. 3—DETECTION AND REGENERATION of vertical-sync pulse are performed by IC1.

PARTS LIST

All resistors 5%, ¼-watt
R1, R11—1 megohm
R2, R15, R30—1000 ohms
R3, R5, R8, R13, R16, R20, R32—10,000 ohms
R4—12,000 ohms
R6, R21—33,000 ohms
R7, R14—25,000 ohms, trimmer potentiometer
R9—10 megohms
R10—1.5 megohms
R12, R19—100,000 ohms
R17, R27, R28—220 ohms
R18, R29, R31—75 ohms
R22, R23—15,000 ohms
R24—2200 ohms
R25—1000 ohms, trimmer potentiometer
R26—100 ohms

Capacitors
C1—47 µF, 16 volts, electrolytic
C2—.022 µF, Mylar
C3, C10—75 pF, dipped silver mica
C4, C11—.001 µF ceramic disc
C5—220 µF, 35 volts, electrolytic
C6, C15—1 µF, 25 volts, tantalum
C7—100 pF ceramic disc
C8—.01 µF, Mylar
C9—22 pF ceramic disc
C12, C13, C16—0.1 µF, Mylar
C14—470 µF, 25 volts, electrolytic

Semiconductors
IC1—CA339 quad comparator
IC2—741 op amp
IC3—LM1889 video modulator
IC4—7812 twelve-volt regulator
Q1—2N3904
Q2—2N2219A
Q3—MPSA05
D1-D3, D6, D7—1N914
D4, D5—1N34A
D8—1N751A 5.1-volt Zener
BR1—full-wave bridge rectifier, 1 amp, 50 volts
T1—12.6 volts, 300 mA, PC-mount (Radio Shack 273-1385 or equivalent)
L1—.071-.082 µH (J.W. Miller 48A778MPC or equivalent)
L2—7-12 µH (J.W. Miller 23A105RPC or equivalent)
F1—¼amp, 3AG pigtail fuse
Miscellaneous: PC board, enclosure, hardware, connectors, optional vestigial-sideband filter (Plessy SW300), etc.

The following are available form JENGCO, 3232 San Mateo NE, Suite 75, Albuquerque, NM 87110: KRF-1—kit including etched, drilled, and plated PC board and all board-mounted components, $65.00; KRF-2—PC-board only, $15.00; KBBV-1—same as KRF-1 but without RF modulator (for video-to-video applications only), $42.00; KBBV-2—PC board only, $13.00. Kits do not include cables, hardware or connectors. Please add 5% for postage and handling; NM residents add 4% sales tax. Please allow six weeks for delivery.

the video carrier. This circuit is shunted by the base-collector capacitance of Q3. The audio input is buffered and amplified by IC2, and then applied to Q3 which acts as a varactor diode in parallel with C7-L2. (You can use a regular varactor diode in place of Q3, but may have to change the value of R21.)

The audio subcarrier and the corrected video are applied in the proper ratio to pin 12 of IC3. Resistor R25 supplies bias for the IC, and affects both the degree of modulation and the level of the RF carrier.

The output of IC3, from pin 10, is attenuated by R30 and R31, and then coupled to the RF-output connector by C13.

Capacitor C13, at the output jack, can be either a capacitor *or* a vestigial sideband SAW (*S*urface *A*coustic *W*ave) filter. The filter eliminates the lower sideband of the TV signal and helps prevent adjacent-channel interference. Normally it is not needed, but should you experience interference problems, you may want to include it (see the "Construction" section).

Finally, as designed, the RF output is intended to match 75-ohm coaxial cable (RG-59). If you prefer to use 300-ohm twin-lead, change the value of R31 to 300 ohms.

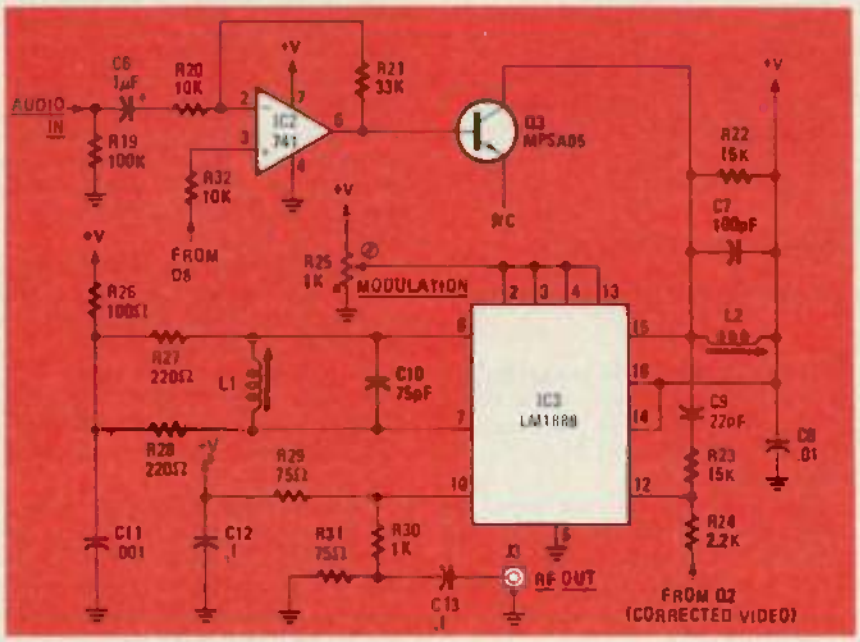


FIG. 4—RF MODULATOR. Capacitor C13 at RF OUT jack may be replaced by vestigial-sideband filter if desired (see text).

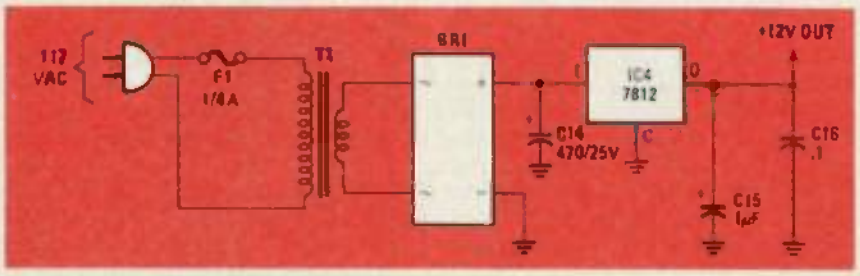


FIG. 5—SIMPLE 12-VOLT POWER SUPPLY is constructed on same PC board as rest of circuit.

Power supply

The power supply (Fig. 5) is of conventional design and is wholly contained on the same PC board as the rest of the circuit, making construction easier. A 7812 positive 12-volt regulator, IC4, supplies power for both the sync-corrector and RF modulator sections of the circuit.

Construction

Because lead length and layout are critical, wire-wrapping or point-to-point wiring techniques are not recommended for this circuit. A foil pattern is provided in Fig. 6 and a board is available from the source shown in the Parts List. A parts-placement diagram is shown in Fig. 7. Note that the section of the board to the right of the dashed line is used only for the RF modulator and may be omitted if a baseband video unit is required; the board could be reduced in size by about 25%.

When installing the polarized components (diodes, IC's, electrolytic capacitors, etc.) make sure they are oriented properly. That is especially true for the power transformer. It's also a good idea to put a piece of heat-shrink tubing over the pigtail fuse to reduce the possibility of getting a shock during the alignment procedure.

FIG. 6—SINGLE SIDED PC BOARD contains sync corrector, RF modulator, and power supply.

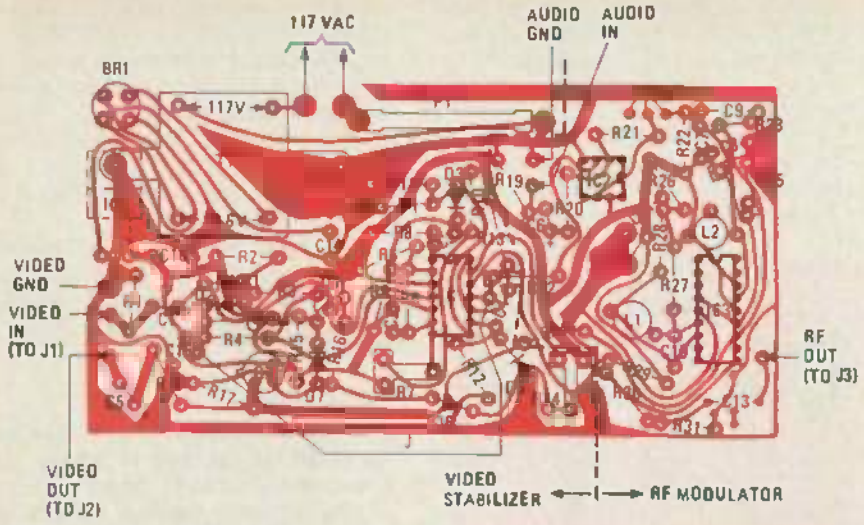


FIG. 7—REGULATOR IC4 mounts on *bottom* of board with tab away from it (see text). Area to right of dashed line contains RF-modulator circuit.

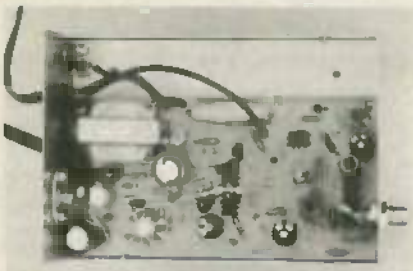


FIG. 8—VIDEO INPUT CABLE can be connected directly to board if desired. Audio jack is RCA phono-type; RF output uses "F" connector.

FIG. 9—CORRECTED VERTICAL-SYNC signal. Note extra amplitude added to tip of sync pulse.

Mount Q2 a little more than ⅛-inch above the PC board to allow its heat sink to clear adjacent components. The heat sink is not an absolute necessity, but serves to add some operating margin to the design.

To heat-sink the voltage regulator, IC4, mount it on the *bottom* of the board and then bend it over so its mounting hole aligns with one of the transformer's. Place a short spacer—about ¼ inch—between the tab of the IC and the board and pass the mounting bolt through the aligned holes so that the IC lies flat on the floor of the enclosure. The enclosure will then serve as the regulator's heat sink.

The 75-ohm RG-59 video-input line can be connected directly to the board, if desired, eliminating the need for J1. For best results keep it short—less than 1½ feet. The output line can be of any reasonable length.

Mount the PC board on spacers in a metal cabinet; add the appropriate input and output connectors, and the power cord.

If you intend to use the vestigial sideband filter, proceed as follows: Remove R31 and R30, and replace R30 with a jumper. Remove C13 and insert the filter in its place. The Plessy SW300 filter has about 20 dB of attenuation at midband, so the RF-output signal level will remain approximately the same as before (2 mV).

The completed board is shown in Fig. 8.

Checkout and alignment

This procedure assumes that you have included the RF modulator on your board. If not, disregard the portions that do not apply.

Apply power to the unit and insure that the 12-volt supply voltage is present at the output of the regulator. Use a meter or scope to verify that this voltage is present at several spots throughout the circuit, such as the IC supply-voltage pins. Also check for 5-volts DC at the cathode of Zener diode D8. (If the voltages are incorrect, D8 is probably installed backwards.)

Now turn R7 (THRESHOLD) fully clockwise and R14 (AMPLITUDE) fully counterclockwise. Adjust R25 until you read about seven volts at pin 2 of IC3. When you're satisfied that all the voltages are correct, you're ready to start the alignment procedure.

You'll need a video source to perform the alignment. That can be your VCR, a video camera, or any other video-generating device. If you use a VCR, make sure that it is supplying a clean, noise-free signal. Connect the video source to the video input of the sync corrector.

If you're using a scope, connect it to pin 1 of IC1 and adjust R7 until the display resembles the top trace of Fig. 9. The negative-going pulses should be about two milliseconds in duration.

If you are using a meter, connect it to pin 1 of IC1—it should read close to zero volts. *Slowly* turn R7 counterclockwise. At some point, the voltage should jump up to about 10 volts. As soon as that happens, stop turning R7—it's now correctly adjusted.

The AMPLITUDE pot, R14, can be adjusted by trial-and-error using a videotape with distorted sync (such as a rental movie) as a video source. If you don't have a scope, turn R14 about ⅜-turn clockwise (approximately its correct setting), jump ahead to the RF-modulator alignment, and return to this step last.

You can set R14 most accurately by connecting a scope to the video output (emitter of Q2) and observing the vertical-sync pulse. Most general-purpose scopes will not lock onto the composite-video signal due to its complex shape. These tips may help: Try using the scopes LINE SYNC position—the frequency of the vertical blanking-interval will either be locked to, or very close to, the 60-Hz power line frequency. If the scope has a trace expander (i.e. 5× or 10×), do the following: Trigger the scope's sync with the signal present at pin 1 of IC1; set the sweep rate at about 2 ms/division; expand the trace, and then adjust the trace's horizontal position until a vertical blanking-interval comes into view. (That is how the display shown in Fig. 2 was obtained.)

Once you have a good display, adjust R14 until the trace looks like the one shown in Fig. 9. Notice that it is exactly like the "ideal" trace in Fig. 2 except for the small addition to the peak of the sync pulse. Be sure you have that extra amplitude, because it will insure proper switching of diodes D6 and D7 when portions of the vertical-sync pulse are missing.

You are now ready to align the RF modulator. Leave the video signal connected to the input of the sync corrector and connect the RF output to the antenna terminals of your TV set. Use an impedance-matching transformer (balun) if necessary. Tune the set to Channel 3 or 4—whichever's not used in your area—and disable the set's AFT (*A*utomatic *F*ine *T*uning) if possible.

Use a non-conductive tuning wand to adjust L1 until you observe some sort of picture on the TV screen. Adjust R25

continued on page 97

Radio-Electronics®

Video Entertainment

A GUIDE TO VIDEO ENTERTAINMENT IN THE HOME

The Video Entertainment Center
Videodisc Systems
Videocassette Recorders
Accessory Gadgets
Video Cameras
Projection TV
Video Games
Video In The Future

The ENTERTAIN

About five years ago there was an explosion in the video field...
Here's a look at the changes it is going to make in our

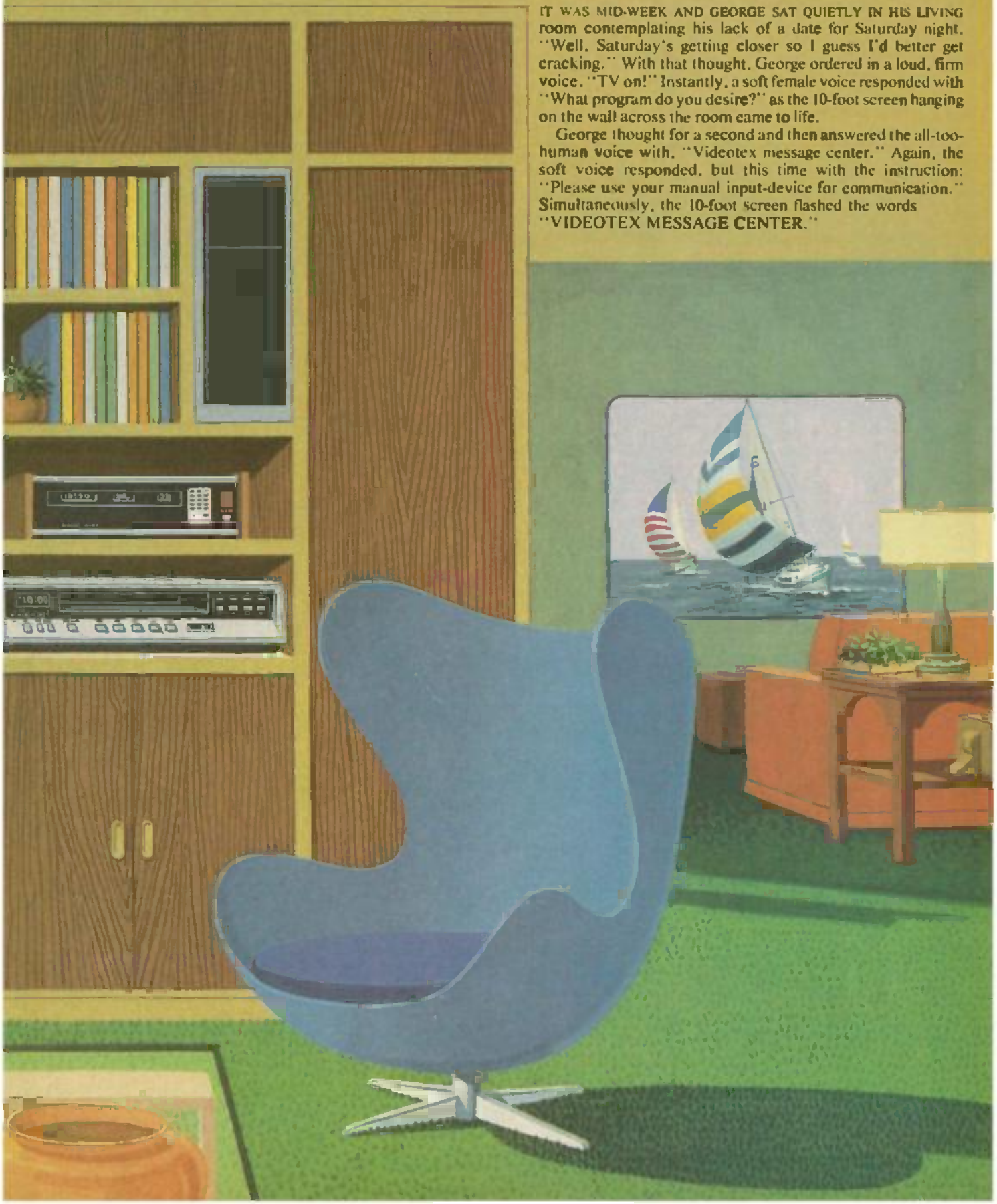
MENT CENTER

ut its effects are just beginning to be felt.
ntertainment and living habits.

ART KLEIMAN
MANAGING EDITOR

IT WAS MID-WEEK AND GEORGE SAT QUIETLY IN HIS LIVING room contemplating his lack of a date for Saturday night. "Well, Saturday's getting closer so I guess I'd better get cracking." With that thought, George ordered in a loud, firm voice. "TV on!" Instantly, a soft female voice responded with "What program do you desire?" as the 10-foot screen hanging on the wall across the room came to life.

George thought for a second and then answered the all-too-human voice with, "Videotex message center." Again, the soft voice responded, but this time with the instruction: "Please use your manual input-device for communication." Simultaneously, the 10-foot screen flashed the words "VIDEOTEX MESSAGE CENTER."



Directly below those words flashed the question: "NATIONAL. STATEWIDE. LOCAL. _____?"

The input device, shaped like a hemisphere, was sitting on the cocktail table. George picked it up and placed each finger of his right hand into an indentation in its surface. Manipulating his fingers, George responded to the question by coding the word "LOCAL." The next question then flashed on the giant screen: "TODAY'S DATE?"

George's expression showed his annoyance. "*When will they ever make computers smart.*" he thought. He entered the date, "SEPT 15, 2004." In response, the screen flashed the words: "PLEASE ENTER MESSAGE."

George carefully composed a tactful message to his latest ladyfriend and entered it. When he had finished, he signed off with his personal ID number and sat back awaiting a response.

As he sat, he thought about his date and the things they might do. He figured that a quiet dinner would be a nice start. But what about after dinner? He drew a blank. Things had been a lot simpler 20 years ago. Back then, you could go to a movie theater or a bowling alley. There had even been miniature golf courses, museums, and art galleries. But not any longer.

The last movie theater had closed its doors about 12 years ago. The demise of the public motion-picture houses had started with cable television. Soon after that, videotape recorders and videodisc systems gave home viewers access to an enormous variety of entertainment. Projection television was around, but it was too expensive to have any great effect on the theaters.

A much more serious blow came when the direct-to-home satellite TV service began. The smaller theaters began to go out of business, but the larger ones managed to hang on...for a while. Then came stereo audio for TV, and videotex. Soon after, the FCC approved the 1125-line, 30-MHz bandwidth television system for use on direct-broadcast satellites. With that system, a television picture looked as good as one projected on a motion-picture screen.

Large-screen, flat-panel TV proved to be the final blow. The first flat-panel units were small; the screen sizes were just a couple of inches across. But a couple of years later, giant-size flat-screen television became available. The first sets were expensive, but it didn't take long for prices to fall. Soon, just about everyone had a huge flat-screen TV in his living room.

George looked at the screen hanging on his wall and recalled the time he'd brought it home. He had been amazed at how easy it had been to set up. After hammering a hook into the wall, the screen was simply hung like a picture. All of the electronics were contained on two IC's so there wasn't even a bulge to reveal where the circuitry was located.

Two years after the introduction of large-screen flat-panel TV, the last movie theater shut its doors. Around the same time, videodiscs containing the works of the world's greatest painters and sculptors began to appear. Barely five years later the last art gallery was gone.

George thought about the other forms of entertainment that no longer existed. Ten years ago, after 3-D television had proven so successful, videodiscs containing three-dimensional images of museum displays were introduced. The last museum shut its doors to the public four years later.

Technology also had a profound effect on other forms of entertainment such as sports. The realism of super-resolution graphics coupled with 3-D television made you feel as though you were right out on a playing field. The last miniature golf courses, bowling alleys, and tennis courts disappeared about seven years ago. It was little wonder that George could think of nowhere to go on his date.

Video today

The preceding scenario is just that—a scenario. It is not an attempt to describe what the future might bring. It is, however, based mostly on products and technologies that do exist today.

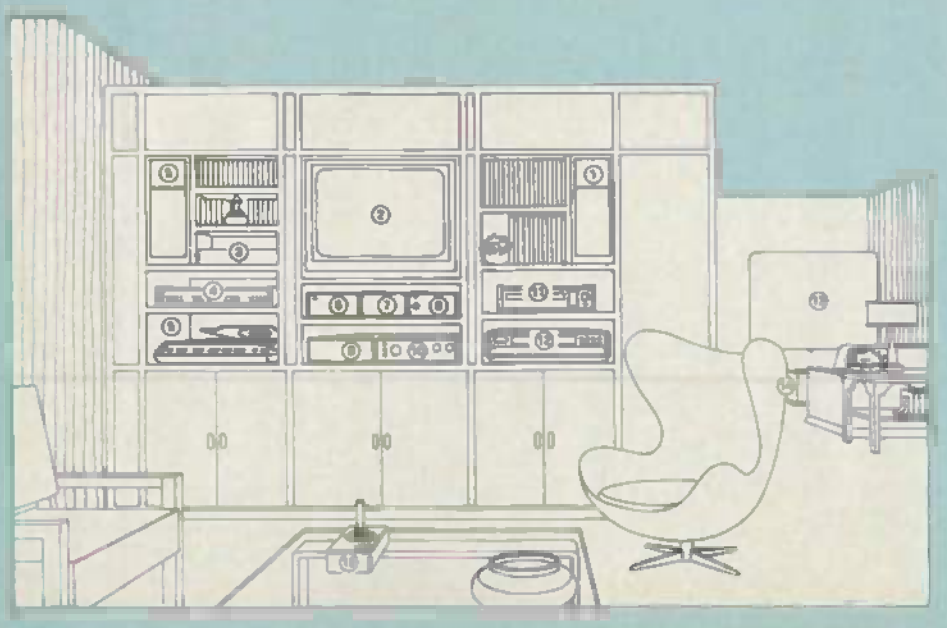
Today, the video industry is in the midst of an electronic revolution. Hardly a day passes where a new product or new technology isn't introduced. The research and development labs of many electronics corporations are working continuously in an attempt to keep up with the consumer demand for new products. If it weren't for you, the consumer, the video revolution would not exist.

Economics, according to many experts, is the driving force behind that revolution. Inflation is cutting deeply into everyone's budget. As a result, we are taking fewer vacations and are staying at home more. But we still need to be entertained, and for many, video electronics is the answer.

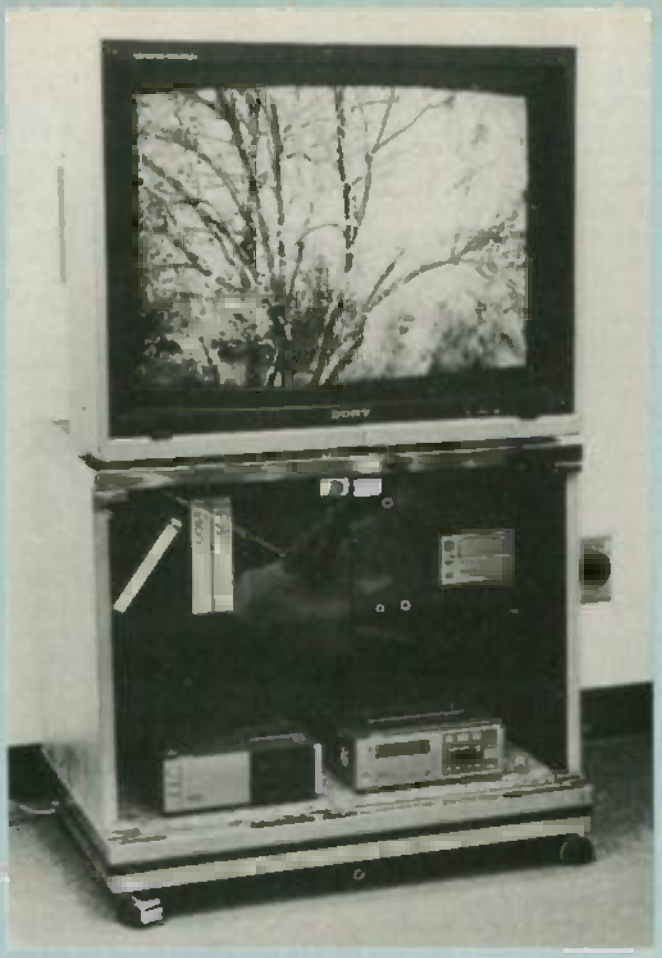
What does a home video entertainment-center consist of? What products are currently available in the marketplace? What could technology offer if money were no object? Should I buy now or will today's products be outdated in a year or two? This special video-entertainment section will answer those and other questions. But before we describe the individual products that make up a video entertainment-center, we must first discuss its central element the TV receiver, or video-display unit.

Television

Since our entertainment center is by definition a video center, the central element must be a display device. The most



1—Component-TV stereo speakers
2—Component-TV monitor
3—Component-TV receiver
4—Video switcher
5—Videodisc player
6—RF converter
7—Stereo simulator
8—Commercial killer
9—Video stabilizer
10—Image enhancer
11—Satellite-TV receiver
12—VCR
13—Projection-TV screen
14—Projection-TV projector
15—Video-Game controller



SONY'S *PROFEEL* SYSTEM is one that can be adapted to just about any present or future video need.

commonly available video-display device is, of course, a television set. It provides two important functions in a video entertainment-center. As a receiver, it supplies the standard video-programming available from broadcasters. When connected to a pay-TV cable service or a satellite-TV earth station, the amount of programming available to a viewer increases tremendously...to say the least. The second function of a TV set is to display the outputs of VCR's, videodisc players, and video games.

Unfortunately, a television set is not the ideal display device for a video entertainment-center. In most cases, to input a video signal to a TV set, you must first modulate an RF carrier with that signal and feed it to the set's antenna terminals. The "receiver" circuitry in the TV then demodulates the RF signal, extracting the video, which is then displayed on the screen. That video-RF-video conversion results in a degradation of resolution and an increase in the "noise" seen in the picture.

As a broadcast receiver, today's TV set has about reached its performance limit. The performance of today's top-of-the-line TV set is limited primarily by the NTSC broadcast-standard rather than by technology. If you look at the improvements made in TV sets over the last several years, you'll discover that primarily they involve convenience features rather than performance. Aside from a total abandonment of the present NTSC standards (highly unlikely, if not impossible), the future will not offer TV sets with greatly improved performance. What you see today is pretty much the same as what you'll see tomorrow.

What will the future bring? TV receivers with more features, as well as receivers that will integrate easily into video entertainment-centers and take full advantage of all the video signals available. For example, there are TV sets currently available that have video-input jacks and therefore avoid the awkward video-RF-video conversion that would otherwise be necessary.

Unfortunately, the features offered by today's top-of-the-line TV set are really inadequate when you consider that the set will be the *heart* of a video entertainment-center. On the horizon lie videotex, two-channel audio, and direct-to-home satellite-TV service (called DBS); all are current proposals before the FCC. What will happen when each of those proposals is adopted? (Eventually, they all will be.) Each of those services will require its own decoder and/or converter box. As a consumer, will you place a box on top of a box on top of *another* box? (And that's in addition to the decoders and converters necessary for receiving cable or pay-TV!)

Matsushita has developed a circuit that will automatically cancel ghosts in a TV picture. They have also developed a system for broadcasting three-dimensional TV pictures; both are being offered to manufacturers through licensing agreements. When those are available in the stores, will you be forced to trade in your TV set?

If we consider a TV set as part of an overall video entertainment-center, then we must take into account *all* the devices and signals that it will be handling.

Let's take video games for example: The resolution and complexity of video games has increased dramatically over the past couple of years. In fact, the resolution of some of today's video games is limited not by the game-manufacturer's technology but by the resolution of the video circuitry in today's color-TV sets. And the resolution (video bandwidth) of today's color TV sets is limited primarily by the NTSC standards. The video-input jack gets around the video-RF-video conversion problems, but there's no getting around the problem of resolution. That same situation exists when you use a TV set as a display device for a home computer.

Component television

Since a television receiver serves as both a receiver *and* a display device in a video entertainment-center, why not separate the two functions? The receiver circuits could be packaged separately and a wide-bandwidth, high-resolution video monitor could be used as the display device. That would let us feed the video signals from other devices within our entertainment center *directly* to the video monitor, and avoid the degradation in quality that would take place if the receiver circuits were used. Systems using that approach, which is called component television, are sold in this country by Sony (9 West 57th Street, New York, NY 10019) and Teknika (1633 Broadway, New York, NY 10019).

Ideally, a component television-system would contain a color video-monitor with a video bandwidth of around 12 to 15 MHz. That contrasts with today's top-of-the-line color receivers that offer a video bandwidth of around 4.5 MHz (at best). Since the receiver circuitry is separate, we could feed video signals directly to the video monitor for display. Those signals could come from a videodisc player, videocassette recorder, satellite-TV receiver, videotex decoder, one or more video games, a home computer, or other devices that eventually will be developed. The high resolution of the video monitor insures high-quality reproduction from all currently available devices, and from devices that will become available in the future.

Packaging the receiver circuitry separately offers some additional advantages. At any time, the receiver portion can be upgraded or replaced without incurring anywhere near the expense of replacing a complete television set. If the "component" philosophy is carried even further, the receiver itself can be packaged into separate modules; i.e., the tuner, IF strip, video detector and amplifier, audio detector and amplifier, etc. That additional flexibility would permit, for instance, the tuner to be upgraded without replacing the entire receiver. Also, with that approach—or perhaps by designing a receiver that can accept modules—the receiver could be eas-

TEKNIKA'S ATV-19 is a component video-system that foreshadows things to come.

ily modified to handle videotex, two-channel audio, etc., as they became available.

What's available

Unfortunately, all of the flexibility and performance that could be provided by a component television system are not offered by either the Sony or Teknika systems. They are, however, a step in the right direction. Let's take a look at each of them.

Sony's component television system is called *Profeel* and it should be available by the time you read this. Two color video-monitors are available, the *KX-2501* 25-inch monitor and the *KX-1901* 19-inch monitor. Although Sony does not publish any bandwidth specifications for their monitors, they do publish a resolution specification. The resolution is quoted as better than 340 horizontal lines for the *KX-1901* and better than 350 horizontal lines for the *KX-2501*. That specification relates to the ability of the monitor to display a video *test* pattern. Sony also states that its monitors, using a special *Trinitron* CRT, are capable of displaying text with 80 characters-per-line. That again contrasts with a conventional TV, which can display only about 40 characters-per-line clearly enough to be read.

Based on that information, we could assume that the Sony monitors have a video bandwidth twice that of a conventional TV or around 8 MHz. Is 8 MHz wide enough? Yes and no; the Sony monitors will display just about any video signal you can feed to them today, with the exception of very-high-density computer graphics. Depending on what the future may bring, the 8-MHz bandwidth may suffice. However, since the component television approach should cushion a consumer against future video breakthroughs, a 12 or 15-MHz monitor would provide a more comfortable margin.

The *Profeel* monitors will accept both a composite video signal as well as digital RGB (*R*ed-*G*reen-*B*lue) signal. A composite video signal consists of the video information, the sync and blanking pulses, and color information. No RF carrier is used. That signal is governed by the NTSC standards and all the inherent limitations still apply. The ideal way, though, to display a video signal is by feeding the monitor with separate red, green and blue signals. Those signals are amplified by the monitor and are used to drive the red, green, and blue electron guns directly.

Unfortunately, only *professional* video equipment provides RGB outputs. Consumer equipment, with the exception of a few super-high-resolution computer graphic-display boards, provides an NTSC composite-video signal. That includes such equipment as video games, videodisc systems, videocassette recorders, and video cameras. We can hope that manufacturers will start providing RGB outputs on their video products in the near future. The *Profeel* video monitors will accept RGB signals that are *digital*. In other words, they will accept the output from a computer graphics-board or a video game (when video games with RGB outputs become available), but not the analog signals from a video camera, videodisc player, or videocassette recorder.

The receiver package is called the *VTX-1000R Profeel Access Tuner*. It is a table-top unit that measures 4¾ × 1 × 5⅝ inches. The tuner is frequency synthesized and can tune the VHF and UHF channels, as well as the midband and superband cable-TV channels. In addition to multiple video and audio inputs and outputs, the receiver offers features such as a back-panel slide switch that selects between intercarrier and split-carrier sound demodulation.

Channel selection is accomplished either randomly, using a 10-button keypad, or sequentially. Separate bass and treble controls, as well as a loudness switch, stereo-balance control, and headphone-level control are included. Front-panel switches select either the TV tuner or up to three video sources. Another switch selects either the antenna or an auxiliary RF-source of the tuner.

The rear panel contains three auxiliary 75-ohm composite video and stereo-audio inputs. A set of 300-ohm UHF antenna terminals plus a 75-ohm VHF antenna jack is provided. In addition, a separate auxiliary 75-ohm VHF input, and an output labelled "TO CONVERTER" are provided. In a standard cable-TV hookup, the cable would be connected to the 75-ohm antenna jack. The TV tuner is capable of tuning the cable stations directly using the front-panel channel selection buttons or the optional remote control. If a cable-TV program is encoded (scrambled), the decoder can be connected to the AUX and TO CONVERTER jacks. Then, by selecting the auxiliary antenna using the front panel or remote control, the cable (attached to the antenna input-jack) would be internally connected to the TO CONVERTER jack. The output of the converter would be connected to the auxiliary antenna-input. The advantage would be that by leaving the cable decoder set to the encoded channel, you could watch the encoded channel just by selecting the auxiliary antenna and tuning the receiver to the output of the decoder, all via the remote control.

The rear panel of the *Profeel VTX-100R* receiver also provides output jacks for two monitors. One of them could feed a video monitor and the other a projection TV set. Each set of output jacks consists of a composite-video output jack and stereo-audio output jacks. In addition, the rear panel provides a multiplex TV-sound output-jack to drive a stereo decoder when stereo TV-sound is approved for broadcast. The audio-output jacks from the receiver are connected to a 5-watts-per-channel stereo amplifier housed within the video monitor.

Overall, the *Profeel* component television system comes close to the ideal. It is flexible and offers better performance than can be obtained with a conventional TV. The only shortcomings are the somewhat limited bandwidth of the video monitor, and the fact that the receiver could have been even more flexible if it were a modular design.

While the Sony *Profeel* system comes close to being the ideal heart for a video entertainment-center, Teknika's *ATV* system falls short, basically because Teknika chose to produce a combination audio/video system rather than a high-quality video system. Teknika's *ATV-M19* video monitor has a video bandwidth of only 3.0 MHz. The *ATV-R* receiver combines a 105-channel TV tuner, FM stereo tuner, and a 10-watt-per-channel stereo amplifier. While such a system will fill the needs of many customers, it is one that your video entertainment-system may outgrow. And, as we've seen, home video's potential for growth is enormous. R-E

VIDEOCASSETTE RECORDERS

The past five years have seen home video cassette-recorders evolve at an incredible rate. Let's bring you up to date on where we stand today, and on what we may see in the future.

LEN FELDMAN
CONTRIBUTING EDITOR

THE MODERN VIDEO CASSETTE-RECORDER (VCR), VINTAGE 1981-82, is a far cry from the first *Betamax* machines introduced into this country by Sony in early 1976, or even from the first VHS-format recorders introduced a year or so later by JVC Company and by its sister company, Panasonic (the trade name used by Matsushita Electric Company of Japan).

To begin with, today's prospective purchaser has at least two tape formats from which to choose, and it is possible that within the near future there will be several more formats available. First-generation VCR's featured mechanically-actuated tape-transport mechanisms, not unlike the "piano key" systems found on audio cassette-recorders. Almost all of today's VCR's, however, are operated by feather-touch electrical switches that control transport operation electronically and protect both the tape and the machine from human error. And, while first-generation machines could be programmed for only a single recording session in a single 24-hour period, modern programmable VCR's can be programmed for days and weeks ahead, and are able to switch channels between programs, working from instructions stored in their microprocessor memories. All of that is in addition to a greatly extended recording-time capability, which has gone from one hour (on the early *Beta-I* format VCR's) to five or six hours on a single cassette.

An overview of the formats

Sony's Beta system was first introduced in late 1975. It uses a plastic, two-hub cassette that measures 6.1 × 3.8 × 1 inches. The earliest Beta cassettes contained about 500 feet of ½-inch video tape, which, at a running speed of 1½ inches-per-second (a speed referred to as X-1 or Beta I) provided only one hour of recording time. Beta-format machines sold today use the slower tape speeds of *Beta II* (0.79 inches-per-second) and *Beta III* (0.53 inches-per-second), for longer play/record times. Using an L-830 Beta cassette, it is now possible to extend recording time to a full five hours.

About a year after Sony introduced the *Betamax* system, Japan Victor Company (known as JVC in this country) introduced its *VHS* (*V*ideo *H*ome *S*ystem) VCR's. While theirs is similar to Sony's format in many respects, there are several differences between the two systems that make them incompatible. (Beta tapes cannot be played on VHS machines and vice versa.) To begin with, the cassette used in VHS recorders is somewhat larger than that used in Beta machines—7.4 × 4.1 × 1 inches.

VHS cassettes are identified in terms of their playing time. Using the original VHS speed of 1.31 inches-per-second, a T-120 cassette contains enough tape for about two hours (120 minutes) of recording or playback. But the designers of VHS were not about to be outdone by Sony's longer-playing Beta speeds, so in mid-1979, makers of VHS machines (who by then outnumbered those making Beta machines under Sony license) slowed down their tape speeds to create four-hour (LP) and six-hour (ELP) tape speeds, which is where matters stand today. Table I shows speeds and recording time for the various Beta and VHS formats now available.

How they work

Considering how difficult it is to maintain "flat" frequency response in an audio tape recorder from 20 Hz to "only" 20,000 Hz, it seems almost miraculous that VCR's can handle the incredibly wide bandwidths associated with a video signal. The trick, of course, is that the actual head-to-tape speed is really hundreds of times greater than the slow linear speed of the videotape.

Record and playback tape heads, in both VHS and Beta format machines, are mounted on a spinning drum or head that rotates at exactly 1800 rpm. That works out to 30 revolutions-per-second, or the exact number of video frames-per-second used in the NTSC TV-system broadcast in this country (and in Japan). Since there are two heads mounted 180° apart on the spinning drum of either type of machine, two fields are scanned for each revolution of the drum. The original track format for professional helical-scanning VCR's was standardized by the EIAJ (*E*lectronic *I*ndustries *A*ssociation of *J*apan) some time ago, and is shown in Fig. 1. Note that there is a space, or guard band, between adjacent tracks. The ability of both the VHS and Beta machines to do away with those guard bands, as shown in Fig. 2, is one of the reasons why such an incredible density of signal information

TABLE 1

Format	Tape speed (ips)	Maximum record/play time (hours)
Beta I	1.57	1.7
Beta II	0.79	3.3
Beta III	0.53	5
VHS SP	1.31	2
VHS LP	0.66	4
VHS ELP or SLP	0.44	6

can be accommodated by the new machines.

Another aspect of home video recorders that has not been sufficiently emphasized is the fact that video signals are recorded as frequency-modulated signals (audio-only recorders use amplitude modulation). FM is used for a number of reasons. For one thing, FM systems can ignore amplitude variations in playback signals. Secondly, because FM signals are sensitive to changes in frequency and not amplitude, the tape can be driven into saturation safely during signal peaks. In addition, because amplitude distortion can be ignored in an FM system, there is no need for the high-frequency bias signals that are normally added in audio recording. Finally, the DC component of the TV signal—a value that changes slowly with overall scene brightness—is never lost in an FM system: it *can* get lost in an AM system.

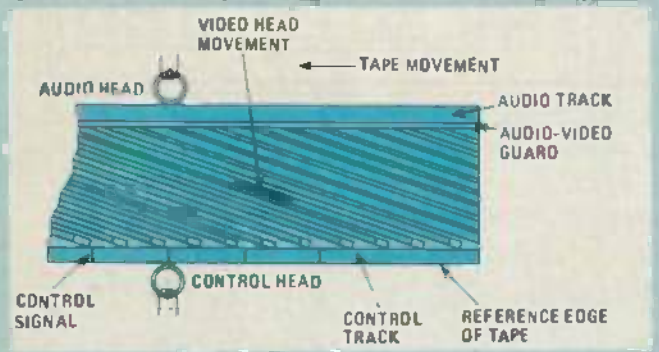


FIG. 1—HELICAL SCANNING uses rapidly rotating recording heads to achieve high packing-density of video information at slow linear tape-speeds. Note guard bands between video tracks as called for by original EIAJ standard.

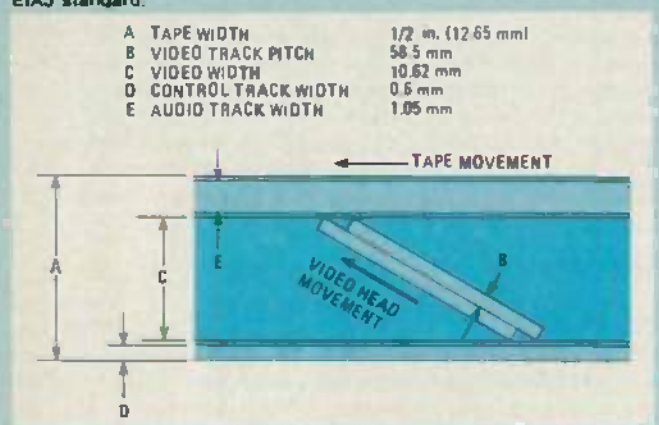


FIG. 2—BETA AND VHS FORMATS do away with guard bands by recording adjacent tracks at different azimuths. That helps to eliminate crosstalk.

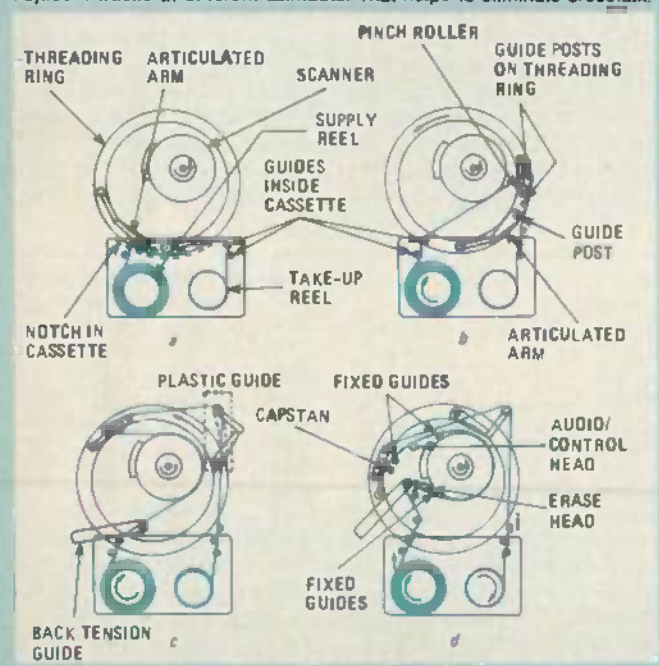


FIG. 3—DETAILS OF BETA THREADING PROCESS. Note resemblance of tape path to a sideways Greek letter omega (Ω) in *d*.

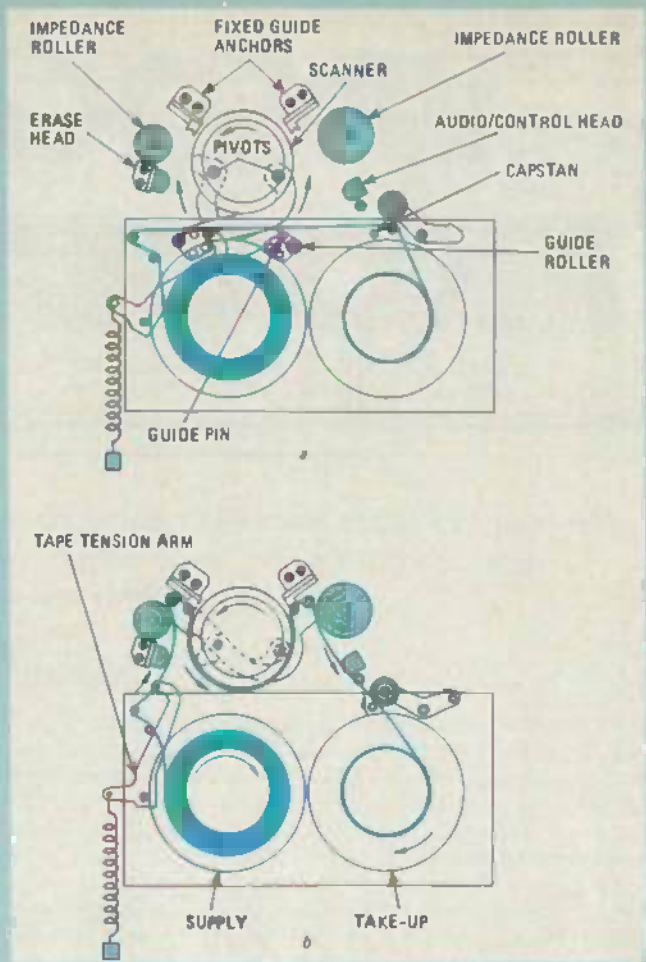


FIG. 4—VHS MECHANISM BEFORE threading (a) and after (b). Tape path resembles letter "M."

