Radio-Electronics

HOW TO CONNECT YOUR VCR TO MORE THAN ONE TV SET

$1.25 NOV. 1981

Next TV revolution
VIDEOTEX
Information explosion

Build this
EXPANDED SCALE VOLTMETER
For your workbench

All about
TEMP MEASUREMENT
Circuits and systems

asy to build
RUMBLE FILTER
or your hi-fi

BS's new
X NOISE REDUCTION
or phono records

Superscope's
PIANOCORDER
Turn your piano
nto a player piano

0 71896 48783 11

In one year our K40™ antenna has become the largest selling CB antenna in the world!

1. It's more expensive...

$42.50 suggested retail

And when you pay more, you expect more!

MORE PERFORMANCE:
The K40 is guaranteed to transmit further or receive clearer than any antenna it replaces. We know it will. We've tested it with 771 CB'ers just like you for one year.

MORE FLEXIBILITY:
You can fit your K40 to any mounting surface. It will fit any vehicle you'll ever own! That includes choppers, dune buggies, gutters, mirror mounts, luggage racks, trunks, hatchbacks, through roofs, semis, pick ups and RV's.

MORE QUALITY:
It's not imported. It's not made in Taiwan, Korea or Japan. It's American made in an American town. It's made with better materials that cost more and by professional people we pay more. And we designed it right here in the U.S.A.

*Including optional mounts at extra cost.

2. It's made better...

3. It's proven best!

...Here's what the leading CB publications said.

CB TIMES: ". . . it's not often that a product bursts onto the market scene, dominates and improves CB'ing for everyone. American Antenna and the K40 are doing it—repeated tests showed the K40 could out-perform the major competitive brands."

RADIO-ELECTRONICS: "The results of our tests showed that, in three different positions of the monitoring receiver, the *model K40* equaled or out-performed the competitive antenna. Apparently, American Antenna's advertising is not merely Madison Avenue showmanship."

PERSONAL COMMUNICATIONS: ". . . an impressive 95% of the trials, the K40 out-performed the existing mobile antennas. We had to try one for ourselves.
". . . in every case, the K40 either equaled or out-performed its competitor.
"No ifs, ands, or buts! The K40 Antenna from American Antenna would have to be just about the best antenna around.

CB MAGAZINE: "Introduced in October, 1977, the K40 quickly became the top seller and in mid 1978, became the number one selling antenna in the nation."

...Here's what CB'ers all across the country said.

ANTENNA SPECIALISTS: ". . . truck driver and CB'er for 10 years . . . 50% further than my M410 'Big Momma'."
—J.H. Collett, 207 McFee, Bastrop, LA

AVANTI: "I'm an electronic technician with a Second Class FCC license . . . I was able to transmit 70% further and tune the SWR 75% lower than my Avanti."
—H.R. Castro, VRB, Monserrante D-67, Salinas, Puerto Rico

PAL: ". . . 20% better in transmission and reception than my 5/8 wave Pal Firestik."
—John A. Blum, Box 446, Zellenolple, PA

SHAKESPEARE: ". . . I've been a CB'er for three years and the K40 is the best I've ever had. Better in reception and transmission than my Shakespeare."
—H. Bachert, Jr., 15 King Rd., Park Ridge, NJ

HUSTLER: "Compared to my Hustler XBLT-4, the K40 can consistently transmit 40% further and the reception was better. The K40 is the perfect way to complete a CB system."
—Jerome R. Brown, 7800 S. Linder, Burbank, IL

...This Antenna is so DYNAMITE you receive a...

DOUBLE GUARANTEE

GUARANTEE I: The K-40 will transmit farther and receive more clearly than the antenna it replaces or the customer will receive a prompt and full refund from the Registered K-40 Dealer who installed and tuned it.

GUARANTEE II: Unconditionally guaranteed for 12 months. Guaranteed against cracking, chipping, or rusting. Guaranteed against mechanical failure. Guaranteed against electrical failure. Guaranteed against accidental breakage. No exclusions. No gimmicks. For a full 12 months.

(SPECIAL NOTE) IF YOU'RE A BEGINNER:

Our K40 Dealers will be happy to sell you any of the older style and less expensive antennas that are great bargains for any beginning CB'er.

AMERICAN ANTENNA
ELGIN, IL 60120

K40 POWER!

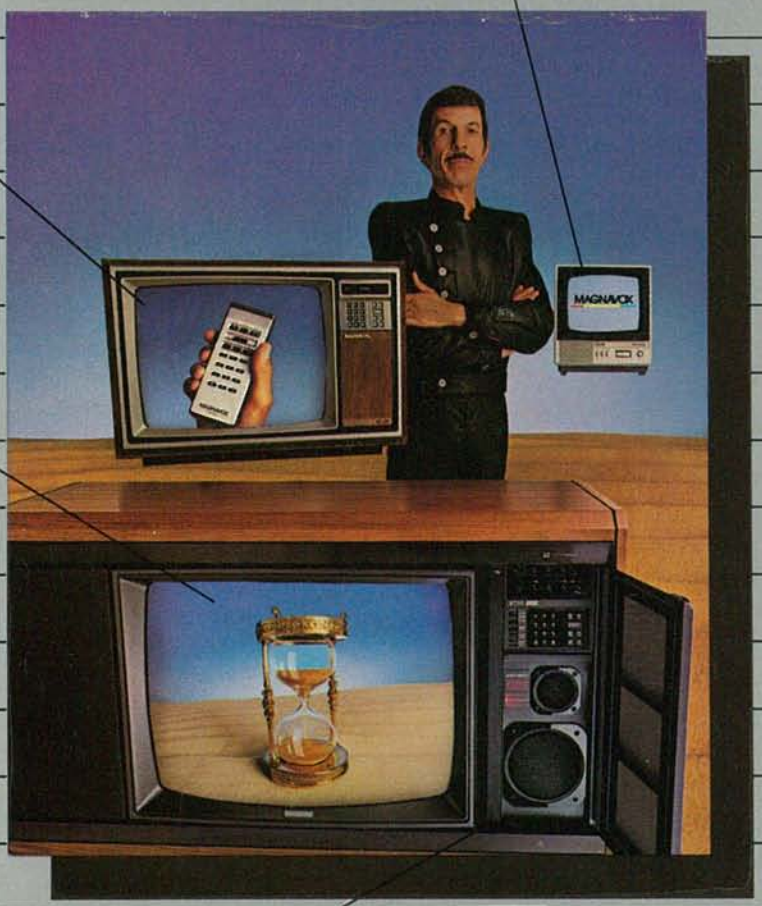
...Sold exclusively by 3500 American K40 Dealers throughout the U.S. & Canada.