In addition to certain minor differences in the makeup of the video signal to be recorded (Beta uses a 688-kHz heterodyned color-subcarrier, while VHS uses a color-subcarrier frequency of 629 kHz), a different approach is taken in the designs of the *Betamax* and *VHS* tape-threading mechanisms. In the Beta system, a loop of tape is drawn around the scanning drum and the entrance and exit guides are in fixed locations. Figures 3-a through 3-d show the step-by-step threading arrangement used in the Beta system.

The VHS system uses moveable entrance and exit guides in a much simpler and faster threading operation. The moveable guides are locked in place against fixed anchors after they reach their final position, as illustrated in Figs. 4-a and 4-b. Since, in the VHS system, the threaded tape resembles the letter "M" (see Fig. 4-b), this system is sometimes referred to as "M-loading" or "M-threading," whereas the Beta system is sometimes referred to as "omega-wrap," due to the threaded tape's resemblance to the Greek letter "omega" (Ω), as can be seen in Fig. 3-d.

Another distinction lies in the fact that in the Beta system, tape threading starts as soon as the cassette is dropped into position, so that tape is ready for playing or recording when appropriate transport buttons are depressed. In the case of VHS, threading only begins when the play or record buttons are depressed, which accounts for the somewhat longer delay between the time you press those buttons and the time recording or playback actually begins.

The Technicolor A/V system

Just about one year ago, Technicolor Audio-Visual startled

the video world with the introduction of another VCR format—the smallest and lightest yet available. This new miniaturized VCR, shown in Fig. 5, uses a new-type cassette containing quarter-inch tape. Figure 6 shows just how small the new cassette package is: almost as small as an ordinary compact audio-cassette. The new Technicolor VCR is the result of a joint effort between Technicolor Audio-Visual and Funai Electric Trading Company Ltd. of Japan. Funai, a manufacturer of electronic equipment for major American companies, initiated the development of what has come to be known as the *Micro Helical System*, and Technicolor engineers joined forces with Funai more than two years ago to launch the project commercially.

Much like Beta and VHS systems, the Technicolor system uses two rotary heads and helical scanning, as well as frequency modulation for applying the signal to the tape. Linear tape speed is 1.26 inches-per-second and tape width is ¼ inch. The cassette package measures only 4⅛ × 2⅝ inches and weighs only 1.78 ounces, compared with the approximate half-pound weight of the two standard-sized Beta and VHS cassettes. The battery operated VCR weighs only 7 pounds (including the battery) and uses only 8 watts when recording. Technicolor is adding products to the line, among them a camera, a matching tuner and, most recently, a product called the *Video Showcase*—an all-in-one VHF/UHV portable color-TV set that includes a videocassette recorder and a tuner for recording TV programs. The entire unit weighs 21 pounds and measures 18 × 13 × 8½ inches. It operates on AC current, car/boat battery, or from its own rechargeable battery.

Maximum recording time for the Technicolor system was initially 30 minutes, but the company has now developed a cassette containing one hour's worth of tape. Because of its time limitations, it is felt by many that the Technicolor system will lend itself best to videotaping using a camera rather than for recording TV programs "off-the-air". Business applications (visual memos, easily mailed from one location to another) are also envisioned.

Much to everyone's surprise, at last summer's Consumer Electronics Show in Chicago, the well known Canon Company, best known for its photographic products, introduced its own version of the *Micro Helical* VCR system. It appeared identical to the Technicolor system and compatible with it.

Another entry

Equally surprising was an announcement from Grundig, the well known West German electronics firm, that it was going to promote a new version of the *Video 2000* system, developed jointly with Philips of the Netherlands. That video-recorder system is widely used throughout Europe; but because it has been confined to PAL and SECAM standards, it has never made any inroads in the U.S. The heart of the new VCR system is a flat cassette, measuring 7.2 × 4.3 × 1.0 inches and designed as a flip-over unit which, like audio cassettes, can be played on both sides. Despite a reduction in tape length, playing time is double that of Beta II or VHS LP, or twice four hours. As shown in Fig. 7, video-track width is set at 0.018 mm and only half the width of ½-inch tape is used for recording. The arrangement permits the use of a higher linear tape speed for improved sound quality. With the *Video 2000* system, tape usage is only 87.9 meters-per-hour, which is about 52% less than for the two standard video systems. The 0.65-mm wide audio track has been designed to accommodate either mono or stereo (two-channel) sound.

To insure best picture quality and interchangeability of tapes from one *Video 2000* machine to the next, the usual tape servo-control has been replaced by a new type of tracking system which Grundig calls *Dynamic Track Following* or *DTF*. In that system, if any track deviations occur, the positions of the two video heads on the headwheel are adjusted by piezoelectric strips so that the full width of the video track is covered and the full level of the scanned signal is retained. In addition, a control signal is derived which effectively regulates the tape transport and makes a manual track-control unnecessary.

FIG. 5—NEW LIGHTWEIGHT PORTABLE VCR from Technicolor.

FIG. 6—VIDEOCASSETTE FOR Technicolor systems uses ¼-inch tape and is barely larger than standard Philips audio cassette.

The dynamic track-following system permits perfect playback of freeze-frame, slow-motion and speeded up "search" video. The principle of the *DTF* system is shown in Fig. 8.

The first unit employing that new format to be introduced in this country by Grundig is known as the *Video 2×4 Super*, and is shown in Fig. 9. The display seen at the left of the unit's front panel gives program timing-information and also displays error messages (the message "CASS" seen in Fig. 9 indicates that the cassette has not been fully or properly inserted).

Video frequency-response claimed for the unit is 3 MHz at −6 dB; audio response is from 40 Hz to 10 kHz. Forward and backward picture search are possible at 7× and 5× normal speed, respectively. An automatic program-finding feature locates the start of any new program, while a dynamic noise-suppression system in the audio circuitry is said to improve the audio signal-to-noise ratio by 8 dB, to an excellent 52 dB.

Despite all its superb features and advantages, it is difficult to imagine that still another VCR format can capture a significant market share, when Beta and VHS have already been so well accepted in this country and when there is so much software, in the form of pre-recorded videocassettes available only in those two formats.

As for overall dominance in the U.S. market, VHS is the clear leader at the moment, with about 70% of all new VCR's being sold using that format. Beta accounts for just about all of the remaining 30%, because the Technicolor portable format is still too new to have captured a measurable percentage of sales.

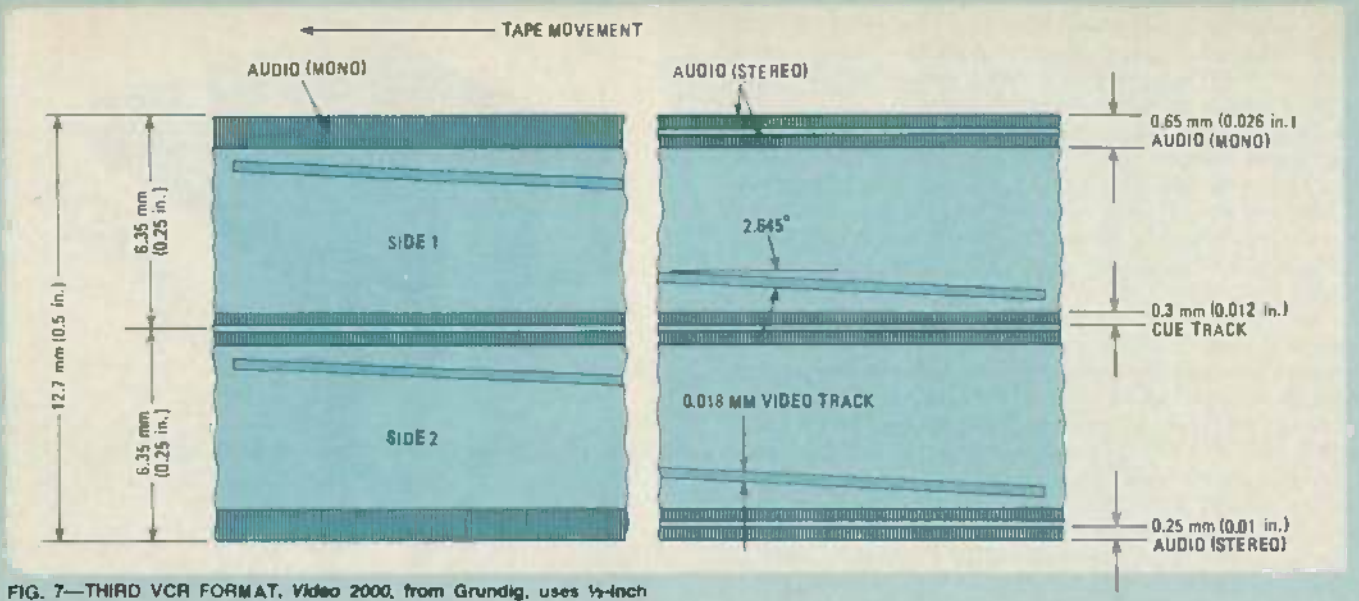


FIG. 7—THIRD VCR FORMAT, *Video 2000*, from Grundig, uses ½-inch tape, but only half the width of the tape is used at a time. Cassette is flipped over (like its audio counterpart) to make use of other half.

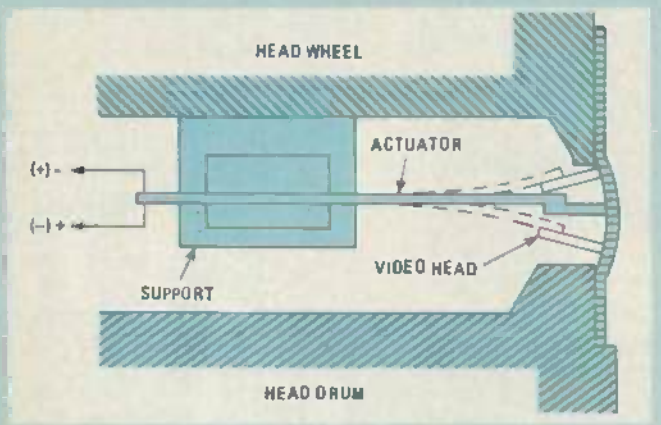


FIG. 8—*DYNAMIC TRACK FOLLOWING*, or DTF, automatically aligns positions of video heads for best tracking.

FIG. 9—U.S. VERSION of *Video 2000* system, Grundig's *Video 2x4*.

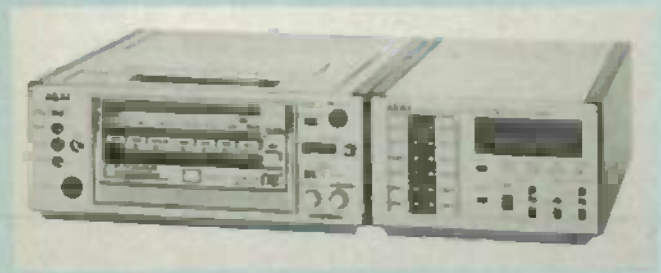


FIG. 10—AKAI'S *VPS-7350* system features stereo-sound capability.

Who makes which?

Of the two major VCR formats (VHS and Beta), VHS is supported by many more manufacturers than Beta. Included in the VHS group are JVC (the originator of the system), Akai, General Electric, Hitachi, N.A.P. Consumer Electronics (Magnavox/Philco/Sylvania), Mitsubishi, Panasonic, Quasar, RCA, and Sharp. Manufacturers making or supplying Beta-format machines include Sony (the developer of that format) Sanyo, Sears, Toshiba, and Zenith.

Update on portable VCR's

About the only thing "portable" about the first portable VCR's was that they could operate from battery power and did not have to be tied to an AC outlet. Furthermore, their programming capabilities were highly limited, and they generally had only a single tape-speed. Now all that has changed as the new generation of portables becomes as fully sophisticated as the latest home units.

For example, consider Akai's *VPS-7350* system, shown in Fig. 10. This modular system features a lightweight VCR unit *(VP-7350)* for both portable and home use, and a tuner/timer *(VU-7350)* capable of recording six events over seven days from any TV channel. The system has both two-hour and six-hour capabilities. Its two audio channels allow the user to add stereo sound to video recordings, or to record directly in stereo if a TV program is being simulcast over an FM-stereo radio station. And, of course, when stereo sound is finally broadcast over TV in the future, the unit will be ready for it. Complete remote control allows all special features (including double-speed playback, and variable-speed playback ranging from still-frame to four-times-normal speed) to be controlled from across the room. The combination also features "program-location search"—a fast-forward mechanism that searches and then stops at any point where there is no video (presumably on the assumption that video will follow).

The companion *VU-7350* tuner/timer transforms the portable VP-7350 recorder into a full-function home VCR that can be programmed to record off-the-air. A fail-safe power-guard system prevents the loss of programmed instructions in the event of a power interruption.

Beta-format portable VCR's have not lagged behind either, as witnessed by Sanyo's new lightweight (8¾ pounds) *model VRP-4800*. Features include full-function remote operation from the optional *VSC-450* color video camera; Sanyo's *Betascan* high-speed search system that locates programs at nine times normal playback speed; a freeze-frame function, with frame-by-frame advance; feather-touch controls, and two-speed operation (Beta II and Beta III) for up to five hours of recording capability.

A compact tuner/timer with all-electronic varactor tuning and seven-day programmability, *model VTT-481* is available

FIG. 11—JVC's *HR-2200U* has an edit-start control to eliminate noise or gaps between scenes.

FIG. 12—SONY's *SL-5800* uses a double-azimuth head to provide noise-free slow and freeze motion.

FIG. 13—FOUR HEADS ARE USED in JVC's *HR-7300-U*. One set is used in two-hour mode, the other in six-hour mode.

as an option to match the portable VCR. The VCR has a suggested retail price of just under $1200.00, while the matching tuner/timer will sell for around $350.00. The prices are typical of those being assigned to the new VCR and tuner/timer units.

JVC's earliest portable VCR was a rather heavy unit that had no special capabilities and only the standard play (SP) two-hour tape speed. The company's latest portable, the *HR-2200*, weighs a mere 11.4 pounds (including battery pack) and consumes only 9.6 watts when operating. Further power saving is possible using a RECORD/STANDBY switch that switches power off while still allowing a smooth transition between separately recorded scenes. As is obvious from Fig. 11, the supplied remote-control unit includes the capability for slow-motion playback (variable from 1/6 to 1/30 normal speed), freeze-frame, and frame-by-frame advance. A feature called ESC (*E*dit *S*tart *C*ontrol) automatically aligns the start of the segment being recorded with the end of the previously recorded one to eliminate noise or gaps between scenes. There is also a shuttle-search feature that allows you to run the tape in either direction at about 10-times-normal speed while watching the picture on a TV set to locate a desired program segment. All that, and portability too!

Progress in home VCR's, too

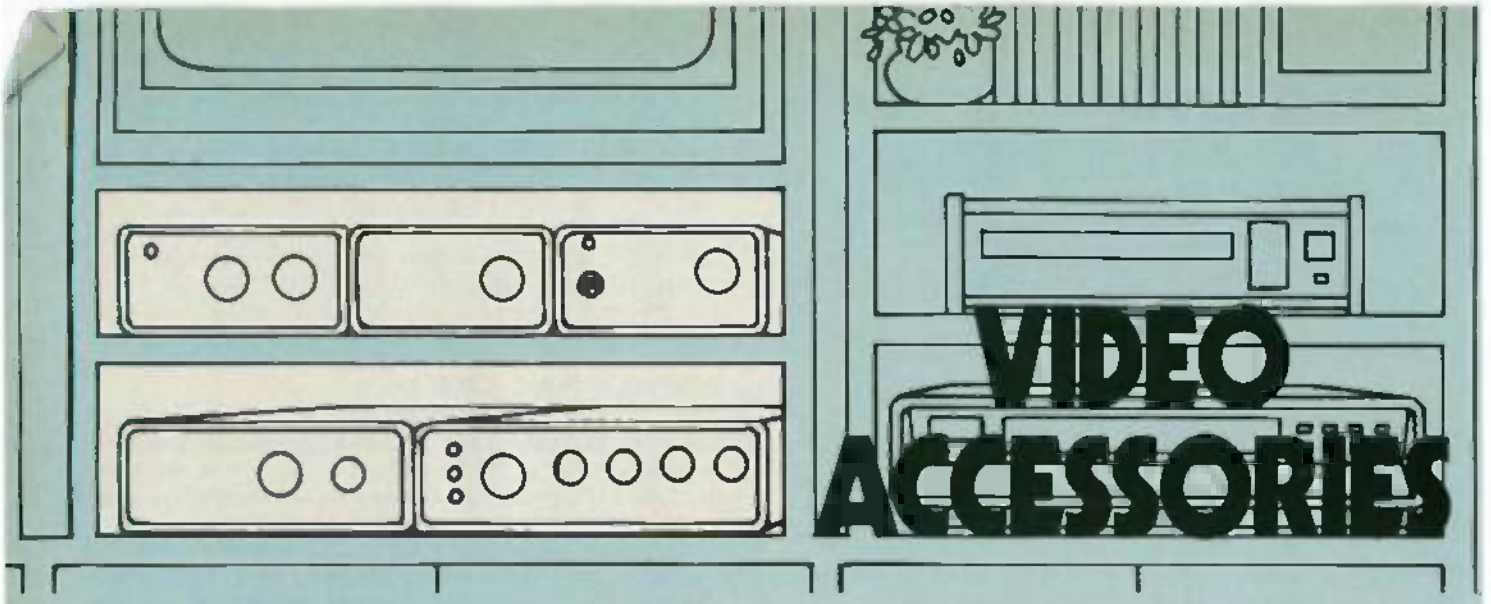
The video consumer benefits from the fact that there are two major systems competing with each other for a share of the market. For, as the Beta people come up with something new, the VHS-supporting companies feel compelled to come up with the same feature, or even an advanced variation of it, for their own machines.

Sony's latest home-model *Betamax* unit, the *SL-5800*, shown in Fig. 12, is a good example of that trend. An outstanding feature of this model is *Variable BetaScan*—a new type of *Betascan* that permits backward and forward picture-search at any rate from 5 to 20 times normal speed with a single control-knob on the accompanying remote-control unit. Programmability covers four events over a 14-day period. The *SL-5800* is also equipped with a newly developed double-azimuth video head (see the May 1981 issue of Radio-Electronics, page 56) that provides improved freeze-frame, frame-by-frame picture advance and variable-speed slow motion (from "stop" to 1/5 normal speed). With the new heads, the TV screen can show a stationary picture with virtually no noise bars. It's almost as if Sony were anticipating the Grundig/Philips introduction discussed above.

JVC's latest home VCR, the *model HR-7300U* (Fig. 13), records in two-hour and six-hour modes but can play back tapes made in 2, 4, or 6-hour modes. One of the ten functions available from the remote-control unit is seven-times-normal-speed shuttle search for locating specific portions of a tape. Shuttle search increases to 21-times-normal playback speed in the six-hour extended-play (EP) mode. The VCR can be programmed for eight events over a two week period. Another innovation included in this machine, though not apparent from the outside, is a four-head system. One set of heads is used for the two-hour mode, while a separate set of heads, optimized for a slower tape speed, is used in the six-hour record/play mode.

Not to be outdone, Toshiba, which manufactures Beta-format units, has incorporated four heads into its newest home-VCR, the *V-8500*. The two extra heads added in this case are designed specifically to provide clear images in the pause/still and variable-slow-motion functions. Circuitry in the additional heads eliminates noise and flickering on the screen. Other special features include visual scanning at 40 times normal speed, visual *Betascan* at 17 times normal speed, and a visual double-speed function. The full-function remote hand-held control offers visual forward, rewind, pause/still, two-times-visual fast-forward, frame-by-frame forward, and variable slow motion. The *V-8500* has a suggested retail price of $1495.00 and is programmable for up to eight different events over a two-week period.

While we have mentioned only a few Beta and VHS machines by actual brand and model number, it should be clear from those descriptions that the difference in the features offered by Beta and VHS machines are fewer and fewer, as the maker of each type of machine attempts to be competitive in a growing market. Our own experience with a number of both Beta and VHS machines indicates that either type is capable of delivering a quite acceptable color picture from ½-inch videotape cassettes, and I suspect that both the Beta and VHS formats will survive for many years to come. As to whether any of the newer formats will find acceptance in the home or portable VCR field, only time will tell. R-E



VIDEO ACCESSORIES

It takes more than a VCR to make a quality home-video system. Here's a lineup of products that will help you get the most out of your equipment.

LEN FELDMAN
CONTRIBUTING EDITOR

WHEN YOU CONSIDER THAT THE FIRST HOME VIDEOCASSETTE recorders went on sale in 1976, it is amazing how many accessories, or "video black-boxes," have appeared in the past five years as add-ons for the three million or so VCR's that are currently in use. Equally amazing is that, while no VCR's are actually produced by U.S. companies (even those bearing familiar domestic brand-names are manufactured under subcontract by two or three overseas companies), with few exceptions just about *all* of the video accessories we will be discussing here come from relatively small *U.S.* firms.

Video accessories fall into four basic categories. There are signal switch-boxes, which simplify the problem of connecting a number of video devices without creating a "rat's nest" of cables. There are signal enhancers or modifers of one kind or another. The third category of accessories is the signal stabilizers. And, finally, we have a whole assortment of video-care products which, though not necessarily "black boxes," certainly qualify as video accessories.

Video switchers

With so many things available to connect to your TV set, it's not surprising that some manufacturers have come up with video switch-boxes. The main feature of those boxes is that they provide a convenient way to connect all your accessories (for expample, a video game, a VCR, and a video disc player) to your TV set, and provide a convenient way to select the accessory you wish to use.

Those boxes can also be very useful for cable-TV subscribers. Often, cable services require the use of a channel selector or cable switch-box supplied by the cable company. Since the output of the cable switch-box is usually on a specific channel, and must be connected to your TV set's antenna-terminals, one of the most important and useful features of a videocassette recorder is defeated—the ability to watch one TV program while recording another. That is impossible when such cable switch-boxes are used, since all channel-selection is made there, and not at your TV set or the tuner of your VCR.

A solution to that problem is one of the many switchers and selectors now on the market. We will use a well-known switcher, Beta Video's *Distrivid*, to illustrate how such devices work. The *Distrivid* uses a series of interlocking front-panel pushbuttons to allow you to record from one to three RF sources, and to view one of any of four sources on one or two TV sets simultaneously. Alternatively, you can record

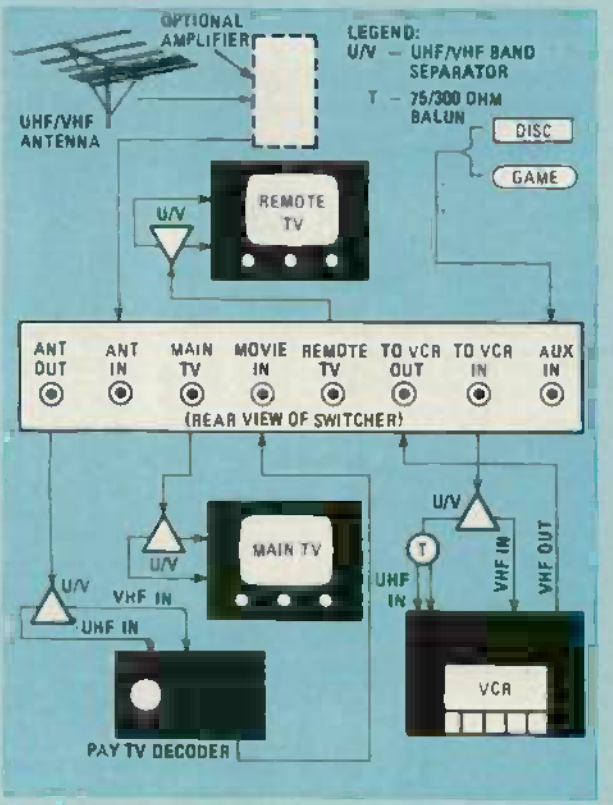


FIG. 1—THIS IS HOW you would hook-up a *Distrivid* switcher if your video system included an over-the-air pay-TV decoder.

from any one of four sources on two VCR's and view any of three sources on a single TV set; the combinations are almost limitless. Figure 1 shows how you could hook up to the *Distrivid* if you subscribe to an over-the-air pay-TV service; Fig. 2 shows a typical cable-TV hookup. The *Distrivid (model IC-28)* has a suggested retail price of just under $200.00. Beta video also manufactures a smaller, less versatile unit, the *Disc-Switch (model IC-08)*, that sells for around $60.00.

A somewhat simpler switcher is the *VideoMate model VM-601*, manufactured by Total Video Supply Company. That small unit, which has a suggested list price of $89.95, is

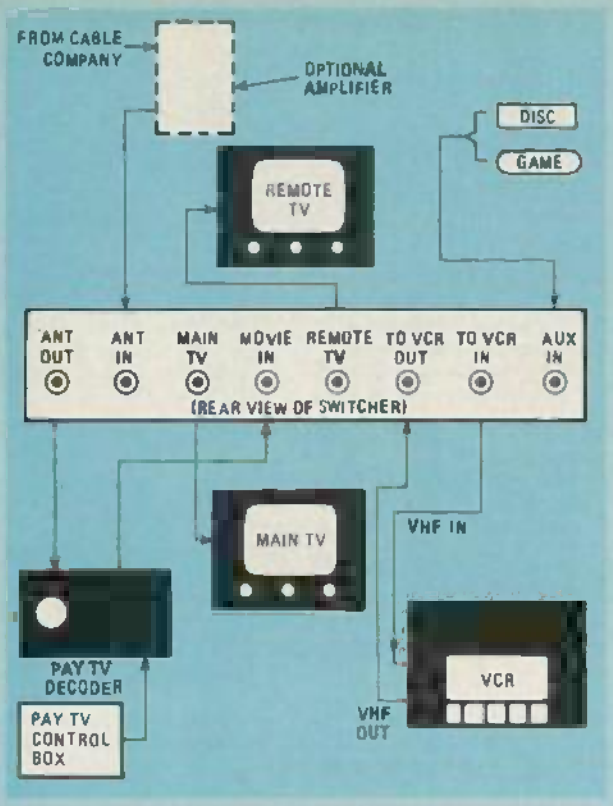


FIG. 2—CABLE-TV SUBSCRIBERS would set up their home-video system as shown here. The switcher allows you to hook up cable TV, pay TV, a VCR, and either a videodisc player or a video game while avoiding a "rat's nest" of wires and the accompanying problems.

FIG. 3—A SOMEWHAT SIMPLER SWITCHER, the *Videomate model VM-601* from Total Video Supply Company still lets you switch to two or three video sources.

shown in Fig. 3; it offers six selectable RF inputs and one RF output. Cable-TV subscribers, however, would be better off with the more elaborate *VideoMate model VM-600*, shown in Fig. 4. That unit sells for around $120.00, but it allows you to record from one video source while watching another.

Signal enhances and modifiers

Whether you buy prerecorded videotapes, record your own programs off-the-air, or make your own videotapes using a video camera, there have probably been times when you wished you could have gotten a picture with better definition. If you copy tapes, you have probably noticed some deterioration in picture quality on those tapes when they were compared with the original. If you view the tape on a large screen or projection television, the lack of sharpness and detail is even more apparent.

There are several products now available that, to a greater or lesser degree, can improve the apparent sharpness or resolution of both off-the-air recordings and of tape copies. Two such products are the *Detailer I* and the *Detailer II* from

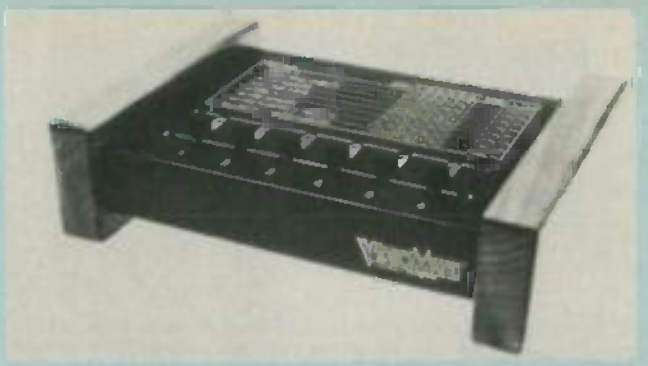


FIG. 4—FOR MORE DEMANDING SITUATIONS, the *Videomate VM-600* allows you to record broadcast-TV while watching your subscription channel.

FIG. 5—SIGNAL ENHANCERS, such as the *Detailer II* from Vidicraft improve the apparent sharpness and resolution of either off-the-air recordings or tape copies.

Vidicraft Incorporated. Both models, in addition to improving the quality of original recordings and tape playbacks by increasing detail and sharpness, include a distribution amplifier that provides multiple video-outputs without any losses in signal levels.

The *Detailer I* is the less expensive of the two models (at a suggested retail price of $140) and performs very much like the *Detailer II* when copying good master tapes or making original recordings. It is less effective dealing with multi-generation tapes (tapes that are many copies removed from the original) or black-and-white video material. The device features three video outputs so that it can be used for making up to three copies at once.

The *Detailer II* (with a suggested retail price of $295.00) is more versatile, and has several additional features; it is shown in Fig. 5. It has separate DETAIL and SHARPNESS controls, and can improve picture quality even when copying multi-generation tapes. A MODE switch provides a BYPASS function that can be used for making comparisons between the signal coming off the original tape and the one that's been processed. Also included is a COLOR position for color-signal enhancement, and a MONO switch position for black-and-white signal enhancement. The unit has three switchable video/audio inputs and four outputs; they allow up to four VCR's to be permanently interconnected. Three of the VCR's can be used either as master or slave machines without changing the cable connections.

It should be noted that image enhancers such as the *Detailer I* and *Detailer II* process video only—not audio. Their use requires either a second VCR or a TV set modified to accept a composite-video signal and audio directly (not an RF signal at the antenna terminals).

Video stabilizers

To prevent purchasers of prerecorded videotapes from copying them, many professional duplicators use signal-processing schemes known variously as *Copyguard*, *Stop Copy*, and *MV-Guard*. All of those systems modify the vertical-sync pulse that normally helps TV sets to "lock" the picture and prevent vertical "roll."

If such modified video signals are fed into most home VCR's (as they would be during the copying process), not only is the resulting signal during playback likely to cause

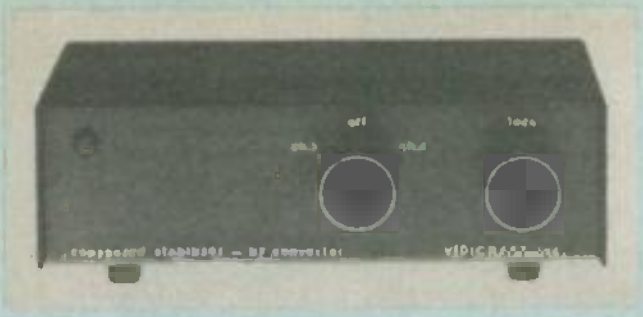


FIG. 6—VIDEO STABILIZERS prevent vertical roll by restoring the vertical-sync pulse when playing prerecorded videotapes. The *Copyguard Stabilizer/RF converter* from Vidicraft shown here also incorporates an RF converter for increased flexibility.

FIG. 7—DROP-IN CLEANING CASSETTE, the *Allsop 3* from Allsop, Inc. uses a "wet" cleaning system.

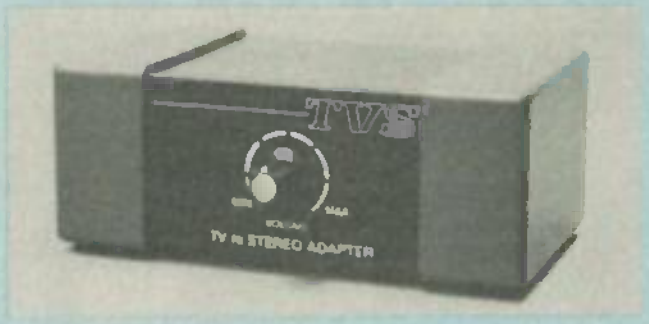


FIG. 8—SIMULATED STEREO SOUND is created by the *model SA-100* from Total Video Supply. It modifies the monophonic sound from your TV and feeds it to your stereo sound-system.

FIG. 9—JUST ABOUT EVERYTHING needed to set up and maintain a home-video system is included in this *model VAK-400* video accessory kit from Total Video Supply.

rolling of the picture, but in many cases a total loss of synchronization will take place, making the picture impossible to watch. Even if you have no intention of copying prerecorded tapes (and we warn readers that doing so may subject them to legal charges of copyright infringement), you may own an older TV set which cannot provide vertical picture-stability, even when watching the prerecorded tape itself. That is especially true if your set is a vacuum-tube type, type.

Several companies manufacture and sell fairly simple devices that fully restore the vertical sync pulse. Vidicraft, for example, makes a tiny device, the *Copyguard Stabilizer* with just a single control on its front panel; that unit sells for $98.00. Since the device uses video, rather than RF signals, two VCR's, or a TV set modified for use as a monitor, are required. A second model, the *Copyguard Stabilizer/RF Converter*, is shown in Fig. 6. That unit, which sells for $195.00, includes an RF converter so that it can be hooked up directly from a VCR to a TV receiver. Both units eliminate the roll and jitter problems associated with many pre-recorded video tapes. The RF modulator can also be used with any video source, such as the image enhancer described earlier, to generate a video-modulated RF signal for direct connection to a TV set's antenna terminals.

Video-care products

Makers of audio cassette-recorders have long encouraged owners of their products to "clean the tape heads often" for best performance. On the other hand, VCR manufacturers have taken the opposite position: almost every VCR owner's manual warns users against trying to clean the highly polished head-drums or head-cylinders found in VHS and Beta-format machines. Despite those warnings, there are many head-maintenance products that, if used strictly in accordance with the instructions, should not lead to premature head wear or head replacement.

Many of those cleaning products look exactly like video-tape cassettes. But, rather than containing video tape, they contain a tape impregnated with a mildly abrasive dry material that removes oxide particles from the tape head. One cleaner, made by 3M, actually displays a message on your TV screen that tells you when the cleaning process is finished. The message tells you when to turn the machine off and keeps you from overdoing the cleaning process.

One company, Allsop, Inc., manufactures a cassette-like cleaning system that it describes as a "wet" cleaner. The cleaning material in the *Allsop 3* (shown in Fig. 7), which has a suggested retail price of $29.95, is a soft chamois that is dampened with a liquid solution. According to Allsop, four critical components in a VCR are cleaned by its device: the video heads, audio head, capstan, and pinch roller.

All the methods mentioned so far do not require you to "go inside" the VCR—something that might void a manufacturer's warranty. The only company I know of that does encourage you to do this is Recorder Care, a division of Nortronics. The company feels that, if its detailed instructions are carefully followed, there will be little chance of damaging the machine.

Recorder Care markets a line of eleven products ranging from a complete maintenance kit (*model QM-50*, with a suggested price of $24.40) to cellular foam swabs ($4.80) and cleaning liquid ($4.20). The company also manufactures and sells a bulk video-tape eraser (*model VCR-211*, for $47.00) and a video-head demagnetizer (*model VCR-205*, for $21.20).

While most video accessories fall into the four categories we've just covered, there are still quite a few that do not. Since those items can also help increase your enjoyment of your VCR, we should take a look at at least some of them.

Waiting for stereo TV

Although Japanese TV-viewers have been enjoying stereo (and bi-lingual) audio for nearly three years now, our own Federal Communications Commission is likely to take another year or two before deciding upon a stereo-TV standard. Until then, however, you can hook up a stereo-simulating device, such as the *model SA-100* adapter, shown in Fig. 8, from the Total Video Supply Company. That small unit takes the mono audio from your television, turns it into simulated stereo, and feeds it to your high-fidelity system. Hooking up the unit is especially simple if your TV set is equipped with a headphone jack; no special wiring is required in that case. A

separate volume control is provided on the device, which bears a suggested retail price of $24.95.

Commercial killers

Several companies offer devices billed as "commercial killers." They are claimed to allow you to record off-the-air programming while automatically stopping the tape during commercials, thus providing interruption-free entertainment.

Two different principles are used. One type of commercial killer works only for black-and-white programs. As long as the material is transmitted in monochrome, the recorder runs. When it senses the color-burst signal, necessary for color (and it is assumed that all commercials are in color these days), the recorder pauses. When the color-burst signal disappears, the recorder starts up again. That is great for watching old Ronald Reagan films, but doesn't do much for his more recent TV appearances.

The other method relies on the assumption that, just before a commercial, the station will "fade to black" for a second or two. That instant of blank-screen is supposed to tell the recorder to pause. The next fade-to-black, presumably signalling that the program is about to resume, restarts the recorder. A little viewing on your part will demonstrate that the reliability of such devices is somewhat dubious.

Another type of accessory is an unconverter. Most VCR's have their outputs on either Channel 3 or Channel 4. While that won't usually cause any problems, that will not be the case if you live in an area where both of those channels are in use. In such a situation, the simplest solution is to use an upconverter. Those devices convert the RF output of your VCR, or any other video accessory, to a UHF frequency.

We have not included such minor accessories as cables, balun transformers, two-set couplers, and pin-to-pin video and audio cables, since those are supplied by a large number of companies and are generally available at any audio/video store. If you want to make your video-accessory shopping easier, the Total Video Supply Company has put together a Video Accessory Kit, *model VAK-400* that sells for about $34.00 (see Fig. 9). It contains just about everything needed to connect, use, and maintain home VCR's and video systems. Included in the kit are coaxial cables, a signal splitter, signal switcher, cable adaptors, impedance matching transformers, a VCR-head cleaning kit, and the company's "dubbing kit" for copying videotapes. R-E

SUPPLIERS OF VIDEO ACCESSORY PRODUCTS

Allsop, Inc.
4201 Meridian Street
Bellingham, WA 98225

Amco Electronics
9181 Gazette Avenue
Chatsworth, CA 91311

Beta Video
9612F Lurline Avenue
Chatsworth, CA 91311

BIB
1751 Jay Ell Drive
Richardson, TX 75081

Colormax Electronics Corp.
180 Northfield Ave.
Building 409, Raritan Center
Edison, NJ 08837

Comprehensive Video Supply Corporation
148 Veterans Drive
Northvale, NJ 07647

Energy Video
20371 Prairie Street
Chatsworth, CA 91311

ETCO
Route 9N
Plattsburgh, NY 12901

Malo-Bauer Corporation
35045 Automation Drive
Mount Clemens, MI 48043

Marken Electronics Inc.
Consumer Video Group
PO Box 1103
Northbrook, IL 60062

Metro Systems
3834 Catalina Street
Los Alamitos, CA 90720

MFJ Enterprises, Inc.
921 Louisville Rd.
Starkville, MS 39759

Niles Audio Corporation
PO Box 160818
Miami, FL 33116

Nortronics Co., Inc.
(Record Care)
8101 10th Avenue N
Minneapolis, MN 55427

Permo Int'l.
3001 Malmo Road
Arlington Heights, IL 60005

Recoton Corporation
46-23 Crane Street
Long Island City, NY 11101

Rhoades National Corporation
Box 1052
Highway 99 E.
Columbia, TN 38401

RK Electronics
30 South 1st Street
Suite 193
Arcadia, CA 91006

RMS Electronics, Inc.
50 Antin Place
Bronx, NY 10462

Robins Industries Corp.
75 Austin Blvd.
Commack, NY 11725

Shelton Video Editors
P.O. Box 860
Vashon, WA 98070

Showtime Video Ventures
2715 Fifth Street
Tillamook, OR 97141

Sigma Sound Equipment
PO Box 114
Pickering, Ontario, Canada L1V 2R2

Smith-Mattingley Productions
515 Kerby Hill Road
Oxon Hill, MD 20022

Sterling Video
PO Box 244
Fraser, MI 48026

Superex Electronics Corporation
151 Ludlow Street
Yonkers, NY 10705

TDK Electronics Corp.
755 Eastgate Blvd.
Garden City, NY 11530

The Video Place
PO Box 36004
Strongsville, OH 44136

3M Company
3M Center Bldg. 4E-03
St. Paul, MN 55144

Total Video Supply Co.
9060 Clairmont Mesa Blvd.
San Diego, CA 92123

Vancouver Video Center
4611 NE 112th Avenue
Vancouver, WA 98662

V.B.O.
18931 West Dixie Highway
North Miami Beach, FL 33180

Vidcor, Inc.
200 Park Avenue S.
New York, NY 10003

Video Commander, Inc.
3621 W. MacArthur Blvd.
Suite 109
Santa Ana, CA 92704

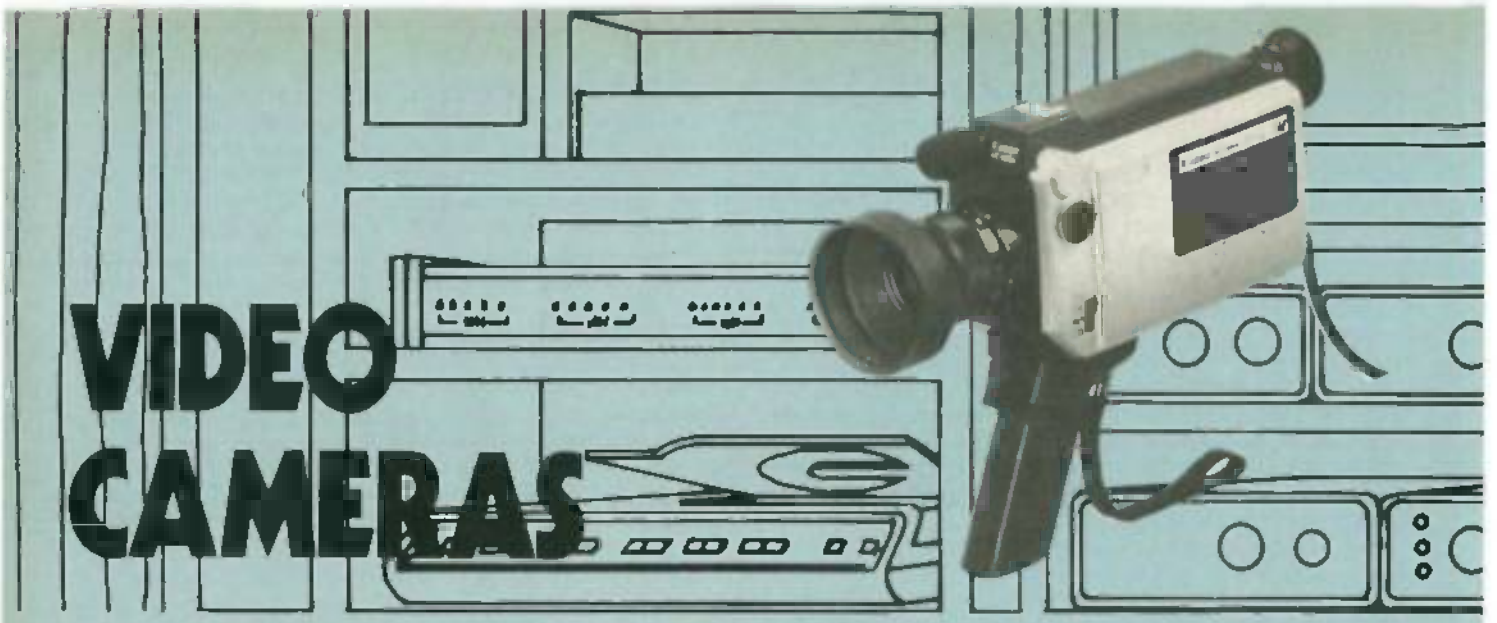
Video Components, Inc.
601 South Main Street
Spring Valley, NY 10977

Video Interface Products
19310 Ecorse
Allen Park, MI 48101

Video Mods
P.O. Box 2591
Sepulveda, CA 91341

Video Services Inc.
80 Rock Ridge Road
Fairfield, CT 06430

Vidicraft, Inc.
P.O. Box 13374
Portland, OR 97213



VIDEO CAMERAS

Make yourself a part of your home video system—add a video camera!

CARL M. LARON
ASSISTANT EDITOR

NOW THAT YOU OWN A VCR, HAVE YOU FIGURED OUT WHAT YOU are going to do with it? Of course, you can use it to record TV programs off-the-air, or view pre-recorded videotapes; but if that is all you do, you are missing out on what could be one of the most rewarding aspects of owning a VCR—recording your own programs.

Every family has those special moments—a wedding, a family reunion, your child's first steps, etc.—that become treasured memories. With a VCR, you can record those moments on videotape so that they can be relived as often as you like. In addition, many of us think that we could be actors, directors, or producers if given the chance; a VCR gives you that chance, even if your productions are seen only by your friends and family. To do all of that, however, you need one piece of equipment in addition to your VCR—a video camera.

But choosing which video camera best fits your needs will not be the easiest task that you have ever undertaken. To begin with, nearly every company that makes or distributes a VCR also makes or distributes a color-video camera; many make or distribute several models with different features. Prices for those cameras range from about $650 to well over $1500. So far it sounds pretty bad, but there are a few factors that do make the choice a little easier. First of all, nearly all such cameras produce outstanding color under good lighting conditions. Secondly, cameras that cost about the same, generally perform about the same. Because of that, once you've determined how much you can spend, your choice will be based strictly on how a camera's features meet your particular needs. However, before you can make that decision, you need to know how a basic video camera works, its limitations, and how the various features affect a camera's performance.