CIRCLE 60 ON FREE INFORMATION CARD

Magnavox model 4012, 9-inch diagonal measurement AC/DC color portable with electronic tuning wheel and dial scale indicator.

Magnavox model 4265, 19-inch diagonal measurement Star System. All Star System sets give you infrared remote control, 105-channel capability, automatic switching between two channels, display time of day and channel number on TV screen.

Magnavox. A picture you can rely on time after time.



Magnavox model 5260, 25-inch diagonal measurement Star System. This set even has expanded range high-fidelity sound.

TV pictures and wood-grain cabinets simulated. All models shown are Star Systems except model 4012.

TELEVISIONARY.

Magnavox sees the next stage of televiewing with you as the participant as well as the recipient.

For that, you will need the most reliable color television possible.

And now Magnavox Star® System color television sets combine advanced design concepts, high technology and new manufacturing systems to deliver the highest level of reliability in Magnavox history.

Magnavox. Television as visionary as tomorrow. With a picture as reliable as it is bright and clear.

Time after time.

MAGNAVOX

The brightest ideas in the world are here today.

CIRCLE 30 ON FREE INFORMATION CARD

More ways to C the value... with B&K-PRECISION

Now you can choose the capacitance measurement instrument you need from the industry's most complete line. For high-speed sorting, there's the 835 Digital Capacitance Comparitor; and for less specialized applications, the 830 Autoranging C-Meter and the 820 Manual Ranging C-Meter. All are GSA listed.

The 835 is a rugged production tool for isolating out-of-tolerance capacitors in the shortest possible time. Program-in acceptable high and low capacitance limits and then start testing. The 835 indicates "LO," "GOOD" or "HI." It also indicates capacitance values on an autoranging C-meter.

Combining autoranging and portability, the B&K-PRECISION 830 C-meter offers features that are tough to match at any price. Resolution is 0.1 pF, with readings displayed on a large 3-1/2-digit LCD display. Basic accuracy is 0.2%, much greater than the tolerance of most capacitors. Ease of operation is another strength of the 830. Even untrained workers can quickly learn its operation, though its performance also makes it ideal for engineering lab use. A selectable "range hold" is also featured.

For field or bench applications suited to manual ranging, B&K-PRECISION offers the 820—the industry's best C-meter value. The 820 displays readings to a full 1 Farad on a 4-digit LED display. Accuracy is within 0.5%.

All of the B&K-PRECISION C-measurement products are protected against charged capacitors. They all also allow you to measure unmarked capacitors, verify capacitor tolerance, measure cable capacitance, select and match capacitors for critical applications, perform quality assurance, measure complex networks, set trimmer capacitors and check capacitance in switches and other components. Options include the CF-10 test fixture for volume sorting; and for the 830 and 820, rechargeable batteries, AC charger and carrying case.

For immediate delivery or more details, see your local distributor, and see why B&K-PRECISION continues to be the leading supplier of digital capacitance measurement instruments. For the name of your nearest distributor call toll-free

800-621-4627.

B+K PRECISION DYNASCAN CORPORATION

6460 W. Cortland Street • Chicago, IL 60635 • 312/889-9087

International Sales, 6460 W. Cortland Street, Chicago, IL 60635 USA: TELEX: 25-3475

Canadian Sales, Atlas Electronics, Ontario

Model 820 $185
Model 830 $229
Model 835 $675

CIRCLE 58 ON FREE INFORMATION CARD

Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

NOVEMBER 1981 Vol. 52 No. 11

ON THE COVER

Television has already revolutionized the way we live. A second TV revolution is now under way with the introduction of videotex. Videotex will allow you to use your TV set to receive information on almost any subject you desire—news of all sorts, local special events, and even restaurant menus. In addition, it will permit you to transact much of your personal business—shopping, banking, etc.—from home. For a look at what's in store, turn to page 43.

VIRTUALLY ALL STEREO records contain very-low-frequency signals that can be annoying to listen to and, potentially, can damage your sound system. A low-frequency filter will remove those signals, and plans for such a device begin on page 47.

SOMETIMES IT'S DESIRABLE to connect several TV sets to the same VCR. If you have a master-antenna setup, you can use it for that purpose. Several methods for taking advantage of your MATV facilities are described, starting on page 72.

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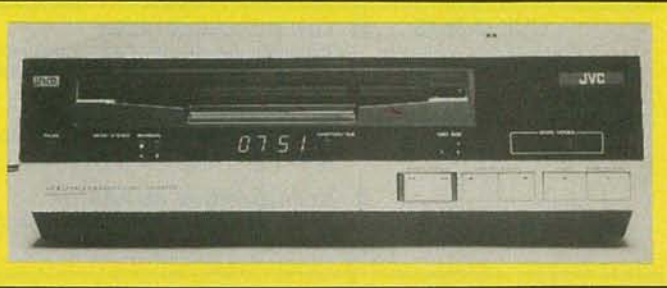
VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR



MONITORS FOR THE HOME

The day when the output of a home video device must be placed on an RF carrier for playing through a TV set may be rapidly drawing to a close, as more TV set manufacturers add video input jacks to their products. Sony's *Profeel* video components have been widely publicized, as has RCA's 19-inch *Monitor Receiver* (see jack-panel in left-hand photo), but video jacks are creeping into many more home-TV sets with screen sizes from 3.7 to 25 inches. Among those now featuring video input jacks in at least one TV model in addition to RCA and Sony are General Electric, JVC, Liberty, Magnavox, Panasonic, and Toshiba, as well as Teknika (1633 Broadway, New York, NY 10019), which, like Sony, has introduced a component video system.

SLIPPED DISC

Introduction of the third videodisc system—the JVC-developed VHD (see right hand photo above)—has been postponed for six months to April in Japan and June in the United States. Originally scheduled for introduction here in January, and October 1980 in Japan, VHD was called back because of problems arising at high temperatures in the compound used to manufacture the discs, according to JVC officials in Japan. JVC said the problems have been solved, and the tool-up period for introducing the new disc compound will be used to redesign the players so they can play discs recorded in any color-TV standard. When introduced, according to JVC, an NTSC player will be able to play back a PAL or a SECAM disc, and so forth.

STEREO VIDEOCASSETTES

Although only one VCR on the U.S. market can play or record in stereo—Akai's high-end model—MVC (*M*agnetic *V*ideo *C*o.), the world's biggest source for pre-recorded videocassettes is quietly recording stereo soundtracks on all video programming (including movies) which is available in stereo. For the time being, this fact is not mentioned by MVC in its advertising or on the cassette album covers, but the company is preparing for the onslaught of stereo-sound VCR's that could start late this year.

In Japan, where stereo sound is being broadcast on TV, stereophonic VCR's are widely available. The compatible stereo system used on Japanese VCR's could easily be used here, and probably will. It's a good guess that stereo sound could be the high-end VCR feature for 1983.

MORE DISCS ON THE WAY

Both videodisc systems may well float or sink on the availability of discs, and proponents of both concede there aren't enough titles on the market now. At press time, there were 125-150 titles available for each system, not enough of an attraction when you consider there are at least 3,000 titles available to the consumer on videocassette. However, this shortage is beginning to ease. There are now two plants stamping out LV discs—the original DiscoVision Associates factory in California, now joined by the massive Universal Pioneer plant in Japan, scheduled to be producing 200,000 discs monthly by the end of this year and with a capacity of 5,000,000 for 1982. And before the year is over, 3M is scheduled to be pressing LV discs in a Wisconsin facility.

In the CED camp, RCA has increased its disc-production estimate for 1981 to 3,000,000 from 2,000,000 and is expanding its Indianapolis plant to support a 10,000,000 level in 1982. RCA is now custom-pressing the first 20 CBS/MGM videodiscs, and CBS's own CED disc plant is scheduled to be in operation next January.

Facts from Fluke on low-cost DMM's

Our new 4½-digit bench/portable: You've never seen anything like it.

Take a close look at the face of this instrument. Notice anything new? If you just realized you've never seen *words* on a low-cost DMM display before, you're on the right track.

This is the new 8050A from Fluke, the *lowest* priced 4½-digit multimeter available that uses microprocessor technology.

The legends on the LCD are clues to what makes the 8050A unique.

dB: You're right. The 8050A delivers direct readouts in dBm, referenced to any of 16 impedances. Use the "REF Z" button to scroll through the memory and locate the zero dBm reference you need, then set it and forget it. No more tedious calculations or conversions.

REL: For relative references in the dB mode or offset measurements in all other functions. Lets you store any input as a zero value against which all others are automatically displayed as the difference. Another timesaving convenience.

HV: Just a reminder when your input is over 40V, so you won't forget about safety while in the dB or relative modes.

Of course there's much more to the 8050A. True RMS measurements to 50 kHz. Conductance for measuring resistance to 100,000 Megohms and leakage in capacitors, pcb's, cables and insulators. Diode test, 0.03% basic dc accuracy and full input protection. Plus a large family of accessories. Just $369 U.S.

For all the facts on the versatility and value of the new 8050A, call toll free **800-426-0361**; use the coupon below; or contact your Fluke stocking distributor, sales office or representative.

FLUKE®

IN THE U.S. AND NON-EUROPEAN COUNTRIES:

John Fluke Mfg. Co., Inc.
P.O. Box C9090, M/S 250C
Everett, WA 98206
(206) 356-5400
Telex: 152662

IN EUROPE:

Fluke (Holland) B.V.
P.O. Box 5053, 5004 EB
Tilburg, The Netherlands
(013) 673 973
Telex: 52237

☐ Please send 8050A specifications.

☐ Please send all the facts on Fluke low-cost DMM's.

RE-11/81

☐ Please have a salesman call.

Name

Title Mail Stop

Company

Address

City State Zip

Telephone ( ) Ext.

For technical data circle no. 43

WHAT'S NEWS

Small business computers to follow economy line

Business computers priced under $20,000 will show a higher rate of growth between now and 1984 than any other segment of the business computer line, according to Venture Development Corp., a market research concern of Wellesley, MA. Shipments of those systems, says VDC, will increase 35.5% annually, accounting for 45% of shipments by 1984. Systems priced between $20,000 and $50,000 will increase by 26% annually, amounting to 35% of the market, and those between $50,000 and $100,000 are expected to increase about 27% each year, holding 20% of the market in 1984.

According to Karen Horowitz, VDC analyst, future technological advances, lower-priced printers, and less expensive storage devices will enable the owner of one of the lower-priced computer setups to obtain the performance of today's middle-priced systems.

Home satellite TV well under $4,000

Downlink, Inc., of Putnam, CT, has announced a reduction of its home-satellite TV system to $3595.00, "the lowest price in the industry." At the same time, the company announced expanded production capabilities and a distributor program aimed at marketing a thousand systems a month.

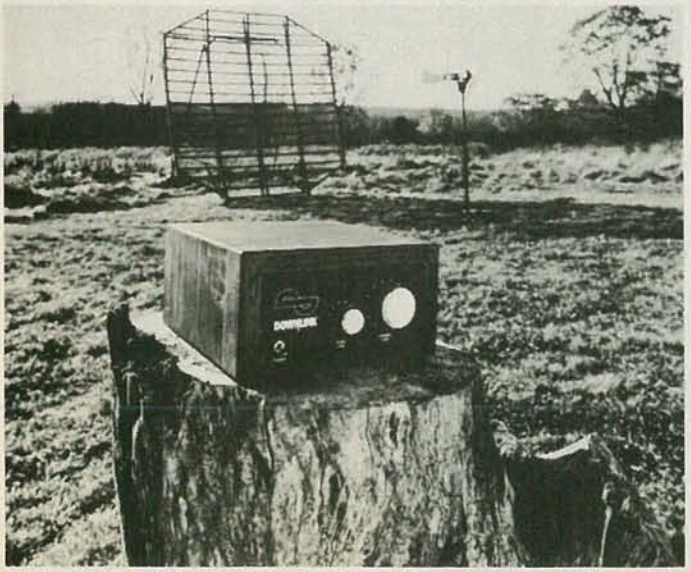
The system includes a 12-foot spherical antenna, a low-noise amplifier, the Downlink *model D2X* receiver, and all of the required cabling.