How a video camera works

The main purpose of a video camera is to transform the light reaching its lens into an electronic signal that can be recorded on video tape. The part of the camera that does that is called a camera tube. One such tube, a Vidicon (used in most low-cost cameras), is shown in Fig. 1. In that tube, light from the outside is focused by the camera's lens and falls on a light-sensitive conductive plate called the target plate. The conductance of any point on the plate varies proportionally to the brightness of the light striking that point. At the same time, an electron gun at the rear of the tube generates an electron beam that is swept across the target plate. The beam current that flows varies with the conductivity of the target, and can be used to generate a record of the brightness levels of a scene—in essence a black-and-white television picture. Color is added to the picture in one of several ways, the simplest of which is through the use of a color-stripe filter.

The primary difference between camera tubes is the composition of their target plates. Another difference is their size. While early home cameras used one-inch tubes, many new models use a ⅔-inch tube. The chief advantages of the smaller tubes is that they are not as susceptible to "image lag" (a streaking effect at low light-levels) and they make it possible to make smaller, lighter cameras. One disadvantage is that the smaller tubes do limit resolution somewhat.

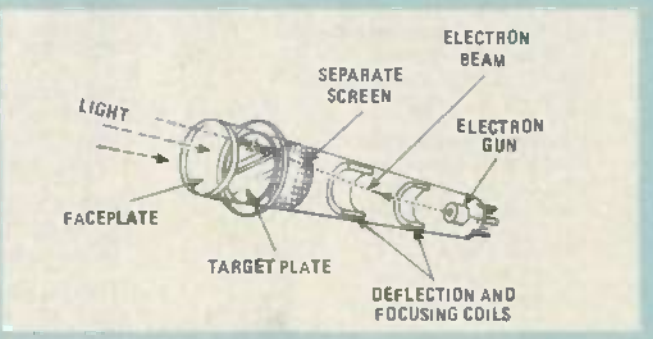


FIG. 1—CROSS-SECTIONAL DIAGRAM of a Vidicon camera tube. An electron beam from the rear of the tube is used to generate a record of the light and dark areas of a scene—in essence, a black-and-white television picture.

Some limitations

Technology aside, one of the biggest differences between a video camera and a film camera is that, rather than storing an image on film that is inside of the camera, the video camera stores the image on videotape that is inside the *videocassette recorder*. That means, of course, that your camera must always be connected to your VCR, limiting your range to the length of the cable. While that cable can be extended to a maximum of about 85 feet, any recording away from home will be impossible unless you have a portable VCR.

Color video cameras also require quite a bit of light for best recording results. Typical minimum illumination requirements range from 8 to 10 foot-candles (80 to 100 lux), although some, such as the RCA *model CC011* shown in Fig. 2, have minimum requirements as low as 5 foot-candles (50 lux), and one, the new Sony *model HVC-2200*, has a minimum light

requirement of just 4 foot-candles (40 lux). For best results, however, most manufacturers recommend lighting levels of 90 to 180 foot-candles (900-1800 lux). If you are shooting outdoors, meeting those lighting requirements will not be a problem because sunlight will produce nearly ideal pictures. That is not the case if you are shooting indoors, however; the average illumination in a moderately lighted house is about 9 foot-candles, which is close to, or even below the minimum requirements of most cameras. Generally speaking, using a couple of 250- to 500-watt photographic lamps is the easiest way to achieve the recommended illumination levels. But hot lights can be a hazard, and, at the least, add a few more cables for someone to trip on. Additionally, the bright lights may be a bit out of place in some situations, such as a wedding ceremony. Of course, if you are shooting at home and are unsure about the light level, you can always monitor the picture on your television set and make any needed adjustments.

The essentials

Generally speaking, all of the cameras available can be classified as one of three types, based primarily on the kind of viewfinder they use. However, as you will soon see, the viewfinder isn't all that's different.

The least expensive models use top- or side-mounted optical viewfinders; such a camera is shown in Fig. 3. Those cameras are really not much more than a camera body with a lens and a microphone. An optical viewfinder has many limitations, including the fact that it tells you almost nothing about the picture you are taking other than what will more or less be in the frame. In addition those viewfinders are useless with zoom lenses.

FIG. 2—ONE OF THE FEATURES of the *model* CC011 color camera from RCA is its sensitivity in low light. It has a minimum light requirement of just 5 foot-candles.

FIG. 3—A LOW-COST COLOR CAMERA, this *model VCC542P* from Sanyo uses a simple optical viewfinder system.

FIG. 4—A TOP-OF-THE-LINE video camera, this *model IK-1850AF* from Toshiba features a movable electronic viewfinder and an auto-focus system.

On the positive side is the relatively low price of those units, generally less than $700. In addition, if you understand the camera's limitations and work within them, they really do take very acceptable pictures. If you are working on a limited budget, those cameras are a better alternative than black-and-white—at least for most applications. Also, in many cases it is possible to upgrade that type of camera by later adding an electronic viewfinder (more on those later).

If you know how a 35-millimeter SLR camera works, then you know how the next type of video camera works. Those cameras use optical TTL or *T*hrough *T*he *L*ens viewfinders that, using mirrors, let you see what the lens sees. That is extremely important with zoom lenses, and in fact, most TTL cameras use them. One disadvantage of this type of viewfinder is that, since some of the light must be split between the camera and the viewfinder, a little more light is required (about 10 to 25 percent) for good recording results. Also, a TTL viewfinder is something you have to choose at the time of purchase; you can't add one later.

If you are looking for a camera with all the "bells and whistles," then you should look into one of the "deluxe" cameras. One of the chief characteristics of those cameras, but by no means the only one, is their use of electronic viewfinders. An electronic viewfinder is essentially a miniature black-and-white television; color is not used because of the prohibitive cost. That type of viewfinder gives you the most information about the picture you are shooting because it shows you the video image, the signal that the VCR is receiving. In addition, many of the viewfinders have indicators or "idiot" lights that let you monitor the various conditions (such as exposure, whether the VCR is running, condition of the batteries, color balance, etc.) that could effect your taping. One unique advantage of an electronic viewfinder is its mobility. Most are mounted externally (see Fig. 4) and can be tilted up and down, or moved from one side of the camera to the other, for ease of use. Some can be completely removed from the camera, and attached to an extension cable for remote viewing.

The frills

While cameras can be grouped into the three main categories, that is not all that separates one camera from another. Almost every camera in every group has one feature that

separates it from every other camera in its own group, as well as those in other groups. Most of those features are useful, and help you get the best results from whatever camera you are using. Unfortunately, not every feature is on every camera; and even among cameras of the same type, the features will vary greatly from brand to brand. Because of that, it is an impossible task to pick a best camera for everyone. That choice is a personal one and will be based mostly on how you plan to use the camera, and how much you want to spend.

Almost all cameras have some sort of microphone. Some have microphones built into the camera body itself, while others have microphones located on telescoping booms; although more susceptible to damage, the boom-mounted microphones do a better job. Some cameras also have microphone-input jacks and those do make the unit more flexible.

One of the most important parts of the camera is the lens. Aside from the least expensive models, most cameras have some type of zoom lens. While the lenses are generally top quality, two factors effect their versatility: the range of focal length and the speed. A zoom lens is really several lenses in one; the most common ranges of focal lengths are 3:1, 4:1, and 6:1. The lens' *minimum* focal length also plays an important role in determining which lens is most suitable for a particular situation. In general, a short minimum focal length will make a lens a little better suited for indoor work; a longer minimum focal length is a little better for outdoor work. Lens speed, given by an *f* number (just like a still camera), refers to the maximum aperture or lens opening; the lower the *f* number the wider the maximum aperture and the more light the lens will admit. Thus an *f*1.2 lens will have a larger maximum aperture than an *f*1.8 lens. Incidentally, most lenses can be changed. That's especially true if your camera uses the popular C-mount; that mount is also used for photographic lenses.

One rather useful lens feature is an automatic iris. What it does is to adjust the aperture automatically, so that the proper amount of light is let into the camera. That also helps prevent accidentally burning the camera tube. Since video cameras have a limited contrast range (the ratio of the brightest part of the picture to the lightest), the aperture setting is critical to obtaining a good color picture. In addition, some cameras have a backlight control that lets you handle situations in which the subject is standing in front of a source of bright light.

As mentioned before, if your camera has an electronic viewfinder, you are almost sure to have a built-in exposure indicator; some TTL cameras also have those indicators. Another feature that is found on a few cameras is a low light-level or sensitivity control. That lets you take pictures under poor lighting conditions with acceptable, although rarely optimum results.

Some new cameras, such as the one shown in Fig. 4, offer auto-focus systems. In those systems, all you need do is point the camera and shoot; the focusing is done electro-mechanically. The auto-focus system can be overridden when needed, such as in a close-focusing situation.

All color cameras must be adjusted for the specific lighting situation. That is because the characteristics of different types of light, or the light's color temperature, can affect the way an object appears. That is the reason that some type of color compensation or a color-temperature control is needed. In its simplest form, it can take the form of a filter that is placed over the lens. More advanced cameras have two to four preset adjustments that balance the camera for the ambient light conditions. Those adjustments are selected by a switch on the side or rear of the camera.

For the most precise adjustment, some cameras add a fine-tuning or white-balance control. That control gives the camera a reference as to how a white object should appear under the prevailing lighting conditions. To set it, simply point the camera at a large white object that is illuminated by the light you will be using, and adjust the control until a meter (either in the viewfinder or on the outside of the camera) gives the proper reading. That control must be adjusted every time the lighting changes.

Other features to look for include automatic fade-in and fade-out, locking controls that prevent accidental operation, mounting brackets for auxiliary microphones and lights, and a tripod mount. All of those lend more flexibility to your camera.

Shopping around

Shopping for a video camera is a lot like shopping for any high-technology electronic product, only perhaps a little harder. If at all possible, try a camera out under daylight and low-light conditions. Also try out the controls to see if they can be adjusted easily. Another important thing to check is the focusing mechanism: see if the camera focuses easily and, in the case of TTL cameras, if the focusing aid (either microprism or split-image rangefinder) is easy for you to use. Among the specifications to look for are the signal-to-noise ratio, the resolution, and the minimum-illumination level.

Most video cameras are small and lightweight. But weight is not the only factor that determines how comfortable a camera is to use. Balance, location of the viewfinder and controls, shape of the handgrip, and many other factors all play a part. Also, it is possible that a camera could be too light, making it difficult to hold steady. Broadcast-camera manufacturers actually add weight to their units to make them easier to use.

As you can see, there are quite a few choices to be made when you purchase a camera. To help get you started, we've compiled a list of camera suppliers (see Table 1). **R-E**

TABLE 1

VIDEO CAMERA SUPPLIERS

Akai America Ltd.
800 W. Artesia Blvd.
Compton, CA 90220

Cannon
10 Nevada Dr.
Lake Success, NY 11040

Curtis Mathes Corp.
1 Curtis Mathes Pkwy.
Athens, TX 75751

GBC CCTV Corp.
315 Hudson St.
New York, NY 10013

General Electric
Portsmouth, VA 23705

Hitachi
401 W. Artesia Blvd.
Compton, CA 90220

JVC Corporation
41 Slater Dr.
Elmwood Park, NJ 07407

N.A.P. Consumer Electronics Corp.
(Magnavox, Philco, Sylvania)
I-40 and Straw Plains Pike
Knoxville, TN 37914

Panasonic
One Panasonic Way
Secaucus, NJ 07094

Quasar Company
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 Keystone Pl.
Paramus, NJ 07652

Sony Corporation of America
9 W. 57th St.
New York, NY 10019

Technicolor
299 Kalmus Dr.
Costa Mesa, CA 92626

Zenith Radio Corporation
1000 Milwaukee St.
Glenview, IL 60025

VIDEODISC SYSTEMS

What's the difference between the four systems? How do they work? Which system will best fit your needs? The answers to those and other questions can be found below.

BEBE F. McCLAIN*

VIDEODISC TECHNOLOGY IS FAR FROM NEW: MANY SYSTEMS have been developed over the years. Today, only four systems are being marketed—or are planned to be marketed—before 1982 comes to a close.

Over 50 years ago, John Baird recorded video signals on a wax disc. During the half century that has passed since then, videodisc systems have been developed independently by Hitachi, I/O Metrics, SEO, Syndor Barnt Scanner Corp., Digital Recording, Robert Bosch, and MDR. And those are the systems that never came to market!

In the 1960's, a good deal of work that was done by 3M and Westinghouse greatly advanced videodisc technology. But it wasn't until the 1970's that decisions were made that resulted in the four systems that exist today. During the past 10 years, an ever-increasing program of research and development devoted to videodisc systems has resulted in an explosion of technology, and a number of systems.

The first system to be marketed was developed by Teldec (Telefunken-Decca). It is no longer available. That system used a grooved 20-cm (approx. 8 inches) flexible disk that was read by a stylus.

Those systems that *did* survive, were developed by the following companies:

RCA	CED system has stylus riding on grooved disc with pits.
JVC	VHD system has stylus riding on non-grooved surface with pits.
Philips MCA	Reflective optical system uses a laser to read shiny disc with pits.
Thompson CSF	Transmissive (non-reflective) optical system uses a laser to read clear disc with pits.

While all four of those systems will have become available before the end of 1982, it is difficult to predict whether all four will survive. The first three systems are aimed at the consumer market. The fourth (Thompson-CSF) is definitely an industrial unit that is much higher priced: the discs it uses are not commercially available but must be custom-made for the user. Yet there are numerous applications for that system in business and industry.

Videodisc systems were developed because they are the most economical way to mass-produce programs containing both audio and video information. A single master disc is made, and from it (just as with audio-only recordings) thousands of discs are pressed quickly and inexpensively.

The stamping takes only seconds, and the raw materials are few and inexpensive compared to videotape duplication. Even more important: The picture quality delivered by a videodisc is better than that from a ½-inch VHS- or Beta-format videotape. And the sound is high fidelity, stereo and/or dual-language capable.

The more industrial-oriented type of videodisc players are able to find and freeze-frame any one of the more than 50,000 frames crammed into each side of the disc. That means that 50,000 individual pictures could be stored on one side of a disc, then called up and displayed on the TV screen in seconds. As opposed to videotape machines, a videodisc machine can freeze frames for long periods of time.

Unlike the home videotape machines, the videodisc machines are used for playback only; they can not record. When a videodisc is played back, the video picture is displayed on the screen of a conventional TV (color or B&W) and the accompanying audio comes through the TV speaker. Some videodisc machines have stereo capability, but they must be hooked up to a home-stereo system to make use of it. None of the four videodisc formats are interchangeable.

A typical videodisc is about the same size as an LP phonograph record, but contains both audio and video information. The information is contained in pits arranged in spiraling tracks or grooves on the disc.

Let's take a brief look at the relationship between the TV signal and the pits on the disc. The TV signal that represents the program that is eventually put on a disc is composed of three separate signals. Those elements are: a) luminance (brightness), b) color, and c) sound (see Fig. 1).

The peaks and troughs (tops and bottoms of the signal (d in Fig. 1) are "clipped" off. The distance between each wave (e) is representative of the length of the pit that is engraved into the surface of the disc. The length of the pits and the number of pits per second determine how the picture on the screen will look. When a disc is played, the pits are read and changed back into a TV signal.

Videodiscs that have grooves, have many more grooves than stereo phonograph records. In fact, 50 to 75 grooves filled with video information fit into a space the width of a human hair.

*This article is an excerpt from Bebe McClain's forthcoming book on videodisc systems and manufacturing.

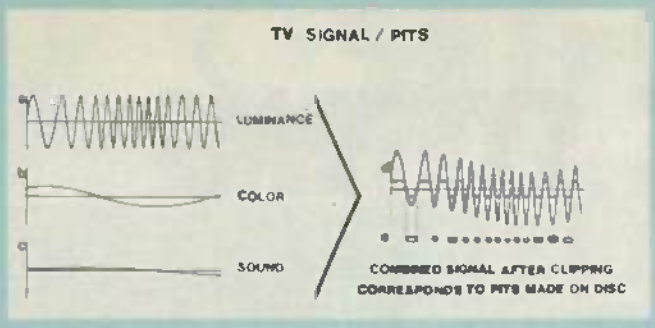


FIG. 1—THE TV SIGNAL placed on the disk is composed of three separate signals—luminance, color, and sound.

There are two basic types of videodisc players. One is the optical player that uses laser light to read the pits in the tracks of the disc. The other is the capacitance player; it uses a stylus that actually rides the surface of the disc. That stylus, in combination with the disc itself, forms a variable capacitor that converts the signal placed on the disc into an electronic representation of the TV signal originally recorded. There are two different kinds of capacitance-type disc players. One plays a disc that has grooves (the CED system); it uses a diamond stylus. The other (the VHD system) plays a disc that has a grooveless surface and uses a diamond or a sapphire stylus. In both versions the stylus actually contacts the surface of the disc.

There are two optical-type disc players, too. One plays a reflective disc (Philips), while the other (Thompson CFS) plays a clear, transmissive disc that allows light to pass through it. Both use a laser beam whose light focuses on pits in the disc. Nothing physically contacts the disc's surface during playback in either of those optical systems.

The capacitance system with grooves was developed by RCA; the grooveless capacitance system came from JVC. The names listed in Table 1 and Table 2 are interchangeable.

TABLE 1—CAPACITANCE SYSTEM
Mechanical, Contact Stylus

CED (Capacitance Electronic Disc
Grooved
RCA System
Selectavision
VHD (Video High Density)
Grooveless
JVC System
Matsushita System

The optical systems, as a group, are often called VLP (Video Laser Player) or Laservision. The optical system that uses a reflective disc is usually defined as reflective optical. The optical system that uses a clear transmissive system is usually called transmissive optical. The two different formats are often identified by the name of the manufacturer that makes either the player or the disc.

TABLE 2—OPTICAL SYSTEM
Laservision, VLP, Non-contact/Laser

Reflective
Magnavision
Discovision
Sony System
Philips System
Universal Pioneer System
Optical/R
MCA System
IBM System
Laser Disc
Transmissive
Thompson System
Optical/T

All videodisc machines do not include the same special features. Some may offer fast and slow play in either forward or reverse; some have a single audio channel while others have two audio channels. In addition to including special play features, some players have microprocessors built in that make it possible to access any individual frame in the program immediately and either freeze-frame it on the TV or use that frame as a starting point for the program to follow.

The same programs are not available on the various systems. Many film companies, TV program distributors, record distributors, etc., have signed agreements with one or more manufacturers to supply programming. Program availability is one of the foremost concerns of potential purchasers.

RCA's CED system

The CED format uses a grooved disc and a contact stylus (see Fig. 2). It was designed by RCA as a simple, low-cost consumer machine that is very similar to a record player. It uses a diamond-tipped stylus that is easily replaced when h wears out. It plays a two-sided disc that has microscopic grooves in which the stylus travels. There are 10,000 of those grooves to the inch; they are so narrow that you could fit 38 of them inside one groove of a standard LP audio disc.

The stylus has a electrode tip that is actually half of a capacitor. (The disc itself acts as the other half.) As the stylus travels down the grooves on the disc, the resulting capacitance variations generate changes in the electrical signal that are converted into video and audio signals.

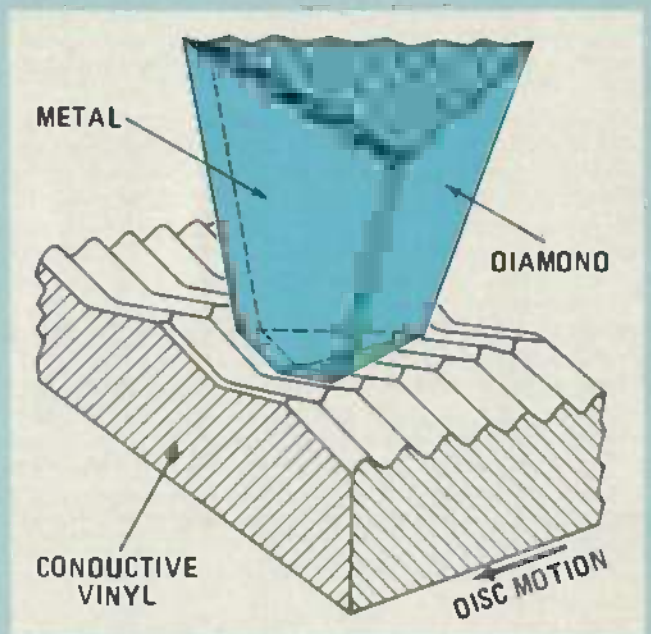


FIG. 2—MUCH LIKE A PHONOGRAPH, the CED system used a diamond-tipped stylus that rides in a groove on the disc. The stylus can be replaced easily.

The stylus rides in grooves that contain pits of different lengths. The stylus senses the electrical changes between where there is no pit and where there is one; the signal that results is transformed into a TV signal.

Because the stylus *does* contact the grooves, the disc must be kept totally clean. It is enclosed in a caddy for protection. The caddy unlocks when it is inserted into a player and the disc is left behind as the caddy is removed.

The caddy is marked side 1 and side 2. Each side plays for one hour, after which the disc must be removed from the player with the caddy, flipped over and re-inserted. On the player, there is an elapsed-time readout, calibrated in minutes, so the viewer can see where he is in the show or can access any particular minute. Other features include visual search that provides a fast-forward or fast-reverse function where the program can be viewed at 16 times normal.

Right now, players that will deliver stereo sound are not available but some discs are being recorded in stereo for use with future playback units offering stereo playback.

In the CED system, four frames of video are placed into each track (one track being one lap around the disc. That means that there are four still pictures read during each revolution of the disc. If one track were played over and over again, as must be done for freeze-framing, four frames would be repeated, and the resulting picture would be jumpy. For good freeze framing only one frame should be repeated. That is why freeze frame is not possible when playing conventional shows on the CED system.

The CED system is by far the simplest system. Because the stylus travels in a groove, there is no need for the additional tracking mechanism that all the other systems need to keep the stylus from wandering all over the disc. Also, since light isn't used as in the optical system, no light-focusing devices are needed.

The CED disc only has one coating applied after it is pressed: that is a lubricant that decreases wear and increases the life of the disc and the stylus.

To date, color-TV manufacturers representing over 50% of the U.S. color-TV market, have indicated their intention of introducing CED-type videodisc players (RCA, Zenith, J.C. Penney, Sears, Sanyo, Toshiba, Hitachi, Radio Shack). RCA has already sold some 40,000 to 50,000 players and hopes to have brought that number to well above 200,000 before the end of 1981. They are also looking for sales of more than 2 million discs made by both RCA and CBS before the end of 1982.

The VHD (*V*ideo *H*igh *D*ensity) system

This system has been seen only in prototype form, but its manufacturers promise that it will be available in the next few months. Originally, JVC and Matsushita developed different systems; but later, they decided that they would both manufacture units using the JVC technology. Matsushita, which owns a large part of JVC, abandoned its technology in favor of JVC's.

The VHD (*V*ideo *H*igh *D*ensity) system uses a grooveless disc that comes in contact with a sapphire (or diamond) stylus (see Fig. 3). The stylus has an electrode tip that reads electrical changes in the same way as the CED system. The main

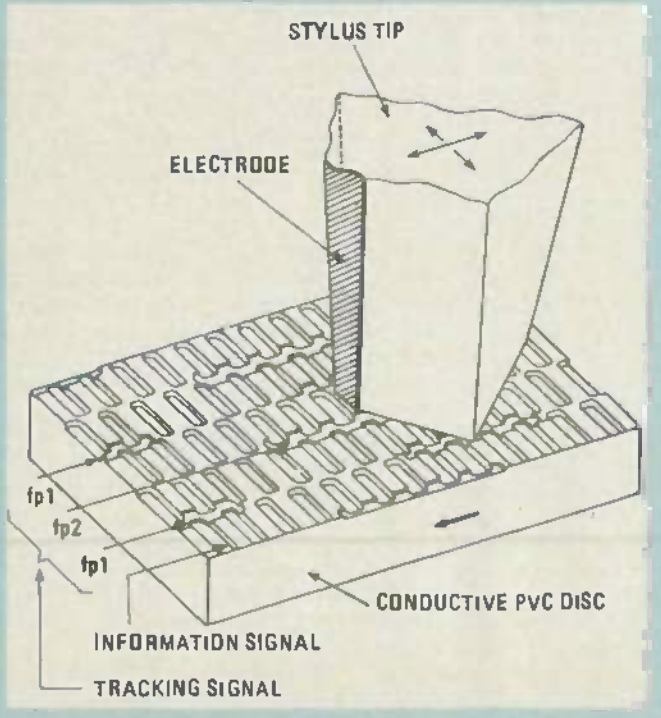


FIG. 3—INSTEAD OF GROOVES, the VHD system uses a series of pits. As in the CED system, the stylus comes in contact with the disc's surface.

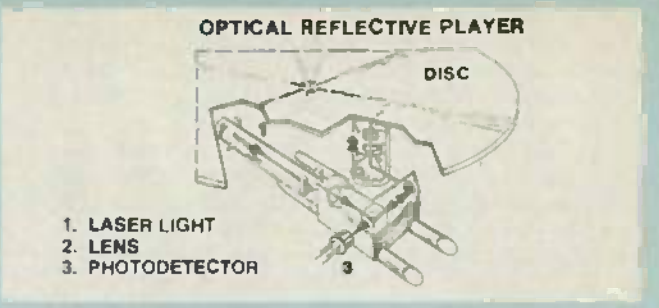


FIG. 4—THE VLP VIDEODISC PLAYER was the first consumer device to use a laser. The three main parts of the system are shown here.

difference is that there are no grooves—only a series of pits in spiraling tracks situated on the disc's surface. Also, like the CED system, the VHD stylus generates different electrical changes as it comes into contact with areas of pits versus areas of no pits.

To explain further, the VHD playback stylus has an electrode that, like the CED stylus, is actually half of a capacitor. The disc is the other half: the electrode detects capacitance variations between the disc and the stylus. Again, the electrical signal is directly related to the spacing and the size of the pits. The resulting signal is converted into a video signal that plays through the TV. The pits are similar to those in the CED system, but they are turned sideways.

There are no grooves to guide the pickup stylus and keep it on the right track, so a tracking signal must be recorded on the disc. A corresponding tracking servo system is needed on the VHD stylus, to make the adjustments needed to keep the stylus on track.

As the VHD stylus travels over the disc, it comes into contact with 10 times more of the surface than the CED stylus does in the CED system. As in the CED system, the stylus must be changed when it wears out. The VHD disc is smaller than 12-inch CED disc: it's 10.2 inches, and it also must be enclosed in a caddy to protect it from dirt and scratches.

The VHD disc plays for 60 minutes on each side and must be removed from the player using the caddy, turned over, and then reinserted to play the flip side. There is variable slow and fast motion. The discs have two soundtracks, so stereo is possible if the system is hooked up to a home-stereo system.

Since the VHD system has two frames per revolution, it cannot have still frame. An optional unit is available to use with JVC's player that allows for still framing. Another optional unit makes the VHD player capable of playing digitally recorded super hi-fi audio (PCM) discs. By offering those options, the VHD system can be aimed at both the industrial and the consumer market.

Player and disc manufacturers are General Electric and the Matsushita affiliated companies, JVC, Panasonic, and Quasar.

Optical reflective system

The third system of the four present disc systems is the optical reflective format developed by MCA and Philips. This player (see Fig. 4) was the first consumer product to use a laser. The disc it plays is a record-type one, but with no grooves. It has a smooth, silvery, mirror-like surface as opposed to a grooved surface. It does not use a stylus. A safe, low-power gas laser light acts as a tracking guide and pick-up system as it scans across engraved pits on the disc.

A spiral series of pits around the disc form tracks. One track plays per each revolution of the disc. That represents one frame (one still picture) of the program. There are 54,000 tracks (with one frame each) on each side. It takes 1/30 of a second for the laser to scan one of those 54,000 tracks. Because one revoluton plays only one frame, it is possible to "still frame" a picture on the screen by repeating the same frame. (The laser just goes around the same track over and over again.) That is important for industrial and educational programs, where viewers want to stop the show and/or cata-

logue thousands of still pictures.

One side plays for 30 minutes. This unit also has multiple speeds in addition to standard play. They include both fixed- and variable-speed slow motion, fast motion, and rapid scan, in both forward and reverse.

If the disc being played was recorded in stereo, the disc player can be hooked up to a home stereo system with an amplifier and two speakers for stereo sound. It would otherwise play through the TV speaker, which is monaural.

A long-playing disc called CLV (Constant Linear Velocity), that has 60 minutes per side, can be used on the player—but the still frame and multiple speeds are sacrificed.

Looking at this in more detail, the standard play, referred to as CAV (Constant Angular Velocity), has 30 minutes per side. Those discs have one frame per revolution. Since, in the standard play, the disc is always turning at the same speed it takes longer to go around an outside track than an inside track. The pits are more spread out on the outside rim and closer together on the inside rim. To extend the playing time, the CLV disc (Constant Linear Velocity) was developed. By putting the pits closer together, four frames of picture could be put on the outside tracks instead of one. That number gradually decreases to one frame as you proceed to the innermost tracks. Since there is more than one frame of picture in some tracks, it would be impossible to repeat one revolution of the disc over and over for a still-frame effect. This long play is for movies and entertainment programs, where 60-minutes-per-side is desirable.

Let us now take a look at the technology behind this optical system. The reflective discs are covered with a metallic coating that enables the laser beam to reflect off the surface, through a lens, and onto photodetectors in the player.

As Fig. 5 shows, the laser (1) travels through the lens (2) and is reflected off the disc back through the lens (2) and out into the photodetectors (3). The actual system has a more complicated path than shown; the beam is reflected by a series of mirrors before it strikes the disc.

The end result is that the laser light, reflected by the disc, is concentrated onto a photodiode inside the player. When a light hits a pit in the surface, much of the light is diffracted about and is not reflected back into the lens. In essence, less light is received when a pit passes in front of the lens than when a smooth section of the disc does. In that way the pits modulate a current.

Because the optical reflective system uses a disc that has a protective coating, no caddy is needed. The pits are actually imbedded in the disc underneath the protective coating. Since no stylus contacts with the disc, dirt or scratches on the surface do not affect the playback. The disc is removed from the jacket and placed on the disc player's turntable as is done with a phonograph record.

An optical system is more complicated than a capacitance system because it has more mechanisms. Two additional systems are needed—one to keep the beam focused on the pits and one to keep the beam on the right track.

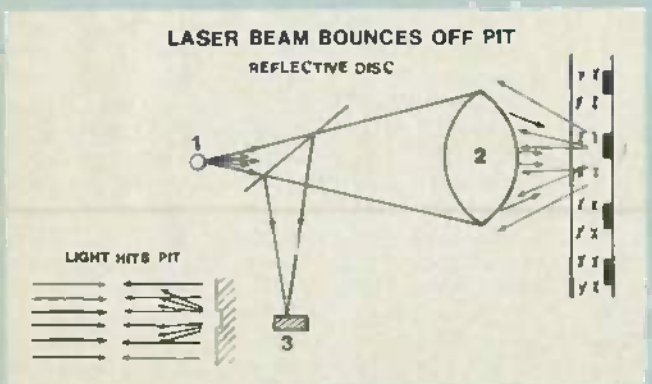


FIG. 5—THE LIGHT FROM THE LASER goes through the lens, is reflected by the disc back through the lens, and is picked up by a photodetector.

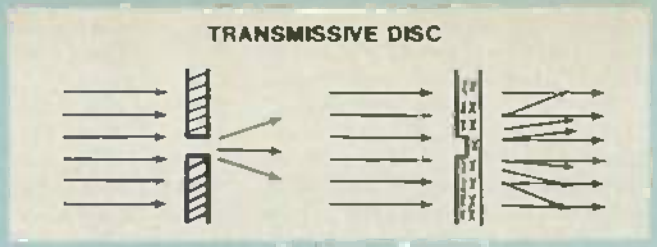


FIG. 6—IN THE TRANSMISSIVE OPTICAL SYSTEM, light from the laser passes through the clear videodisc.

The light beam needs a servo system to stay correctly focused on the pits within the track as the disc rotates. If the disc moves (vertically) up or down the light beam will not be focused on the track. To compensate for any such movement, there are two photodiodes, one on each side of the slit through which the light beam passes. After the beam passes through the objective lens, it hits the disc and reflects back equally onto the photodiodes. But if the disc changes position (moves vertically) the light beam is reflected more onto one photodiode than onto the other. Sensing that, the lens refocuses so that the light is evenly reflected.

In addition to that focusing system, a tracking system is needed to insure that the beam stays on the track and does not wander radially across the surface of the disc. As the main laser beam strikes the disc, two other light beams also strike it—one on each side of the main beam. Those two additional beams send information back to separate photodetectors that are part of the tracking system. The system adjusts the main beam radially to keep it on track.

It is interesting to note that in the optical system the pictures in the outer tracks are better than those in the denser inner tracks, and yet the manufacturers have seen fit to have the optical discs play from the inside to the outside. (The CED and VHD systems play like records—from the outside in.) That means that the first pictures seen are of the poorest quality found on the disc.

Transmissive optical system

The fourth and final system to be outlined is the optical transmissive format developed by Thomson CSF. It is designed for the industrial and educational market, and is priced at more than $3000 for the player. It can be interfaced with a computer for retrieval of information.

Thomson and 3M are mastering discs in this format. The price for having a program mastered is over $1500 for one side (30 minutes). Replication of discs from the master costs on the order of $18 each.

The system works on a method similar to the reflective optical system in that it uses a laser beam that reads pits that have been developed on the disc in spiral tracks. There are two sides to the disc, with pits on each side.

The disc is transmissive to light and the difference in the path of the laser light where there are pits, as opposed to where there are no pits, causes the modulation as the beam travels along the track (see Fig. 6). The laser light shines through the disc to photocells underneath the disc. Unlike all the other systems, it is not necessary to turn this clear disc over, since the laser can refocus on the bottom side. Since a protective surface is not applied, the disc uses a caddy that inserts with the disc into the player and is then removed (as with the CED and VHD system).

Like the reflective disc, one revolution represents one frame. Therefore, still framing is possible by merely repeating the same frame; variable fast and slow motion both forward and reverse are possible, too. There are two audio channels, but stereo play is not available now since only one channel can be played at a time.

As you can tell, that unit is intended to be interactive with the viewer and is not for the mass market, where viewers usually watch a program uninterrupted and do not need special features and retrieval capability. R-E

VIDEO GAMES

Enjoy the action and excitement of an arcade in the comfort of your home with one of these video-game systems.

DANNY GOODMAN

THE HISTORY OF THE HOME VIDEO-GAME DID NOT BEGIN IN guarded research labs of the late 1960's, where engineers worked round the clock trying to control blips on a TV screen, but in a bar in Sunnyvale, California. There, in 1972, Nolan Bushnell, founder of a small electronics company called Atari, was called in to fix a prototype *Pong* video game he had installed only two days earlier. The fault he discovered, was not in the circuit, but in the coin box—it was jammed to the gills!

It didn't take long for the game to appear in a coin-operated home version that hooked up to your TV set. You may remember the first Magnavox *Odyssey* video game—a simple gadget compared with today's—that sold in 1972 for about $100, even though the graphics were so limited that a TV-screen overlay was required for the background.

The home video-game has come a long way since those days. During the first few years, products were replaced every six months by less expensive models with more game variations. Things have been a lot more stable since 1977—the year that the first cartridge-programmable video game was introduced.

The programmable games released the avid game-player from buying an entire console unit for every new video game that came out: he could update his master console with a $25-$30 plug-in cartridge. And today, they're still selling like mad! When the sales figures for 1981 are finally tallied, they should show that nearly 2½ million consoles and over 20 million cartridges were sold. Now, a new coin-operated arcade game called *Pac Man* is breaking all records. The world seems to be going video-game crazy. For those of you who have had your eye on one of those home video-games, we'll take a close look at three of the major systems and see what kinds of games those machines play.

Atari *Video Computer System*

The Atari *Video Computer System*, which sells for under $200, is one of the survivors from a treacherous time in video-game history that saw the end of at least one formidable opponent, Fairchild's *Channel F* video game. Atari held on through the tough times, slowly rewarding early *Video Computer System* buyers with more and more cartridges. Atari now offers 43 different cartridges—the largest library of any video-game maker—and another dozen compatible game packs are available from a company called Activision (see below).

FIG. 1—THIS REMOTE-CONTROLLED Atari *Video Computer System* eliminates the controller wires and lets you control the action from anywhere in the room.

The Atari game console is a modest-looking affair, with a series of slide switches for power, color/black-and-white TV, game select, game start, and difficulty. The rear panel has a jack for the output from the power pack that plugs into the wall (that setup keeps the potentially-warm power transformer away from heat-hating IC's) and two nine-connector jacks for the hand controllers.

Two different types of hand controllers come with the console unit—joysticks and paddles. If you jump around from cartridge to cartridge, switching controllers gets to be a problem, with cords sometimes getting tangled up. Joysticks are used by 28 of the cartridges, paddles by 10. Two optional controllers are also available. Keyboard controllers with 12 pushbuttons are used by four of the cartridges; steering controllers are packaged with the only cartridge that uses them, *Indy 500*.

To help eliminate the maze of wires running to and from the console, Atari is gradually introducing a new wireless model (see Fig. 1). The wireless model, which sells for about $100 more, looks like something out of the 21st century. But a close inspection reveals the same console controls as the hard-wired version, but in pushbutton form. The control panel also has red LED's to indicate how the controls are

set: those can be seen from across the room.

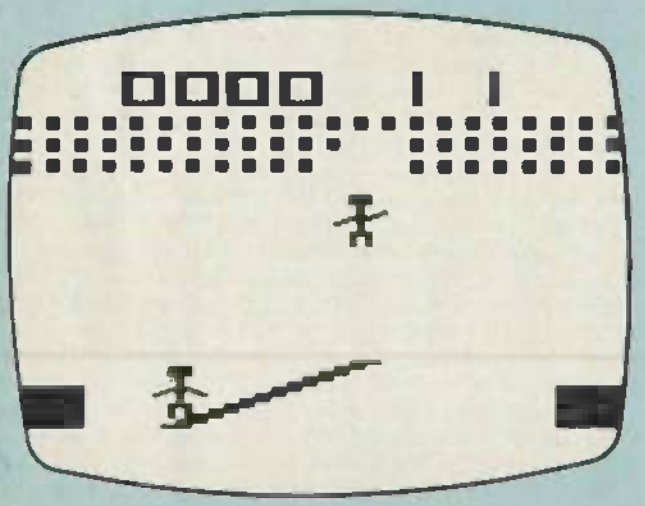
The wireless unit accepts all of the available cartridges. Furthermore, we are told that aside from remote control, there is nothing about the wireless unit that will make the wired version obsolete.

The wireless hand-controllers are stored beneath a flip-top cover in the unit, keeping everything together. The controllers themselves have some well-conceived features: Each controller is a combination joystick *and* paddle; also, GAME SELECT and GAME RESET pushbuttons are on each controller, so you don't have to get up to start every game. The only thing missing is a robot arm to switch cartridges!

One of Atari's major attractions has been its ability to adapt very popular arcade video games to the *Video Computer System*. Since Atari makes many of the arcade games, they pretty much know which are the hottest. Most Atari cartridges have multiple-skill levels or variations in play—the 43 cartridges offer a total of almost 950 variations! Instruction pamphlets are, for the most part, easy to follow. A number of the cartridges offer truly challenging play. You should consider the following if you choose the Atari game:

Missile Command, from the arcade game of the same name, places you at the control of an antiballistic-missile base charged with protecting six cities. That by itself would be easy, except that your base and cities are under attack from waves of interplanetary ballistic-missiles and cruise missiles. For each wave, you have 30 ABM's (in three magazines of 10) to intercept the enemy missiles. Using the joystick, a cursor is moved to the point on the screen where you want your ABM to intercept enemy missiles; your ABM's are "launched" using the red button on the controller. An ABM rushes up to that spot and explodes. If the enemy missile is touched by the ABM's blast, it is destroyed. As you successfully defend each wave, another, more intense wave follows. Missile Command can be played by one player, or by two players taking turns. There is also a beginner's level so that you can get the feel of the game.

Adventure is a challenging game of logic, memory, and often hair-raising action. Your task in this one-player game is to locate an enchanted goblet hidden somewhere within castles, dungeons, and mazes of a video kingdom, and restore it to its proper castle. Other objects help you in your hunt: keys to castles, a bridge to go through dead-end mazes, a magnet to retrieve objects stuck in walls, and a sword for protection—but you can only carry one thing at a time. There are also three hungry dragons who will gleefully chase you through a pitch-black maze just to eat you. And just when you think you've got the game licked, the "magic flying bat" steals away your prize and hides it somewhere else. The game offers three levels of difficulty, in steps carefully planned to give you the feel of the kingdom and its mystical objects and inhabitants. The top level is the best, with all the objects scattered about at random.



ONE OF THOSE GAMES that sounds almost too simple to be fun, try *Circus Atari* once, and you'll be hooked.

Circus Atari is one of those games that sounds almost too simple to be fun—but try it, and you'll be hooked. It has a broad appeal, perhaps because it is based on a humorous premise instead of attacking alien invaders. Two circus clowns must propel each other on a teeter-totter to hit and puncture three rows of balloons overhead. Your job is to position the teeter-totter under a falling clown so the other can get up there to break more balloons. Except it's not always easy to predict where those guys are going to fall. And if you miss—SPLAT! With a little practice you'll learn how to get the clowns to jump to the high-scoring top row. Every time you eliminate a row of balloons, a new one takes its place. One variation of the game changes the speeds of the jumping and falling clowns at random. *Circus Atari* can also be played by one person, or two can challenge each other, taking turns when an opponent's clown hits the floor of the "Big Top."

Activision cartridges

Atari owners have the advantage of a second source for game cartridges. After all, it takes a great deal of time to design, program, perfect, and document a consumer-oriented program, and there are only so many games a company even as large as Atari (or Magnavox or Mattel) can produce at one time. Activision is a company founded by four Atari game designers who went out on their own in late 1979. It has produced 12 cartridges for the Atari *Video Computer System*. Many of them have won awards in video magazines.

One significant feature of the Activision games is the quality of the instruction pamphlets. For the most part, they are easy to read, and get you playing the game very quickly. They also give you playing tips right up front, rather than having you learn the game's idiosyncracies along the way. To give you something to try for, most games against time or the computer offer you a chance to earn a membership emblem in a "club" for that cartridge by attaining specific scores. All you need is a photo of the TV display with your score on it. Each pamphlet also has a photo of the designer, with a few paragraphs about some of the game's special aspects. Whether or not those blurbs were actually written by the designers, they add a personal touch to the package not found on any other video-game cartridge.

Skiing is a one-player game offering your choice of slalom or downhill runs of varying length and difficulty. Unlike the usual "bombs away" video game, this one requires a light touch on the joystick to maneuver your skier through the gates. Just as in real life, it is a race against the clock, with elapsed time plus either the number of gates left on the slalom course, or the distance in meters remaining on the downhill run, displayed on the screen. The time to shoot for in the hardest slalom course is 28.2 seconds. A time better than that qualifies you for the "Activision Ski Team."

Freeway is an Activision game that is just plain fun for kids as well as adults. Here, one or two players try to maneuver as many chickens as possible to the other side of a 10-lane superhighway in two minutes and sixteen seconds. If a chicken gets hit by a car or truck, it has to go back, so you've really got to dodge the vehicles as they race by at varying speeds. As a warmup, you can try game 1, which is called "Lake Shore Drive, Chicago, 3 A.M.," with little auto traffic. Then you can build up to rush-hour car and truck traffic on Dallas' "LBJ Freeway." If you're good enough to get at least 20 chickens across, you can apply for a "Save the Chicken Foundation" membership emblem.

Kaboom is a maddening test of hand-eye coordination. The "Mad Bomber" runs back and forth at random along the top of the screen dropping live bombs; you can hear the lighted fuses crackle. You start out with three buckets of water, with

THE CONSOLE of the Magnavox *Odyssey²* looks more like a computer than that of any other video game.

which you must catch the bombs before they hit the ground, gaining points for each catch. If a bomb hits, all the bombs remaining on the screen explode; you lose a bucket, and the "Mad Bomber" smiles. But for every 1000 points, you can earn back one lost bucket. The "Mad Bomber" starts bombing slowly enough for novice players to get the hang of it. But each succeeding wave of bombs gets longer and much faster—up to 13 per second. It has all the addictive tension of a space invaders-type game, but is purely defensive. And 3000 points gets you in the "Bucket Brigade."

Magnavox *Odyssey²*

In the same price class as the Atari game is *Odyssey²* by Magnavox. It does not yet have as many cartridges as the Atari, but it offers a selection of games in arcade style, sports, and a few elementary-education activities.

The game console looks more like a computer than any other video game. A touch-sensitive typewriter-like alpha keyboard comes into play on a few games; numeric and reset keys are used with every game. A set of universal joystick controllers are hard-wired into the rear of the console—there's no need to switch around controllers from game to game. One welcome feature on the controllers is that there are shallow slots at each of eight directions around the circle; that comes in handy when trying to maneuver accurately along a diagonal path. With other games' controllers, you're never quite sure where that diagonal position is—which can cost you valuable time in getting away from some video attacker.

The majority of cartridges for the *Odyssey²* have coarser graphic displays than other video games. Characters and objects tend to be very block-like, and animation is somewhat stiff. But those characteristics would be noted primarily by frequent arcade game-players who are accustomed to high-resolution graphics requiring more program-memory capacity than *any* home video game. Younger children, and adults who don't get to the arcade too often, should thoroughly enjoy the *Odyssey ²* games.

Blockout! and **Breakdown!** are both offered in one cartridge. The object in *Blockout!* is to work your way through the four rows of colored blocks by paddling a ball up against them to destroy them. This part of the game is similar to Atari's *Breakout*. But there's an added challenge here—either the computer or a second player has control over little men on the rows of blocks who can restore destroyed blocks. Play goes on for 90 seconds, or until the offense breaks through. Then sides change, and the second player tries to outmaneuver his opponent. There are more subtleties to the game, with added variations in *Breakdown!*, that make this a highly competitive one- or two-player cartridge.

UFO, is an arcade space-battle game showing that the *Odyssey²* is capable of more detailed graphics displays than earlier cartridges indicated. As master of a battle cruiser, you meet a screenful of roving UFO's, some of which are quicker and more powerful than others. Two types are kamikazes that try to ram you. A third shoots at you, with deadly accuracy. Fortunately, your cruiser is surrounded by a force field that will ward off some shots at you and will destroy some of the kamikazes. Unfortunately, when your force field is hit, it is temporarily drained and needs an interminably long second or so to recharge. Fortunately, you also have a laser cannon to shoot at any UFO. Unfortunately, firing your laser also drains your energy field for a moment, making you open to attack. Fortunately, you can zoom all around the screen to escape or attack. Unfortunately, the direction of your laser is dependent on your direction of flight, which means you have to fly toward your menacing target. The alpha keyboard comes into play with UFO because you can enter the name of the highest scorer on the screen, where it stays for as long as the current series of games continues. Any number of players can take their shot at beating the highest score, and having both their scores and names appear for all to see.

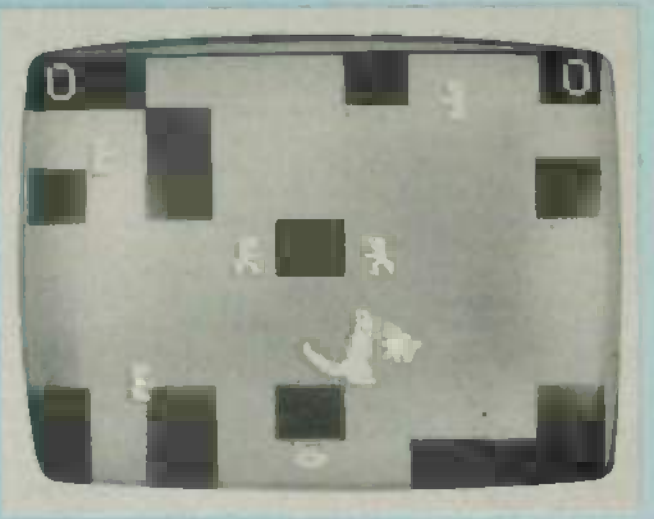


FIG. 2—FIREBREATHING DRAGONS. Doomwinged Bloodthirsts, and assorted other nasties inhabit the castles in *Quest For The Rings*, the video/board game for Magnavox's *Odyssey²* video-game system.

The Quest For The Rings, is a Master Strategy series game (see Fig. 2). At almost $50, it is the most expensive cartridge for any video game, but is more than just a cartridge. It is unquestionably the most elaborately packaged game around. Instructions are contained in a 30-page book with a gold-color-foil stamped cover; but what really makes *Quest For The Rings* unique is that it is both video game and board game. Here's how it works.

The first player (the "Ringmaster") hides ten ring tokens and assorted monster tokens under 23 castle tokens at each castle location on the game board. The game board is a map of a mythical land, with roads connecting the 23 castle locations. Two other players work together, advancing from castle to castle to search for all 10 rings. At each castle, they must search a dungeon, cavern, shifting hall, or inferno as designated on the underside of the castle token. The search takes place on the video screen, with the heroes using the controllers to go after the rings and escape the monsters. The conditions of each search are entered into the *Odyssey²* by the "Ringmaster," with the aid of a special keyboard overlay. The action shifts back and forth between board and video screen throughout the quest.

There are, of course, many more aspects of the game that take a little time to learn, but is well worth it. Graphics are rather detailed, especially when the "Doomwinged Bloodthirsts" gobble up a hero, or as the fire-breathing dragons huff about. There are also provisions for one or two heroes to practice against monsters in the various kinds of castles. This

is best as a three-player game, although just two can also play.

Mattel *Intellivision*

The newest video-game system is Mattel's *Intellivision*. It is priced at about $100 more than either the Atari or Magnavox units, but for that extra money, you get superior graphics, a better utilized sound package, more complex games, and the prospect of adding a keyboard unit that will offer you a full-fledged home computer (see Fig. 3).

The computer-keyboard component should be available nationally by the fall of 1982; it will sell for about $500. It features a 60-key typewriter keyboard and cassette player for prerecorded programs. Planned software includes *Conversational French* (with audio also on tape), *Physical Conditioning*, *Stock Analysis*, *Super NFL Football* (with instant replays), and educational programs. Mattel has also been demonstrating a voice-synthesis peripheral, which may be offered some time in 1982.

In the meantime, we have the *Intellivision* game console, an uncomplicated unit with an on-off slide switch and reset button on the top panel. Two game controllers are hard-wired to the top of the unit using coiled cords. When not in use, the controllers and cords are stored neatly in the console.

The universal controllers have a variety of action buttons (2 on each side), a 12-button numeric keyboard, and a direction disk capable of steering in 16 directions. To veteran players of Atari and Magnavox games, where you watch the screen while your hands work the controllers automatically, the *Intellivision* controllers may seem distracting on a number of games; you often need to input keystrokes during play. But that is also an advantage to the skilled player looking for challenging games requiring strategy and offering more realistic play. Many of Mattel cartridges are sports games, with two-player action only, not one versus the computer.

NASL Soccer is one game in which you don't need much eye contact with the controller once the game gets going. The offense controls the man with the ball, with the computer keeping the other offensive players in motion to help out. You can pass the ball to a computer-controlled offensive player. If he gets the ball, you are then in control of the new player. The characters are fairly well detailed, with a lot of animation. Dribbling the ball down the field, the game makes periodic "kicking" sounds—very realistic. On defense, you control the defensive captain and have partial control of the goalie. With the exception of offsides calls, the game has all the major elements of real NASL soccer—throw-ins, goalie kicks, and corner kicks. The sound of two men fighting for possession of the ball is also rather realistic. Side-to-side scrolling of the playing field is smooth, and it gives you the feel of playing on a full-size field.

Major League Baseball is both graphically exciting and an interesting version of America's favorite pastime; here the game is won with good defense. Fielders literally run out to their positions from the dugout. The pitcher has the option of 8 different pitches, or he can throw to any infielder to try to tag out a runner with a big lead. There are no fly-outs in this game. The defense must use the controller to select the fielder who is to pick up the ball, then designate the infielder who is to receive the hit-saving throw. The faster you become in pressing the right buttons on your controller, the easier it will be to keep the offense from getting on base. The offense also has options up its sleeve, like leading off, stealing bases, and bunting. And, of course, there is always the chance of an over-the-wall home run. The game goes nine innings, with extra innings for ties. This too is a two-player game only.

Space Battle. No video game system is complete without some kind of space game, and *Intellivision* is no different. *Space Battle* is a one-player game that puts you at the center of a galaxy under attack by bands of alien ships. You have three squadrons, each with three ships, to defend your "Mother Ship." To survive, you need to deploy your squadrons to the most threatening alien bands, and destroy all their ships before they "zap" your squadron. It is possible to carry on three battles at once, putting two in control of on-board computers, while you watch the action of the third squadron. But you'd better be quick, because there are more alien bands than you have squadrons.

The game starts with you looking at a "galaxy-wide radar screen," showing where the alien groups are. Using the buttons of your controller, you send out the "blue," "white," or "yellow" squadron to meet the approaching enemy. When a squadron encounters the aliens, their position on the radar screen flashes. Pressing the GO TO BATTLE controller button for that squadron, you shift your perspective to the viewfinder of one squadron ship in your space dogfight. Alien ships twist and spin out of the way while firing lasers, just as in the movies. Things really get frantic when you're engaged in combat and you hear the alarm that the "Mother Ship" is under direct attack. But if you're quick and get all the aliens, you'll see "ALL CLEAR" on your radar screen.

FIG. 3—SUPERIOR GRAPHICS is just one of the features of Mattel's *Intellivision* system. The video game is shown here with the optional *Keyboard Component*, which should be available toward the end of 1982.

Conclusion

As with nearly every major purchase, no one video-game system does everything the way you want it. Some players might want the combination of the broad selection of Atari/Activision cartridges, the potential of *Odyssey²*'s alpha-numeric keyboard, the quality graphics and sound of the *Intellivision*, and the uncluttered appearance of the wireless Atari *Video Computer System*. But this overview of three popular systems will give you a feeling for how they compare. Whichever one you choose, though, you will have lots of video fun. **R-E**

VIDEO GAME AND VIDEO-GAME CARTRIDGE MANUFACTURERS

Activision
759 E. Evelyn Ave.
Sunnyvale, CA 94086

APF
1501 Broadway
New York, NY 10036

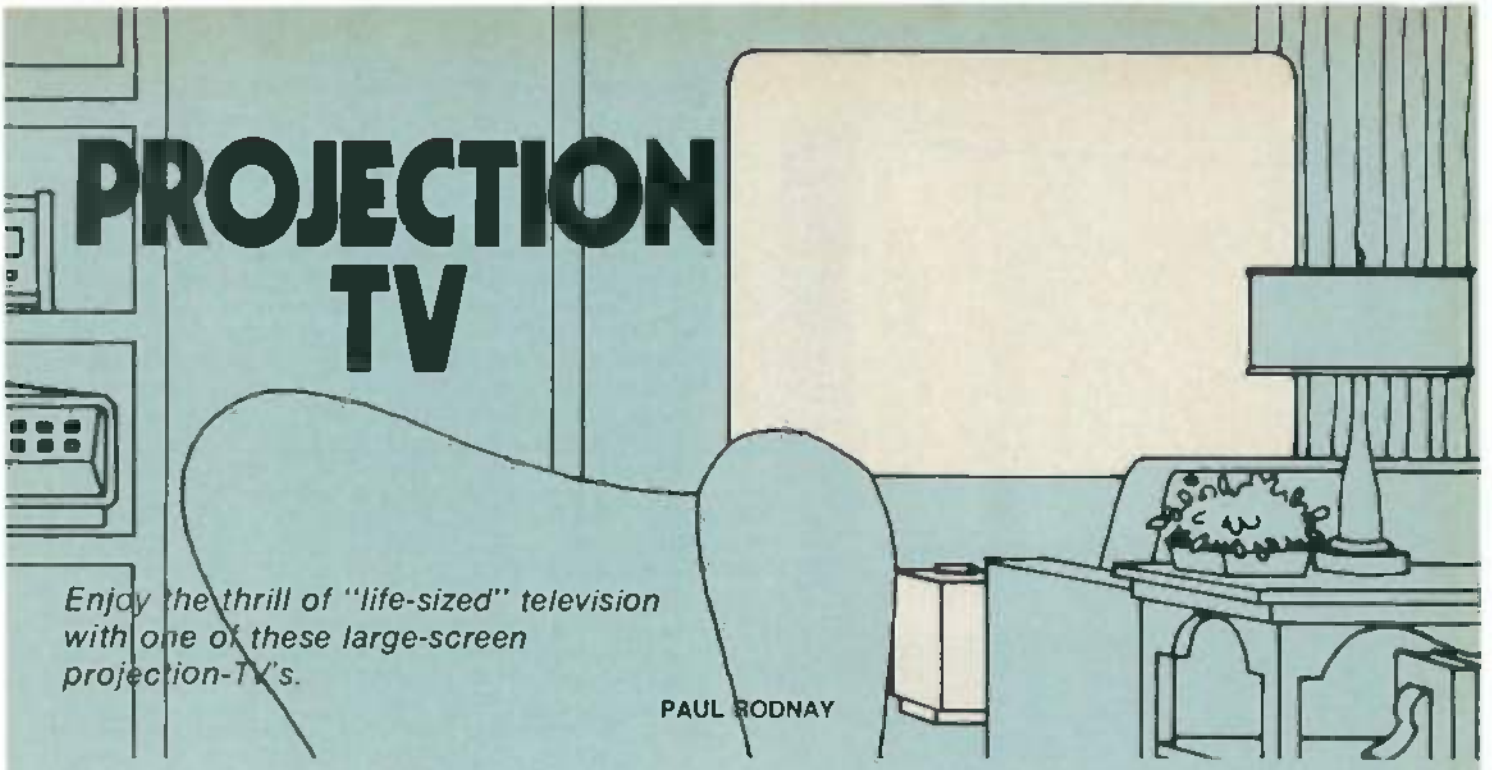
AstroVision, Inc.
6460 Busch Blvd., Suite 225
Columbus, OH 43229

Atari, Inc.
1265 Borregas Ave.
Sunnyvale, CA 94086

Magnavox Consumer Electronics Co.
I-40 and Straw Plains Pike
Knoxville, TN 37914

Mattel Electronics
5150 Rosencrans Ave.
Hawthorne, CA 90250

PROJECTION TV



Enjoy the thrill of "life-sized" television with one of these large-screen projection-TV's.

PAUL RODNAY

HANG-ON-THE-WALL 3-D TV WON'T BE PART OF THIS 1982 VIDEO spectacular. But the big-screen TV *is* here—in the form of projection-television receivers. The only problem the buyer faces is making his decision. Now that doesn't appear to be any more difficult than selecting a new TV does it? After all, once you know you want a set all you have to do is go to your favorite retailer, select the model you want, and then shop around for the best price, right? *Wrong!* It's far from being that simple.

To start, there are three entirely different kinds of projection-TV systems to select from: and the selection's more complicated than deciding how much you want to spend. You could be willing to buy the largest, brightest, and best, but you might not be able to fit it into your viewing room. The three major categories of home projection-TV systems include:

1. Over the screen of a conventional TV receiver—the special lens takes the picture from the TV screen, blows it up, and projects it onto the screen.
2. Front projection—two or three separate projection-TV picture tubes that are coupled to individual lenses. Each tube/lens combination projects its picture (each one is a single color—red-blue-green for 3-color systems; magenta and blueish-green for 2-color systems) onto the screen. The pictures are carefully overlapped to produce a full-color TV image.
3. Rear projection—the tube/lens system is enclosed in a single cabinet, and through a system of mirrors and additional lenses the picture is formed on the rear of a screen mounted on the cabinet front. When that type of receiver was first introduced by General Electric it used a single three-gun projection CRT. The current model has three separate projection tubes.

There is actually a fourth method, too. It goes back to the first days of television—a magnifying lens placed in front of the TV screen. One such unit available today is a Fresnel lens that will double the size of the image you see. Since that is not big-screen television within the scope of this article it will not be mentioned again here.

The problem is further compounded by the different variations available in each of the three basic systems. For systems that simply place a lens in front of the screen of a conventional color set there are glass lenses and plastic ones. There are systems that require 15-inch TV's and others that call for 19-inch sets. There are 2-tube and 3-tube direct front-projection systems as there are 1-tube and 3-tube rear-projection systems. There are front-projection systems that come all in one piece and there are others that have a separate projector and screen.

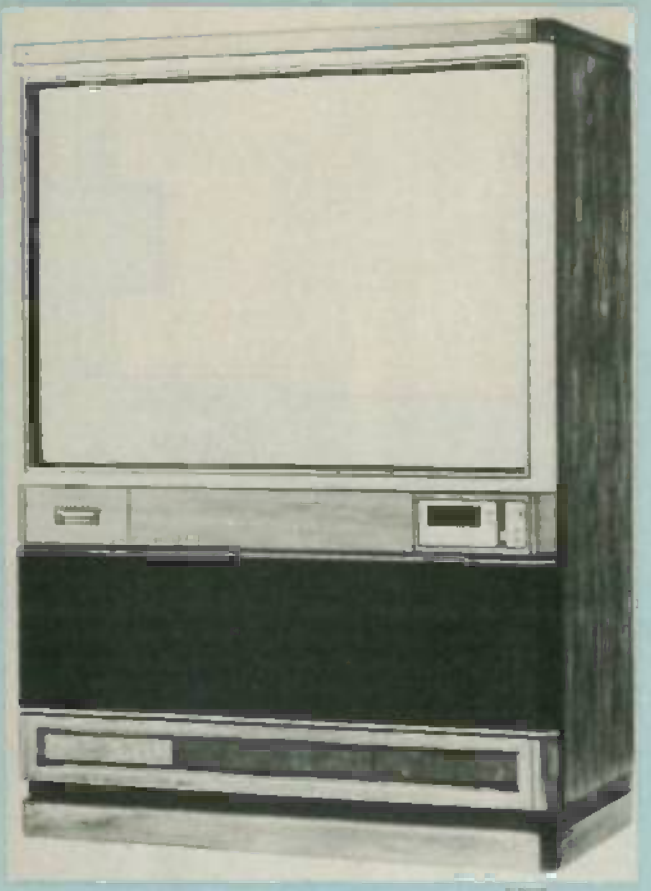
What we are going to do here is give you an insight into the advantages and disadvantages of each of the three basic systems and take a look at the variations and their characteristics. You will then have the information you'll need to select a system that is right for you.

First some basics

The picture on the screen of a TV set is relatively bright. Usually, it is easily viewed—even with relatively high ambient light levels, as long as those lights do not fall directly on the TV screen. Naturally, bright sunlight falling directly on the screen will wash out even the brightest picture. The important difference between direct viewing and projection viewing is that in one instance we are looking directly at the source of the light, while in the other we are seeing the picture after it has been projected and then reflected from the screen to our eyes.

In any projection system that light, in the form of a TV picture, is fed through a lens system. All lens systems cause a loss—less total light comes out of the lens than was fed in. Then it is projected over a distance to a screen. The intensity of the light declines progressively as that distance increases. In addition the image is magnified, so that the light that originally filled—say a 5-square-inch area—now fills a 25-square-inch area. The total amount of light has not changed: it has been distributed over a larger area, so it is now much dimmer than it was originally. As a result, the CRT in a projection system must provide a much higher light level than a directly-viewed TV set, or the image that we see must be viewed in a room with less ambient light.

Another problem that large-screen pictures present can be summed up simply as: "It may be larger, but it won't be better, and it may be worse." That means that the picture quality is determined by the quality of the picture on the screen of the projection tube. Making it larger does not add detail; actually, the larger picture will probably not look as good as the picture on your 25-inch console. The number of lines of information has not changed, so the quality cannot improve! And if you have a less than perfect picture—ghosts, smears, snow, etc.—it will look still worse when it is blown up to 5 or 6 feet across. Every defect in the picture that you



THIS REAR-PROJECTION TV from Panasonic features a three-tube projection system and a 45-inch viewing screen.

receive will be enlarged and emphasized in the huge picture delivered by a projection set. So unless you already have "near perfect" reception, be prepared to buy a new antenna.

Projection through a lens

This is the simplest and usually the least expensive method of delivering large-screen pictures. In it, a lens is placed in front of the screen of a conventional color-TV set. The image is focussed on a screen usually positioned several feet in front of the lens.

The good points behind that system include the obvious fact that it is inexpensive and simple. You can use an existing table-model TV. Generally, the larger the starting screen size, the brighter the image on the screen. Plastic lens systems are available. The only cheaper method than that is a magnifying lens placed in front of the screen—but that would limit the picture to about double the size of the set's screen.

There are disadvantages, too. It's like a movie theater: The viewing room must be kept relatively dark. The TV receiver is not designed to be part of a projector. Its light output level is not adequate enough for it to be used in a normally illuminated room. Since the projection unit includes a complete table-model color TV, it is relatively large and heavy. Positioning the unit and supporting it in a off-the-floor location can become a problem. Screen size is limited by the brightness of the picture that can be delivered. As we explained earlier, the brightness of light projected through a lens suffers a loss. Also, as you make the picture larger that same reduced amount of light is spread over a larger area making it even dimmer to the eye.

One other point about that kind of system. Since you are starting with *only* the light delivered from the picture tube of a TV set, anything less than an excellent lens system will introduce light losses that may not be tolerable. The quality of the lens used in this kind of system is critical. The more light you lose in the lens, the dimmer the picture.

Direct front-screen projectors

Probably the ultimate projection-TV system is the 7-foot screen from Kloss. The picture is gigantic: it's bright, and you'd love to own one. Of course, there are many others. Some combine screen and projection set in a single unit that unfolds. Others are two-piece units—a separate screen and a separate projector. My preference is for the two-piece system. It delivers the largest, brightest projection pictures that are available for home use. Of course, you need a large room. You'll have to keep 5 to 10 feet of space between the projector and its screen and you'll have to find a space large enough to place that screen. In addition, you'll need room to arrange your furniture to make room for people to sit where they can see the screen.

Because of the light problems in watching a projection TV, almost all screens built for projection TV are concave in shape. They focus the light falling on the screen so that it is reflected back at the viewers in a restricted angle. While that reduces the viewing angle, it improves the brightness of the image on the screen. But it also means that you have a limited area in which to arrange seats for the viewers.

In the one-piece sets, the screen and projector are combined into an attractive piece of furniture. When it's time for the news, your favorite soap opera, or that classic great movie, the "furniture" unfolds to reveal a screen and projector. Limitations of the system are the size of the screen. Maximum size is usually 3 × 5 feet. That's several times larger than a 25-inch set, but smaller than that 7-foot screen we mentioned earlier.

Another variation available in those sets is a 2-color projector. Only two projection tubes are used. The colors are combined, using the Land process, and believe it or not you get almost all the colors that a 3-color system would deliver. As there is one less projection tube, the system costs less. The two-tube system definitely works, but I'd recommend spending a little more for the 3-tube system. It is more natural and, most important of all, delivers a brighter picture.

Rear-projection systems

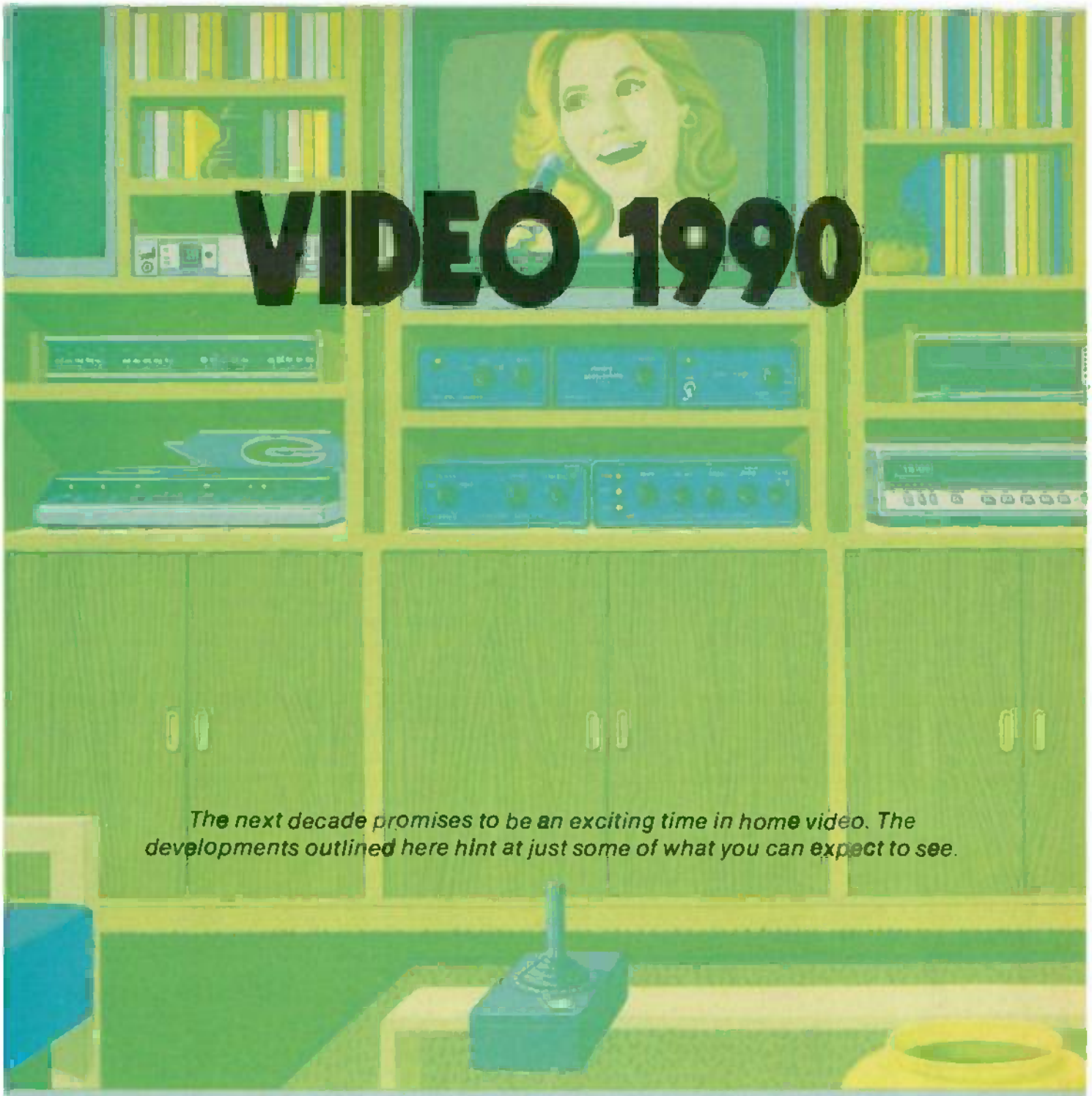
General Electric started this one with a console that had a 50-inch screen, one projection tube, and a set of elaborate optics that kept the picture inside the cabinet until it was projected (from the inside—hence the rear screen) onto the screen. To improve the brightness, G-E went to a three-tube projection system and today that type of TV set is available from a large group of set makers.

The pictures are bright and clear; not as large as those delivered by front-projection systems, of course, but certainly large enough for most viewing rooms. The great advantage of those units is that they are one piece. The space they fill when they are not being used is the same as when they are on, so it is easier to set them up, see how they fit into the room and leave them there. There is also some choice in cabinet styles.

On the negative side, that's one huge piece of furniture. In addition, the optical system is the most elaborate of any of the projection types. If any element should ever go out of alignment you could be faced with an expensive adjustment. Naturally, the manufacturers have sealed the optics to protect them against dust getting in and reducing picture quality; but after several thousand hours of use a cleaning may also be required: that is not a job for an untrained person.

Before you buy

Just like any other major purchase, shop before you buy. Look at all of the systems; see which one suits your needs first. Then, within the system type you choose, shop some more. Look at models, styles, and prices. Investigate warranties, find out who will do the set-up and take care of repairs, should they be needed later. Then buy and enjoy. Once you start watching those life-size images, you may not be able to go back to your table-model set again. R-E



VIDEO 1990

The next decade promises to be an exciting time in home video. The developments outlined here hint at just some of what you can expect to see.

DANNY GOODMAN

WITH ALMOST TWICE AS MANY VIDEOCASSETTE RECORDERS (VCR's) purchased in 1981 than in 1980, it is safe to say that video fever is spreading. More consumers are seeking alternate or enhanced sources of video entertainment because the standard commercial-network fare seems less appealing. At the same time, improvements in microprocessor, digital, and optical technology will likely bring us many new video program-sources, as well as new ways of watching them.

It's surprising, but many "new" ideas aren't new at all. They have been kicking around research labs for decades, with occasional unsuccessful trials in the general marketplace. Like the Avco *Cartrivision* videocassette recorder of the early 1970's, they were products and concepts "before their time"—that is, before most of us were aware that television could offer something other than the Gong Show.

Let's look ahead at the video that is likely to come our way between now and the end of the decade.

Two-channel TV sound

Mention the word "stereo," and the first things that come to mind are hi-fi and music. With the introduction of stereo TV, perhaps as early as 1983, that may change. Actually, "two-channel" might be a better term than stereo; the difference lies in the circuitry, as well as the way it is used.

Stereo, as we said, implies music—which makes up only a small percentage of today's TV programming. But two-channel sound opens the way for multilingual broadcasts of drama, comedy, news, and—lest we forget—commercials. Broadcasters would have a way of reaching the large, varied non-English-speaking population in this country in their native tongues. For example, English might be broadcast on audio channel 1, and a second language on audio channel 2. Then, if a musical special, opera, or concert were broadcast in true stereo, a sub-audible pilot tone could be used to signal your TV to switch to the STEREO mode, turning on both channels

automatically. Other applications are possible, including a service for the blind featuring the regular audio on one channel and a descriptive narration on the other.

From a technical standpoint, two distinct voice tracks require more channel separation than is needed for stereo music. Otherwise, one channel may interfere with the other. Domestic manufacturers have been preparing for two-channel sound ever since AT&T changed its TV-network relay system from phone lines (with a top-end frequency response of 5 kHz) to microwave (with 15-kHz response). Up until then, there wasn't much even a high-fidelity TV amplifier could do with such a low-fidelity source. Several console sets currently on the market do offer pseudo-stereo sound, but without a stereo video-source (with the exception of a few laser videodiscs) or an established technical standard, there is little incentive to make a true-stereo receiver. That is about to change. More stereo VCR's, to join Akai's, the only one now on the market, will begin to appear here in 1982. They will be backed by a trickle of prerecorded-cassettes of concerts in stereo. Industry predictions are for that trickle to become a steady flow within a couple of years.

While two-channel TV broadcasting is now in service in Japan and, as of last September, in West Germany (one of the West German receivers is shown in Fig. 1), the concept is still in the testing stages in this country. The Multichannel Sound Subcommittee of the Electronic Industries Association (EIA) has completed over-the-air testing of three proposed stereo-broadcast techniques. Furthermore, tests are also under way to choose a noise-reduction system for the stereo broadcasts. Systems from Dolby, dbx, and CBS are those under consideration.

When stereo TV does arrive, you won't have to run out to buy a new TV set. You will suddenly find many stereo tuners available at your favorite video emporium. Some will receive only audio for headphone listening, or for patching into your hi-fi set-up. Others will also receive video for use with a video monitor. The age of video components will be upon us!

Flat-panel TV

Growing interest in home projection-television may be one of the reasons why TV researchers are working on a large, flat-panel television set. Typically, such a set would be just four inches deep and simply hang on a wall. Even now, the industry joke is that for the last 25 years, flat-panel home TV has been 10 years away. And true to form, last year RCA demonstrated a new technique for a wall-hung TV that they predicted would be on the consumer market "close to 1990." But with 100,000 or so American consumers having spent between $2500 and $4300 each for big-screen projection units in 1981, and with predictions of that interest tripling by 1984, it is likely that "breakthroughs" in technology will, indeed, make large wall-TV's affordable by 1990.

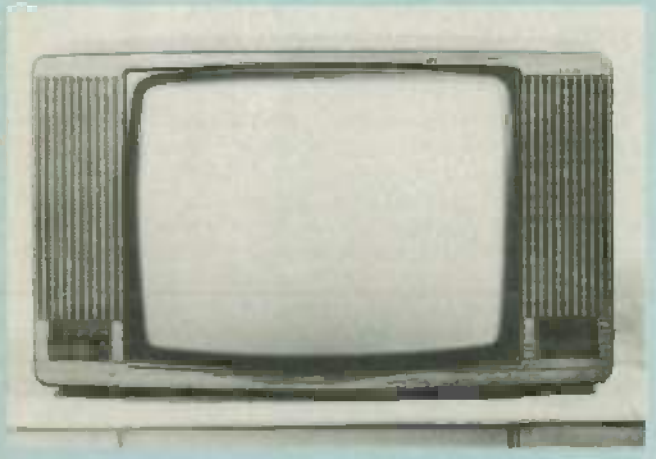


FIG. 1—CURRENTLY AVAILABLE in Japan and West Germany, two-channel TV audio should be here within the next few years. The receiver shown here is one of the new West German models.

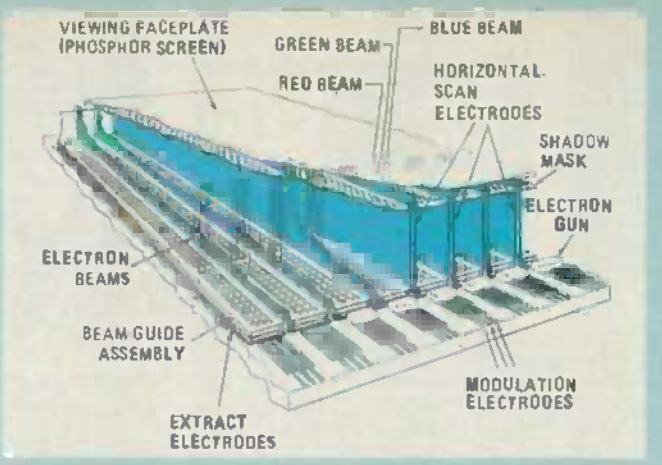


FIG. 2—TECHNICAL DETAILS of the RCA large-screen flat-panel TV. The receiver will have a 50-inch diagonal screen but measure just 4 inches thick, allowing it to be hung on a wall.

The RCA system under development consists of 40 one-inch-wide vertical modules, making up a 50-inch (diagonal measure) color-TV display panel, as shown in Fig. 2. Instead of a single electron beam sweeping across the face of a cathode-ray tube (CRT), each module in that system has its own electron beam, and those are turned on sequentially from left to right to produce a scan line that sweeps at the same speed as on a CRT. The beam is generated by electrodes along the back panel, only about four inches away from the face plate. It's a tricky system, to be sure, and one that will take some time to perfect, particularly in color.

We will, however, soon have a taste of flat TV, although in a pint-sized version. Portable and handheld flat-TV's from Sinclair and Japanese manufacturers like Toshiba, Hitachi, and Matsushita will start showing up on store shelves before the end of 1982. (See Radio-Electronics, October 1981 issue).

The Sinclair unit will probably be first, with its 3-inch diagonal CRT made flat by swinging the electron gun over to one side; a previously unsuccessful idea that had been researched for more than 25 years.

Soon after, solid-state LCD panels will make a super-slim pocket TV possible (see Fig. 3). The LCD display will actually be a mosaic of 52,800 picture elements, resulting in a receiver with a 2-inch (diagonal measure) black-and-white screen, such as the one Toshiba recently demonstrated.

Teletext/videotex

Of all the video applications of the future, probably none has had as much discussion—some of it quite heated—as teletext and videotex. Teletext is the one-way transmission of information over the air by a television broadcaster. The data is coded and sent along with the regular TV picture. It cannot be seen without a decoder, since it is located in one of the scanning lines found within the black horizontal bar that you see when your vertical hold needs adjustment. Videotex, also called viewdata, is a two-way interactive system that links your television to a central computer either by telephone lines or by a cable-TV hookup. Not only can you get the news, sports, and weather, as with teletext, but you can also place airline reservations, for example, by communicating with the computer using a small calculator-like keyboard wired to the TV.

Many U.S. and foreign-based manufacturers are interested in the potentially lucrative market in home (decoders, either attached to your TV set or built-in) and originating-station (broadcast encoders, computer data banks, etc.) equipment. Once a technical standard is established, we can expect a great many stations to begin transmitting teletext, just as they are currently transmitting closed captioning for the hearing-impaired; also, we can expect that videotex will be widely used by the many cable-TV systems already in operation.

Here is an example of what to expect by the late 1980's:

FIG. 3—THESE HAND-HELD televisions from Toshiba use two-inch diagonal flat-panel LCD displays.

Let's say your old microwave oven finally bit the dust, and you feel it's time to buy a new one. You turn on your television, using its many-buttoned infrared remote control, and select the main menu listing the videotex services that are available on your cable system; a typical menu, in this case listing financial news stories, is shown in Fig. 4. Among the menu's listings is one called "Consumer Information," probably a good place to start. Entering the corresponding code using the remote control, another menu appears, listing several sources of consumer guidance. The one you want at the moment is comparative testing by an independent consumer lab. Continuing the process in the same manner soon leads you to the information available on microwave ovens.

Once you've found the unit with the features you want, when the proper buttons are pushed, the videotex system will display prices, service terms, and delivery information for the stocking dealers in your area. Next, using your personal bank code, you can use the system to see if you have enough money to pay for the oven, and if so, order it, arrange for delivery, and pay the dealer.

But you aren't done with your videotex system yet. If you wish, you can use it to get new recipes, and get a printout from a companion printer for future reference. You could also use the system to take a mini-course in microwave cooking, or any of the many other mini-courses offered. Some videotex systems may also offer typewriter-like keyboards that will let you type a letter or message, say to a friend, and then send it over the system to its destination.

Several of the services mentioned above are already available in England, where videotex and teletext have been in operation for the past few years. We'll also have them here, as soon as everyone agrees on which system to use.

One very important aspect of teletext/videotex is noted by Ed Tingley, staff vice-president of engineering for the EIA. He believes that the interactive use of television, "...will be the bridge between the public and their familiarity with data processing." Indeed, the TV viewer with a videotex controller in his or her hand will have access to a vast amount of computer-originated information.

Direct-broadcast satellites

To anyone who has wrestled with TV rabbit ears to get a reasonably clear picture of Lou Grant from a television station only 25 miles away, the idea of almost-perfect video from a satellite 22,300 miles away is mind-boggling. But, starting as early as the mid-1980's, that is exactly what will be happening. DBS (*D*irect *B*roadcast *S*atellite) satellites will soon join the dozens of other birds in geostationary orbits around the earth. (For a satellite to be in geostationary orbit, its orbital speed has to match precisely the speed of the Earth's rotation: to us on Earth, it seems to hang motionless in the sky.) Currently, geostationary satellites are used for military, commercial, telephone, pay TV, cable TV, and network-TV relays over long distances. The satellite dishes and receivers you now see advertised are designed to "eavesdrop" on the signals.

FIG. 4—A TYPICAL VIDEOTEX menu. The one shown here lists financial news stories. To call up one of them, the appropriate code is keyed into the accompanying controller.

DBS satellite transmissions, however, are intended for home viewing. A relatively-high-power (about 100 watts) transmitter in the satellite will make it possible for almost anyone with a 2½-foot diameter dish to receive cable-quality signals.

Satellite Television Corporation has received FCC approval to go ahead with its plans for a 3-channel satellite network. Non-commercial programming will include movies, popular concerts, children's programs, sports, education, cultural programming, and more. The signals will be scrambled, so it will be a subscription type of service, costing around $25 per month (plus abut $100 for dish installation). Other services will be possible as part of the DBS network, with two-channel audio and teletext data among the most likely. The first Satellite Television Corporation bird is scheduled for 1985 launch, with a total of six satellites planned for complete U.S. coverage, as well as backups.

High-definition television

You can add a new set of letters to the video alphabet soup: HDTV, which stands for *H*igh-*D*efinition *TV*. Systems demonstrated by Matsushita and Sony have shown resolution equivalent to that of 35-millimeter motion-picture film. By comparison, today's color-TV image has resolution that is between that of 8-millimeter and 16-millimeter film.

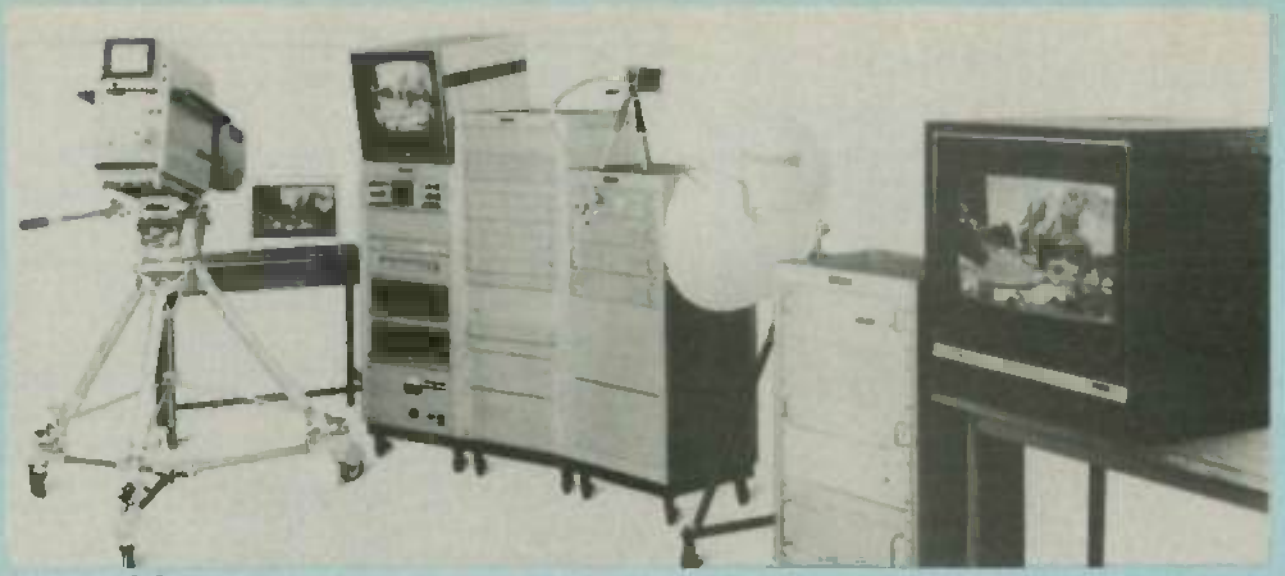
The key to HDTV is squeezing more scan lines onto the screen: 1125 to be exact, compared with the U.S. standard of 525. Another part of HDTV is changing the aspect ratio (the ratio of the horizontal to the vertical screen dimensions) from today's 4:3 to at least 5:3 and perhaps 2:1—making the TV picture more rectangular, much like the screen in a movie theater. But before all of that can happen, a new standard, both for video cameras and receivers must be accepted.

An HDTV signal requires a lot more bandwidth than a standard transmission. While that may be a problem at first for broadcasters, wire and fiber-optic cable networks could easily handle the HDTV signals. Interestingly enough, the proposed DBS satellites will also be capable of relaying HDTV signals. Tests will likely be conducted early in the DBS program.

Combine an HDTV-quality picture with a large-screen projection receiver, like Matsushita's prototype, and you will really have a movie theater right in your living room.

3-D television

If you remember back to the 1950's, there were several films in which the action seemed literally to jump out at you. Of



A COMBINATION OBS/high-definition TV system is just one of the things we can look forward to. Such a system is shown here.

course, the images did not really jump out at you, but your brain was "tricked" into believing that they did. If you have ever seen one of those films, you have a pretty good idea of what 3-D television is all about.

Several significantly different systems for producing 3-D effects for home television are under study. All of the systems require the viewer to wear some sort of special glasses to see the 3-D effect; a few of the systems allow the viewer to see a standard, two-dimensional image without the glasses.

Matsushita has demonstrated a prototype system in which the viewer wears special glasses (see Fig. 5) that are connected to the TV. Electronically controlled polarized "shutters" over the left and right lenses are triggered by the vertical-sync signal; they open and close in time with the specially prepared program material. The stereoscopic effect can not be seen without the special glasses.

Another prototype system, called DOTS (*D*igital *O*ptical *T*echnology *S*ystem) electronically adapts an existing film for 3-D television broadcast. Essentially, the sytem analyzes the motion in a film, and separates the images into what appear to be three planes to anyone wearing the special glasses. The program material can also be viewed without the glasses, although the image will be two-dimensional. William Etra, DOTS inventor, concedes, however, that for the moment "...there is no compatible form of 3-D that compares with the total left-right separation of two taking lenses." Anyone who has used a stereo slide viewer knows what Mr. Etra means by total separation.

There is hope that 3-D and high-definition TV will make a successful combination. In such a system, a 1125-line color screen would have lines 1, 3, 5, etc. fed the signal from a left-taking camera, and lines 2, 4, 6, etc. fed the signal from a right-taking camera. Using polarizaton and a polarized viewer, the resolution of the resulting 3-D image would be equal to or better than today's TV image.

Cable TV will be the first to use 3-D television, mainly in an attempt to attract new subscribers. The 3-D material that will initially appear will most likely be specially prepared entertainment features, particularly movies produced to take the best advantage of 3-D effects. Shortly thereafter, educational programming may use 3-D for added clarity. Possible applications range from pre-school awareness drills ("near" vs. "far") to a college-level explanation of recombinant DNA.

All-in-one remote control

With all of the high-technology, home-entertainment equipment that will soon be available, it may be comforting to know that you may be able to link everything together and operate it all using a wireless, microprocessor-controlled remote unit. Among the things that such a remote-control system will allow you to do is program your VCR, monitor the outside of your house using your security-TV system, play a two-channel TV broadcast through your hi-fi amplifier, check the treble control of your stereo, and get the local weather from a videotex system.

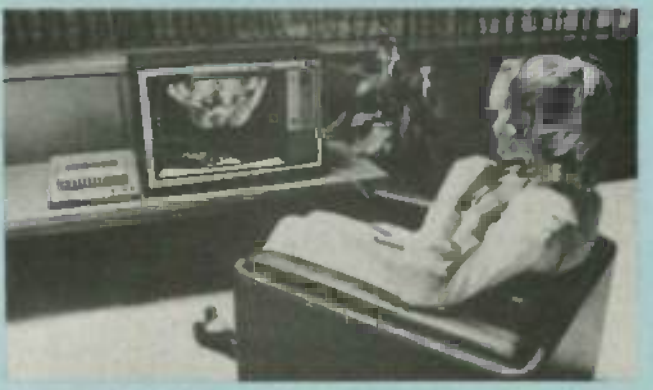


FIG. 5—THE IMAGE on the television would appear three dimensional to a viewer wearing special glasses in the Matsushita system.

Video after 1990

Work is already in progress on an international standard for digital television and the equipment to handle it. It is estimated that a color HDTV signal in digital form would require a digital VCR capable of recording at a rate of nearly 1 gigabit (1000 million bits) per second! Digital TV will help eliminate the differences between the three TV standards used throughout the world: NTSC, PAL, and SECAM. Material recorded in one part of the world could be viewed anywhere else without requiring costly scan conversion.

By the early 1990's, we may be reading about crude laboratory demonstrations of moving holographic images, television that will not be restricted to the two-dimensional plane of a video screen. When that system is finally perfected, we will be treated to images so realistic that it will seem as if our favorite entertainers were performing right there in our homes.

Television is evolving into more than a passive entertainment medium. Viewers will be choosing programming from an increasing number of sources, not just the traditional networks. Video equipment will be changing to give us more realism in sight and sound, better communications with the outside world, and more control over what we watch. This decade promises to be an exciting time for video. R-E

BUILD THIS

HI-FI CX Decoder For Records

With this expander, you can enjoy the improved dynamic range and 20-dB of noise reduction offered by the CBS CX system for records. The complete construction details are presented below.