Downlink introduced other models and combinations, including the *model D-2S* and *model D-3* receivers, as well as the *Skyview III* parabolic antenna, at the Chicago Consumer Electronics Show that was held last June.

Information, control: 1995 market leaders?

The growth of home information services, video, and control electronics will completely alter the face of the consumer electronics industry by 1995. The market, now $7.8 billion annually, will reach $28 billion by 1995. Thus believes Venture Development Corp., of Wellesley, MA. The home electronics field, once dominated by radio, and now getting most of its revenue from television, will find itself chiefly involved with the hardware and software of home information services, says the Massachusetts market research firm.

The key challenge facing manufacturers will be to orchestrate product development and introduction to coincide with evolving consumer demand, says Venture Development. Correct calculation of consumer demand, and especially the timing of a product's introduction, will be critical.



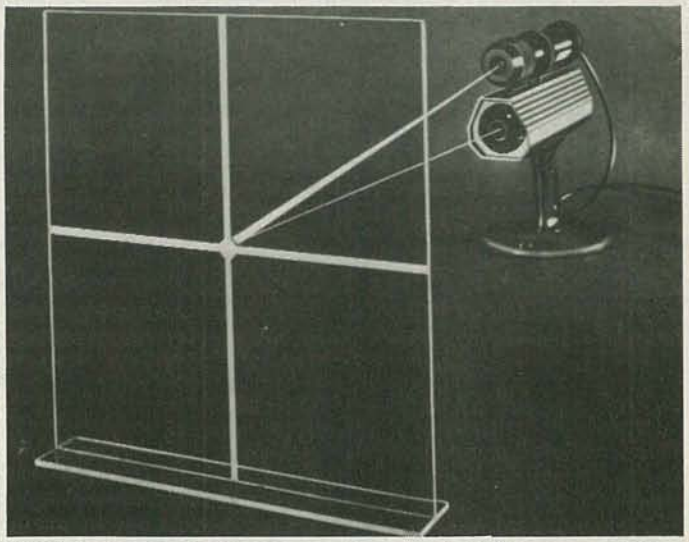
DOWNLINK'S SKYVIEW I TV ANTENNA AND D-2 RECEIVER

Laser sight improves infrared thermometer

A new handheld portable infrared (IR) thermometer uses a laser sight for fast, precise focal-distance range-finding. The *model 44L* infrared thermometer from Telatemp, is equipped with a 0.5-milliwatt laser, mounted on top of the basic housing. The laser beam is split in two. The primary beam is projected parallel to the thermometer's IR optics to form an intense red spot on the target. A secondary, more diffused beam intersects the primary beam at the thermometer's preset focal distance.

By properly aligning the two beams the user can measure the temperature of a precisely known area of the target. The illumination provided by the beam also aids sighting, particularly when lighting conditions are poor or if the target is in darkness.

The infrared radiation emitted by the target is captured by a primary concave reflector. It is then focused on a secondary reflector and transmitted from there to an IR detector. A digital readout is calibrated in either Celsius (0° to 600°) or Fahrenheit (0° to 1000°) with 5% accuracy.



THE TELATEMP'S LASER SIGHT not only makes focal-distance range-finding precise and rapid, but also facilitates temperature measurement by illuminating the target, a great aid under poor light or no light.

Focal distances are 24 inches to infinity, preset at the factory.

With laser sighting, unlike using rifle-type sights, the user can literally "shoot from the hip." The temperature detected while the trigger is depressed is held on the digital readout for the operator to read after the trigger is released.

Howard Sams Photofacts publishes Set No. 2,000

The Howard W. Sams company reached a milestone this past July with the publication of their 2000th *Photofact* folder. Sams *Photofact* folders first appeared in 1946, introducing a

continued on page 12

ODYSSEY²
THE EXCITEMENT OF A GAME. THE MIND OF A COMPUTER.

Simulated TV picture
© 1981 N A P CONSUMER ELECTRONICS CORP.

ALL FOR THE PRICE OF AN ORDINARY VIDEO GAME.

Some video games are exciting but short on challenge.

Odyssey², on the other hand, lets you choose your excitement from more than 40 arcade, sports, education and new Master Strategy games that are full of challenges as well as fun, so they keep you coming back for more.

And some video games have an abundance of brainpower, but cost an arm and a leg. Only Odyssey² includes, *at no extra cost,* a full 49-character alphabet and number computer keyboard that gives you access to the mind behind the games.

And now there's The Quest For The Rings™ from Odyssey². It's the first in our new Master Strategy Series™ of video games that combine computer technology, your TV set and an advanced game board to transport you to a startlingly realistic alternate world.

Odyssey². Video game fun. Computer keyboard challenge. All for the price of an ordinary video game. It's waiting for you now, at your Odyssey² dealer.

Odyssey² games include:
The Quest For The Rings • Speedway* • Spin-Out* • Crypto-Logic* • Las Vegas Blackjack • Armored Encounter • Subchase • Football • Bowling • Basketball • Math-A-Magic • Echo • Computer Intro • Matchmaker • Logix • Buzzword • Baseball • Computer Golf • Cosmic Conflict • Take The Money And Run • I've Got Your Number • Invaders From Hyperspace • Thunderball • Showdown in 2001 A.D. • War Of Nerves • Alpine Skiing • Helicopter Rescue • Out Of This World • Hockey • Soccer • Dynasty • Volleyball • Electronic Table Soccer • Pocket Billiards • Pachinko • Blockout • Breakdown • Casino Slot Machine • UFO • Alien Invaders—Plus.
*Included with original Odyssey² purchase.