JOEL COHEN

Part 2 NOW THAT WE'VE EXplained how this *CX** expander works, it's time to begin construction. If you've already etched or purchased the PC board (the pattern appeared in last month's issue of Radio-Electronics), you're all set. If not, that's the first thing you'll need to do.

Construction

The PC board for the expander is laid out for use with the cabinet shown; a similar cabinet is available from the supplier listed in the Parts List. If you should choose to use your own, you can substitute panel-mounted components for the ones listed and run leads to the appropriate points on the board.

A parts-placement diagram for the PC board is shown in Fig. 5. Begin by installing resistors R38, R39, R61, and R62. Then mount the power transformer and the dual phono jacks. Transformer T1 has a single 117-volt primary and mounts with the frame running from front to back on the PC board. The transformer's tabs should be bent under the board for mechanical integrity and then soldered to the pads on the foil side so that the transformer's frame is electrically grounded. The transformer's terminals are numbered; be sure that terminals 1 and 2, which connect to the primary, face the rear of the circuit board. You will notice some extra pads on the board. They were included to accommodate some of the possible substitutes for the transformer described in the Parts List.

The special dual phono-jacks are mounted next. First, remove the plastic tab at the rear of each jack. Then snap the front ground-tabs into the slots in the ground bus and solder them in place. Also solder the center terminals of the jacks, taking care that the jacks themselves are lined up parallel to the board's surface.

Next install the rest of the resistors, and the capacitors and diodes, on the board, followed by the five jumpers that go on the top side of the board. (Do not install the three jumpers on the bottom side of the board at this time.) When that is done, install all of the transistors and IC's; to prevent damaging the IC's, it's a good idea to use sockets.

The volume control, R22-a and R22-b (a dual audio-taper potentiometer), can be mounted next, followed by the switches. The switches listed on the Parts List come as a single assembly; they can also be purchased (and mounted) individually. For the Schadow F-series switches, the switch height is determined by the shoulder on the PC pins. The Centralab switches require 5/16-inch spacers. Two of those spacers are required if the switches are mounted individually, three are required—two at the front and one at the back—if the switch assembly is used. The switches should be lined up so they are at right angles to the front of the board—otherwise the switch buttons may not fit through the holes in the pre-drilled enclosure cleanly.

The LED has three leads of different lengths. The center lead, which is the longest one, is the common cathode. The red-element lead is the second longest one; the green-element lead the shortest. Holding the LED with the red-element lead to the right, bend the body of the LED forward 90° at the point where the leads taper down. Solder the LED to the board, allowing a lead length from the bend to the top of the board of ½ inch.

Mount two stake-on terminals at the upper-left corner of the board, near the transformer. They are used to attach the line cord, **but do not do that at this time.** If you do not have stake-on terminals, you can make them out of short pieces of tinned 18-gauge (or larger) uninsulated wire. Finish up by installing the three long insulated jumpers on the foil side of the board; those are located in the lower right-hand corner (as seen from the top side of the board) and are connected to switches S2 and S3.

Final assembly

The expander board is now complete and needs only to be installed in its cabinet. Almost any enclosure can be used, the only requirement being that it be large enough to hold the PC board, controls, and jacks without crowding. While the instructions that follow apply specifically to the pre-drilled cabinet mentioned in the Parts List, the procedure is essentially the same for any other one.

The plastic lens for the LED should be snapped into the small hole near the center of the front panel. Then, making sure that all of the switches are in the "in" position, ease the board into the cabinet so that the shaft of the VOLUME control passes through the left-hand hole in the front panel. Push the board forward, lower the rear edge, and finally slide it back until the mounting holes in the board line up with the cabinet standoffs. Mount the board using four ¼-inch 6-32 sheet-metal screws.

Thread the line cord through the hole in the rear of the chassis and place a plastic strain-relief over it. Solder the line cord to the stake-on terminals (or short pieces of wire), using a heat sink to prevent melting the solder securing the terminals to the PC board. When that is done, squeeze the strain-relief

*"CX" is a trademark of CBS, Inc.

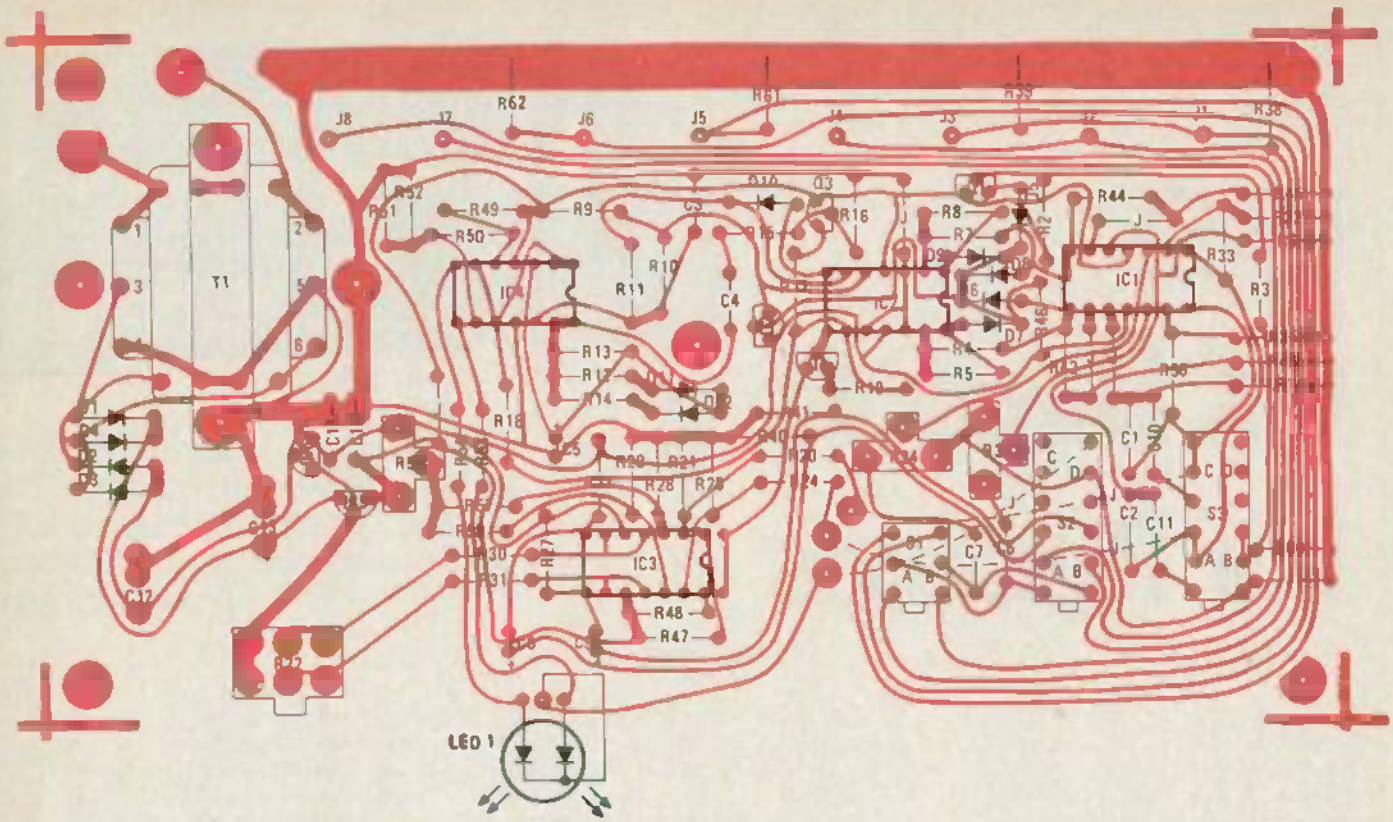


FIG. 5—PARTS-PLACEMENT DIAGRAM for the CX expander. The three long jumpers in the lower right-hand corner of the board go on the foil side, and are installed last.

PARTS LIST

Resistors, ¼ watt, 5%, unless otherwise noted

R1, R6, R52—470,000 ohms
R2, R23, R27—15,000 ohms
R3, R53, R54—1200 ohms
R4, R5, R7, R8, R11, R18-R20, R24, R32, R33, R35, R36, R51—10,000 ohms
R9, R46—33,000 ohms
R10, R42, R44—91,000 ohms
R12—3000 ohms
R13—200,000 ohms
R14, R49—20,000 ohms
R15, R16—150,000 ohms
R17—4700 ohms
R21, R25, R28, R29, R50—1000 ohms
R22—100,000-ohm dual potentiometer, audio-taper, PC mount
R26—not used
R30, R31, R43, R45, R60—5100 ohms
R34, R37, R59—250,000 ohms, trimmer potentiometer, PC mount
R38-R41, R57, R58, R61, R62—100,000 ohms
R47, R48—68,000 ohms
R55, R56—not used

Capacitors

C1, C2—680 pF, axial ceramic, 5%
C10, C11—2700 pF, axial ceramic, 5%
C3, C4, C6, C7, C14, C15—0.1 µF, ceramic disc
C5, C8, C9—10 µF, aluminum electrolytic, 16 volts
C12, C13—470 µF, aluminum electrolytic, 35 volts

Semiconductors

D1-D4—1N4002
D5-D12—1N458
LED1—dual element LED, Dialight 521-9178 or equivalent (DO NOT USE A BIPOLAR TWO-COLOR LED)
IC1, IC2—LF347N quad FET-input op-amp
IC3—LM13700N dual transconductance amplifier
IC4—LM324N quad op-amp
IC5—LM340L-15 or 78L15 regulator, +15 volts, 100 mA.
IC6—LM320L-15 or 79L15 regulator, −15 volts, 100 mA.
Q1, Q3—2N3904 NPN transistor
Q2, Q4—2N3906 PNP transistor
J1-J8—dual RCA-type phono jack, right-angle PC mount
S1-S3—three-switch assembly (1 DPDT, 2 4PDT), PC mount, Centralab PB20 series or Schadow F series
T1—35 VCT, PC mount, Dale PL-12-09 or equivalent

Miscellaneous: PC board, case, wire, hardware, line cord, solder, etc.

NOTE: The following are available from Sound Concepts, Inc., P.O. Box 135, Brookline, MA 02146: **SX-1**—PC board (etched, drilled, solder masked, with power terminals), $16.00; **SX-2**—switch assembly with knobs, volume control with knob, four dual-phono-jacks, three trimmer potentiometers, and the dual LED with lens, $13.50; **SX-3**—IC1-IC6, $11.00; **SX-4**—all resistors, capacitors, diodes, and transistors, $8.00; **SX-5**—power transformer, $7.50; **SX-6**—silk-screened chassis, cover, line cord, strain relief, and hardware, $18.00; **SX-7**—calibration record, $2.00; **SX-80**—assembled unit with one-year warranty, $119.00. Add $2.00 for shipping and handling for all orders within the continental United States. Massachusetts residents add 5% sales tax.

and insert it into the hole in the cabinet, leaving a little slack in the cord inside the enclosure. Snap the LED into the back of the lens, attach the volume-control knob, slide the fiber washers that come with the switches over their shafts, push on the switch buttons, and you are nearly finished. Figure 6 shows how the expander should look at that point.

Calibration

Calibrating the expander requires feeding a 1-kHz, 0-dB-reference tone into each channel and adjusting potentiometers R37 and R34 so that LED 1 glows orange (both the red and green elements on). A test record for calibration is available from the supplier listed in the Parts List. Once the unit has been

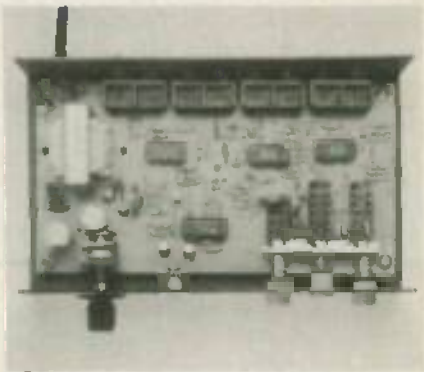


FIG. 6—THIS IS HOW the completed CX expander should look just before the case is closed up. Note that the unit shown here was a prototype and its layout is slightly different from that of the one described in this article.

calibrated for a particular amplifier and phono cartridge, it should not need any further adjustment until either one is changed.

As you might suspect from the fact that *CX* records can be played satisfactorily without any expansion, the *CX* system is very tolerant of mismatches in the encode and decode reference-levels. In fact, it is almost impossible to detect a mismatch of as much as 6 dB. Thus, if you do not have access to a recording of the reference tone, and do not wish to purchase the test record, a 150-millivolt, 1-kHz signal can be used for the calibration procedure. That signal will be within 1 or 2 dB of the proper reference level for the majority of amplifier/phono-cartridge combinations.

The last adjustment that has to be made is nulling the offset voltage of the transconductance amplifiers. That is done to insure that there is a minimal DC shift at the outputs (pins 8 and 9) of the LM13700 as the gain of that IC changes. The 0-dB reference tone is used for that adjustment, also. With the VOLUME control (R22) set at maximum, feed the tone to either of the channels and monitor the corresponding output of IC3 (pin 8 or pin 9) using a high-resolution DC voltmeter. Note the voltage measured and remove the tone, still monitoring the output from IC3. Continue to apply and remove the tone, and adjust R59 until the difference in output levels (with the signal applied and absent) is at a minimum. Since the magnitude of the voltage shift, as well as the signal level, is increased as the VOLUME control is rotated clockwise, the control is set to maximum to get the best resolution. Because the two halves of IC3 are closely matched, the adjustment need only be made for one of the channels.

The final step is buttoning up the cabinet. Note that the front and back of the cover are different: the mounting holes are farther in from the front edge than they are from the rear. Slide the cover over the chassis and attach it using four 4-40 bolts. Attach the four rubber feet to the bottom of the unit, and your expander is ready for use.

Set-up and use

The expander is designed so that it can be connected as part of an external-processor loop, a tape loop, or between your pre-amp and power amp. If you connect the expander in an external-processor loop, connect the jacks labled OUTPUT on your receiver or pre-amp to jacks J1 and J2, INPUT FROM PREAMP, on the expander; connect jacks J7 and J8, OUTPUT TO PREAMP, on the expander to the input to the processor loop on your receiver or pre-amp.

When it is part of a tape loop, the TAPE OUT or RECORD OUT jacks on your receiver or pre-amp should be connected to jacks J1 and J2 on the expander. Also connect the tape recorder's line inputs to jacks J3 and J4, TO TAPE RECORDER LINE IN, and connect jacks J7 and J8 to the TAPE IN jacks on your receiver or pre-amp. Finally, connect your tape recorder's output to jacks J5 and J6, FROM TAPE RECORDER OUTPUT, on the expander. When the expander is connected in that way, the tape recorder will record normally, regardless of how the expander is set. However, to play back a tape, switch S1, TAPE/SOURCE, will have to be in the TAPE (in) position. To use either the tape recorder or the expander, the tape-monitor switch on your receiver of pre-amp must be in the ON position.

To use the expander between your pre-amp and power amp, the output jacks on the pre-amp should be connected to jacks J1 and J2 on the expander. Jacks J7 and J8 should be connected to the INPUT jacks on the power amplifier.

The expander is fairly simple to use. When the ON/OFF switch (S2) is in the OFF position (out), the expander is bypassed and no processing takes place. When that switch is in the ON position (in), there are two operating modes; those are selected by switch S3 (PEAK/*CX*). The *CX* position (out) should be used for all *CX*-encoded material. When S3 is in the PEAK position (in), the dynamic range of non-encoded material is expanded. The position of switch S1 depends on how the expander is connected. If it is installed in a tape loop, that switch should be in the TAPE position (in); it should be in the SOURCE position (out) for all other applications. The VOLUME control (R22) is active only when the expander is in use; it should be adjusted so that the volume on loud passages is the same regardless of whether the expander is on or off. R-E

COMPUTER CORNER

Peripherals for your computer

KATHY TEKAWA*

THE WORD "COMPUTER" IS SUCH A GENeral term that it is often difficult to define exactly what it means. The computer itself is a box with many electronic parts, but alone it serves no purpose. There are many accessories—called peripherals—that, although not an intrinsic part of the basic system, are needed to get a computer running and performing tasks. Generally speaking, peripherals are used for input and/or output, and include such devices as cassette tape-recorders, disk drives, terminals, modems, printers, and many other add-ons. As you can see, that would be quite a bit of material to cover, so, for now, we'll take a close look at just a few popular types of peripherals: terminals, printers, and modems.

Terminals

A terminal, perhaps the most important peripheral, is the human interface with the computer—you use it to get information into and out of the system. It consists of a keyboard for input, and either a video display or printer for output. Both types of terminals, video and printing, have advantages and disadvantages.

There are four basic parts to a video-display terminal such as the one shown in Fig. 1. They are the CRT (*C*athode *R*ay *T*ube) used for displaying data; the alphanumeric keyboard for inputing data; the video-display circuitry, and the interface circuitry that sends and receives data to and from the computer.

FIG. 1

The principal advantage of video-display terminals over printing terminals is speed; video terminals can fill a screen with information almost instantaneously, while printers run at speeds between 10 and 180 characters-per-second. Speed is an important factor when transferring data—whether it's to or from the computer. Video terminals, having no moving parts in the display section, also offer improved reliability and much lower noise levels. For those reasons, video terminals are more widely used than printing terminals.

One disadvantage of video terminals is that they do not produce a permanent record of the output data. Video displays, as a rule, can present a maximum of about 2,000 characters at a time, and many have less than half that capacity. Once a screen is full, the information on it has to be removed to make room for more. To get a permanent record, you need to add a peripheral called a printer or, instead of a video terminal, use a *printing* terminal. A printing terminal presents the information on paper instead of on the screen of a CRT.

Printers

A printer differs from a printing terminal in that it is an output-only device: it has no keyboard for inputing data. Printers, now more than ever, offer faster printing speeds, lower power consumption, better reliability, and lower cost. The main advantage of a printer over a printing terminal is cost and, in the case of some printers, speed.

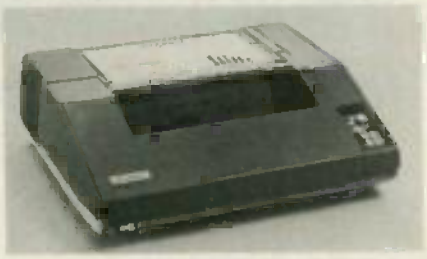


FIG. 2

There are two basis types of printers —dot-matrix and solid-character. Print speeds vary from 10 to 180 characters per second, with dot-matrix printers usually operating at the higher speeds. A dot-matrix printer is shown in Fig. 2. While dot-matrix printers are frequently faster and more versatile than solid-character printers, the quality of the dot-matrix letters leaves something to be desired when compared to the typewriter-quality output of the solid-character devices. For that reason, most businesses use solid-character printers for applications such as word processing.

Modems

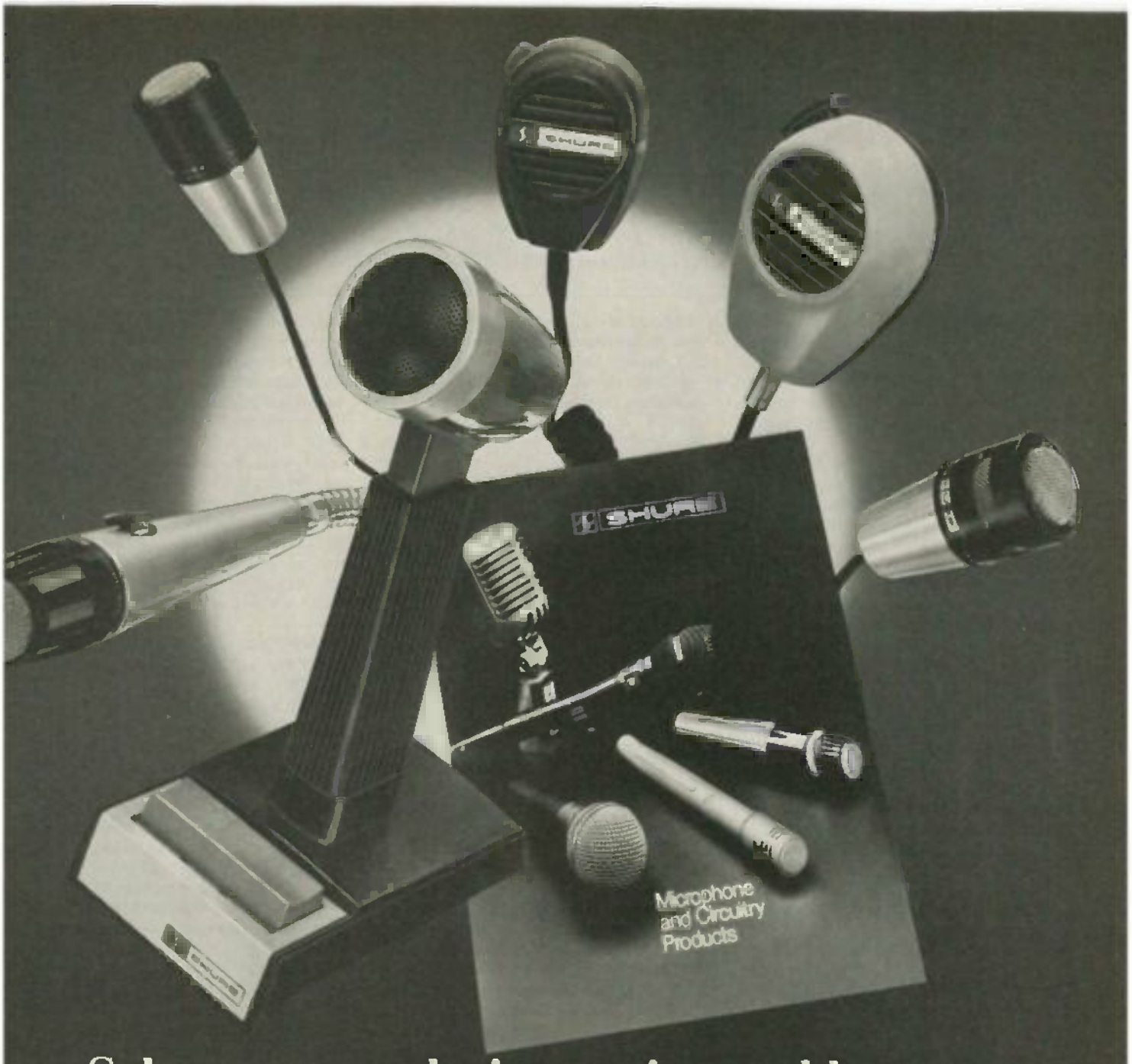
Let's turn our attention to another type of peripheral device—the modem. ("Modem" is an acronymn for *MO*dulator-*DEM*odulator.) It gives you the ability to communicate with other computers over long distances, most often using telephone lines. On the transmitting end, the modem turns serial binary data from a computer into audio tones. On the receiving end, another modem turns the audio tones back into serial binary data.

Data is sent using one of three basic systems: simplex, half-duplex, and full-duplex. The simplex system allows data to be sent in one direction only. Half-duplex allows two-way communication, with one computer at a time sending data. Full-duplex allows both computers to send and receive data simultaneously. While full-duplex is generally preferred, simplex and half-duplex modems are less costly and complex.

FIG. 3

There are two types of modems—acoustically-coupled, and direct-connect. An acoustically-coupled modem needs no connection to the telephone line—the telephone receiver fits into two cups in the top of the modem, as shown in Fig. 3. A direct-connect modem, on the other hand, is wired directly into the telephone line and provides more reliable communications because there is no way for ambient noise to be transmitted. It's not important to know the technical differences between the two, or how they operate at this time, but acoustically-coupled modems are more popular due to lower cost and convenience. R-E

*Managing Editor, Interface Age Magazine



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A state-of-the-art scanning receiver

HERB FRIEDMAN, COMMUNICATIONS EDITOR

IN THE PLAY AND MOVIE *OKLAHOMA!* A young cowboy named Curly visits Kansas City and sees a "skyscraper"—a building seven stories high. When he returns home he tells his friends, "They've gone about as far as they can go."

Last time I looked at VHF-UHF scanners I also thought they'd gone about as far as they could go. Electronically, they had about the maximum theoretical sensitivity (and the optimum selectivity) for the price; and in the area of features, using computer technology, they could be set to scan a user-determined range of frequencies, cross bands during a search or scan, be bank-selected, and do just about anything else you could want.

But like the height of buildings, there seems to be no limit when it comes to applying computer technology to convenience features, for the microprocessor makes yesterday's dreams today's technology. We have come to expect any "deluxe" scanner to have a microprocessor and a random-access memory (RAM) that is user-programmed by using a keypad to enter the desired frequency for a channel, or frequencies for a "search."

Fortunately, a microprocessor is a microprocessor, and if it can accommodate a random-access memory programmed by the user it can accommodate a read-only memory (ROM) that is pre-programmed by the manufacturer for specific frequencies. That's exactly what we get in the latest generation of scanners, represented by the *Bearcat 300* (shown in Fig. 1), which, in addition to all of the expected microprocessor-controlled features, has a feature called *Service Search*.

For that mode a ROM is programmed with the frequencies for specific services such as Police, Fire, Marine, and so forth. In the case of the *Bearcat 300*, 11 services, covering over 2100 active frequencies, spread over 3 bands—Low-VHF, High-VHF, and UHF—are pre-programmed. Each of the 11 services can be user-programmed to scan any combination of the three bands. The digital frequency-display indicates the frequencies as they are scanned and, when an active frequency is found, where the scan stops. If you try to search a band that is not used by a particular service, the scanner automatically switches to a band that *is* used.

For example, there are police frequencies assigned to all three bands. If all three are selected, the scan will start at the Low-VHF band and proceed through the High-VHF and UHF frequencies assigned for police use; when it has scanned all of the frequencies, it will cycle back to the Low-VHF band. If, however, the user "punches up" only the UHF band, the scanner will cycle through the UHF police frequencies of 460.025 to 460.500 MHz. (The Fire-service search would cover 460.600 to 460.625 MHz.)

The Marine service, however, only uses frequencies on the High-VHF band; regardless of which band is selected, the scanner will always switch to the Marine VHF segment when the MARINE *Service Search* button is pressed. It's the same with the Aircraft band; regardless of which bands are selected, the receiver always switches to the Aircraft band when the AIR *Service Search* is activated.

Cute? Yes. Useful? Most certainly—at the very least for the scanner hobbyist! But there's even more. (You can really load up a microprocessor—the sky's the limit.)

The *Service Search* feature always starts on a user-selected reference channel, one that's intended for programming. For example, assume that the user wants to program channel 25 for the local police handie-talkie frequency. He would manually select channel 25 using the keypad, and then press the POLICE button and the UHF button. When he was certain the scan had stopped on the local police frequency, pressing the E (for "ENTER") on the keypad would enter the display frequency into channel 25. By pressing the appropriate buttons, the user could also program the microprocessor to count the number of times channel 25 was active, and even program the scanner so that activity on a channel would cause a set of relay contacts (rated at 500 mA) to close. That, for example, could start a tape recorder to record the channel-25 traffic.

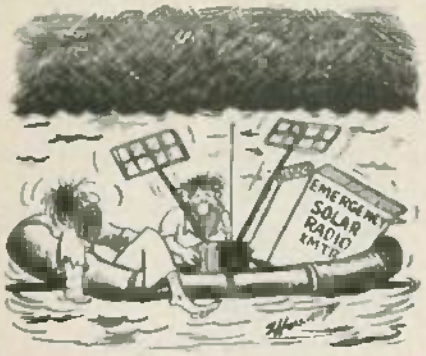
That feature can be programmed for any channel or channels. If five channels are programmed, for instance, the microprocessor will close the auxiliary contacts whenever any of the five become active during a scan.

Surprisingly, the *Bearcat 300's* microprocessor is not programmed to accept user-lockout of "birdies"—spurious signals generated by the frequency synthesizer (common in consumer equipment). The scanner has a few birdies, which (though weak) are sufficiently strong to break a "soft" squelch setting. If they are "received" during a service- or programmed-search the scan will

FIG. 1

stop until the RESUME button is depressed. Alternatively, the SQUELCH control could be advanced slightly so as not to open the squelch on the weak birdies—but it would also not open on weak signals.

Actually, the birdies rarely prove to be a problem, but it's curious that they weren't programmed out, or that at least some way for the user to program them out of the reception range wasn't provided. Perhaps the next generation of ROM's will take care of that shortcoming, but at least we know that they haven't "gone as far as they can go"—yet. R-E



"Cloudy again! That makes it twenty-six straight days!"

STATE OF SOLID STATE

What's new in solid-state technology?

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

FOR THE NEXT FEW MONTHS, UNTIL WE hear from you exactly what sort of column you'd like this to be, I'll devote most of my attention to solid-state devices and circuits of interest to the experimenter, "do-it-yourselfer," and technician.

You won't hear too much about new, sophisticated devices costing several hundred dollars each unless they use a new technology that I know you'll want to read about.

Space permitting, here are the topics you *can* expect to find covered in this column: descriptions of new solid-state devices along with technical data and applications for them, and possible suggestions as to how you can use them as replacements for more familiar devices; new circuits along with schematics that you can use to build a new device or instrument, or improve an old one; announcements of new literature, and short book reviews. From time to time, we'll cover new solid-state technologies—what they are, how they were developed—and will evaluate their usefulness.

Constant-current diodes

From Teledyne Crystalonics (147 Sherman St., Cambridge, MA 02140): The CIL-250 through CIL-257 current-regulator diodes provide a constant current (nominally 5 to 10 mA) with a high source-impedance over a wide voltage-range. The diodes are basically N-channel JFET's with the gate and source shorted together internally. That short maintains V_{GS} at zero volts, so when the device is operated with a drain voltage greater than pinch-off (6 volts) it becomes a high-impedance constant-current source.

TABLE 1

Type No.	Regulator current (mA at 25V)	Minimum dynamic impedance (ohms)	Peak operating voltage (volts)
CIL-250	5.10	230K	80
CIL-251	5.60	230K	80
CIL-252	6.20	230K	70
CIL-253	6.80	225K	70
CIL-254	7.50	225K	60
CIL-255	8.20	225K	60
CIL-256	9.10	220K	50
CIL-257	10.00	220K	50

The diodes are in a glass-body DO-7 package with a wide color-band marking the cathode end. The main electrical specifications appear in Table 1.

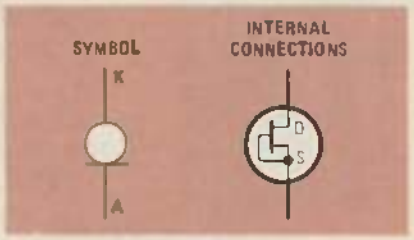


FIG. 1

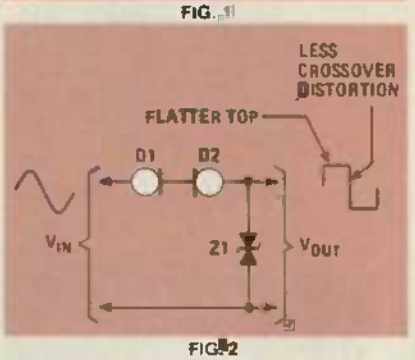


FIG. 2

The symbol and internal connections for the CIL-250 series are shown in Fig. 1. Figure 2 shows a clipper or square-wave generator made from two current-regulator diodes and a back-to-back Zener diode. Peak output-voltage is approximately $0.7 + V_Z$. Figure 3 shows how a high-quality triangle wave can be developed from either a sine wave or square wave. The square-wave input provides the cleaner waveform at zero crossover. Output amplitude is equal to the diode current multiplied by the time period (T) divided by capacitance (C).

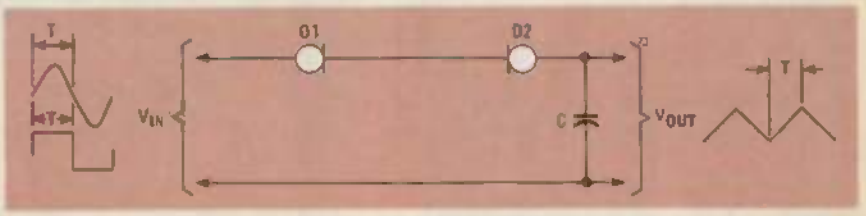


FIG. 3

JFET op-amps

From Texas Instruments (PO Box 225012, Dallas, TX 75265) come the TL091 and TL092 JFET op-amps: they are designed for single-power-supply, low-level input-signal applications. The new op-amps use the Texas Instruments NFET technology that combines N-channel JFET's with bipolar devices on the same chip. They are considered ideal for use with high-impedance signal sources, and for single-power-supply applications where the input signal is at or near ground potential (0.5 volt or less), as in some automotive, telecommunications, and instrumentation systems. With an input impedance of about 10^2ohms (1 million megohms), the device features low-distortion class-AB outputs. The input common-mode range includes ground or $-V_{CC}$, so the IC's can be used when input signals are as low as ground of $-V_{CC}$. The bandwidth is MHz.

The devices are fast and operate with low offset-current and low input-bias. The offset current is typically 50 picoamps. Most comparable op-amps have an offset current in the 50-nanoamp range. The input bias is 100 picoamps.

The op-amps can operate from a single supply over a range of 3 to 36 volts. When operating from a dual supply, the difference between the two supply lines can range from 3 to 36 volts. Output is from $-V_{CC}$ to a value of $+V_{CC}$ minus 1.5 volts.

The IC's include internal frequency-compensation and short-circuit protection. Continuous total-power dissipation at or below 25°C is 680 mW. Free-air temperature range is 0°C to 70°C.

The Texas Instruments TL091 and TL092 are identical in function but the TL091 is a single op-amp while the TL092 is a dual device. Both are available in either 8-pin DIP plastic (P suffix) or ceramic (JK suffix) packages. The 100-piece price ranges from $0.65 to $1.22 each, depending on device type and packaging.

Frequency synthesizer

Another new device from Texas Instruments is the AC5945N AM/FM synthesizer IC that electronically tunes

in radio stations, thus eliminating mechanical and electromechanical operations. All tuning-functions are on a single IC to simplify and improve the tuning of auto and home AM/FM radios. The IC contains the digital portion of a phase-locked-loop synthesized AM/FM radio, plus an interface to a microprocessor, such as a Texas Instruments TMS1000, which is hooked up to the radio and to a digital keyboard.

The AC5945N is fabricated using I^2L (*I*ntegrated *I*njection *L*ogic) technology, which allows the device to operate at very low standby-current levels, typically 5 mA at 5 volts—a prime consideration in auto radios. That makes this IC ideal for such an application.

The synthesizer provides frequency-reference signals to the microprocessor to aid in tuning the radio and to provide a time-of-day clock. The device uses three power supplies: 5 volts at 80 mA for the ECL and I^2L sections; 7 to 15 volts at approximately 2 mA for the phase-detector output driver, and 4.5 to 24 volts at about 5 mA for the count-down chain. The phase-detector output is a constant 10 volts, so it can be used in a wide range of tuners that also makes it useful as a direct varactor-drive. The IC frequency synthesizer has a wide tuning-range and is intended for use with 10.7-MHz FM and 460-, 455-, or 260-kHz AM IF's.

Free-air temperature range is −40°C to +85°C. The AC5945N comes in a 16-pin plastic DIP package and is priced at $5.66 each, in 100-piece lots.

Voltage regulators

Motorola has introduced a 0.5-amp, positive, adjustable, 3-terminal linear voltage-regulator series—the LM117M, LM217M, and LM317M. The devices are capable of supplying over 500 mA at output voltages ranging from 1.2 to 37 volts. They feature internal current limiting, thermal shutdown, and safe-area compensation, thus making them virtually failure proof. They can be used to make simple adjustable switching-regulators and programmable-output regulators. By connecting a fixed-value resistor between the adjust and output terminals of the IC, the LM117M series can be used as a precision current-regulator.

The devices are available in TO-66 and TO-220 packages. Devices in TO-66 packages are available in 0°C to 125°C, −25°C to 150°C, and −55°C to 150°C operating ranges, with prices ranging from $1.25 to $5.07 in lots of 100 to 999. The TO-220 plastic package is available only in the 0°C to 125°C operating range.

For data sheets or other information on those devices, contact Motorola Semiconductor Products, PO Box 20912, Phoenix, AZ 85036.

Data-acquisition catalog

Data Acquisition Components and Subsystems is a 880-page catalog listing the complete Analog Devices line of IC and modular data-acquisition components and subsystems for measurement and control. Among the 18 categories of components and devices listed are operational, instrumentation, log-antilog and isolation amplifiers; RMS-to-DC, analog-to-digital, digital-to-analog, and frequency-to-voltage and voltage-to-frequency converters. Included in each section are data sheets, application notes and definitions of pertinent terms.—**Analog Devices**, PO Box 280, Norwood, MA 02062.

Diodes and transistor data

1980-1981 Data Book is a 300-page diode and transistor product catalog issued by General Semiconductor Industries. The separate listings include the company's *TransZorb* PN silicon transient-voltage suppressors, Zener diodes, temperature-compensated diodes, and NPN switching transistors with I_C's ranging from 3 to 50 amps.—**General Semiconductor Industries**, PO Box 3078, Tempe, AZ 85281.

Optoelectronics data

Solid-State Emitters (Book SSE-100) is 24 pages of tabular data and outline drawings for RCA's line of infrared-emitting diodes, pulse and CW-operated injection lasers, stacked-diode lasers, and laser systems. The applications section has schematics of typical drive-circuits for IR diodes and injection lasers. Write for SSE-100 product guide.—**RCA, Solid State Division**, Box 3200, Somerville, NJ 08876.

IC data catalog

1981 Data Catalog from Standard Microsystems Corp. is a 255-page data book listing IC's designed especially for computer applications. Included are baud-rate generators, keyboard encoders, video processors, and timing controllers for CRT displays, character generators, and row bufferes.—**Standard Microsystems Corp.**, 35 Marcus Blvd., Hauppauge, NY 11788.

Zener cross-reference

Zener Diode Cross-Reference Guide contains pertinent information on all Siemens and JEDEC-registered types from 1N255 to 1N6091; they are listed with their electrical characteristics, device outlines, and Siemens-recommended substitutes. Three reference-guides list industry-preferred types of Zener diodes by voltage and power ratings. A fourth table lists voltage-reference diodes by their nominal voltage ranges, test currents, operating ranges, and by temperature coefficients.—**Siemens Corp., Components Group**, 186 Wood Avenue South, Iselin, NJ 08830. R-E

SERVICE CLINIC

Troubleshooting tube-type horizontal-output stages

JACK DARR, SERVICE EDITOR

BACK IN THE DAYS WHEN WE WERE MAKING the transition from vacuum tubes to transistors, I used to get quite a few questions on solid-state horizontal-output stages. Recently, I've been getting quite a few questions on a variation of that theme. Now that most things are solid-state, it's the tube-type horizontal-output stages that are mystifying everyone. Actually, the tube stages are pretty easy to work on, if you know the right tests to make and how to interpret them.

There are two key tests that should be made on all sets. One is easy: Read the negative bias, developed by grid-leak action, on the control grid (grid G1 in Fig. 1) of the horizontal-output tube. It will be high, usually between −60 and −70 volts.

If the drive signal from the horizontal oscillator is lost, it makes the output tube's grid go too far positive, causing the tube to draw a very heavy cathode current. The amplitude of the drive should be around 150- to 175-volts peak-to-peak, although it can be more than that in some sets. That voltage must be present. If it isn't, the output tube won't last very long—turn the set off if there's no drive.

The other key test is for the horizontal-output tube's cathode current. In a typical color set, that current will run about 200 milliamps. To make the test, open the cathode connection to ground, and put it in series wth a 0-500-milliamp DC-milliammeter. Bypass the meter with a 0.47 μF, 600-volt capacitor. The test set-up is shown in Fig. 1. Incidentally, unsoldering the cathode connection is usually hard to do; the easiest way to get at that connection is to use a "cathode-break" adapter. Plug the adapter into the tube socket, plug the tube into the adapter, and hook the test leads to the meter.

Now when you've done all of that, it's time to interpret what you've seen. First of all, if you see the plate of the output tube glowing red hot, turn off the set quickly; the tube is taking a heavy overload of current. The plates of most modern tubes won't get red hot due to their construction, but the plates of older tubes will. After letting the tube cool off, turn the set back on briefly and use an oscilloscope or a DC voltmeter to read the voltage on the control grid. You will usually be able to do that before the plate current gets too high. If there is no voltage on the grid, fix the horizontal oscillator! If you see drive on the plate but none on the control grid, you probably have an open circuit between the output of the oscillator and the grid of the tube. That was a fairly common problem in some older sets; it killed quite a few output tubes.

The plate current will come up slowly as the tube warms up. Watch it carefully. If the current keeps rising past 200 milliamps, turn the set off about when it gets to 300 milliamps to avoid any damage.

That test can also be used to determine how "healthy" the horizontal-output tube is. If the current continues to rise (in theory it should go to 400-500 milliamps with no bias or with the control grid grounded), the tube is good. On the other hand, if you find no grid bias, but the cathode current is no more than about 125 milliamps, the tube must be replaced.

If you're working on an all-tube set, the low-voltage DC supplies will not be derived from the flyback circuit; in hybrid sets (part tube, part solid-state) they may be. In hybrid sets, check all of the diodes in the low-voltage supplies. If those diodes, or any of their filter capacitors, are shorted, that will overload the output tube. For a quick check, simply disconnect the suspected diode. If the current drops back to normal, you've found your problem. Other things, such as the horizontal yoke, can be checked that way; although without the horizontal-yoke winding, you'll have no boost voltage, and the current will drop to well below normal.

A shorted high-voltage rectifier tube can also be a cause of overload. If you suspect that, disconnect the plate capacitor and check the current.

Getting back to the horizontal-output stage, there are a few other areas that can be causing problems. Be sure to check for such things as low screen-voltage, an open boost-capacitor, etc.

A picture tube with shorted guns can also be the cause of your problems. To check, disconnect the high-voltage lead to the picture tube and test for shorts. Here's something else to look for: The output tube has a rather large grid-leak resistor, usually at least 1 megohm. If that is open, or if it has drifted upwards in value, it can let the tube develop so much negative bias that the tube will cut itself off. To test for that, read the grid voltage using a 20,000-ohms-per-volt VOM. If the set starts to work, you've found the problem. The reason is that you've substituted the meter's resistance for the open resistor!

Don't jump to conclusions. Even if you think you've found the cause of your problem, check the other possibilities. Keep looking until you're sure you've pinpointed the problem. R-E

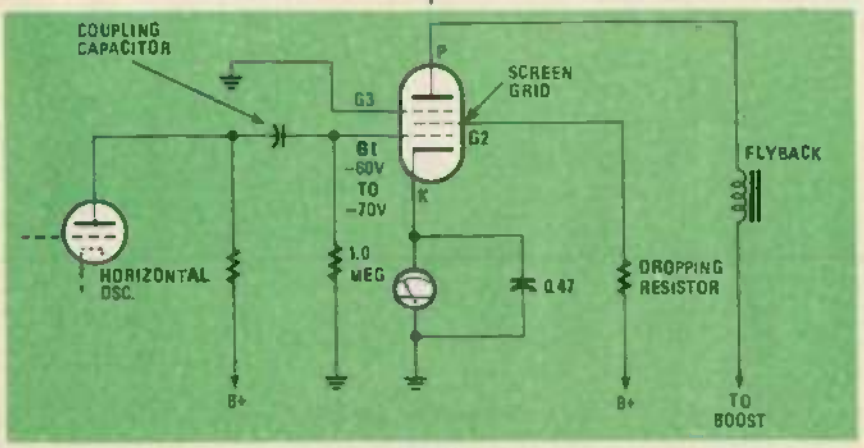


FIG. 1

SERVICE QUESTIONS

POOR HORIZONTAL SYNC

I've got several odd problems in a Zenith 19EC45. The breaker trips, and the hori-

zontal sync is poor. Need help!—S.F., Port Jefferson Sta., NY

This sounds like a chronic problem that's come up in several of those chassis. Look on the 9-90 horizontal module. There's a 330-ohm resistor in the horizontal sawtooth-shaper circuit. Check it, or better still, take it out and put in a 2-watt type.

(Feedback: "I pushed R808 on the 9-90 module and it fell apart. A new resistor fixed the problem. And I got a bonus! I had two 9-90 modules in the junk box; checked and replaced that resistor in both—now I've got two spares!")

VERTICAL BARS

I've got two dark vertical bars on the right side of the screen in this Motorola TS931. With a scan-derived DC power-supply, where could that be coming from. There is also a high-pitched squeal. Help! —J.H., Pine Ridge, KY

From the symptoms and the circuit, this looks like just plain old ripple. That can happen as easily with scan-derived power supplies as others. Check for open filter-capacitors in the supply to the CRT, as well as in other locations such as the video amplifier. The problem should be easy to spot with a scope.

MANY SYMPTOMS, ONE CAUSE

I've got several problems with this Ward's 12946. The set takes a long time to warm up; there's a high-pitched whistle that goes away when the picture appears; the sides of the picture shake, and it looks as if there are 120-Hz hum bars floating through the raster from the bottom to the top. The 120-volt regulated-DC supply takes quite a while to stabilize; could the problem be there?—G.M., Lansing, MI

I think you've found it! When you have that many symptoms at once, there must be a common cause. Since there is only one thing common to all of the stages in the set, the DC supply, that should be it. I'd suspect some bad filter capacitors; they can allow feedback from one stage of the set to reach all of the others, causing the multiple symptoms. Check the DC supply with a scope. It should be perfectly clean—just a straight line. Anything else you see means trouble.

POSTAGE STAMP RASTER

Here's one for you! I've got this Sony KV-1910 with a pulsating postage-stamp sized raster. Transistor Q931 had failed; I replaced it with a new one, which also failed after about an hour. Something's odd about Q602—it shows the same voltage on all three pins. The B+ is down to about 100 volts, and on the other side of the bridge rectifier I'm getting −60 volts instead of −30 volts. To top all of that off, I'm confused about the schematics—

Sam's has three for this set and all of them are different. Help!—A.G., Oakland, NJ

Well, this is an "unusual" DC-power supply, to say the least. Transistor Q931 is the voltage regulator, and it is in the *ground return path* of the filter capacitors. When the voltage changes, that transistor effectively varies the "size" of those capacitors. A couple of things need checking. You are obviously getting too much current in the ground path, so check all the filter capacitors for leakage. Also, check all of the diodes in the bridge to see if one of those is open or shorted. That sometimes doesn't affect the DC output too much, but does increase the ripple very badly. That excess ripple could be what's blowing out Q931.

COMPUTER PROBLEM

I wrote you some months ago about a problem I was having getting my PET computer and home-brew modulator to give me something other than what looked like early Sanskrit on the screen. You suggested a few things, one of them was to check out the sync. Sure enough, that was where the problem was. Turns out that there was only a small amount of sync in the video output I was accessing—probably stray coupling on the board. That computer, it seems does not have fully-composite video. The sync is separate, and requires processing for normal use. Since I was using a home-brew modulator, I could add separate sync-processing, and that did it.—*L.P. Davies, Middle Village, NY.*

FLYBACK REPLACEMENT

I'm trying to fix the TV section of a 1950-vintage Bendix 6100 TV/radio/phono console for a friend. The flyback is bad, but I can't find a substitute for it anywhere. Is it possible to modify it?—D.H., Sebastopol, CA

Well, you can, but it would be a very hairy job. I've got some good news for you, however. Thordarson shows a FLY-138 as a replacement for the TSOH03 Bendix part. If your distributor does not stock it, he can order it for you.

COLOR SYNC PROBLEM

I had a color-sync problem in a Sylvania D16-09. Wrote you about it, and got your reply. I found out that coil L606 was bad. I had replaced a transistor and several resistors in that circuit, but had never suspected the coil. When I checked the coil, it measured about 6 ohms less than it should have. Replacing it brought back the color sync. I suspect that the coil had been overloaded, and developed an intermittent. Thanks for the help—*John F. Fitzpatrick, Holyoak, MA.* R-E

NEW PRODUCTS

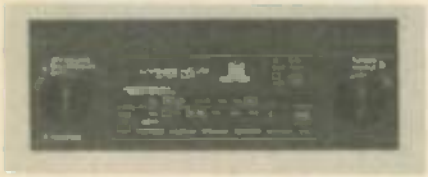
For more details use the free information card inside the back cover.

TONEARM HEADSHELL, *model OS-7MH,* is made of low-resonance magnesium, designed to minimize mass to accommodate low-mass, high-compliance cartridges. The unit weighs 6.5 grams, including the 99.99% pure-pitch copper Litz lead wires.

CIRCLE 111 ON FREE INFORMATION CARD

The *model OS-7MH* is finished in matte black, measures 2¼ inches beyond the end of its mount, and provides 9 millimeters of overhang adjustment. It comes packaged with mounting bolts and nuts. The price is $19.95. — **Osawa & Co. (USA) Inc.,** 21 Harbor Park Drive, Port Washington, NY 11050.

IN-DASH CASSETTE PLAYER, *model CSR-3300,* is an AM/FM/MPX in-dash auto-reverse cassette offering a brushed-aluminum-clad nosepiece and a variable-voltage output, with high-impedance connectors that make the unit compatible with nearly every amplifier on the market.



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The *model CSR-3300* offers pushbutton pre-set tuning and Dolby noise-reduction circuitry, and is metal-tape compatible. It has an FET front end; durable sendust head; key-off eject, and loudness, mono/stereo, local/dx, muting, bass, and treble controls.

There is 2.2 watts-per-channel minimum continuous actual power into 4 ohms, from 30 to 15,000 Hz ±3 dB, with no more than 1% THD, and tape-frequency response of 31.5 to 15,000 Hz (with metal). The dimensions are 7 × 2 × 5¼ inches.

The *model CSR-3300* is priced at $299.95. — **Autotek Electronics,** 1447 N. Carolan Ave., Burlingame, CA 94010.

PANEL METERS, the *2430* series, are designed basically for metering DC voltages (in four ranges to 200 volts), but with immediately available options for

CIRCLE 113 ON FREE INFORMATION CARD

measuring DC current, AC voltage and current, resistance, and for process monitoring. The meters interface with industrial-standard current and voltage loops.

Basic accuracy for the *2430* series is 0.05% reading ±1 digit. Basic ranges (and resolutions) are 200 millivolts (100 microvolts), 2 volts (1 millivolt), 20 volts (10 millivolts), and 200 volts (100 millivolts). Input impedance and maximum input voltage are more than 2000 megohms and ±50 volts on the two lower ranges and 5 megohms and ±500 volts on the two upper ranges. The conversion rate is 3 readings/second (7.5 or 15 rdg/sec. optionally available). The maximum common-mode voltage is 500-volts RMS. Outputs available to power auxiliary circuitry may be, optionally, +5 volts or −5 volts at 25 milliamperes or +5 volts at 60 milliamperes.

The *2430* series meters are priced at $135.00 each. — **Weston Instruments,** 614 Frelinhuysen Avenue, Newark, NJ 07114.

EARTH-STATION MODULATOR, *model ESM-4928,* is designed with all features required for operation with TVRO (*Television Receive Only*) satellite terminals, where the audio and video are provided as separate baseband signals. It is available for VHF channels 2-13, and midband channels A-I.

The *model ESM-4928* is a vestigial sideband audio/video modulator with crystal-controlled video and audio carriers to minimize color beats and audio

CIRCLE 114 ON FREE INFORMATION CARD

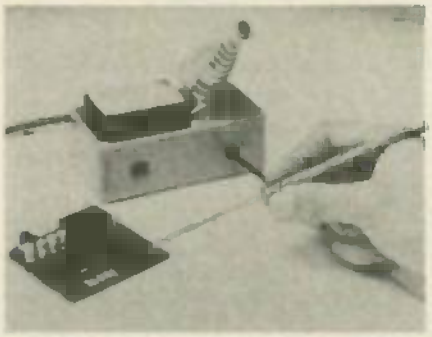
distortion. The unit has a calibrated video-modulation meter and a true peak-reading LED audio-overmodulation indicator to insure precise modulation control. The audio indicator permits adjustment for optimum sound quality.

A video low-pass filter rejects unwanted

subcarrier frequencies of secondary satellite services, preventing adjacent-channel interference, and a low-loss RF loop-through diplexer allows higher output levels with lower distortion when combining channels. The unit is compact, lightweight (8 pounds), and can be mounted in a standard EIA 19-inch rack. All indicators and controls are located on the front panel for easy monitoring and adjusting.

The *model ESM-4928* is priced at $1703.61 — Blonder-Tongue, One Jake Brown Road, Old Bridge, NJ 08857.

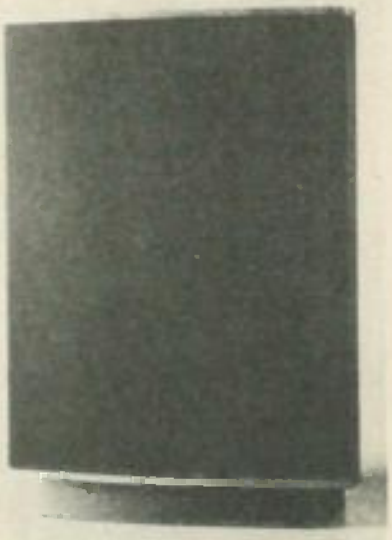
SOLDERING STATION, *model 7230*, operates on 6 watts (AC) allowing precise, safe soldering on miniature circuits and instruments, as well as on heat-sensitive components. It is well suited for production-line operations or any others where fine, close work is required. The ½-ounce, pencil-size iron is easy to control for fast, accurate soldering — even of hair-thin copper leads.



CIRCLE 115 ON FREE INFORMATION CARD

The *model 7230* has a double-insulated transformer, a tip-cleaning sponge, sponge well, spring holder, indicator lamp, and internal safety fuse. Fourteen tips, from 1/25 to 5/32 inch, are available and can be interchanged quickly, without special tools. Tips cool down quickly from 360°C., and resist seizure. The *model 7230* is priced at $39.95.—Wahl Clipper Corporation, Sterling, IL 61081.

SPEAKERS, *model ESL-63*, feature a very light, electrically polarized diaphragm suspended between two sets of rigid and acoustically transparent concentric annular anodes to which the signal is fed through sequential delay lines. The sound-pressure pattern produced is a replica of that from an ideal source some 30 centimeters behind the plane of the diaphragm; the motion of the diaphragm is roughly analogous to the wave motion which results when a stone is dropped into a still pond. The result is a totally homogeneous sound source, phase-true and free from all the problems associated with multiple drive units, crossovers, and cabinet resonances.



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An important aspect of the design of the *model ESL-63* is that the sound pressure at any point in space, and electrical currents in the electrodes, are directly related, giving the designer complete control over the frequency response and directivity characteristics of the speakers, which can then be optimized; thus they achieve a greater degree of realism than has ever been possible before.

The *model ESL-63* is priced at approximately $3300.00 a pair. — Quad Electroacoustics Ltd., 425 Sherman Ave., Palo Alto, CA 94306.

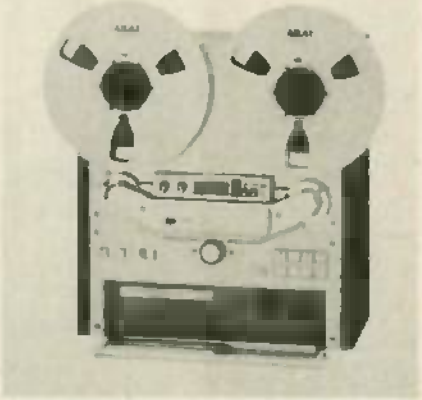
CORDLESS TELEPHONE, *model MP 600/601*, transmits and receives calls over a range of 750 feet, even during recharging; downtime is totally eliminated. The unit will operate for up to 24 hours without recharging; a manual RF gain control reduces range to meet urban and industrial requirements, eliminating the pos-

CIRCLE 117 ON FREE INFORMATION CARD

sibility of interference. It is compatible with rotary-dial and touch-button telephones and has the added convenience of a security switch which, when activated, prevents outgoing calls.

The *model MP 600/601* operates on the FCC-approved 49 and 1.7 MHz personal communications bands; five channels are available. It can also interface with two-, five-, and nine-line phone systems when used with the available Mura adaptor kits, which include a call/page feature. The *model MP 600/601* is priced at under $200.00. — **Mura Corporation**, Westbury, NY 11590.

TAPE DECK, *model GX-747*, is an open-reel deck and handles the new high-density "EE" tapes; it uses three motors and will accommodate both 10½-inch and 7-inch reel-to-reel tape. It is a bi-directional, quick-reverse deck (less than 0.4 seconds) that automatically reverses in both play and record modes. A multi-function electronic digital counter includes a real-time display in minutes and seconds that counts back down when the deck is in reverse, a lap counter, and automatic "0" stop.



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Tape loading is made easy with an automatic tension-arm lock method and the deck allows pitch control and fine-bias adjustment. Six separate heads, including four GX crystal ferrite heads, insure superior recording and playback in both directions.

Additional features include full-logic feather-touch controls, tape/source monitoring, two-color LED meters, with peak hold, cue and review, and automatic muting. The *model GX-747* is priced at $1250.00. — **Akai America, Ltd.**, 800 West Artesia Blvd., PO Box 6010, Compton, CA 90224. **R-E**

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NEW BOOKS

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TROUBLESHOOTING SOLID-STATE CIRCUITS, by George Loveday and Arthur H. Seidman. John Wiley & Sons, One Wiley Drive, Somerset, NJ 08873. 110 pp including index. 7¼ × 9¼ inches; softcover; $7.95.

This is a practical "how-to-do-it" text that covers both discrete and integrated circuits. Suitable for either self-study or lecture-lab courses, the material is intended for students, technicians, and hobbyists. The text provides a concise description of major solid-state devices and their operation in practical circuits, with many diagrams, each carefully explained.

The majority of the circuits shown in the text have been built and tested, and measurements have been made under various failure modes. For practical lab work and experience, the circuits can be duplicated by the reader. Readily available components, whenever possible, are indicated on the circuits; equivalent devices for those given in the diagrams may be used.

After the opening chapter dealing with troubleshooting basics, we go into single-stage transistor amplifiers (2); power-supply circuits (3); amplifier circuits (4); oscillator and time-base circuits (5); pulse and waveform-shaping circuits (6); thyristor and triac circuits (7), and a final chapter on circuits using linear and digital integrated circuits. Each chaper offers exercises to test your understanding of the material. The answers to the exercises are given in the back of the book. R-E

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EQUIPMENT REPORTS

continued from page 32

handset user that he or she has a call. Three LED indicators on the base unit are used to let the user know when the unit is on, when there is a call in progress, and when the base unit is in the charge mode. To charge the handset's batteries, simply leave it in the base unit overnight.

The manufacturer states that the operating range of the unit can be as great as 600 feet. With a claim like that, we were eager to try it out.

Our test

After charging the cordless handset overnight, we proceeded with our test of the *Freedom Phone 3500*. With the antenna extended to its full length, we called up a friend. He reported that the unit had excellent audio quality, and we noted that our reception was also excellent. Moving several hundred feet away from the base unit, two-way communications remained reliable. Even when there was some noise present, we had no trouble placing a call.

The handset is small enough to be carried in your shirt pocket or, if you prefer, you can use an optional carrying case. If that is inconvenient, the unit can be set down near you—an incoming call will produce a loud warbling sound that can be heard at some distance.

The cordless phone uses the 1.7- and 49-MHz bands for full-duplex operation. Because those bands are so far apart, a different antenna is used for each. The base station uses the AC-power cord and the handset uses a ferrite bar for the 1.7-MHz band; the collapsible whips are used for 49 MHz. While that system generally works well, using the AC cord as an antenna can sometimes limit the phone's range, especially if your house has shielded conduits. If that is the case, a three-wire extension cord can be used as an additional radiating element and extend the range. Also, if the base station is located near large metallic objects, some phase cancellation can take place, limiting range. In that instance, the base station should be moved to a more favorable location. Alternately, the whip antenna can be swiveled to get the best radiation pattern.

All-in-all, we were very impressed with this little cordless phone. Considering its versatility, compact size, and useful range, it's one of the nicest units we've seen. The *Freedom Phone 3500* is manufactured by Electra Company, 300 East County Line Road, Cumberland, IN 46229. It sells for $329.00. R-E

CIRCLE 102 ON FREE INFORMATION CARD

VIDEO SYNC STABILIZER

(Continued from page 48)

(MODULATION) and L1 alternately until you get the best picture quality you can. Now you can bring in the sound by adjusting L2. The two coils and R25 are interactive, so you may have to readjust them several times to get the best results.

If you have been working without a scope, now is the time to return to R14 and carefully adjust it for the best and steadiest picture from the distorted tape you've been running (this stage had to wait until the RF modulator was adjusted so you could refer to the picture on the TV screen). As you turn the pot, the picture should suddenly "lock in." Stop at that point—if you go farther, the regenerated sync pulse may be too strong and interfere with the rest of the signal.

Should you run into any problems in performing the alignment, go back and check your work—especially for poor solder joints and solder bridges, and for the proper component orientation. Also try readjusting R7 and R14 slightly.

If the circuit seems to be working properly but you are still having problems with vertical roll, try increasing the value of R12 to 150K or 220K. That will widen the vertical-sync pulse farther, and should lock-in even the most stubborn TV set. R-E

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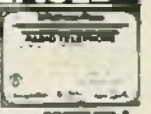

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7404N	.28	7446N	.64	74111N	.72	74163AN	.64	74246N	1.44	74S11N	.89	74S162N	3.70	74S374N	2.85	74LS37N	.44	74LS125N	.44	74LS181N	1.98	74LS275N	4.89	78LS390N	.89
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7408N	.29	7453N	.29	74122N	.64	74170N	9.89	74273N	2.39	74S32N	.89	74S174N	1.06	74S472N	6.45	74LS48N	.89	74LS136N	.42	74LS192N	.64	74LS290N	.72	74LS490N	1.89
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7412N	.47	7473N	.36	74126AN	.89	74174N	.89	74279N	.89	74S40N	.44	74S182N	2.10			74LS65N	.24	74LS145N	1.89	74LS195N	.89	74LS299N	3.98	74LS670N	1.94
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7426N	.39	7491AN	.44	74147N	1.39	74190N	.89	74380N	.89	74S133N	.89	74S251N	1.49	74LS11N	.28	74LS92N	.48	74LS161N	.89	74LS248N	1.89	74LS352N	2.89		
7427N	.36	7492AN	.39	74148N	.89	74191N	.89	74390N	1.29	74S134N	.72	74S253N	2.29	74LS12N	.24	74LS93N	.48	74LS162N	1.10	74LS249N	1.19	74LS365N	.52		
7428N	.48	7493AN	.39	74150N	1.44	74192N	.89	74S00N	.44	74S135N	1.56	74S257N	1.42	74LS13N	.29	74LS95N	.48	74LS163N	.89	74LS251N	.84	74LS366N	.89		
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COLLECTOR needs hi-fi components—Broiner. Lafayette kits. Dynatuner. HARRISON. P.O. Box 24. Terrace Park. OH 45174

COMPUTER MARKET CENTER

COMPUTER MARKET CENTER ADVERTISING RATES 1" by 1 column (1 5/8") $55.00. 1 1/2" by 1 column (1 5/8") $82.50. 2" by 1 column (1 5/8") $110.00. All ads must be prepaid. Send order and remittances to Computer Market Center, Radio-Electronics Magazine, 200 Park Avenue South, New York, New York, 10003. Address telephone inquiries to 212-777-6400. Frequency rates are available.

TEXAS

USED COMPUTER TERMINALS. PRINTERS. MODEMS. SURPLUS ELECTRONIC PARTS. CATALOG $1.00
RONDURE COMPANY
THE COMPUTER ROOM
2522 BUTLER STREET
DALLAS, TEXAS 75235
(214) 630-4621

RETAILERS

An ad for your computer store in this space in Radio-Electronics COMPUTER MARKET CENTER puts you in touch with our computer audience. They use microcomputer equipment for both business and hobby interests. For further details call 212-777-6400.

ARIZONA

SAVE 90%

You can save up to 90% by building your own Micro or Minicomputer! IE: a 4MHZ Z80A with 64KB of Memory and a real front panel costs $150.00. FREE DETAILS. Digatek Corp., 2723 W. Butler Dr., Suite E. Phoenix AZ 85021.

7400

[illegible]

74LS

[illegible]

74S

[illegible]

CA–LINEAR

[illegible]

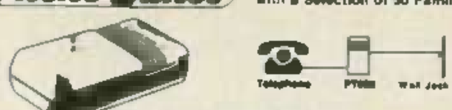
CD–CMOS

[illegible]

Phone Tunes

As Seen on "Good Morning America"

Replaces the Telephone Ringer Bell with a Selection of 30 Familiar Tunes



Each unit will play any of the following tunes

- Rule Britannia
- O Canada
- Colonel Bogey
- Westminster Chimes
- Mexican Hat Dance
- Twinkle, Twinkle Little Star
- Deutschlandlied
- God Save the Queen
- Close Encounters
- Happy Birthday
- Wedding March
- Jingle Bells
- Auld Lang Syne
- Soldiers Chorus
- Sailor's Hornpipe
- Charge!
- Greensleeves
- Lorelei
- Eyes of Texas
- Star Spangled Banner
- Oranges and Lemons
- Whittington
- Mozart Sonata
- Pomp & Circumstance
- William Tell Overture
- Bach Toccata in D Minor
- Shave and a Haircut
- Blue Danube Waltz
- Beethoven's 5th
- La Marseillaise

FEATURES

Replaces mechanical telephone ringer bell. Easily connects to any standard telephone. Can be used alongside regular phone or replace a remote ringer elsewhere in building or outside. FCC approved. Can be used on any telephone system — worldwide. Use a different tune to identify extension phones. Microprocessor controlled. Adjustable volume control and variable tune speed control. Operates on two 9-volt batteries or AC Adapter (not included).

PT030 Phone Tunes $49.95
AD30 AC Adapter $8.95

DISCRETE LEDS

XC[illegible]R	.[illegible]" red	[illegible]
XC[illegible]G	.[illegible]" green	4/$1
XC[illegible]Y	.[illegible]" yellow	4/$1
XC[illegible]C	.[illegible]" clear	4/$1
XC22R	.[illegible]" red	[illegible]
XC22G	.[illegible]" green	4/$1
XC22Y	.[illegible]" yellow	4/$1
MV100	.110" red	[illegible]
MV50	.[illegible]" red	[illegible]
XC[illegible]R	.[illegible]" red	[illegible]
XC[illegible]G	.125" green	4/$1
XC[illegible]Y	.125" yellow	4/$1
XC[illegible]R	.[illegible]" red	[illegible]
XC[illegible]G	.[illegible]" green	4/$1
XC[illegible]Y	.[illegible]" yellow	4/$1
XC[illegible]C	.[illegible]" clear	4/$1

.200(T1½) Red/Green

Diffused Bi-Color LED

Part No.	1-99	100+
XC5491	.79	.65

RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

C.A. — Common Anode
D.D. — Double Digit
C.C. — Common Cathode
RHD — Right Hand Decimal

Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95
MAN 2	5x7 D.M.—red	[illegible]	4.95
MAN 3	C.C.—red	.125	[illegible]
MAN [illegible]	C.A.—green	[illegible]	[illegible]
MAN [illegible]	C.C.—green	[illegible]	[illegible]
MAN 71	C.A.—red	[illegible]	[illegible]
MAN 72	C.A.—red	[illegible]	[illegible]
MAN 74	C.C.—red	[illegible]	[illegible]
MAN [illegible]	C.A.—yellow	[illegible]	[illegible]
MAN [illegible]	C.C.—yellow	[illegible]	[illegible]
MAN [illegible]	C.A.—orange	[illegible]	[illegible]
MAN [illegible]	C.A.—orange ± 1	[illegible]	[illegible]
MAN [illegible]	C.C.—orange	[illegible]	[illegible]
MAN 4[illegible]	C.A.—orange	[illegible]	[illegible]
MAN [illegible]	C.A.—orange—DD	[illegible]	[illegible]
MAN [illegible]	C.A.—orange ± 1	[illegible]	[illegible]
MAN [illegible]	C.C.—orange—DD	[illegible]	[illegible]
MAN [illegible]	C.C.—orange ± 1	[illegible]	[illegible]
MAN [illegible]	C.A.—orange	[illegible]	[illegible]
MAN [illegible]	C.A.—red—DD	[illegible]	[illegible]
MAN [illegible]	C.C.—red—DD	[illegible]	[illegible]
MAN [illegible]	C.C.—red ± 1	[illegible]	[illegible]
DLO[illegible]	C.C.—orange	[illegible]	1.25
DLO[illegible]	C.A.—orange	[illegible]	[illegible]
DLO[illegible]	C.C.—green	[illegible]	[illegible]
DLG[illegible]	C.A.—green	[illegible]	[illegible]
DL704	C.C.—red	.300	[illegible]
DL707	C.A.—red	[illegible]	[illegible]
DL7[illegible]	C.C.—red	.300	[illegible]
DL[illegible]	C.A.—red	[illegible]	[illegible]
DL[illegible]	C.A.—red	[illegible]	[illegible]
DL7[illegible]	C.C.—red	[illegible]	[illegible]
DLO[illegible]	C.A.—orange	[illegible]	[illegible]
DLO[illegible]	C.C.—orange	[illegible]	[illegible]
DL[illegible]	C.C.—red	.110	[illegible]
FND[illegible]	C.C. ± 1	[illegible]	[illegible]
FND[illegible]	C.C.	[illegible]	[illegible]
FND[illegible]	C.C. (FND[illegible])	[illegible]	[illegible]
FND[illegible]	C.A. (FND[illegible])	[illegible]	[illegible]
HDSP-[illegible]	C.A.—red	[illegible]	[illegible]
HDSP-[illegible]	C.C.—red	[illegible]	[illegible]
HDSP-[illegible]	C.C. red ± 1	[illegible]	[illegible]
5082-7751	C.A., R.H.D.—red	[illegible]	1.25
5082-7760	C.C., R.H.D.—red	[illegible]	1.25
5082-7300	4x7 Numeric (RHD)	[illegible]	[illegible]
5082-7302	4x7 Numeric (LHD)	[illegible]	[illegible]
5082-7340	4x7 Hexdcl. (0-9/A-F)	[illegible]	[illegible]
4N[illegible]	Photo Xsistor Opto-Isol.		[illegible]
LIT-1	Photo Xsistor Opto-Isol.		[illegible]
MOC[illegible]	Optically Isol. Triac Driver		[illegible]

COMPUTER GRADE CAPACITORS

[illegible]

OVER 200 OTHER VALUES AVAILABLE — CALL OR WRITE FOR YOUR REQUIREMENT

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	[illegible]	[illegible]	[illegible]
16 pin LP	[illegible]	[illegible]	[illegible]
18 pin LP	[illegible]	[illegible]	[illegible]
20 pin LP	[illegible]	[illegible]	[illegible]
22 pin LP	[illegible]	[illegible]	[illegible]
24 pin LP	[illegible]	[illegible]	[illegible]
28 pin LP	[illegible]	[illegible]	[illegible]
36 pin LP	[illegible]	[illegible]	[illegible]
40 pin LP	[illegible]	[illegible]	[illegible]

SOLDERTAIL STANDARD (TIN)

[illegible]

SOLDERTAIL (GOLD) STANDARD

[illegible]

WIRE WRAP SOCKETS (GOLD) LEVEL #3

[illegible]

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 Ohm / 27 Ohm	12 Ohm / 33 Ohm	15 Ohm / 39 Ohm	18 Ohm / 47 Ohm	22 Ohm / 56 Ohm	50 pcs.	$1.95
ASST. 2	5 ea.	68 Ohm / 180 Ohm	82 Ohm / 220 Ohm	100 Ohm / 270 Ohm	120 Ohm / 330 Ohm	150 Ohm / 390 Ohm	50 pcs.	$1.95
ASST. 3	5 ea.	470 Ohm / 1.2K	560 Ohm / 1.5K	680 Ohm / 1.8K	820 Ohm / 2.2K	1K / 2.7K	50 pcs.	$1.95
ASST. 4	5 ea.	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	50 pcs.	$1.95
ASST. 5	5 ea.	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	50 pcs.	$1.95
ASST. 6	5 ea.	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	50 pcs.	$1.95
ASST. 7	5 ea.	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	50 pcs.	$1.95
ASST. 8R		Includes Resistor Assts. 1-7 (350 pcs.)						$10.95 ea.

$10.00 Min. Order — U.S. Funds Only
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1/82

INTERSIL

Part No.	Function	Price
7[illegible]IPI	CMOS Precision Timer	[illegible]
7[illegible]EV/KR*	Stopwatch Chip, XTL	[illegible]
7[illegible]CPL	3½ Digit A/D (LCD Drive)	[illegible]
7[illegible]EV/Kit*	IC, Circuit Board, Display	[illegible]
7[illegible]CPL	3½ Digit A/D (LED Drive)	[illegible]
7[illegible]EV/KR*	IC, Circuit Board, Display	[illegible]
7[illegible]CPL	3½ Digit A/D LCD Dis. HLD	[illegible]
7117CPL	3½ Digit A/D LED Dis. HLD.	17.[illegible]
7[illegible]IO[illegible]	Low Battery Volt Indicator	[illegible]
7[illegible]IPG	CMOS LED Stopwatch/Timer	[illegible]
7[illegible]EV/KR*	Stopwatch Chip, XTL	[illegible]
7[illegible]CJPE	Tone Generator	[illegible]
7[illegible]CEV/Kit*	Tone Generator Chip, XTL	[illegible]
7[illegible]IPD	Oscillator Controller	[illegible]
7[illegible]AEV/KR*	Freq. Counter Chip, XTL	[illegible]
7[illegible]IPI	Seven Decade Counter	17.[illegible]
7[illegible]IPA	Clock Generator	[illegible]
7215IPG	4 Func. CMOS Stopwatch CKT	[illegible]
7[illegible]EV/Kit*	4 Func. Stopwatch Chip, XTL	[illegible]
72[illegible]AIJI	8-Digit Univ. Counter C.A.	[illegible]
72[illegible]CIJI	8-Digit Freq. Counter C.A.	[illegible]
72[illegible]DIPI	8-Digit Freq. Counter C.C.	[illegible]
7217IJI	4-Digit LED Up/Down Counter	[illegible]
72[illegible]CIJI	8-Digit Univ. LED Drive	[illegible]
72[illegible]IPL	LCD 4½ Digit Up Counter DRI	[illegible]
72[illegible]AIJL	8-Digit Univ. Counter	[illegible]
72[illegible]AEV/KR*	8 Function Counter Chip, XTL	[illegible]
72[illegible]IJE	CMOS Bin Prog. Timer/Counter	[illegible]
72[illegible]IJA	CMOS Divide-By-[illegible] RC Timer	[illegible]
72[illegible]IJE	CMOS BCD Prog. Timer/Counter	[illegible]
72[illegible]IJE	CMOS BCD Prog. Timer/Counter	[illegible]
7[illegible]IPA	CMOS 555 Timer (8 Pin)	[illegible]
7[illegible]IPD	CMOS 556 Timer (14 pin)	[illegible]
7[illegible]BCPA	CMOS Op Amp Comparator 1MV	[illegible]
7[illegible]BCPA	CMOS Op Amp Ext. Cmer. 5MV	[illegible]
7[illegible]BCPA	CMOS Dual Op Amp Comp. 5MV	[illegible]
7[illegible]CCPE	CMOS Tri Op Amp Comp. 10MV	[illegible]
7[illegible]CCPD	CMOS Quad Op Amp Comp. 10MV	[illegible]
7[illegible]CCPD	CMOS Quad Op Amp Comp. 10MV	[illegible]
[illegible]CPA	Voltage Converter	[illegible]
[illegible]CCPD	Waveform Generator	[illegible]
[illegible]CCPE	Monolithic Logarithmic Amp	[illegible]
[illegible]CCQ	[illegible]ppm Band-GAP Volt Ref. Diode	[illegible]
[illegible]CPA	Volt Ref/Indicator	[illegible]
[illegible]CPA	Volt Ref/Indicator	[illegible]

74C

[illegible]

LINEAR

[illegible]

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

[illegible]

100 VOLT MYLAR FILM CAPACITORS

[illegible]

+20% DIPPED TANTALUMS (Solid) CAPACITORS

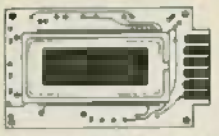
[illegible]

MINI ALUMINUM ELECTROLYTIC CAPACITORS

[illegible]

CIRCLE 5 ON FREE INFORMATION CARD

National Semiconductor Clock Modules



12VDC AUTOMOTIVE/ INSTRUMENT CLOCK

APPLICATIONS
- In-dash automotive
- Alarm, marker buoy, RV clocks
- Aircraft marine clks
- 12VDC oper. instru.
- Portable/battery powered instruments

Features: Bright 0.3" green display, internal crystal time-base, ±0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete – just add switches and lens.

MA1003 Module (1.5"W×1.3"H×.95"D) . **$16.95**

CLOCK MODULES

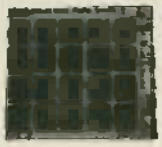
MA1023 .7" Red Digital LED Clock Module	8.95
MA1026 .3" Dig. LED Alarm Clock/Thermometer	18.95
MA8036 .3" Red Digital LED Clock/Timer	8.95
MA1002 .8" Red Digital LED Clock & Xformer	9.95
MA1010 .8" Red Digital LED Clock	7.95
MA1032 CBA .8" Digital LCD Clock	17.95
MA1043 .7" Green Digital LED Clock	8.95

TRANSFORMERS

102 P20 Xformer for MA1023, 1043 & 8036 Mods.	3.49
102 P22 Xformer for MA1026 Clock Modules	3.49
102 P24 Xformer for MA1010 Clock Modules	3.49

NEW!

Sun Power Your Electronics! SOLAR CELL PANEL KIT



Features:
- Output 12VDC to 100mA in Series 5VDC to 200mA in parallel
- Panel may be easily connected for Series or Parallel use
- Over 11 square inches of active cell surface
- Voltage Out up @ 0.6V increments
- Provision for charging batteries
- Overall panel size 4¼"L x 4¼"W x ⅛"D

The JE305 Solar Cell Panel Kit contains 20 each solar cells. On the panel board are power line taps which allow the [illegible] voltage from 0.5VDC to 10VDC. The [illegible] of which panel can be further expanded by coupling additional panels together for more voltage or to parallel for more current. This panel's power easily provides the current necessary for the operation of mini pan-table transistor radios, small battery powered cassette tape players and assorted experimental solar projects.

JE305 . . . . . **$39.95**

EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 8308O, 8204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conducting liquid liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact – only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVB-11BL Replacement Bulb **$19.95**

UVS-11E **$79.95**

JOYSTICKS

JS-5K	5K Linear Taper Pots $5.25
JS-100K	100K Linear Taper Pots $4.95
JVC-40	40K (3) Video Controller in Box . . . $4.95

ALLIGATOR CLIP TEST LEADS

Heavy-duty leads, color coded, insulated alligator clip on each end, 15" long. Two each black, red, blue, white and yellow.

#ALCP (10 per pack) . . . . . **$2.95/pkg.**

NEW!

JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC
- Power Output (each supply) 5VDC @ 500mA, 10VDC @ 250mA, 12VDC @ 200mA, and 15VDC @ 170mA
- Two, 3-terminal adj. IC regulators with thermal overload protection
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Sized 3-1/2"W x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . **$24.95**

(Picture not shown but similar in construction to above)

JE200 Reg. Power Supply Kit (5VDC, 1 amp)	$14.95
JE205 Adapter Brd. (to JE200) ±5, ±8 & ±12V	$12.95
JE210 Var. Pwr. Sply. Kit, 8-15VDC, to 1.5amp.	$19.95

MICROPROCESSOR COMPONENTS

6800A/6800A SUPPORT DEVICES

[illegible]	CPU
[illegible]	8-Bit Input/Output
[illegible]	Priority Interrupt Control
[illegible]	Bi-Directional Bus Driver
[illegible]	Clock Generator/Driver
[illegible]	Bus Driver
[illegible]	Timer Controller/Bus Driver
[illegible]	System Controller
[illegible]	I/O Expander for 6800
[illegible]	Asynchronous Comm. Element
[illegible]	Prog. Comm. I/O (UART)
[illegible]	Prog. Interval Timer
[illegible]	Prog. Peripheral I/O (PIO)
[illegible]	Prog. DMA Control
[illegible]	Prog. Interrupt Control
[illegible]	Prog. SAT Controller
[illegible]	Prog. Keyboard/Display Interface
[illegible]	Synchron. Timing Element
[illegible]	4-Bit Bi-Directional Receiver
[illegible]	8-Bit Bi-Directional Receiver
[illegible]	8-Bit Bi-Directional Receiver
[illegible]	Octal Latched Peripheral Driver
[illegible]	Octal Latched Peripheral Driver

6800/6800 SUPPORT DEVICES

[illegible]	MPU
[illegible]	MPU with Clock and RAM
[illegible]	1K x 8 Static RAM
[illegible]	Peripheral Input, Output
[illegible]	Priority Interrupt Controller
[illegible]	1024-bit ROM (MCM6830)
[illegible]	Asynchronous Comm. Adapter
[illegible]	Synchronous Serial Data Adapter
[illegible]	8-Stage Dynamic Shift Register
[illegible]	Quad 3-State Bus Trans. (MC3T26)

MICROPROCESSOR CHIPS

[illegible]	CPU (MC6800P) (CERAM)
[illegible]	CPU (MC6800CP) (CERAM)
[illegible]	CPU
[illegible]	MPU
[illegible]	CPU-6-Bit Slice (Com. Temp. 0-+70)
[illegible]	MPU w/Clock (8K Bytes Memory)
[illegible]	MPU-6-Bit (Ceramic)
[illegible]	CPU-6st. Chip 6-Bit (256Bytes x Axis)
[illegible]	CPU (8K Bytes Max)
[illegible]	CPU-8K Bytes RAM
[illegible]	CPU w/Serial Interface
[illegible]	CPU
[illegible]	MPU-16-Bit

SHIFT REGISTERS

[illegible]	Dual 16-Bit Dynamic
[illegible]	Dual 80-Bit Dynamic
[illegible]	Dual 100-Bit Static
[illegible]	Dual 16-Bit Accumulator
[illegible]	256-Bit Dynamic
[illegible]	1024-Bit Dynamic/Recirculator
[illegible]	1024-Bit Dynamic
[illegible]	Octal 16-Bit
[illegible]	Octal 80-Bit
[illegible]	1024-Bit Dynamic
[illegible]	Hex 16-Bit Static
[illegible]	Dual 32-Bit Static
[illegible]	1024-Bit Dynamic
[illegible]	256-Bit Dynamic
[illegible]	Dual 64-Bit Static
[illegible]	Dual 128-Bit Static
[illegible]	Dual 256-Bit Static
[illegible]	Quad 64-Bit Static
[illegible]	1Mb Charge CCD

DATA ACQUISITION

[illegible]	Universal 3-Bit Latch
[illegible]	Touch Tone Low Band Filter
[illegible]	Touch Tone High Band Filter
[illegible]	Super Gain OP Amp
[illegible]	Constant Current Source
[illegible]	Temperature Transducer
[illegible]	JFET Input OP Amp
[illegible]	Sample & Hold Amplifier
[illegible]	Three Comp. Prec. Ref. (Military/VC)
[illegible]	8-Bit A/D Converter (1 LSB)
[illegible]	8-Bit D/A Converter & Ref. (Mil.)

DATA ACQUISITION (CONTINUED)

[illegible]	8-Bit A/D Converter (8-Ch. Multi.)
[illegible]	8-Bit A/D Converter (16-Ch. Multi.)
[illegible]	8-Bit D/A Conv. Mltpg. Comp. (Mil.)
[illegible]	10-Bit D/A Conv. Mltpg. Comp. (Mil.)
[illegible]	12-Bit D/A Converter (Mil. Lbl.)
[illegible]	12-Bit D/A Converter (Mil. Lbl.)
[illegible]	8-Channel Multiplexer
[illegible]	256 BAUD UART

RAM's

[illegible]	16-1 Static
[illegible]	2048 Dynamic
[illegible]	2048 Static
[illegible]	1024 Static
[illegible]	1024 Static
[illegible]	256 Static
[illegible]	1024 Static (CMOS)
[illegible]	1024 Static (CMOS) Low Power
[illegible]	4096 Static
[illegible]	4096 Static (CMOS) Low Power
[illegible]	1024 Static
[illegible]	4096 Dynamic (Mil. Temperature)
[illegible]	16K Dynamic (Mil. Temperature)
[illegible]	16K Dynamic
[illegible]	4096-1 Pin Static
[illegible]	16K Dynamic
[illegible]	16384 Dynamic Fully Decoded
[illegible]	2048 Dynamic
[illegible]	16384 Dynamic

PROMS/EPROMS

[illegible]	8K UV Erasable EPROM
[illegible]	8K EPROM
[illegible]	8K EPROM (5V, +9V, +12V)
[illegible]	8K EPROM (Single +5V)
[illegible]	16K EPROM
[illegible]	8K EPROM (Military Temp.)
[illegible]	8K EPROM (Single +5V)
[illegible]	8K EPROM (Military Temp.)
[illegible]	2048 PROM (Open Collector)
[illegible]	256 Bipolar PROM
[illegible]	2048 Tri-State Bipolar PROM
[illegible]	8K EPROM

— Over 25 More PROMS Listed in Our Catalog —

ROM's

[illegible]	Character Generator (Upper Case)
[illegible]	Character Generator (Lower Case)

NMOS READ ONLY MEMORIES

[illegible]	128-Bit ASCII Shifted w/Parity
[illegible]	128-Bit Mask Program'd Parity
[illegible]	128-Bit Alpha, Comma Char. Gen.

MICROPROCESSOR MANUALS

[illegible]	User Manual
[illegible]	User Manual
[illegible]	User Manual

SPECIAL FUNCTION

[illegible]	Dual 6800 Clock Driver (MP)
[illegible]	Dual 6800 Clock Driver (MP)
[illegible]	Floppy Disc Controller
[illegible]	Communications Chip
[illegible]	Microprocessor Real Time Clock
[illegible]	Microprocessor Companion Circuit
[illegible]	Microcontroller with 64-Byte RAM and Direct LED Drive
[illegible]	Microcontroller with 64-Byte RAM & Direct LED Drive with Shift Int.
[illegible]	8-Deg VAC Phase Driver (60-Hz plug.)

TELEPHONE/KEYBOARD CHIPS

[illegible]	Push Button Telephone Dialer
[illegible]	Repertory Dialer
[illegible]	CMOS Clock Generator
[illegible]	Keyboard Encoder (53 keys)
[illegible]	Keyboard Encoder (53 keys)
[illegible]	Keyboard Encoder (53 keys)
[illegible]	Keyboard Encoder (89 keys)
[illegible]	Push Button Pulse Dialer
[illegible]	64-Key Fully Serial Keyboard Encoder

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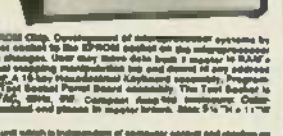
Part No.	Pos.	Configuration	Sealed	Price
[illegible]	1	12	8 pin	70 - 99 / 5.95
[illegible]	1	123	8 pin	80 - 99 / 7.95
[illegible]	1	1234	8 pin	88 - 99 / 8.95
[illegible]	4	ABCD	8 pin	88 - 99 / 8.95
[illegible]	4	0-4321	14 pin	1.09 - 99 / 9.95

Part No.	Pos.	Configuration	Sealed	Price
[illegible]	5	12345	10 pin	1.09 - 99 / 9.95
[illegible]	7	1234567	14 pin	1.19 - 99 / 10.95
[illegible]	8	12345678	16 pin	1.79 - 99 / 12.95
[illegible]	8	12345678	16 pin	1.29 - 99 / 10.95
[illegible]	10	12345678910	20 pin	1.49 - 99 / 11.95

JE608 PROGRAMMER
2704/2708 EPROM PROGRAMMER



GENERAL APPLICATIONS:
- To program EPROMS 2704 and 2708.
- Developmental system for microcomputer circuitry
- To read the contents of 5 pre-programmed EPROMS
- To compare EPROMS for programming differences
- To emulate a programmed EPROM
- To store [illegible] in RAMS for subroutines
- To check programming operations. 3 LED's for this.

Key board, 16 LED's for Address, Register and 8 LED's for Data Memory Register. The Data Memory Register displays the contents of the RAMs from the EPROM Chip. Development of microprocessor systems by writing of custom control logic for programmable parallel test control to the EPROM socket on the microprocessor board. Partial checking verification of programmed data changes. User may store data from 1 register to RAM's or from RAM's into temporary registers. Allows manual changing manipulation (up and down) of any address/data. Hand-shake EPROM Programmer operation. [illegible] 16 key Hexadecimal Keyboard assembly. Program, Read and Verify power supplies and 8 LED's on Control Panel Board assembly. The Test Socket is [illegible] 24 pin socket for [illegible] 1100 VAC, 60 Cps. Compact design for [illegible] Overall [illegible] case with right side panels and control and plenum for register buttons. Size: 5¼"H x 11"W x 11"D. Weight 5 lbs.

The JE608 EPROM Programmer is a versatile unit which can read and verify the contents of computer control and routines on additional memories. The EPROM can be programmed from the manufactured Keyboard or from a pre-programmed EPROM. The JE608 Programmer can emulate a programmed EPROM by the use of its internal RAM circuits. This will allow the user to test or prevent a program for a problem, prior to programming a chip. Any changes in the program can be ordered directly into the memory circuits with the manufactured Keyboard or you can modify the entire program with out re-programming. The JE608 Programmer requires a Programmable Power Supply for +5V, +12V and +25V. The Microprocessor Keyboard and LED/Test Socket Panel Board are separate assemblies within the system.

JE608K Kit	**$399.95**
JE608A Assembled and Tested	**$499.95**

JE608-16K ADAPTER BOARD
FOR 2716/2758 EPROMS

GENERAL DESCRIPTION:
The JE608-16K Adapter Board allows the JE608 Programmer to be modified for the additional programming of the 2716 and 2758 EPROMS. This adapter provides for adding an address switch for the 2" pin slot and for selecting the proper power and timing pulses to be applied to the EPROM. Programming and emulating the 2716 (16K) EPROM is done separate to each half (8Bytes) of the EPROM because of the existing 8K RAM capacity in the JE608 Programmer.