ODYSSEY²

The excitement of a game.
The mind of a computer.

CIRCLE 28 ON FREE INFORMATION CARD

Everybody's making money selling microcomputers. Somebody's going to make money servicing them.

New NRI Home-Study Course Shows You How to Make Money Servicing, Repairing, and Programming Personal and Small Business Computers

Training includes the new TRS-80 Model III microcomputer, 6-function LCD Beckman multimeter, and the NRI Discovery Lab with hundreds of tests and experiments.

Seems like every time you turn around, somebody comes along with a new computer for home or business use. And what's made it all possible is the amazing microprocessor, the tiny little chip that's a computer in itself.

Using this new technology, the industry is offering compact, affordable computers that handle things like payrolls, billing, inventory, and other jobs for businesses of every size...perform household functions including budgeting, environmental systems control, indexing recipes. And thousands of hobbyists are already owners, experimenting and developing their own programs.

Growing Demand for Computer Technicians

This is only one of the growth factors influencing the increasing opportunities for qualified computer technicians. The U.S. Department of Labor projects over 100% increase in job openings for the decade through 1985. Most of them *new* jobs created by the expanding world of the computer.

Learn at Home in Your Spare Time

NRI can train you for this exciting, rewarding field. Train you at home to service not only microcomputers, but word processors and data terminals, too. Train you at your convenience, with clearly written "bite-size" lessons that you do evenings or weekends, without going to classes or quitting your present job.

Your training is built around the latest model of the world's most popular computer. It's the amazing TRS-80™ Model III, with capabilities and features to perform a host of personal and business functions. No other small computer has so much software available for it, no other is used and relied on by so many people. And it's yours to keep for personal or business use.

You get plenty of practical experience. Using the NRI Discovery Lab® that also comes as part of your course, you build and study circuits ranging from the simplest to the most advanced. You analyze and troubleshoot using the professional Beckman LCD digital multimeter you keep to use later in your work. Then you use the lab and meter to actually access the interior of your computer...build special circuits and write programs to control them. You "see" your computer at work and demonstrate its power.

Become the Complete Computer Person

You're also trained in writing and debugging both BASIC and advanced machine language programs...gain hands-on experience in the operation and application of computers to business and personal jobs. You're trained to become the fully rounded, new breed of technician who can interface with the operational, programming, and service facets of today's computers. You're ready to take your place in the new electronic age.

Other Opportunities

NRI has been giving ambitious people new electronic skills since 1914. Today's offerings also include TV/Audio/Video Systems servicing with training on our exclusive computer-programmable 25" diagonal color TV...Communications Electronics for servicing and installing microwave, broadcast, CB, radar, etc...and other state-of-the-art courses.

Free Catalog...Mail Card No Salesman Will Call

Send the postage-paid card for our 100-page catalog showing all courses with equipment and complete lesson plans. There's no obligation other than to yourself. See how NRI can help you grow with the most exciting and important new field of the 80's. If card has been removed, please write to us.

NRI SCHOOLS
McGraw-Hill Continuing Education Center
3939 Wisconsin Ave.
Washington, DC 20016

We'll give you tomorrow.

(TRS-80 is a trademark of the Radio Shack division of Tandy Corp.)

WHAT'S NEWS

continued from page 6

revolutionary new type of service information. Each piece of equipment described was disassembled, so that all data would be complete and accurate for the parts and circuits actually appearing in the equipment. (The "official service manuals" of the time—Gernsback's, Rider's, and Beitman's—merely reprinted the manufacturer's schematic, often with extracts from manufacturers service information.

PHOTOFACT FOLDER NO. 2000 has a gold cover, to mark an era in service information publishing.

The Sams approach resulted in the *Photofact* Standard Notation schematic; complete alignment and adjustment instructions; chassis and waveform photographs; comprehensive parts lists with replacement parts, and test measurements. The sequence and format of the information has been presented in the same consistent, standardized and clear manner from Folder No. 1.

Number 2,000 was reached with a folder containing information on the Hitachi *NPX-L* and the Sears *564-44150050/4200050* color-TV receivers, and on the Realistic *12-1524 Chronomatic 219* radio. The cover for this special set is printed in gold to mark the occasion.

Initially, *Photofact* folders provided service information for radios; their coverage was later expanded to include television receivers, as well as a variety of other consumer electronics equipment. Recently, coverage has been expanded to include video-cassette recorders, and videodisc players will soon be covered. Currently, seven *Photofact* sets are published every month. Some technicians have been members of the *Photofact*-of-the-Month Club from the beginning and have received all 2000 sets. Beginning with No. 2000 the publisher states that *Photofacts* has been updated and streamlined graphically.

RCA, Columbia, uniting to market home video abroad

RCA Corporation and Columbia Pictures Industries, Inc., have formed a joint venture to market home-video entertainment programs throughout the world, excepting the United States and Canada. The participants will develop an organization with offices in all principal countries, to market existing and future theatrical and television programs produced by the two companies and other producers, as well as original productions created specifically for the home-video market.

Japan has a new weather satellite

Japan's second weather satellite, launched last August, is called GMS-2 (the second Geostationary Meteorological Satellite). Its position in space is just south of Japan, at 140° East longitude, where it will replace GMS, launched in 1977. Its area of operation extends over China and Korea in the north, Australia and New Zealand in the south, Burma and Tibet on the east, and Hawaii on the west.

The most important instrument aboard GMS-2 is a visible/infrared spin-scan radiometer. It detects visible and invisible radiation from the earth and transmits it to ground for analysis by weather forecasters. The information helps them to determine the intensity and direction of storms.

GMS-2 also provides information on tidal, tsunami ("tidal wave"), and ice conditions, by gathering data from sensors on buoys and at fixed land locations, and relaying the data to ground.

Another instrument, a Space Environment Monitor (SEM), takes measurements of energetic protons in space, for use in scientific studies. The satellite also supplies the usual TV-like images of cloud patterns.

GMS-2 was developed and built by Hughes Aircraft Company for Nippon Electric. It is the first U.S.-produced geosynchronous satellite to be launched by a foreign country. The SEM system was built by Nippon Electric, which also assembled a number of the satellite's electronic units. Sharp Corp. of Japan provided solar cells for the spacecraft.