JE608-16K	Adapter Board Kit **$29.95**
JE608-Upgrade	(Send assembled JE608 to factory for adapter installation **$80.95**
	of the JE608-16K Adapter Board Kit)
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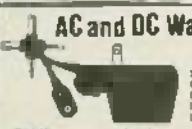

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SO239	UHF Panel Recp.	$1.29
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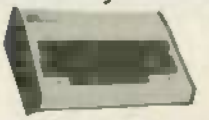
JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double sided printed wiring board. The keyboard assembly requires +5V @ 150mA and –12V @ 10 mA for operation. Features: 60 keys generate the 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14¾"W x 8¾"D

JE610/DTE-AK (After assembled as pictured above)	**$124.95**
JE610 Kit 62-Key Keyboard, PC Board, & Components (no case)	$ 79.95
K62 62-Key Keyboard (Keyboard only)	$ 34.95
DTE-AK (case only – 3¾"H x 11¾"W x 8¾"D)	$ 49.95

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JE212 – Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT
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FULL 8-BIT LATCHED OUTPUT 16-KEY KEYBOARD

The JE600 encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and maintained with 8 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 8 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¾"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above)	**$99.95**
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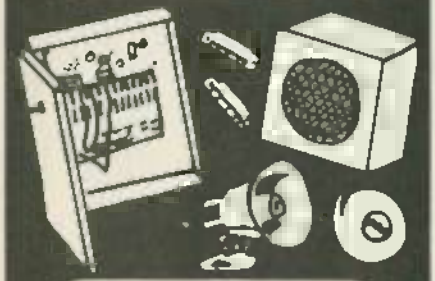

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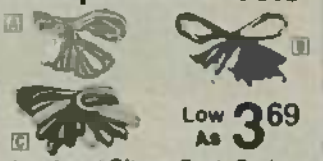

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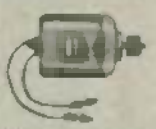

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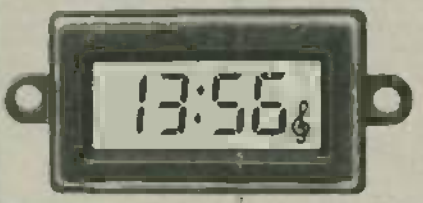

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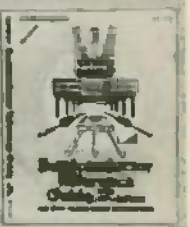

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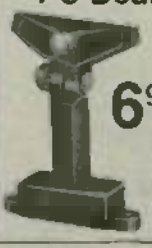

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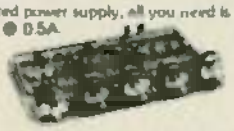

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- Frequency response: 10Hz-100KHz
- T.H.D. less than 0.008%
- S/N ratio: better than 80dB
- Input sensitivity: IV rms
- Power supply: ± 40V @ 5 amp
- One channel, needs two for stereo

TA-1000KIT
$51.95
Power transformer
$24.00 each

50 WATTS AUTO STEREO BOOSTER BY VERTRONIX

Specifications:

Model V-Amp 500

- 50 watts RMS total (25W + 25W)
- Frequency Response ± 0.5dB, 20Hz ~ 20KHz
- T.H.D. 0.2% at full rated output
- Input Impedance: 20K ohms
- Crosstalk: Better than 90dB
- Sensitivity: 1.5V for full rated output
- S/N Ratio: Greater than 95dB
- Speaker Load: 2 ~ 8 ohms
- Voltage Supply: 9 ~ 18V D.C.

REG. PRICE $119.00 EACH
OUR SPECIAL PRICE $55.00 EACH

"FISHER" 30 WATT STEREO AMP

MAIN AMP (15W x 2)

Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply ± 16V DC (not included). Power band with (KF 1% ± 3dB). Voltage gain 33dB 20Hz-20KHz.

Super Buy Only $18.50

5W AUDIO AMP KIT

2 LM 380 with Volume Control
Power Supply 6 - 18V DC
ONLY $6.00 EACH

2 WATT AUDIO AMP

Pre assembled units. All you need is to hook up the speaker and the volume control. Supply voltage from 9 to 15V D.C. measures only 2" x 3½", making it good for portable or discrete applications. Comes with hook up data.

BUY 2 FOR $4.99

1 WATT AUDIO AMP

All parts are pre-assembled on a mini PC Board. Supply Voltage 6 ~ 9V D.C.

SPECIAL PRICE $1.95 ea.

NEW MARK III 9 Steps 4 Colors LED VU

Stereo level indicator kit with arc-shape display panel!!! This Mark III LED level indicator is a new design PC board with an arc-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by rose). The power range is very large from −30dB to +5dB. The Mark III indicator is applicable to 1 watt - 200 watts amplifier operating voltage is 3V-9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

IN KIT FORM $18.50

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

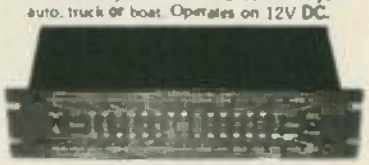
This new stereo level indicator kit consists of 36 4-color LED (15 per channel) to indicate the sound level output of your amplifier from −36dB +3dB. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6 - 12V D.C. with THG on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W!

Kit includes 70 pcs. driver transistors, 38 pcs. matched 4-color LED, all other electronic components, PC board and front panel.

MARK IV KIT
$31.50

MARK V 15 STEPS LED POWER OUTPUT INDICATOR KIT

All functions same as Mark IV but this is with heavy duty aluminum front plate and case. Can be easily slot into the front panel of your auto, truck or boat. Operates on 12V DC.



$41.50 EACH KIT

SOLID STATE STEREO GRAPHIC EQUALIZER PRE AMP KIT TA-2500

Specifications:

- Total Harmonic Distortion: Less than 0.05%
- Intermodulation Distortion: (70Hz:7KHz = 4:1 SMPTE Method) Less than 0.03%
- Frequency Response: Overall 10Hz ~ 100KHz +0.5dB, −1dB
- RIAA Curve Deviation: (Phono) +0.2dB, −0.2dB (30Hz ~ 15KHz)
- Channel separation (at rated output 1KHz)
- Phono Tuner, Aux and Tape Monitor better than 70dB
- Input sensitivity and impedance (1KHz for rated output)

Phono: 2MV 47K ohms Aux: 130MV 50K ohms
Tuner: 130MV 50K ohms Tape: 130MV 50K ohms

Graphic Equalizer control: 10 Band Slide Control
Frequency Bands: 31.5Hz, 63Hz, 125Hz, 250Hz, 500Hz, 1KHz, 2KHz, 4KHz, 8KHz, 16KHz also with on panel selector for Phono Tuner, Aux 1 and Aux 2.
Power Supply: 117 VAC

Kit comes with all electronic components, transformer, instructions and • 19" rack mount type metal cabinet.

MODEL TA-2500
$119.00 PER KIT

ELECTRONIC DUAL SPEAKER PROTECTOR

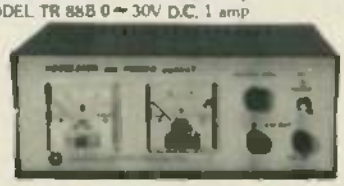
Cuts off when circuit is shorted or over load to protect your amplifier as well as your speakers. A must for OCL circuits.

KIT FORM **$8.75 EA.**

PROFESSIONAL REGULATED VARIABLE D.C. POWER SUPPLY KIT

All solid state circuitry with high efficiency power transistor 2SD388 and I.C. voltage regulator MC1733. Output voltage can be adjusted from 0-30V at 1 amp current limited or 0-15V at 2 amp current limited. Internal resistance is less than 0.005 ohm, ripple and noise less than 1 MV, dual on panel meter for voltage and amp reading, also with on board LED and audible over load indicator. Kit comes with predrilled P.C. board, instructions, all necessary electronic components, transformer and a professional look metal cabinet. The best project for school and the most useful instrument for repairman. Build one today!

MODEL TR 88A 0 ~ 15V D.C. 2 amp
MODEL TR 88B 0 ~ 30V D.C. 1 amp



$59.50 PER KIT

REGULATED DUAL VOLTAGE SUPPLY KIT

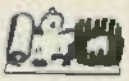
± 4 ~ 30V DC 800 MA adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator I.C. Kit includes all electronic parts, filter capacitors, I.C., heat sinks and P.C. board.

$12.50 PER KIT

POWER SUPPLY KIT

0-30V D.C. REGULATED

Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts. Tranformer for Power Supply. 2 AMP 24V x 2 **$9.50**

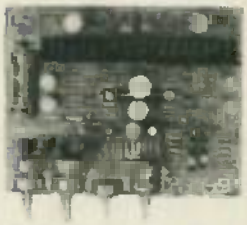


0-30 Power Supply
$10.50 each

TA-323 6 WATTS TOTAL 30W + 30W STEREO AMP KIT

★ SPECIAL ★

EXCELLENT PRICE!



MODEL 001-0034
Transformer (Optional)

This is a solid state all transistor circuitry with on board stereo pre-amp for most microphone or phone input. Power output employs 2 pairs matching Darlington Transistors. Driven by the popular 2N3053 Driver Transistors. Four built on board controls for, volume, balance, treble and bass. Power supplies requires 48 VET 2.5 amp transformer. T.H.D. of less than 0.1% between 100 Hz and 10KHz at full power. (30 Watts + 30 Watts loaded by 8~).

$29.50 PER KIT
$10.50 EACH

POCKET STEREO CASSETTE PLAYER WITH STEREO HEAD PHONE

This unit is a high fidelity stereo player which will give you years of listening pleasure and follow you wherever you go. Made by the same company in Japan who use the "Big Name." Complete set comes with 1 Stereo headphone, 3 AA size alkaline batteries, 1 leather like carrying case for player and 1 carrying case for storage of 4 cassette tapes and 1 demo tape.

MODEL SWM-33
OUR DIRECT IMPORT PRICE **$67.50**

FORMULA INTERNATIONAL INC. 1/82

	Shipping and Handling Charges	
	Under $50.00 Purchase	Over $50.00 Purchase
Inside California	5%	5%
Outside Calif. (Includes Hawaii & Canada)	$3.00	5%
Overseas	20%	20%

Minimum Order $10.00/Cash. Residents Add 6% Sales Tax
Phone Orders Accepted on Visa or MC ONLY. NO C.O.D./Store Hours 10 to 7 Mon. thru Sat.

Send $1.00 For Detailed Catalogue

VISA

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PHONE (213) 973-1921 • (213) 679-5162

CIRCLE 3 ON FREE INFORMATION CARD

FOR COMMERCIAL FREE TV BOX BUILDERS

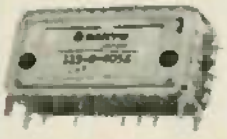
MC 1358	$2.50	LM 7815	$1.20
MC 1350	$2.00	NE 565	$2.00
MC 1330	$3.00	Connectors Set	$1.00
LM 1458	$1.00	I.C. Socket Set	$2.00
LM 380	$2.00	Matching Transformer	$1.40
Sanyo UHF Tuner	$35.00	Toroid Coils (Set of 4)	$3.00
Capacitors Set	$12.50	Speaker Cabinet	$12.95
Resistors Set	$2.00	Transformer 18V 800MA	$3.00
Trim Pots. Trim Cops Set	$13.50		
Pots and Knobs	$2.00		

We sell you all the above components in a package for **$125.00** and you will receive a free predrilled P.C. board and instructions at no charge!

SANYO UHF VARACTOR TUNER

For UHF CH 14 - 83

Tuning voltage +1V~ +28V D.C. Input impedance 75 OHM I.F. band width 7~16 MHz. Noise figure 11.5dB MAX. Size 2⅝" x 1¼" x ¾" Supply voltage 15V D.C. Sound I.F. = 58.0 MHz, Video I.F. = 62.5 MHz



All units are brand new from Sanyo.
MODEL 115-B-405A

$35.00 EACH

Tuner is the most important part for the circuit. Don't let those $19.00 tuners fool you!

TV GAME BOARD

PLAYS 4 GAMES: TENNIS, HOCKEY, HANDBALL AND JAI-ALAI

All boards complete with all parts ready to play. Requires 6C size batteries and a small speaker for sound effects. The boards were surplus from a famous game manufacturer. They will play on all US standard black and white or color TV sets. (Regular price for these games were $39.50 each)

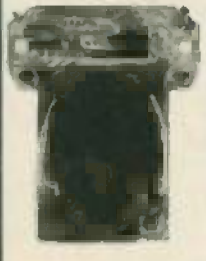
OUR PRICE ONLY $6.50 EACH

PART #57456

TENNIS JAI-ALAI

HOCKEY HANDBALL

ELECTRONIC PIN BALL MACHINE



That sounds and plays like the real thing. All units are brand new but without the case. Functions of the game include double flipper control, kicker control, 1-4 players, 3 speed ball control, tilt switch, automatic score, extra bonus cave and many more. All solid state with LED panel, no moving parts. Requires 9V battery to operate, speaker not included.

A perfect gift for yourself or friends

SPECIAL **$8.99** EACH SPEAKER **$1.25** EACH

ELECTRONIC MUSICAL TELEPHONE REST KIT

This telephone rest can be used as a door charm, an audible indicator and for many other sound projects. The special custom made I.C. is pre programmed with 4 musical tunes. Kit comes with a nice looking plastic case, pre-drilled P.C. board, volume control, special sound I.C. speakers and all electronic components and instructions. Ideal for home or school projects.

MODEL FIH-3000

BUY NOW! SPECIAL PRICE! ONLY $15.50 PER KIT

DIGITAL TIMER/CLOCK

- 24 Hour preset time to turn on or off
- 12 Hour green 0.5" display for time
- operated on 12~16V A.C.

The whole timer is self contained in a compact plastic case (as seen in photo). Designed for VTR with push button switch for easy setting. Limited quantity available.

NOW ONLY $12.94 MODEL VEQ 0143

SANYO ANTENNA SIGNAL BOOSTER

This Booster is specially designed for UHF Channels (14-83). After installed this unit (between the antenna input cable and the UHF tuner) will have a minimum of 10dB gain, that is approximately 2 times better than what you are seeing now. Ideal for those who live in apartments that cannot put up an outdoor antenna. Size is so small, only 2" x 1⅛" x 1". Supply voltage is 15 VDC

★ NEW ITEM ★

MODEL 001-0076

$12.50 EACH

13 FUNCTIONS LCD TIME MODULE

- Displays month, date and day of the week
- Displays hour, minute and second
- AM, PM Indicator
- Alarm 1 and Alarm 2 (Independent)
- 10 Hours Stop Watch
- 12 Hours presettable count down time
- Hour Chime Indicator
- Back light by touch of the switch

MODEL 001-0062

$7.94 EACH

These modules are brand new and made by LITRONIX. Designed for a man's watch. Can be used for many applications. Comes with 2 silver batteries and the ceramic round transducer.

MATCHED PAIR POWER TRANSISTORS BY MOTOROLA

MJ2955 PNP 2N3055 NPN	150 Watts	BV=60 V I.C.=15 A	$3.50 per pair
MJE2955 PNP MJE3055 NPN	90 Watts	BV=60 V I.C.=10 A	$3.00 per pair
MJ15003 NPN MJ15004 PNP	250 Watts	BV=140 V I.C.=20 A	$12.00 per pair

All above parts guaranteed to be prime and come with data sheets.

MUFFIN FANS FOR EQUIPMENT COOLING

These fans are pulled out from used computers. But carefully cleaned by ultrasonic cleaner. All in "like-new" condition. Size 4 11/16" x 1-1/2" x 4 11/16".

MODEL MF505

$9.50 EACH

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED

Lights up 8~15 Watt Fluorescent Light Tubes. Ideal for camper, outdoor, auto or boat. Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and P.C. Board, light tube not included!

$6.50 Per Kit

PRESS-A-LIGHT SELF GENERATED FLASHLIGHT

EXCLUSIVE! **$3.95 ea.**

Never worry about battery, because it has none! Easy to carry in pocket and handy to use. Ideal for emergency light. It generates its own electricity by squeezing grip lever. Put one in your car, boat, camper or home. You may need it some time!

Model F-179

No FCC license required.

OUR PRICE $49.50

ADDITIONAL MICROPHONE (TRANSMITTER) AVAILABLE AT $28.00 EACH

CRYSTAL CONTROLLED WIRELESS MICROPHONE SYSTEM

MURA WMS-49

Transmitter: FET mic for flat 30~18 KHz response, extra controlled 49MHz AM Band for drift-free performance. 100 MW output (range approx. ¼ mile) for reliable long range transmission. Powered by a 9V radio battery (included). Receiver: Extra controlled locks on 49MHz transmitter signal. With on panel VU meter monitors the signal strength from the microphone. Standard phone jack outlet connection to a P.A. or other phone input. 9V battery included. This professional set is ideal for on stage, in field, church, in house or outdoor use.

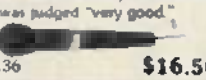
SUPER FM WIRELESS MIC KIT—MARK III

This new designed circuit uses high FEQ, FET transistors with 2 stages pre-amp. Transmits FM Range (88-120 MHz) up to 2 blocks away and with the ultra sensitive condensor microphone that comes with the kit, allows you to pick up any sound within 15 ft. away. Kit includes all electronic parts, OSC coils, and P.C. Board. Power supply 9V D.C.

FMC-105 **$11.50 PER KIT**

WEM-36 FM WIRELESS MICROPHONE

TEET MODEL WEM-36 is a factory assembled FM wireless microphone powered by two AA size batteries. Transmits in the range of 88-108 MHz with 3 transistor circuits to meet with F.C.C. part 15 regulations. Element is built in a plastic tube type case with an omni-directional electret condenser microphone unit. By using a standard FM radio, signal can be heard anywhere on a one-acre lot. Sound quality was judged "very good."



MODEL WEM-36 **$16.50 EACH**

WHISTLE ACTIVATED SWITCH BOARD

All boards are pre-assembled and tested. Your whistle to its FET condenser microphone from a distance as far as 30 feet away (sensitivity can be easily adjusted) will turn the switch on, then match your whistle to it again, then it turns off. Ideal for remote control toys, electrical appliance such as lights, coffee pots, TV, Hi-Fi, radio or other projects. Unit works on 9V D.C.

MODEL 968 **$4.50 EACH**

ULTRASONIC SWITCH KIT

Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver. All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operates by 9-12 DC.

$15.50

ELECTRONIC SWITCH KIT

CONDENSER TYPE
Touch On Touch Off
uses 7473 I.C. and 12V relay

$5.50 each

FORMULA INTERNATIONAL INC. 1/82

	SHIPPING AND HANDLING CHARGES	
	Under $50.00 purchase	Over $50.00 purchase
Inside California	10%	10%
Outside USA* (including Mexico & Canada)	15%	15%
Overseas	20%	20%

*Minimum Order $10.00 C.O.D. Accepted on Visa or MC ONLY. NO C.O.D. to Mexico. Phone Orders Accepted on Visa or MC ONLY. NO C.O.D./Store Hours: 10-7 Mon. thru Sat.

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CIRCLE 73 ON FREE INFORMATION CARD

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Phone: (305) 887-8228
TWX: 810-848-6085
We accept MasterCard and Visa.

EQUIPMENT/COMPONENTS/WIRE & CABLE/ACCESSORIES

"TANK BATTLE" TV GAME

In just a short time and with a few minor parts, the most novice hobbiest can complete this exciting Tank Battle game. Create a fun-filled evening for the whole family. Two independent tanks rumble thru land mine fields, shoot shells and fragment when hit. Four distinct engine sounds are produced for the different speeds. Sounds of gunfire, shell bursts and tank explosions are realistic. Automatic on-screen scoring. Supplied with schematic drawing.

SOLD AS IS

$9.95 ea.

C.B. SPECIAL

CONVERT THESE TO 10 METER FM

New HY-GAIN printed circuit board assembly with PLL02A chip and 3 crystals. (Squelch pot, volume control and channel switch not included.) Boards sold as is, the way we bought them from the manufacturer. Board dimensions 6" x 6⅝".

1-9 **$7.50**
10-49 **$6.50**
50-99 **$6.00**
100-UP **$5.50**

COPPER CLAD BOARD

(Double Side)

Size 9.25 x 10.75
Thickness .062

$2.00 ea.

DIP SWITCH

5 POSITION **$1.00** ea.
8 POSITION **$1.50** ea.
10 POSITION **$2.00** ea.
12 POSITION **$2.50** ea.

AMP METERS

2¼" square, no shunt required. Easy-to-read dial.

Movements 0-6, 0-10, 0-17

$2.50 ea.

SPEAKER

3" Diam.
8 OHM.
5 Watts

$2.00 ea.

COAX CONNECTORS

UG-273/U BNC-F/UHF-M	$2.50
UG-255/U BNC-M/UHF-F	$3.00
UG-146 A/U N-M/UHF-F	$4.50
UG-83B/U N-F/UHF-M	$4.50
UG-175 RG-58 Adapt	$ .20
UG-176 RG-59 Adapt	$ .20
UG-1094 BNC-F/Panel	$1.00
SO239	50c
PL259	60c

COAXIAL CABLE

50 OHM-RG 174

$4.95/100' $3.00/50'

SCREW DRIVER KIT

Handle stores four blades
2 single slot 5/32" & 3/32"
1 phillips 1 scratch awl
6" long with one blade inserted

$1.00 ea.

TRIMMER CAP

1.5-20pF
(ARCO PC-402)

50¢ ea.

SUB-MINI 10K POT

with On-Off
¼" hole mount.
⅛" D shaft.
¾" thread section.

5/$1.00

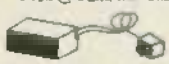
POWER TRANSFORMER

$14.95 ea.

Primary – 115 vac
Secondary – 32 v with
24 v tap at 15 amps
Dim. 4½" h X 3¾" w X 4" deep

SOLID GEL BATTERY

6 volt @ 8 a.h. with Charger



$14.95

Elpower EP 680 may be charged constant voltage or constant current. Battery is self-contained and requires no maintenance. Connections made with quick connect lugs. All plastic case size 5½ h x 2¾ w x 4½ l, weight 4 lbs.

TEXAS INSTRUMENT KEYBOARD

Has 3 slide switches, 26 different keys, key pad removable by 4 screws

$1.95 ea. 5/**$8.00**

C & K SWITCHES

L-3 J-60 J-3

Part #		Movement
J-60	7101	SPDT
L-3	7108	SPDT (momentary)
J-3	7201	DPDT (special large rocker)

$1.00 ea. **6/$5.00**

E. F. JOHNSON "S" METER

Edge Meter 250 UA. fits in ⅞" x 1⅜" hole. Black background. Scale 1-20 Top, 0-5 Bottom.

$1.25 ea. **5/$5.00**

COMPUTER GRADE ELECTROLYTICS

VALUE/MFD	VOLTS	DIAM.	LGTH.	PRICE
63,000	@ 15V	3"	x 5½"	$4.00 ea.
10,000	@ 20V	1½"	x 5¾"	$3.00 ea.
2,700	@ 25V	1¼"	x 2¼"	$2.00 ea.
2,900	@ 25V	1¼"	x 2"	$2.00 ea.
100,000	@ 30V	3"	x 5½"	$6.00 ea.
39,000	@ 30V	1"	x 5¾"	$4.00 ea.
34,800	@ 50V	3"	x 5½"	$3.00 ea.
450	@ 75V	1¼"	x 2¼"	$2.00 ea.
500	@ 100V	1½"	x 3¼"	$2.00 ea.
50	@ 450V	1¼"	x 2"	$2.00 ea.

TELEPHONE & TTY INTERFACE MODEM

MFG by Anderton Jacobson
DAA Modem Model DC 230 with A-36 Telephone Coupler

$69.95

Rated 300 Baud, half or full duplex. DAA level adjustable 0 to –3, –4 to –6, –7 to –10. TTY and DAA outputs brought out to 15 pin Molex connectors. FSK oscillator sends 1070 Hz space and 1270 Hz mark. Receives 2025 Hz space and 2225 Hz mark. Telephone coupler has 4-ft. cord and plug. Size 4¼" W x 15 L x 3" Dp designed to be recessed in deck of panel. Electronics in case, 8⅛ W x 12 x 2⅝" Dp with 8-ft., 3-wire U-ground cord and plug. Operates on 115 VAC, 50/60 Hz, ¼ Amp. Supplied with connection sheet. Removed from equipment. Excellent condition guaranteed.

AXIAL LEAD ELECTROLYTIC CAPACITORS

2 uF @ 15V	12/$1.00
10 uF @ 15V	12/$1.00
20 uF @ 15V	12/$1.00
50 uF @ 15V	12/$1.00
2.2 uF @ 25V	12/$1.00
3.3 uF @ 25V	12/$1.00
1 uF @ 35V	12/$1.00
2 uF @ 150V	12/$1.00
25 uF @ 25V	15/$2.00
3 uF @ 50V	15/$2.00
5 uF @ 50V	15/$2.00
10 uF @ 50V	15/$2.00
250 uF @ 25V	10/$2.00
50 uF @ 75V	10/$2.00

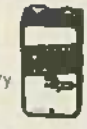
MODEM CABLE ASSEMBLIES

$5.50 ea.

Conn & Hood	22 AWG # Cond	Length
25 P	14	15'
25 S	10	17'

9 VOLT NiCd RECHARGEABLE BATTERY

NEW. Replaces the popular 9V Transistor Battery



$4.75 ea.

MAHOGANY PROJECT BOX

$1.50 ea.

4⅝" w x 7⅛" l x ¾" to 1½" h

Has a lip for recessed face plate and a felt bottom

POWER SUPPLY

- 12 vdc 1 amps
- 5 vdc 4 amps

$3.95 ea.

IC SOCKETS GOLD-PLATED WIRE WRAP

14 pin **40c** ea.
16 pin **45c** ea.

24-Volt POWER SUPPLY 5.4 AMPS

MFG by ACDC Electronics Inc.
Model OEM 24N5.4-1

$45.00

Input 105-125 vac 50/60 Hz. Has volt adj and O.L. adj. Output terminals contain + out, + sen, – sen, – out, ac neut, ac line and GND. 13 LBS.

10" l x 5" h x 5" w

MUFFIN FANS

MFG By Rotron Inc.
3 Blades 4¼" Square
USED
110 VAC **$5.95** ea.
NEW
230 VAC Model MU3A1

$12.00 ea

NEW SPRITE FAN

Mfg. by Rotron Inc.
Model SU2A5
115v AC .19 amps.
(Impedance protected.)
3¼" x 3¼" x 1¼"

$12.00 ea

7' POWER CORD

HEWLETT PACKARD TYPE

Molded 3 Prong Plug with molded receptacle
Belden 16 AWG

$3.00 ea

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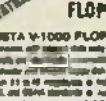

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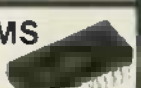

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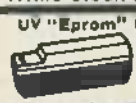

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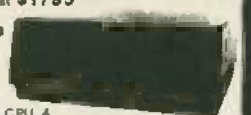

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5082	.300	Red	Common Anode + Overflow + dp
5082	.300	Red	Common Cathode + Overflow + Right dp
5082	.300	Red	Common Anode + Overflow + Right dp
5082	.300	Red	Common Cathode + Overflow + Left dp
5082	.300	Red	Common Anode + Overflow + Left dp
5082	.300	Red	Common Cathode + Overflow + Right dp + Left dp
5082	.300	Red	Common Anode + Overflow + Right dp + Left dp
5082	.300	Red	Common Cathode Right dp
5082	.300	Red	Common Anode Right dp
5082	.300	Red	Common Cathode Left dp
5082	.300	Red	Common Anode Left dp
5082	.300	Red	Common Cathode Right dp + Left dp
5082	.300	Red	Common Anode Right dp + Left dp
5082	.300	Yellow	Common Cathode
5082	.300	Yellow	Common Anode
5082	.300	Yellow	Common Cathode Right dp
5082	.300	Yellow	Common Anode Right dp
5082	.300	Yellow	Common Cathode Left dp
5082	.300	Yellow	Common Anode Left dp
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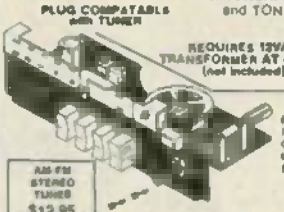

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Does not include speaker, switches or 2708 ROM

Now you can play hundreds of songs using the Bullet Super Music Maker. The unit features a single factory programmed microprocessor IC that comes with 20 pre-programmed short tunes. By adding the additional PROMS (2708's) the system can be expanded to play up to 1000 notes per 8 PROM. Just think ... a compact electronic instrument that will play dozens, hundreds or even thousands of selections of music. The kit comes with all electronic components (less the PROMS), and a drilled, plated and screened PC Board which measures 4" x 4½". The 7 watt amplifier section is on the same PC board and drives an 8 ohm speaker (not included), from a whisper to ear splitting volume. Since the unit works on 12 VDC or 12 VAC*, vehicle or portable operation is possible. What do you get for $24.95? Everything but a speaker, transformer, case, switches, and PROMS. Additional 2708 albums containing popular tunes are available for $15.00 each or you can program your own PROMS using information provided with the kit instructions. Lists of available PROM albums are available on request. (*Note: Unit plays electronic music one note at a time. It is not possible to play chords or a melody with harmony simultaneously.)

- Envelope control gives decay to notes.
- "Next tune" feature allows sequential playing of all songs.
- On board inverter allows single voltage (+12) operation.

OPTIONAL ACCESSORIES

DIP Switches One 8 pos., One 5 pos. (Can be directly soldered to PC Bd. to access tunes)	2.95/Set
Rotary Switches Two 8 position (For remote wiring to PC Bd. to access tunes)	2.60/Set
Attractive Plastic Case	6.50
Wallplug Transformer (For operation on 117VAC house voltage)	3.00

CIRCLE 39 ON FREE INFORMATION CARD

ramsey the first name in Counters !

9 DIGITS 600 MHz $129.95 WIRED

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!

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

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 indications 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:	0.1 uA to 2.0 Amps, 5 ranges
Resistance:	0.1 ohms to 20 Megohms, 6 ranges
Input impedance:	10 Megohms, DC/AC volts
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells

AUDIO SCALER

For high resolution audio measurements, multiplies UP in frequency

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

$29.95 Kit $39.95 Wired

ACCESSORIES

Telescopic whip antenna - BNC plug	$ 7.95
High impedance probe, light loading	15.95
Low pass probe, for audio measurements	15.95
Direct probe, general purpose usage	12.95
Tilt bail, for CT-70, 90, MINI-100	3.95
Color burst calibration unit, calibrates counter against color TV signal	14.95

COUNTER PREAMP

For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer included.

- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop

$34.95 Kit $44.95 Wired

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Included in the kit are a 12 foot fully steerable parabolic dish, low noise amplifier, antenna, rotator, receiver, modulator, necessary cables/connectors and complete assembly/operating instructions. EVERYTHING — down to the last nut, bolt and screw is provided.

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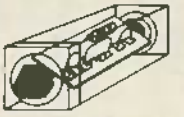

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ANTENNA AMPLIFIER
MODEL ALL-1
50 MHz — 900 MHz
12 dB GAIN ± 0.5dB

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A REVOLUTIONARY NEW ONE STAGE HYBRID IC BROADBAND AMPLIFIER

This unit is not available anywhere else in the world. One unit serves many purposes and is available in Kit or Assembled form. Ideal for outdoor or indoor use. Input/output impedance is 75 ohms. Amplifier includes separate co-ax feed power supply. Easily assembled in 25 minutes. No coils, capacitors etc. to tune or adjust.

ALL-1 Complete Kit plus Power Supply $24.95
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7 + 11 PARTS KITS

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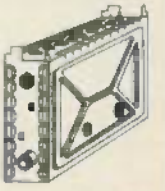
VARACTOR
UHF TUNER
Model UES-A56F
$34.95

Freq. Range UHF470 - 889MHz
Antenna Input 75 ohms
Channels 14-83 Output Channel 3



Qty	Part No.	Description	Price
1	VT1-SW	Varactor UHF Tuner, Model UES-A56F	$34.99
2	CB1-SW	Printed Circuit Board, Pre-Drilled	18.95
3	TP7-SW	P.C.B. Potentiometers, 1-25K, 1-1K, and 5-10K ohms, 7-pieces	9.95
4	FR35-SW	Resistor Kit, ¼ Watt, 5% Carbon Film, 32-pieces	4.95
5	PT1-SW	Power Transformer, PRI-117VAC, SEC-24VAC, 250ma	5.25
6	PP7-SW	Panel Mount Potentiometers and Knobs, 1-100T and 1-5MAT w/Switch	5.95
7	SS14-SW	IC's 7-pcs, Sockets 6-pcs, Regulators 2-pcs Heat Sink 1-piece	28.95
8	CE9-SW	Electrolytic Capacitor Kit, 9-pieces	5.95
9	CC33-SW	Ceramic Disc Capacitor Kit, 50 W.V., 33-pieces	7.99
10	CT-SW	Variable Ceramic Trimmer Capacitor Kit, 5-30pfd, 5-pieces	5.95
11	L4-SW	Coil Kit, 1 Bobbin 3-pieces, 22µhy 1-piece (powdered inductors) and 1 T37-12 Ferrite Toroid Core with 3 ft. of #26 wire	5.00
12	IC5-SW	I.C. Sockets, Tin plated, 8-pin 5-pieces and 14-pin 2-pieces	1.95
13	SR-SW	Speaker, 4x6" Oval and Preamplifier Wood Enclosure	14.95
14	MISC-SW	Misc. Parts Kit Including Hardware, (8/32, 8/32 Nuts, 6 Bolts), Hookup Wire, Anti Static, DPDT Ant. Switch, Fuse, Fuseholder etc.	8.95

When Ordering All Items, (1 thru 14), Total Price 139.95

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STVA-1STV	Yagi Antenna, 13.5 dB, 75 ohm, Chan. 42-54	$9.95
STVA-2-STV	Yagi Antenna, 13.5 dB, 75 ohm, Chan. 20-28	9.95
	CX-26 Coaxial 75 ohm Low Loss Ant. Cable	.18 P/FT.
	F-59 Coaxial Connectors ea	.39
	MT-1 Special UHF 75-300 OHM Matching Transformer ea	1.00
	ALL-1 Indoor/Outdoor HYBRID IC Wideband VHF-UHF-FM 75 OHM Antenna Amplifier Kit	24.95
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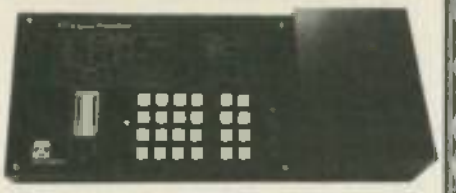
CIRCLE 43 ON FREE INFORMATION CARD

MICROPROCESSOR CONTROLLED EPROM PROGRAMMER

PROGRAMS - TESTS - COPIES - VERIFIES

☐ 2716 ☐ 2516
☐ 2732 ☐ 2732A



The K2578 EPROM Programmer is a microprocessor based stand-alone unit complete with power supply, housing and test socket. The unit comes expanded with 16Kbit RAM (2K byte), and is expandable to 32Kbit (4K byte). It has a crystal controlled clock and requires no personality modules.

CONTROLS
- 24 Key pad includes hexadecimal keyboard and function keys.
- 12 address LED's
- 8 function LED's (error, program, OK and data).
- 2 hexadecimal displays.

FUNCTIONS
- Blank Test, Blank Enter, Verify Test, Verify Error and Reset.
- Program with automatic blank and verify test.
- Input or modify data in user RAM at any desired address.
- Load RAM function to fill the RAM area with data from a preprogrammed PROM to perform a copy.
- Parallel load capability from a DMA controlled RAM field.
- Size selection (16K/32K) with single push-button.
- OK indication for successful executed functions.
- ERROR indication with error codes on display.
- Illegal address access error.
- Increment function which stores the input data via hex keyboard and jumps to the next address in user RAM.

Model No.	Regular $649.95
K2578	SPECIAL WITH COUPON $595.00
K2578-KIT	SPECIAL WITH COUPON $495.00

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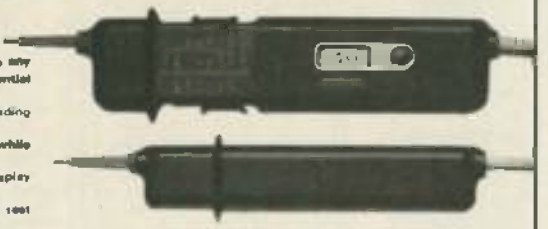
STEINEL HANDHELD 3½-DIGIT MULTIMETER

The hand-held instrument is a persuasive concept –
- since you can apply the two probe tips directly to any potential points to be tested, when measuring potential differences.
- since the points being tested and the display reading are in view simultaneously.
- since the needs range selected can be changed while making a measurement.
- since the dimension symbol appearing in the display assures unambiguous reading.
- since you can store the reading displayed if the test points are of fairly hard-to-reach sites, and
- since you can carry this meter with you at all times, thanks to its small size, without having to transport additional parts such as a lead or battery charger.



TECHNICAL SPECIFICATIONS

D.C. VOLTAGES from 0.1 mV to 500 V
A.C. VOLTAGES from 10 mV to 500V
RESISTANCES from 0.1 Ω to 20 MΩ
High contrast 3½-digit liquid crystal display
Automatic DIMENSION and DECIMAL POINT DISPLAY
Automatic POLARITY INDICATION
INTEGRATING A/D CONVERTER using the dual slope method, on a CMOS LSI, single chip, providing high resistance to aging, high reliability, and AUTOZERO function.
Push-button READING STORAGE, so that measurements can be made even at hard-to-reach places, and then the display brought out to where it can be read.
The ROLLING CONTACT SLIDING SWITCH and the multilayer circuit board provide great reliability and convenience; the scale range can be changed during measurement.

High INPUT IMPEDANCES of more than 10 MΩ—even in the A.C. ranges. Input impedance of more than 1 GΩ in the 200 mV D.C. range, with a resolution of 100 μV.
FOOLPROOF OPERATION in all scale ranges up to 500 Vᵉᶠᶠ
Built-in NI-CD STORAGE BATTERY
INTEGRATED BATTERY CHARGER—can be recharged without accessories of any suitable voltage between 110 and 240 V, 50 or 60 Hz, overcharge-proof
BATTERY VOLTAGE reading 12 hours consecutive operation per charge. Charging time at 220 V/50 Hz is 12 hours.

SIZE AND WEIGHT

Display unit, without probe tip	165 × 44 × 17 mm
Battery unit, without probe tip	135 × 32 × 16 mm
Length of connecting lead	1 m
Weight of complete meter	250 g

Order No. 1677 ..... $169.00
Case $10.00

6500 SERIES MICROPROCESSOR IC's

A = (2 MHz) B = (3 MHz) C = (4 MHz)

P6502 1	8.82	P6808A	10.82	P6520A	3.74	P6530-005	15.84
P6502A	9.84	P6507	8.00	P6820	3.40	P6532	10.82
P6502B	15.02	P6507A	8.82	P6820	3.74	P6532A	11.87
P6502C	21.00	P6512	8.82	P6831	4.80	P6546-1	17.84
P6503	8.00	P6512A	8.66	P6521A	5.34	P6545A-1	22.66
P6503A	8.82	P6513	8.00	P6821	4.80	P6551	10.91
P6504	8.00	P6513A	8.82	P6821	5.34	P6561A	11.76
P6504A	8.82	P6514	8.00	P6523	8.80	P6801	40.00
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Z-80-P10	6.80	Z80-DMA	21.80	Z-80A-P10	6.36
				Z-80A-S10/0	21.15
				Z-80A-S10/9	16.70
				Z-80A-DMA	22.70

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FREQ (MHz)	CASE	PIN	PRICE	FREQ (MHz)	CASE	PIN	PRICE	FREQ (MHz)	CASE	PIN	PRICE
1.00	HC33	CY1A	10.00	4.9152	HC18	CY4A	10.00	15.00	HC18	CY15A	14.75
1.8432	HC33	CY1A	9.50	5.00	HC18	CY5	9.00	18.00	HC18	CY18A	4.20
2.00	HC33	CY2A	8.75	5.000	HC18	CY5	9.00	18.432	HC18	CY18A	4.75
2.4576	HC33	CY2A	8.75	5.7143	HC18	CY6C	9.00	18.4800	HC18	CY20A	4.75
3.2000	HC33	CY3A	8.00	6.00	HC18	CY6	9.00	20.00	HC18	CY22A	9.85
3.579	HC33	CY3A	8.00	6.144	HC18	CY6C	9.00	22.464	HC18	CY23A	9.75
3.58	HC18	CY3A	8.00	8.00	HC18	CY8A	9.00	24.00	HC18	CY25A	9.85
3.684	HC18	CY4C	8.00	10.00	HC18	CY10A	8.75	24.000	HC18	CY26A	9.85
4.00	HC18	CY4A	8.00	14.31818	HC18	CY14A	8.75	24.576	HC18	CY27A	9.11

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74C00N	.38	74C89N	$1.32	74C221N	2.10	74C918N	1.71
74C02N	.31	74C93N	1.32	74C240N	2.28	74C917N	11.00
74C04N	.34	74C95N	1.81	74C244N	2.28	74C918N	1.64
74C08N	.38	74C107N	1.09	74C373N	2.87	74C922N	5.85
74C10N	.38	74C150N	5.87	74C374N	2.87	74C923N	5.75
74C14N	.78	74C151N	2.80	74C901N	.31	74C926N	7.46
74C20N	.38	74C154N	5.87	74C902N	.31	74C927N	7.46
74C30N	.38	74C157N	3.40	74C903N	.31	74C928N	7.46
74C32N	.38	74C160N	1.71	74C904N	.31	74C932N	2.32
74C42N	1.43	74C161N	1.71	74C905N	11.30	74C939N	7.80
74C46N	2.12	74C162N	1.71	74C906N	.71	80C95N	.79
74C73N	.80	74C163N	1.71	74C907N	.71	80C96N	.79
74C74N	.87	74C164N	1.81	74C908N	1.49	80C97N	.79
74C76N	.80	74C165N	1.81	74C909N	2.56	80C98N	.79
74C83N	2.00	74C173N	1.80	74C910N	12.05	82C15N	5.67
74C85N	2.00	74C174N	1.20	74C911N	11.00	86C75N	2.68
74C86N	.59	74C192N	1.71	74C912N	11.00	88C30N	2.95
74C89N	7.80	74C193N	1.71	74C914N	2.10		

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VIC1110 8K Memory Expander Cartridge 8K RAM expansion cartridge plugs directly into the VIC . . . $99.95
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VIC1112 IEEE-488 Interface Cartridge provides interface between the VIC and IEEE-488 instruments, including PET/CBM IEEE peripherals. Connects to the VIC's expansion port . . . $99.95

APPLICATIONS SOFTWARE ON CARTRIDGE

VIC1211A Super Expander everything Commodore could pack into one cartridge — 3K RAM memory expansion, high resolution graphics planning, color, paint and sound commands. Graphic, text multicolor and modes modes. 1024 x 1024 dot screen plotting. All commands may be typed as new BASIC commands or accessed by hitting one of the special function keys. Includes tutorial instructions book. Excellent for all programming levels . . . $79.95
VIC1212 Programmers Aid Cartridge more than 20 new BASIC commands help new and experienced programmers renumber, trace and edit BASIC programs. Trace any program line-by-line as it executes, pause to edit. Special KEY commands lets programmers redefine function keys as BASIC commands . . . $49.95
VIC1213 VICMON Machine Language Monitor helps eliminate code programmers write fast, efficient 6502 assembly language programs. Includes one line assembler/disassembler . . . $59.95

RECREATIONAL GAMES ON CARTRIDGE

VIC1901 Avengers space action for arcade enthusiasts . . . $29.95
VIC1904 Superfast colorful pilot machine game works just like real thing! Great music and sound effects . . . $29.95
VIC1906 Super Alien you're trapped in a maze and your only defense is the "alien buster" . . . $29.95
VIC1907 Super Lander pilot your "Jupiter Lander" through the treacherous crevices of a mysterious planet . . . $29.95
VIC1908 Draw Poker casino-style poker recreates the real thing! Superb animation and sound effects add fun, mystery and bluff . . . $29.95
VIC1909 Midnight Drive authentic night driving simulation provides thrills, chills and . . . spills? An unusual computer challenge . . . $29.95

COMPUTER PROGRAMS ON TAPE the following prerecorded programs are designed for use with the Commodore Datasette Tape Recorder. Programs on tape come in several varieties and are color coded by category as follows: Recreation (red), Education (blue), Business/Calculation (green), Home Utility (orange) and Computing Aids (black).

VT 108 A Recreation Program Pack A: Car Chase — Fast-paced road action • VIC 21 — Casino-style blackjack • Blue Meanies From Outer Space — Space game • Biorhythm/Compatibility — Computer biorhythms • Spacemath — Math improvement grades 1 – 8 • Slither/Super Slither — dexterity games . . . $9.95
VT 107 B Home Calculation Program Pack A: Personal Finance I — Home budget • Personal Finance II — Home budget • VIC Typewriter — Word processor for home use • Expense Calendar — Income, expenses, appointments • Loan & Mortgage Calculator — Decision-making aid • Home Inventory — Home belongings list. (October) . . . $9.95
VT 104 Programmable Character Set/Game-graphics Editor lets the VIC user create up to 64 programmable characters and use them in BASIC programs. The Editor takes only one-half kilobyte of program space, works with tape, disk and printer. (October) . . . $14.95
VT 232 Term I — Terminal Emulator a handy VIC terminal program on tape which converts any VIC to a terminal for use with a telephone modem. (Has RS232 interface) (October) . . . $9.95

ANCRONA

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ok Wire Wrap & Electronic Tools

PRB-1 DIGITAL LOGIC PROBE

- DC to > 50 MHZ
- 10 Nsec. pulse response
- 120 K Ω impedance
- Automatic pulse stretching to 30 Msec
- Automatic resetting memory
- Open circuit detection
- Automatic threshold resetting
- Compatible with all logic families
- 4-18 VDC
- Range extended to 18-28 VDC WITH optional PA-1 adapter
- Supply O.V.P. to ± 28 VDC
- No destructive oscillation

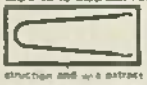
Compatible with DTL, TTL, CMOS, MOS and Microprocessor using a 4 to 18V power supply. Thresholds automatically programmed. Automatic resetting memory. No adjustment required. Visual indication of logic levels, using LED's to show high, low, bad level or open probe tips and pulses. Highly sophisticated, short pocket portable protective clip cap and removable end seal.

PRB-1-Each $39.95

MOS-40 IC INSERTER

A unique tool insertion tool, uses slight bend-out pins. A base of the handle compresses the pins to proper .600" spacing and locks the IC into the tool. Simply place tool on the socket and depress the plunger for output and accurate insertion. Tool features heavy chrome plating throughout for reliable static dissipation. Includes terminal lug for attachment of ground strap (strap not included).

MOS-40 IC Insertion Tool-Each 19.95



EX-1 IC EXTRACTOR

The Model EX-1 is ideally suited for hobbyist or engineer. It features side-pulling, spring steel construction and will extract all LSI, MOS, and CMOS devices with 8 to 24 pins.