The N-II rocket, developed in Japan, can carry a 350-kg (772-lb) geostationary satellite. It stands 35 meters (115 feet) high and develops 170,000 pounds of thrust with its main engine and nine strap-on boosters.

THE JAPANESE GMS-2 UNDERGOES TESTS at Hughes Aircraft in El Segundo, CA. It will collect weather pictures from an area of some 65 million square miles in the Western Pacific.

Electronic mail system to begin in 25 cities

The United States Postal Service has placed a $31-million contract with RCA to provide an Electronic-Computer Originated Mail (E-COM) system, to begin operation in 25 U.S. cities early in 1982. The new system will offer mailers high-speed delivery of notices, statements, and other computer-originated letters.

The system will accept information from a customer's computer-generated magnetic tape or from a computer via private telecommunications carriers. This will be printed at the electronic mail center designated by the customer, then entered into the First Class mailstream.

Pages will be trimmed to 8½ × 11 inches, folded and placed in envelopes, all automatically. The address printed on the letter will be displayed through a window in the envelope, and delivery made by the U.S. Postal Service. **R-E**

Synthesized Hand-Held Scanner!

Chances are the police, fire and weather emergencies you'll read about in tomorrow's paper are coming through on a scanner right now. All scanners sold by **Communications Electronics** bring the real live excitement of action news into your home or car. With your scanner, you can monitor the exciting two-way radio conversations of police and fire departments, intelligence agencies, mobile telephones, energy/oil exploration crews, drug enforcement agencies and more.

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NEW! Bearcat®† 350

The Ultimate Synthesized Scanner!

Allow 30-120 days for delivery after receipt of order due to the high demand for this product.

List price $599.95/**CE price $419.00**

7-Band, 50 Channel • Alpha-Numeric • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC

Bands: 30-50, 118-136 AM, 144-174, 421-512 MHz.

The new *Bearcat* 350 introduces an incredible breakthrough in synthesized scanning: Alpha-Numeric Display. Push a button—and the Vacuum Fluorescent Display switches from "numeric" to word descriptions of what's being monitored. 50 channels in 5 banks. Plus, Auto & Manual Search, Search Direction, Limit & Count. Direct Channel Access. Selective Scan Delay. Dual Scan Speeds. Automatic Lockout. Automatic Squelch. Non-Volatile Memory. Reserve your *Bearcat* 350 today!

Bearcat® 300

List price $549.95/**CE price $349.00**

7-Band, 50 Channel • Service Search • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC

Bands: 32-50, 118-136 AM, 144-174, 421-512 MHz.

The *Bearcat* 300 is the most advanced automatic scanning radio that has ever been offered to the public. The *Bearcat* 300 uses a bright green fluorescent digital display, so it's ideal for mobile applications. The *Bearcat* 300 now has these added features: Service Search, Display Intensity Control, Hold Search and Resume Search keys, Separate Band keys to permit lock-in/lock-out of any band for more efficient service search.

NEW! Bearcat® 350

Bearcat® 250

List price $429.95/**CE price $279.00**

6-Band, 50 Channel • Crystalless • Searches Stores • Recalls • Digital clock • AC/DC Priority Channel • Delay • Count Feature

Frequency range 32-50, 146-174, 420-512 MHz.

The *Bearcat* 250 performs any scanning function you could possibly want. With push button ease you can program up to 50 channels for automatic monitoring. Push another button and search for new frequencies. There are no crystals to limit what you want to hear. A special search feature of the *Bearcat* 250 actually stores 64 frequencies and recalls them, one at a time, at your convenience.

NEW! Bearcat® 20/20

Allow 30-60 days for delivery after receipt of order due to the high demand for this product.

List price $449.95/**CE price $289.00**

7-Band, 40 Channel • Crystalless • Searches AM Aircraft and Public Service bands • AC/DC Priority Channel • Direct Channel Access • Delay

Frequency range 32-50, 118-136 AM, 144-174, 420-512 MHz.

The *Bearcat* 20/20 automatic scanning radio replaces the *Bearcat* 220 and monitors 40 frequencies from 7 bands, including aircraft. A two-position switch, located on the front panel, allows monitoring of 20 channels at a time.

Bearcat® 210XL

List price $349.95/**CE price $229.00**

6-Band, 18 Channel • Crystalless • AC/DC

Frequency range: 32-50, 144-174, 421-512 MHz.

The *Bearcat* 210XL scanning radio is the second generation scanner that replaces the popular *Bearcat* 210 and 211. It has almost twice the scanning capacity of the *Bearcat* 210 with 18 channels plus dual scanning speeds and a bright green fluorescent display. Automatic search finds new frequencies. Features scan delay, single antenna, patented track tuning and more!

Bearcat® 160

List price $299.95/**CE price $189.00**

5-Band, 16 Channel • AC only • Priority Dual Scan Speeds • Direct Channel Access

Frequency range: 32-50, 144-174, 440-512 MHz.

Would you believe...the *Bearcat* 160 is the least expensive *Bearcat* crystalless scanner.

This scanner presents a new dimension in scanning form and function. Look at the smooth keyboard. No buttons to punch. No knobs to turn. Instead, finger-tip pads provide control of *all* scanning operations, including On/Off, Volume and Squelch. Of course the *Bearcat* 160 incorporates other advanced *Bearcat* features such as Priority, Direct Channel Access, Dual Scan Speeds, Lockout, Scan Delay and more.

NEW! Bearcat® 100

The first no-crystal programmable handheld scanner.

Allow 60-180 days for delivery after receipt of order due to the high demand for this product.

List price $449.95/**CE price $299.00**

8-Band, 16 Channel • Liquid Crystal Display Search • Limit • Hold • Lockout • AC/DC

Frequency range: 30-50, 138-174, 406-512 MHz.