EX-1 IC Extractor-Each 11.00

EX-2 IC EXTRACTOR

The Model EX-2 is safe and self-adjusting while it gently lifts an IC from a socket or board using uniform pressure applied simultaneously at both ends of the IC. Designed for one-hand operation and heavily chrome plated for reliable static dissipation. Features attaching terminal lug for ground strap. Intros rust indefinitely. Extracts all 2x 40 pin ICs having standard .600" pin spacing.

EX-2 IC Extractor-Each 19.95

IC INSERTION/EXTRACTOR KIT

Kit includes DIP IC extractors and inserters to accommodate all ICs from 14 to 40 pins. Tools that engage conductive surfaces are CMOS safe and include grounding lugs where needed. Kit includes: extractor EX-1 for 14-16 pin devices, EX-2 for 24-40 pin devices, MOS-1416 for 14-16 pin devices, MOS-2428 for 24-28 pin devices, and MOS-40 for 36-40 pin devices.

WK-2 IC Inserter/Extractor Kit-Each $34.95

MINI-SHEAR

- Flush cutter for component leads
- Cuts in tight areas
- Cuts up to AWG 18 wire

MS-10 Mini Shear-Each ... $4.95
MS-20 Mini Shear with Safety Clip-Keeps snipped leads from flying. Each $4.95

VACUUM VISE

Unique vacuum-based, light-duty vise for precision handling of small components and assemblies. Rugged ABS construction. Jaws are 1 ½" wide and have 1 ¼" travel. Also features screw legs for permanent mountings.

VV-1 Vacuum Vise-Each ... $3.79

14 & 18 PIN DIP INSERTION TOOL

Inserts both 14 and 18 pin IC packages into sockets or pre-drilled boards in an easy one-hand operation. Has built-in pin straightener and features precision parts for long life. The narrow profile permits tool to work on densely spaced boards, while unique insertion mechanism assures accuracy. Simply support IC into the straightening saddle, rock it, and push down on the tool. The automatic ejector delivers the IC ready to be placed in the insertion end of the tool for installation in the board or socket.

INS-1418 IC Inserter-Each $3.95

WIRE WRAPPING KIT WK-2

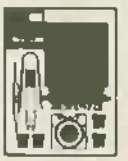
Ideal for the prototype engineer and hobbyist alike, this kit includes the combination tool that wraps and unwraps 4WG 30 wire on .025" square pins, plus it strips the wire using a handy built-in stripper. The wire is top quality Kynar insulated, silver plated solid copper. Supplied in the kit are a 10 ft. roll plus pre-cut and stripped wire in assorted lengths from 1 to 4 inches each stripped 1" on each end.

WK-2-B Kit-With blue wire. Each $19.95
WK-2-W Kit-With white wire. Each $19.95
WK-2-Y Kit-With yellow wire. Each $19.95
WK-2-R Kit-With red wire. Each $19.95

WIRE WRAPPING KIT WK-3

This kit includes the WSU-30 combination tool that wraps and unwraps 4WG 30 wire on .025" square pins, plus a stripper the wire using built-in stripper. The wire is top quality Kynar insulated, silver plated solid copper. The DIP sockets feature gold plated 3-finger wire wrap pins .025" square on .100" centers, phosphor bronze test spring contacts, and UL recognized, glass-filled, thermoplastic socket. The H-PCB-1 board measures 6" X 4 ¾", consists of glass-epoxy material 1.6E, copper pads. Also, the board has 22/22 edge-connector contacts on standard 1.96" spacing.

WK-30 Kit-With blue wire. Each $17.95



WIRE WRAPPING KIT WK-4

This kit features a full range of tools and parts for prototype and hobby applications. The kit includes a universal PC board. The kit includes a universal PC board, an edge connector with dual wire terminals, two 14-pin and two 16-pin industrial quality, wire wrapping DIP sockets, a DIP inserter, a DIP extractor, a wire dispenser with 50 ft. of wire, and a new wire wrapping and unwrapping tool.

WK-4B Kit-With blue wire. Each $27.00

TRI-COLOR WIRE DISPENSER

- 3 rolls of wire in one dispenser • 3 colors: red, blue, white • 50 feet of each color • AWG 30 Kynar insulated wire • Built-in plunger cuts wire to desired length • Built-in stripper strips 1" of insulation • Refillable (see below)

WD-30-TRI Tri-Color Dispenser Each $8.49

REPLACEMENT ROLLS

R-30-TRI Replacement rolls Each $4.49

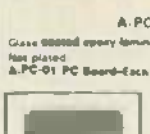
WIRE DISPENSER

- AWG 30 Kynar wire wrapping wire • 50 foot roll
- Built-in plunger cuts wire to desired length
- Built-in stripper strips 1" of insulation
- Refillable (see below)

WD-30-B Blue Wire—Each $3.49
WD-30-Y Yellow Wire—Each $3.49
WD-30-W White Wire—Each $3.49
WD30-R Red Wire—Each $3.49

REPLACEMENT ROLLS

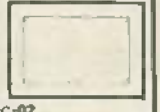
R-30B-0060 Blue Wire—Each $3.49
R-30Y-0060 Yellow Wire—Each $3.49
R-30W-0060 White Wire—Each $3.49
R-30R-0060 Red Wire—Each $3.49



A-PC-01

Glass epoxy laminate board, 6.3" x 3.84". Tin plated.

A-PC-01 PC Board-Each $4.49



A-PC-02

Glass epoxy laminate board, 6.3" x 3.84". Metal pattern of copper plated and solder plated on one side.

A-PC-02 PC Board-Each $6.79

A-PC-03

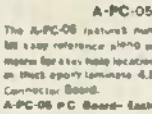
Same specifications as A-PC-02. Each line of holes is connected with copper plated, solder coated parallel strips on one side.

A-PC-03 PC Board-Each $6.79

A-PC-04

Some specifications as A-PC-02, except one side has copper coated horizontal strips; other side has vertical parallel bars.

A-PC-04 PC Board-Each $6.79



A-PC-05

The A-PC-05 features numbered contacts for easy reference along with a numbered matrix for easy hole locations. Made of .062 in thick epoxy laminate 4.5 in. x 6 in. Edge Connector Board.

A-PC-05 PC Board-Each $7.95

A-PC-06

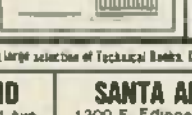
Same as A-PC-05 except outside dimensions are 4.5 in. x 6.5 in. Edge Connector Board.

A-PC-06 PC Board-Each $8.95

A-PC-07

Same as A-PC-06 except outside dimensions are 4.5 in. x 6.5 in. Edge Connector Board.

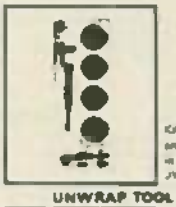
A-PC-07 Printed Circuit Board-Each $9.95



- AWG 30 Wire
- .025" Square Posts
- Daisy Chain or Point To Point
- No Retapping or Honing Required
- JUST WRAP™
- Built In Cut Off
- Easy Loading of Wire
- Available Wire Colors: Blue, White, Red & Yellow

PATENTED U.S.A. FOREIGN PATENTS PENDING

JWK-1-B Just Wrap Tool—With roll of blue wire. Each $18.95
JWK-1-W Just Wrap Tool—With roll of white wire. Each $18.95
JWK-1-R Just Wrap Tool—With roll of red wire. Each $18.95
JWK-1-Y Just Wrap Tool—With roll of yellow wire. Each $18.95

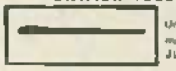


JUST WRAP KIT

Kit contains the Just Wrap Tool, unwrapping tool, and 50 ft. spool of blue, white, red and yellow wire in plastic box.

JWK-B Just Wrap Kit—Each $26.95

UNWRAP TOOL FOR JUST WRAP SYSTEM



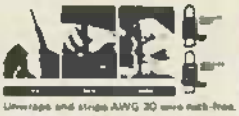
Unique tool specifically designed to remove wraps made by the Just Wrap tool to allow for changes.

JUW-1 Unwrapping Tool—Each $7.20

JUST WRAP REPLACEMENT WIRE ROLLS

Rolls of AWG 30 Kynar insulated wire (50 ft.) for use with Just Wrap Tool.

R-JW-B Blue Wire—Each $3.29
R-JW-W White Wire—Each $3.29
R-JW-Y Yellow Wire—Each $3.29
R-JW-R Red Wire—Each $3.29



WRAP/STRIP/UNWRAP TOOLS

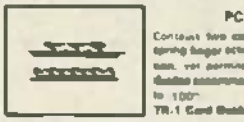
Tools perform complete wire-wrapping functions for AWG 30 wire .025" square DIP socket posts. Unwraps and strips AWG 30 wire rust-free. Compact all-metal construction for dependable service.

WSU-30—For regular wrap $7.49
WSU-30M—For modified wrap $8.49

PRINTED CIRCUIT BOARD

Glass epoxy laminate board, 4x4 1/2x1/16 in., with solder coated 1 oz. pads. The board has provision for a 22/44 two-sided edge connector, .156 in. spacing. Edge contacts are non-dedicated for maximum flexibility. Drill in the holes on 100 in. centers. Components side contains 78 Test-Hole pads. Two independent bus systems are provided for +5VDC and ground on each side of the board.

H-PCB-1 Printed Circuit Board—Each $6.49



PC CARD GUIDES

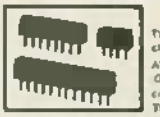
Contains two card guided precision molded with spring finger action that damps shock and vibration, yet permits smooth insertion or extraction. Guides accommodate any card thickness from .040" to .100".

TR-1 Card Guides-per pair $3.29

PC CARD GUIDES AND BRACKETS

TRS-2 kit contains two TR-1 guides plus two mounting brackets. Support brackets feature unique stabilizing post that permits secure mounting with one screw.

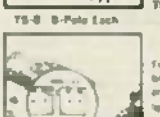
TRS-2 Card Guide Kit-Each $6.49



P.C.B. TERMINAL STRIPS

The TS strips provide positive screw activated clamping action, accommodates wire sizes 14-30 AWG (1.8 - 0.25mm) Pins are solder plated copper, .042 inch (1mm) diameter, on .200 inch (5mm) centers.

TS-4 4-Pole Each $1.99
TS-6 6-Pole Each 2.89
TS-12 12-Pole Each 3.99



TS-8 8-Pole Each

MODULAR TERMINAL STRIPS

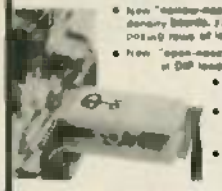
For wrapping economical connecting especially in breadboarding and short runs. Two basic modules are designed together as various combinations to form printed circuit boards or harnesses. A screwdriver is all that is needed to make low resistance connections for 26 through 18 AWG wire. Fits on .10 inch (2.50mm) hole spacing on boards up to 1.28 inch (3.20mm) thick.

TS-6MD 2-Pole (3 per package)
Each Package $2.19

CIRCLE 10 ON FREE INFORMATION CARD

TEST CLIPS

22 new models for troubleshooting DIP's safely and quickly

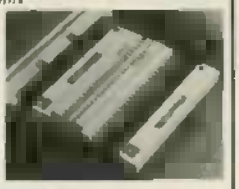


- New "space-case" shape allows easy attachment on high-density boards. Fits with IC's with only .040" between dip-posts rows of leads.
- New "open-end" design now permits probe ID access of DIP leads.
- New "rod-hood" gang loop probe hooks begin sliding off ends.
- Offset gas relief clipper probes to hang loop on longer pins in the top row and not interfere with shorter pins in the bottom.
- Heavy-duty industrial-grade springs for firm contact pressure. They'll keep their spring indefinitely. No interruptions.
- Steel DIP and hinge design. Made to last!

DIP	STANDARD CONFIGURATION	PRICE	CONNECTOR COMPATIBLE	PRICE
8-PIN	923686	7.90	923680-08	7.90
14-PIN	923688	4.85	923680-14	4.85
16-PIN	923700	5.10	923680-16	5.10
16-LSI	923702	9.40	923680-16LSI	9.40
18-PIN	923703	10.60	923680-18	10.60
20-PIN	923704	12.15	923680-20	12.15
22-PIN	923706	13.60	923680-22	13.60
24-PIN	923714	14.15	923680-24	14.15
28-PIN	923715	18.85	923680-28	18.85
36-PIN	923720	20.35	923680-36	20.35
40-PIN	923722	21.45	923680-40	21.45

INTRA-SWITCH

Allows any line to be opened or closed . . . another time saver in testing flat ribbon cable systems



- Permits instant line-by-line switching for diagnostic or QA testing.
- Switches actuated with pencil or probe tip.
- Mates with standard .100" x .10" dual-row connectors.

INTRA-CONNECTOR

Provides full access to lines . . . saves valuable time testing flat ribbon cable systems

- Permits quick testing of previously unprobed circuits.
- Provides both straight-in and right angle functions.
- Mates with standard .100" x .10" dual-row connectors.

INTRA SWITCH

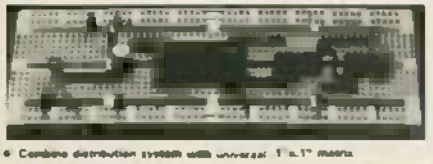
No. of Contacts	Part Number	Price
20	922678-20	$13.44
26	922678-26	16.46
34	922678-34	18.15
40	922678-40	20.20
50	922678-50	23.86

INTRA-CONNECTOR

No. of Contacts	Part Number	Price
20	922676-20	99.76
26	922676-26	7.75
34	922676-34	8.10
40	922676-40	10.10
50	922676-50	11.80

SUPER-STRIPS

Universal breadboarding elements with solderless plug-in tie points



- Combine distribution system with universal 1" x 1" matrix
- 840 solderless, plug-in tie-points
- Accommodates up to 8 14-pin DIPs
- Compatible with all DIP's and discretes with lead diameters to .032"
- Request as several patch cords

The A P Super-Strips combine a power/signal distribution system with a matrix of 1.2" centerwells, each with 5 tie points. The distribution system consists of eight buses, each individual bus consisting of a line of 25 tie points. All tie points are the solderless, plug-in type of the same design used on A P Terminal Strips and A P Distribution Strips.

Order No. 923252 ..... $18.50

LOGIC TIMING RECORDER

Ingenious plastic board with sliding line segments for charting your logic timing sequences!

- Line segments slide vertically between 2 click-stop positions to chart logic "1" and logic "0" levels of your circuit signals.
- 40 line segments (1/4" long) per row
- 8 rows of line segments permits charting logic timing sequences of up to 8 functions simultaneously
- Make paper copies on any copier
- Faster and neater than drawing, printing and rub-lettering on paper
- Totally re-usable just slide any of the 320 line segments where you need them for new timing sequences
- Durable ABS plastic 11"W x 8¼" x ¾".

Order No. 923758 Logic Timing Recorder $44.95

ALL-CIRCUIT EVALUATORS

Seven A.C.E's for fast, solderless circuit building and testing

A.C.E 200-K
Part No. 87333
$22.75
728 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: UP TO 8 16-PIN DIP's
- Two 5-way binding posts
- Size: 4-9/16" by 6-9/16"
- Kit form — lowest cost

A.C.E 208
Part No. 92332
$30.70
872 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: UP TO 8 16-PIN DIP's
- Two 5-way binding posts
- Size: 4-9/16" by 6-9/16"
- Fully assembled

A.C.E 201-K
Part No. 92334
$29.95
1,032 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: UP TO 12 14-PIN DIP's
- Two 5-way binding posts
- Size: 4-9/16" by 7"
- Kit form

A.C.E 212
Part No. 92331
$37.05
1,224 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: UP TO 12 14-PIN DIP's
- Two 5-way binding posts
- Size: 4-9/16" by 7"
- Fully assembled

A.C.E 218
Part No. 923326
$49.80
1,780 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: UP TO 18 14-PIN DIP's
- Two 5-way binding posts
- Size: 6-1/2" by 7-1/8"
- Fully assembled

A.C.E 227
Part No. 923326
$63.55
2,712 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: UP TO 27 14-PIN DIP's
- Four 5-way binding posts
- Size: 8" by 9-1/4"
- Fully assembled

A.C.E 238
Part No. 923324
$84.75
3,648 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: UP TO 38 14-PIN DIP's
- Four 5-way binding posts
- Size: 10-1/4" by 9-1/4"
- Fully assembled

TERMINAL AND DISTRIBUTION STRIPS

PART NO.	DESCRIPTION	PRICE
923281	Terminal Strip 126 5-tie-points	$14.80
923265	Terminal Strip 96 5-tie-points	11.20
923269	Terminal Strip 60 5-tie-points	8.65
923273	Terminal Strip 24 5-tie-points	5.35
923289	Terminal Strip 180 4-tie-points	11.20
923251	Terminal Strip 54 4-tie-points	8.75
923277	Distribution Strip 24 4-tie-points	3.60
923281	Distribution Strip 16 4-tie-points	2.80
923285	Distribution Strip 12 4-tie-points	2.60
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JUMPER WIRE KIT

Ideal for quick, neat circuits

Each kit contains 350 wires cut in 14 different lengths from 0.1" to 6.0".

Each wire is stripped and the leads are bent 90° for easy insertion.

Wire length is identified by color coding.

All wire is solid tinned 22 gauge with PVC insulation.

The wires come packed in a convenient plastic box.

Order No. BK-1 ..... $13.95

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Bring this **COUPON** into one of our stores or mail to our Mail Order address shown below to receive the Discount Allowance listed below for all O.K. Machine & Tool and AP Products in our Ad.

DISCOUNT ALLOWANCES

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$ 10— 99	NET	500—999	Less 20%
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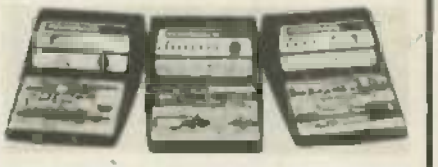
Coupons accepted only with full name and address filled in

POWERACE

Use a POWERACE for faster and easier prototyping of all types of electronic circuits

Check these important features!

- 1680 solderless, plug-in tie points . . . will hold up to 16 14-pin DIP's.
- Breadboard eliminates need for DIP cuts . . . including DTL, RTL, TTL and CMOS devices. TO-5's and discretes with leads up to .032" dia.
- All connections by 5mm molded, solderless, power supplies and meters are made via patchcord, plug-in, tie-point blocks on control panels.
- Interconnect with any solid 22 to 30 AWG wire.
- Breadboard elements are separated on grounded planes . . . ideal for high-frequency and high-speed-low noise circuits.
- Short-circuit proof board power supplies.
- Operate on 110 to 130 VAC at 50 Hz or 200 to 240 VAC at 50 Hz.
- Space-age compact styling and high-grade components permit convenient, organized and quick prototyping.



POWERACE 101 923101 ..... $299.95
The general purpose model for prototyping all types of circuits.

POWERACE 102 923102 ..... $149.95
The complete digital prototyping lab with FREE logic probe built in!

POWERACE 103 923103 ..... $149.95
Triple-output power supply for prototyping both linear and digital circuits.

POWERACE 101

POWER SUPPLY is regulated and adjustable from +1 to +15 VDC at 800mA. Regulation is ≤10 mV at full load. Line and load regulation is ≤3%.

METER is built in 0-15 VDC inputs are accessible at the panel binding posts. An optional patch panel allows monitoring of power supply or circuits. Meter accuracy is 5% of full scale.

TWO LOGIC INDICATORS FILED at logic buffered inputs that require 1 μA max.

TWO LOGIC SWITCHES, momentary, with debounced circuitry. Both 0 and 1 outputs can sink 10 mA and source 5 mA.

TWO DATA SWITCHES with logic 1 and logic 0 outputs have universal debounced circuitry and can source 10 mA.

POWERACE 102

POWER SUPPLY is regulated +5 VDC at 1 amp. Regulation is ≤10 mV at full load. Line and load regulation is ≤1%.

PULSE DETECTION WITH MEMORY is built in. Will detect positive or negative going pulses as short as 10 nanosec and. Effectively is reset by momentary switch on control panel.

THREE LOGIC INDICATORS FILED at logic buffered inputs that require 1 μA max.

FREE LOGIC PROBE: the above pulse detection with memory plus logic indicator that also constitutes a free, built in logic probe!

TWO LOGIC SWITCHES momentary with debounced circuitry. Both 0 and 1 outputs can sink 10 mA and source 5 mA.

FOUR DATA SWITCHES with logic 1 or logic 0 outputs have universal debounced circuitry and can source 10 mA.

CLOCK GENERATOR has one switch selectable frequency: 1 Hz, 10 Hz, 100 Hz, 1 KHz, 10 KHz and 100 KHz with a 50% duty cycle. C output can sink 10 mA and source 5 mA. C output can sink or source 50 mA.

ONE SHOT PULSE GENERATOR has pair of 2 TTL compatible or negative going. Both Q and Q outputs can sink 10 mA and source 400 μA.

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Our Price:$859.00

- TV sync separator circuit
- High-sensitivity 1mV/div (5MHz)
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- Z-axis input (intensity modulation)
- Signal delay line
- Complete with 2 probes
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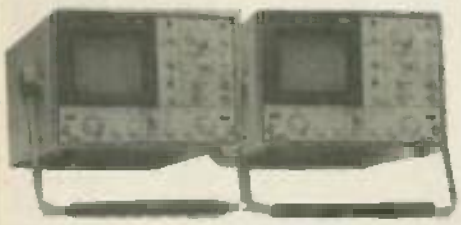
- X-Y operation
- Trace Rotation

30 MHz DUAL TRACE OSCILLOSCOPE
Hitachi . . . The measure of quality.
HITV152B DUAL TRACE 15MHZ (no delay)
LIST $735.00 **OUR PRICE $629.00**



HIT-V352
35MHz DUAL TRACE WITH DELAY
LIST PRICE: $1150.00
OUR PRICE: $996.00

Economically priced dual trace oscilloscope
Square CRT with internal graticule (illuminated scale)
High-accuracy voltage axis & time axis set at ±3% (certified at 10° to 35° C)
High-sensitivity 1mV/div.
Low drift
2 Year Warranty

HIT-V202
20MHz DUAL TRACE
LIST PRICE: $850
OUR PRICE: $765

Dynamic range 8 div
TV sync separator circuit
Built-in signal delay line (V-352)
X-Y operation
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Trace rotation system
Fine adjusting click-positioning function

50 MHz & 100 MHz
DUAL TRACE WITH CALIBRATED TIME DELAY

HIT V550B
50MHz with 3rd TRACE TRIGGER VIEW
LIST $1745.00
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HIT V1050
100MHz with 3rd & 4th TRACE TRIGGER VIEW
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The HITACHI V550B (50mHz) and V1050 (100mHz) offer all the capabilities you might expect from a lab grade oscilloscope. Capabilities such as 3rd trace trigger view, a bright 8" square CRT and a max sweep rate of 2ns/div (V1050) 5ns/div (V550B). Also, features you may not expect like, sensitivity of 1mv/div (V550B) .5mv/div (V1050) @ 10mHz, automatic focus correction.

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Nine functions
1. dc voltage
2. ac voltage
3. dc current
4. ac current
5. resistance
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7. conductance (1-R)
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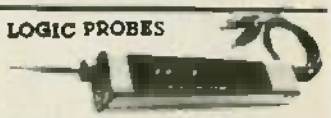
LOGIC PROBES



LP-1 LOGIC PROBE—Hand-held logic probe provides instant reading of logic levels for TTL, DTL, HTL or CMOS. **Input Impedance:** 100,000 Ohms. **Min. Detectable Pulse:** 50 ns. **Max. Input Signal (Frequency):** 10 MHz. **Pulse Detector (LED):** High speed train or single event. **Pulse Memory:** Pulse or level transition detected and stored.
GSCLP1 . . . . . List $50.00 OUR PRICE $45.00

LP-2 LOGIC PROBE—Economy version of Model LP-1. Safer than a voltmeter. More accurate than a scope. **Input Impedance:** 300,000 Ohms. **Min. Detectable Pulse:** 300 ns. **Max. Input Signal (Frequency):** 1.5 MHz. **Pulse Detector (LED):** High speed train or single event. **Pulse Memory:** none.
GSCLP2 . . . . . List $32.00 OUR PRICE $30.00

LP-3 LOGIC PROBE—High speed logic probe. Captures pulses as short as 10 ns. **Input Impedance:** 500,000 Ohms. **Minimum Detectable Pulse:** 6 ns. **Max Input Signal (Frequency):** 60 MHz. **Pulse Detector (LED):** High speed train or single event. **Pulse Memory:** Pulse or level transition detected and stored.
GSCLP3 . . . . . List $77.00 OUR PRICE $69.00

DIGITAL PULSER
GSDCP1 . . . . . List $83.00 OUR PRICE $76.00

GSCLTC-1 Logical Analysis Kit—Complete with LP-1 logic Probe, DP-1 Logic Pulser, LM-1 Logic Monitor, wiring accessories, manuals and molded case. OUR PRICE $220.00

GSCLTC-2 Logical Analysis Kit—For high-speed and memory analysis. Same as Model LTC-1 except substitutes LP-3 High Speed Logic Probe. OUR PRICE $245.00

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With our ingenious new MS-230, 30-megahertz, battery-operated dual-trace miniscope, portability is suddenly not a problem anymore. At 3 lbs. 10 oz., it's the smallest, lightest miniscope in the field today.
The state-of-the-art MS-230 works wonders on site or in the shop. Anywhere there's a need to accurately test or measure electronics equipment.
The versatile MS-230 is perfect for TV repairmen. Services microcomputer systems when the chips are down. Maintains avionics equipment with flying colors. And diagnoses sophisticated medical equipment with the precision of a surgeon.
However, if your budget or needs demand something more economical or less sophisticated, chances are the MS-215 dual-trace or MS-15 single-trace will fit the bill.

PART #	LIST PRICE	OUR PRICE
* NLSMS230 30 MHz DualTrace Miniscope	$449.00	$379.00
* NLSMS215 15 MHz Dual Trace Miniscope	$497.00	$439.00
* NLSM15 15 MHz Single Trace Miniscope	$389.00	$345.00

*Typical 3 dB point is 8 MHz at 2-division deflection. Typical maximum frequency for full scale (4div) deflection is 2 MHz.

NLS41141 Deluxe 10 to 1 100MHz probe		$30.00
NLS41140 Leather case for MS15 & MS215		$45.00
NLS41180 Leather case for MS230		$45.00

The remarkable Touch Test 20 DMM.
With the Touch Test 20, Non-Linear Systems introduces the 2 lb. 4 oz. test lab. Now with 20 keyless functions at your fingertips (plus the ability to measure 10 electrical parameters and 44 ranges) you can take one lab to the field instead of a cumbersome collection of individual testers.
Another bright idea. The Touch Test 20 is the only DMM with light pressure touch function selection. No more dials to fiddle, with. Instead, an LED shows the function you choose. And when you switch, you get an audible bleep and visual blip to let you know.
This small wonder is miniaturization at its best. The new Touch Test 20 is the most innovative portable/bench-type multimeter in the industry today.
TOUCH/TEST 20 comes complete with Test Leads, Temperature Probe, and Component Test Adaptor (LED Display).

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NLS TT21	$495.00	$455.00
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All the speed and convenience of DT sockets and Bus Strips plus backplanes and binding posts in both kits and pre-assembled units. Assemble, test and modify circuits as fast as you can think.

Part No.		Dip Capacity	Board Size Inches	Price
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BSCPB160	Kit	10(14's)	4½x6x¼	21.95
BSCPB101	ASM	10(14's)	6x4½x¼	28.95
BSCPB102	ASM	12(16's)	7¼x4½x¼	34.95
BSCPB103	ASM	24(14's)	9x6x¼	59.95
BSCPB104	ASM	32(14's)	9¼x8x¼	77.00

PROTO-BOARD PB-203 · HOLDS 24 14-PIN IC'S

Fully assembled breadboard contains built-in, short-proof, fused 5VDC at 1 amp, regulated power supply, in addition to three DT-59S sockets, four DT-59B bus strips, one DT-47B bus strip and four binding posts. Capacity for most digital and many analog projects. SIZE: 8.75" LB. 6.6" w. 3.25" h. WEIGHT: 5 lbs

BSCPB203		List Price	$133.00
		Our Price	$125.00
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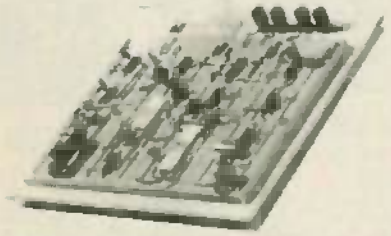
		Our Price	$160.00
BSCPB203AK	Kit version of the 203A		$149.95
		Our Price	$138.00

ALL-CIRCUIT EVALUATORS



- ACE for fast, solderless, plug in circuit building and testing. Plug in any components with leads up to 0.032" diameter interconnect with solid wire up to 20 gauge. Gold-anodized aluminum base/ground. Non corrosive nickel silver terminals. 4 rubber feet.

PART NO.	ACE MODEL NO.	DIP CAPACITY	TIE POINTS	NO. BUSES	NO. POSTS	PRICE EACH
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923332	208 (assem.)	8	872	6	2	$30.70
923334	201-K (kit)	12	1032	2	2	$29.95
923331	212 (assem.)	12	1224	8	2	$37.05
923326	218 (assem.)	18	1760	10	2	$49.00
923325	227 (assem.)	27	2712	28	4	$83.95
923324	236 (assem.)	36	3648	36	4	$84.75

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FREE!

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Includes UNG6966 Heat Gun ($65.00) Included FREE!

ZENITH LIST PRICE $159.00

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The new Zenith ZVM-121 features a P31 green phosphor tube along with 15 MHz bandwidth. Switch selectable for 40/80 character screen. Fully compatable with 80 column Apple cards. 20 lbs

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SH WT 2lbs

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sh. wt 8 lbs
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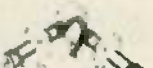

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PNV-390 $6.95 (pair) Box

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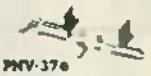
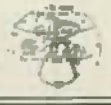


PNV-376



APPLE DOUBLE DENSITY 8" DISK CONTROLLER

Vista introduces high-speed, DMA data transfer and high-capacity IBM compatible single and double-density data storage to the Apple II* computer with the A800 Eight-Inch Floppy Disk Controller.

- High Speed DMA Transfer of Data (7 Microsecond/Byte)
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- Interfaces to All Shugart 4A/SI Standard Eight-Inch Floppy Disk Drives
- 2Kx8 PROM Contains Autoboot Functions and All Eight-Inch Floppy Driver Code Allowing Complete Memory Usage Map Compatibility with Apple DOS 3.2/3.3
- 120 Days Parts and Labor Warranty

PART NO.	DESCRIPTION	LIST PRICE	OUR PRICE
VISA900	Controller and disk	$595.00	$550.00
VISA800	When purchased simultaneously with one of the "PDB" Vista and PEI disk specials below		$525.00

VISTA DUAL 8" DISK CABINET

- Features modular construction with removable sub-assembly that allows easy cabinet positioning and mounting
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- Desk or rack mountable
- Internal power and data cables

		List Price	OUR PRICE
VISV100	Disk Drive Cabinet	$495.00	$449.00

Shipping Weight 35 lbs

BUY THE CABINET AND SHUGART BOTHs OR QUME DT-8s AND SAVE

	with ONE drive	
PDBV100S1	With Shugart 801R	$ 900.00
PDBV10001	With Qume DT-8	$1045.00
	with TWO drives	
PDBV100S2	With Shugart 801R	$1380.00
PDBV10002	With Qume DT-8	$1600.00

Due to UPS shipping regulations, disk drives will be shipped separately from the cabinet. Don't forget to include shipping for each drive. 16 lbs ea.

PR150SKSX $10.95

SPECIAL PURCHASE
GOLD
16 PIN LOW PROFILE IC.
C95 SOCKETS

TIG-16LP pkg of 100 ..... $16.00
TIG-16LP pkg of 1000 ..... $120.00
OEMS Stock up at this LOW PRICE

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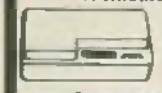

39.95

HOT NEW IMPORT! REMOTE CONTROL 30 CHANNEL CABLE TV CONVERTER!

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VIDCOR 2000 CONVERTER ELIMINATES PROBLEMS WHEN VIDEOTAPING FROM CABLE TV

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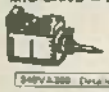
UNUSUAL FACTORY SURPLUS MID BAND – SUPER-BAND CABLE TV TUNER



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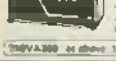

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Aaron-Gavin Kits

Equalizers Mixers LED Meters

COMPARE! 21 BANDS

A One Half Octave EQ for LESS than most 10band EQs. unique LINEAR Mirror Image Circuitry. Totally eliminates snap on. Generates a TRUE ±15db Boost and Cut on EVERY BAND without band to band phase cancellation or rainbow effect.

- Super Low Noise J-Fets ON ALL BANDS
- Regulated Power Supply
- Slew Rate 13 Volts per microsecond
- Built-in Record Switching - no need to re-patch

And as always with Aaron-Gavin Instruments. Lowest Noise. Lowest distortion and Great Over-All PROFESSIONAL Quality.

GRAPHIC EQUALIZERS

Description	Kit	Mfg
31 Band Stereo EQ	$279.36	$344.54
31 Band Mono EQ	$157.05	$322.53
21 Band Stereo EQ	$205.02	$421.02
21 Band Mono EQ	$125.05	$258.64
11 Band Stereo EQ	$114.84	$230.00
11 Band Mono EQ	$ 75.64	$151.87
11 Band Stereo EQ	$129.90	$249.80
5 Band Stereo EQ	$ 76.80	$148.99
5 Band Mono EQ	$ 49.14	$ 96.27

LED METERS (All integrated circuits!)

DOT or BAR Pattern, 3 position range switch

Description	Kit	Mfg
Front panel mount only		
10 LED (Mono)	$44.40	$55.80
20 LED (Stereo)	$82.20	$88.00
Cabinet or Rack Mount		
20 LED (Mono)	$50.40	$68.00
40 LED (Stereo)	$97.00	$88.80

Down to – 71dB!

Kit/mfg prices good only to January 1, 1982

Order with this Coupon or send for product specifications.

Check box for the item of your choice send check, money order, COD or Visa, Master Charge Your card number_____ Exp. date_____

Add $7.00 for shipping and handling Check Freq. Range: ☐ 16Hz-16KHz ☐ 20Hz-20KHz

Check style: Rack Mount ☐ Flat Cabinet ☐ Upright Cabinet

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ADDRESS

CITY STATE ZIP

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CIRCLE 56 ON FREE INFORMATION CARD

SURPLUS BONANZA!!

Complete "Selectric" WORD PROCESSORS

These fantastic office machines originally sold for over $3000.00 each. The system is comprised of a heavy duty, unique designed IBM Selectric I/O Printer/Typewriter and a Console Unit which combines the CPU/Pwr. Supply/Storage Media (mag. card or cassette). The printer is a quality Selectric typewriter with self contained solenoids, aux. keypad, solenoid driver circuitry, etc. *WORTH OUR PRICE & MORE FOR THE PRINTER ALONE.* Fantastic interfacing possibilities as I/O machine/terminal. These amazing machines are used, off-lease and are fully tested & operational when shipped. Schematics included. Takes std. mag cards or modified Philips cassettes with metallized BOT & EOT sensor tape.

— USE AS A TYPEWRITER, I/O MACHINE or WORD PROCESSOR —

A GENUINE BUSINESS MACHINE

QUANTITY PRICES AVAILABLE

Features

- "Selectric I" Typewriter/Printer w/TTL I/O
- 15" Carriage (Frame)
- Correspondence Code
- Takes Std. "Selectric" Type Elements
- Printer may be direct driven (parallel input)
- Small, compact size
- LSI circuitry
- Full record/playback operation
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Includes mag. cassette or card. Type element not included. Add $40 for pkg. and hdlg., pay shipping on delivery. Shipped via motor freight.

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Tested and Operational

Single Cassette or Card _____ $595.00ea.
Dual Cassette or Card _____ $795.00ea.
Operator's Manual _____ $20.00ea.

Sorry, we cannot guarantee choice of cassette or card units

— ALSO AVAILABLE —

TTY ASR-33 TELETYPES.....$99.00ea.

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CIRCLE 54 ON FREE INFORMATION CARD

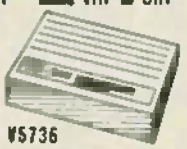
VIDEO

36 Channel Up Converter for TV & VTR

cable VHF to UHF

1-3 pieces **$29.95 ea.**

4 pieces & up **$24.95 ea.**



Model VS736

- Allows complete programming of VTR
- Watch or record any combination of standard or Pay-TV programs
- Receives Midband and Superband channels on UHF
- For Beta/VHS type recorders

BRUCE 37-Channel Wireless Remote Control TV Tuner

Commander 500

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6 pcs. & up **$99.95 ea.** Reg. $199.95

- For all channels; for all TV's
- Red LED channel readout 1-99
- Master power switch and fine tune controls on remote
- Easy to install
- Scan channels up and down

TEKNIKA Wireless Remote Control TV Tuner

$109.95 ea.

Reg. $169.95

Model 6301

- Easy to install; just 4 wires
- Electronic channel selection and indication. VHF: 2-12, UHF: 14-83.
- Ultra-Infrared Beam Control
- Master power switch

Video Control Center

Model VTS-157

$59.95

- No need to change cable to access input to TV set.
- One output; 4 inputs
- No AC power required to operate.
- Auxiliary input and output.

CATV 30-Channel Remote Control

Model RSC-8C **$79.95**

Consists of 2 units: remote control channel selector with fine tuning, ON/OFF switch; and converter body.

TV Accessories

7002 2 Set VHF/FM Amplifier $ 9.95 ea.
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Coax Accessories

DCS-A/B CATV/MATV Switch $9.00 ea.

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2304 MHZ DOWN CONVERTERS. TUNES IN ON CHANNELS 2 TO 7 ON YOUR OWN HOME T.V. HAS FREQUENCY RANGE FROM 2000 MHZ TO 2500 MHZ. EASY TO CONSTRUCT AND COMES COMPLETE WITH ALL PARTS INCLUDING A DIE-CAST ALUM CASE AND COAX FITTINGS. REQUIRE A VARIABLE POWER SUPPLY AND ANTENNA (Antenna can be a dish type or coffee can type depending on the signal strength in your area.)

2304 MOD 1 (Basic Kit) (Less case & fittings) $49.95

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Assembled $34.95

Slotted Microwave Antenna For Above Downverters $39.95

PREAMPLIFIERS

HAL PA-19—1.5 mhz to 150 mhz. 19db gain operates on 8 to 18 volts at 10ma. Complete unit $8.95.
HAL PA-1.4—3 mhz to 1.4 ghz. 10 to 12 db gain operates on 8 to 18 volts at 10ma. Complete unit $12.95.
(The above units are ideal for receivers, counters, etc.)

16 LINE TOUCH TONE DECODER KIT WITH P.C. BOARD AND PARTS $69.95

12 LINE TOUCH TONE DECODER KIT WITH P.C. BOARD AND PARTS $39.95

16 LINE ENCODER KIT, COMPLETE WITH CASE, PAD AND COMPONENTS $39.95

12 LINE ENCODER KIT, COMPLETE WITH CASE, PAD AND COMPONENTS $29.95

MANY, MANY OTHER KITS AVAILABLE

Send 13¢ stamp or S.A.S.E. for information and flyer on other HAL-TRONIX products. To order by phone: 1-313-229-1702.

HAL-TRONIX
P.O. Box 1101
Southgate, MI 48195

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- Pure Class A 25W + 25W
- Switchable to Class AB 100W + 100W
- Switchable to Bridge Class A 100W mono
- Switchable to Bridge Class AB 300W mono
- Frequency Response 5-200kHz (-1dB)
- Signal-to-Noise Ratio 120dB
- Non-magnetic Chassis
- "Out-board" comprehensive protection circuitry
- DC circuitry with limited use of NFB
- High Efficiency Fluid Convection Cooling
- THD under 0.007%

KIT ONLY $299.00

$299.00

Model A502 DC Stereo Control Center

- Direct DC coupling from Input to Output
- DC servo circuitry
- Cascade FET input in all stages
- Separate Moving Coil RIAA amplifier
- Distortion below 0.005% (3V)
- Max Output 15V
- Frequency Response 20Hz-20KHz ±0.2 dB
- Maximum Phono Input
  - MC = 16mv RMS (1KHz)
  - MM = 270mv RMS (1KHz)
- Built-in Headphone amplifier
- Relay Output Muting

KIT ONLY $349.00

$349.00

Model A1033 Integrated Tube Amplifier

- Latest Japanese Design
- Distortionless Output Transformer using special winding techniques
- Most circuitry on PCB for easy assembly and humfree performance
- Output 30W x 2 Ultra Linear (Switchable to Triode) 15W x 2 Triode Output (near class A performance)
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- Frequency Response 30~30,000 Hz (-1dB)
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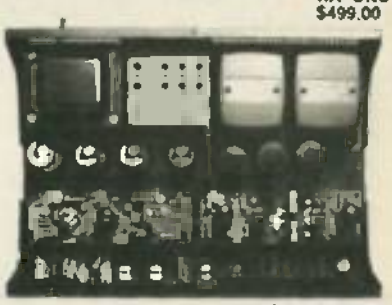

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Send $5.00 for each assembly manual, refundable with order.

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Visa or Mastercharge acceptable.

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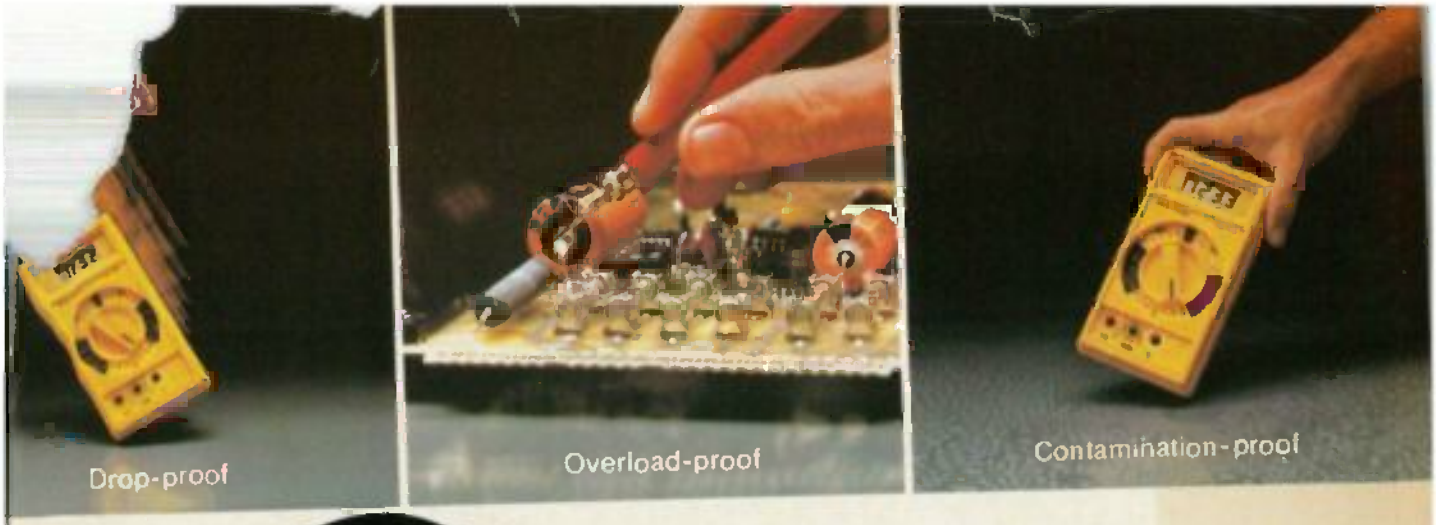

Oops proof.

Now there's a
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ugh enough to withstand acciden-
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The HD-100 from Beckman
s drop-proof, sealed against contam-
ination, and packed with overload protection. You won't find a more rugged meter inside or out.

Drop-proof

Constructed of double-thick thermoplastics, the HD-100 resists damage even after repeated falls. All components are heavy duty and shock mounted.

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The special o-ring seals, ultrasonically-welded display window and sealed input jacks protect the internal electronics of the HD-100 from any source of contamination. The HD-100 is sealed so tightly, it's even waterproof.

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All voltage inputs are protected up to 1500 Vdc or 1000 Vrms. Current ranges are protected to 2A/250V with resistance ranges protected to 600 Vdc. Transient protection extends up to 6KV for 10 microseconds.

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For starters you get 2000 hours of continuous use off a common 9V transistor battery. You can run in-circuit diode tests and check continuity. You even get a one year warranty.

The 0.25% basic volt dc accuracy HD-100 serves you with 7 functions and 29 ranges. With one simple turn of the single selector switch, you can go directly to the function and range you need. There's less chance of error.

Feature for feature you can't find a more dependable meter priced at just $169 (U.S. only).

To locate your nearest distributor write Beckman Instruments, Inc., Instrumentation Products, 2500 Harbor Boulevard, Fullerton, CA 92634 or call (714) 993-8803.

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2 THE BRAND NEW K40 RADAR DETECTOR USING A UNIQUE WAVE GUIDE COUPLED DIE CAST ANTENNA DETECTED X BAND RADAR AN AVERAGE OF 54% FURTHER THAN ALL OTHER DETECTORS AND 67% FURTHER ON THE K BAND FREQUENCY.

3 HERE'S THE TEST* THAT PROVED IT!

TEST RESULTS

MANUFACTURER	COMBINED K & K-BAND DISTANCE FROM GUN
K40	2.96 MILES
ESCORT	2.30 MILES
GUL	2.28 MILES
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RADAR INTERCEPTOR	1.92 MILES
WHISTLER 01000	1.43 MILES
AUTOTRONICS	1.30 MILES
FOX	1.25 MILES

*April 24, 1981 TKI International

OUTPERFORMS ESCORT
THE K40 OUTPERFORMED THE ESCORT 17% ON K-BAND AND 34% ON X-BAND. THE K40 AVERAGED 28% MORE DISTANCE THAN ESCORT AND 60% FURTHER THAN ALL OTHERS COMBINED.

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IT COSTS MORE BECAUSE IT'S MADE BETTER!

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