The world's first no-crystal handheld scanner has compressed into a 3" x 7" x 1¼" case more scanning power than is found in many base or mobile scanners. The *Bearcat* 100 has a full 16 channels with frequency coverage that includes all public service bands (Low, High, UHF and "T" bands), the 2-Meter and 70 cm. Amateur bands, *plus* Military and Federal Government frequencies. It has chrome-plated keys for functions that are user controlled, such as lockout, manual and automatic scan. Even search is provided, both manual and automatic. Wow...what a scanner!

The *Bearcat* 100 produces audio power output of 300 milliwatts, is track-tuned and has selectivity of better than 50 dB down and sensitivity of 0.6 microvolts on VHF and 1.0 microvolts on UHF. Power consumption is kept extremely low by using a liquid crystal display and exclusive low power integrated circuits.

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List price $134.95/**CE price $94.00**

4-Band, 8 Crystal Channels • Lockout • AC only

Frequency range: 33-50, 146-174, 450-508 MHz.

The *Bearcat* 5 is a value-packed crystal scanner built for the scanning professional — at a price the first-time buyer can afford. Individual lockout switches. Order one crystal certificate for each channel.

Bearcat® Four-Six ThinScan™

List price $189.95/**CE price $124.00**

Frequency range: 33-47, 152-164, 450-508 MHz.

The incredible, *Bearcat* Four-Six Thin Scan™ is like having an information center in your pocket. This four band, 6 channel crystal controlled scanner has patented Track Tuning on UHF. Scan Delay and Channel Lockout. Measures 2¾ x 6¼ x 1". Includes rubber ducky antenna. Order crystal certificate for each channel. Made in Japan.

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List price $169.95/**CE price $109.00**

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List price $149.95/**CE price $99.00**

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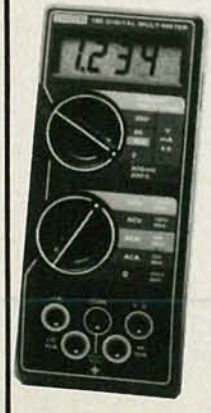

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	2mA, 20mA, 200mA, 2000mA, 10A	2%
AC CURRENT		
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RESISTANCE		
	200Ω, 2kΩ, 20kΩ, 200kΩ, 20MΩ	.5%

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EDITORIAL

Just Another Technological Advance?

Electronics technology plays a vital role in almost every industry. Every day, in medicine and energy conservation, to name just two, electronics is making an important and continuing contribution.

One industry greatly changed and influenced by electronics is photography. The portable all-in-one video camera/VCR combination is encroaching upon and often replacing home-movie camera/projector/screen combinations. Photographic still-picture cameras have also felt the impact of electronics. Integrated circuits have made possible such features as automatic exposure, LED metering, and even auto-focusing.

Now Sony has announced the all-electronic still camera. Called the MAVICA (*MA*gnetic *VI*deo *CA*mera), it looks very much like a conventional 35-mm SLR. It weighs $1\frac{3}{4}$ lbs. and measures $5\frac{1}{8} \times 3\frac{1}{2} \times 2\frac{1}{16}$ inches. It is a single-lens reflex camera with interchangeable lenses. Shutter speeds range from 1/60 to 1/1000 on manual and 1/60 to 1/2000 on automatic.

Here the similarity ends. The MAVICA does not use photographic film. Instead, it uses a CCD image sensor with about 280,000 picture elements (570 horizontal and 490 vertical). The images are recorded on a magnetic disk that rotates inside a flat cassette (very much like a floppy disk). The magnetic cassette sits inside the camera and records up to 50 color pictures. Pictures can be selectively erased and re-recorded.

To see the pictures you've taken, the cassette is removed from the camera and placed into a viewer that is connected to a TV set. A transmitter/receiver combination will be available that attaches to the viewer. With this, pictures can be transmitted over telephone lines. In addition, the camera provides output signals for direct connection to a VCR. Now when the camera is switched to a continuous mode, it becomes a video camera.

Specifications include a 1-MHz bandwidth, an image S/N ratio of 45 dB and a horizontal resolution equivalent to 350 TV lines. The price of the camera will be around $650 and the viewer about $230. Each magnetic cassette is expected to sell for $2.65.

Commercial introduction is scheduled for the fall of 1983. Although I haven't seen any pictures from this camera, Sony claims that they are somewhat disappointed in the picture quality and resolution. However, they are working feverishly to improve the quality before introduction. Sony is also working on a hard-copy color printer for the system.

Although this latest development won't have a profound effect on our day-to-day lives, it is one more reason why I feel proud to be a member of the electronics industry. It also prompts me to ask why this, like so many other recent advances, comes from abroad instead of from our own research and development labs?

ART KLEIMAN
Managing Editor

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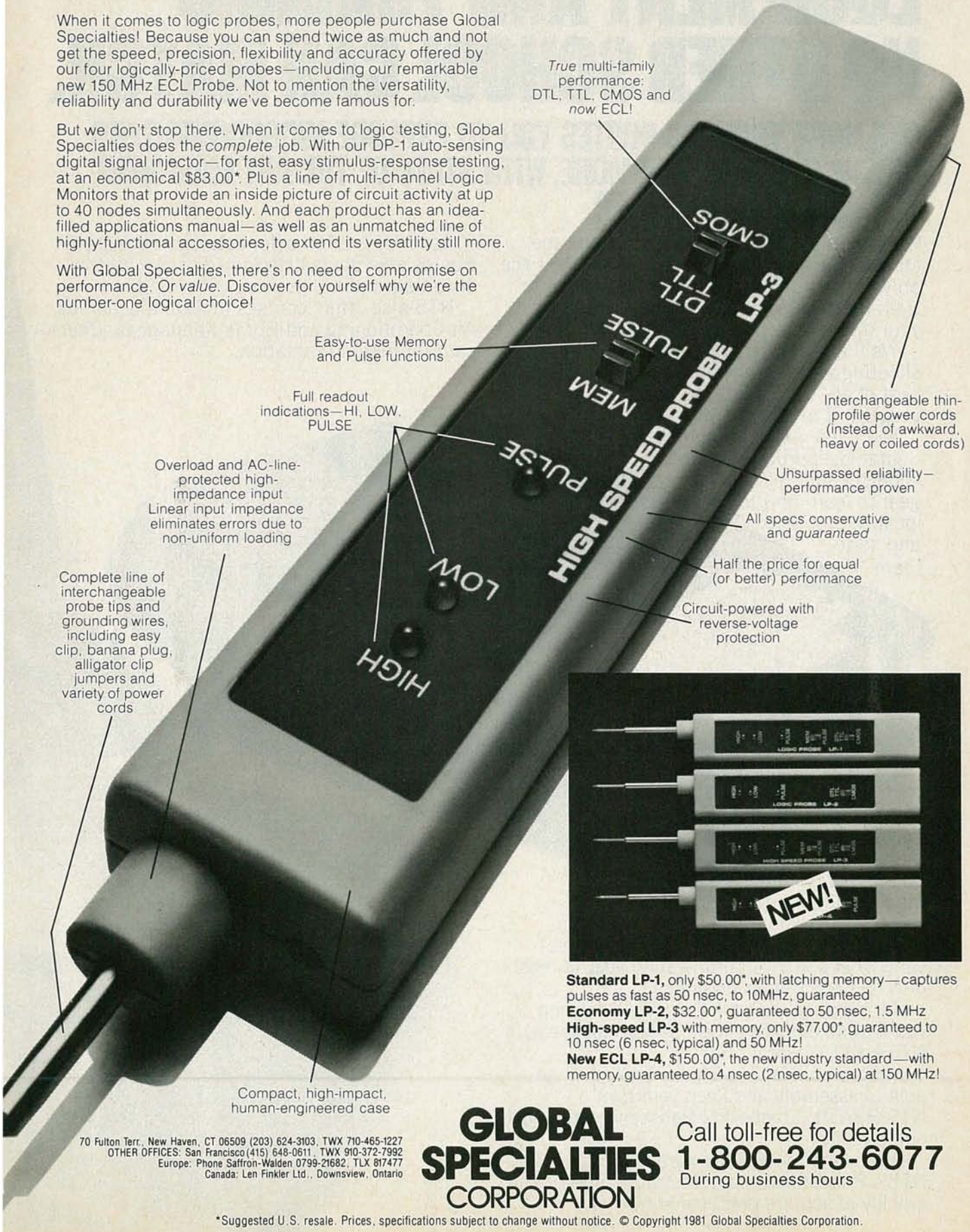

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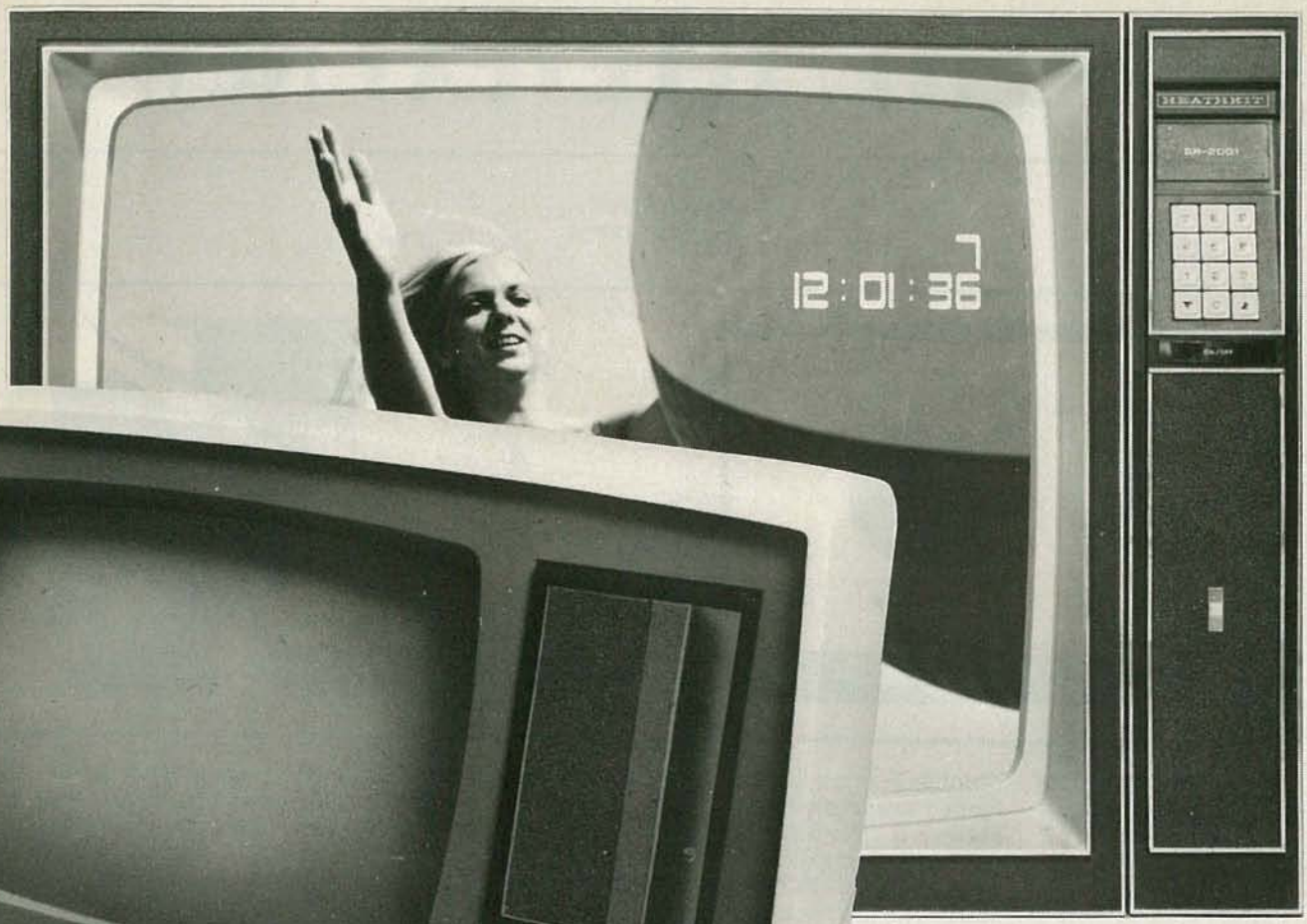
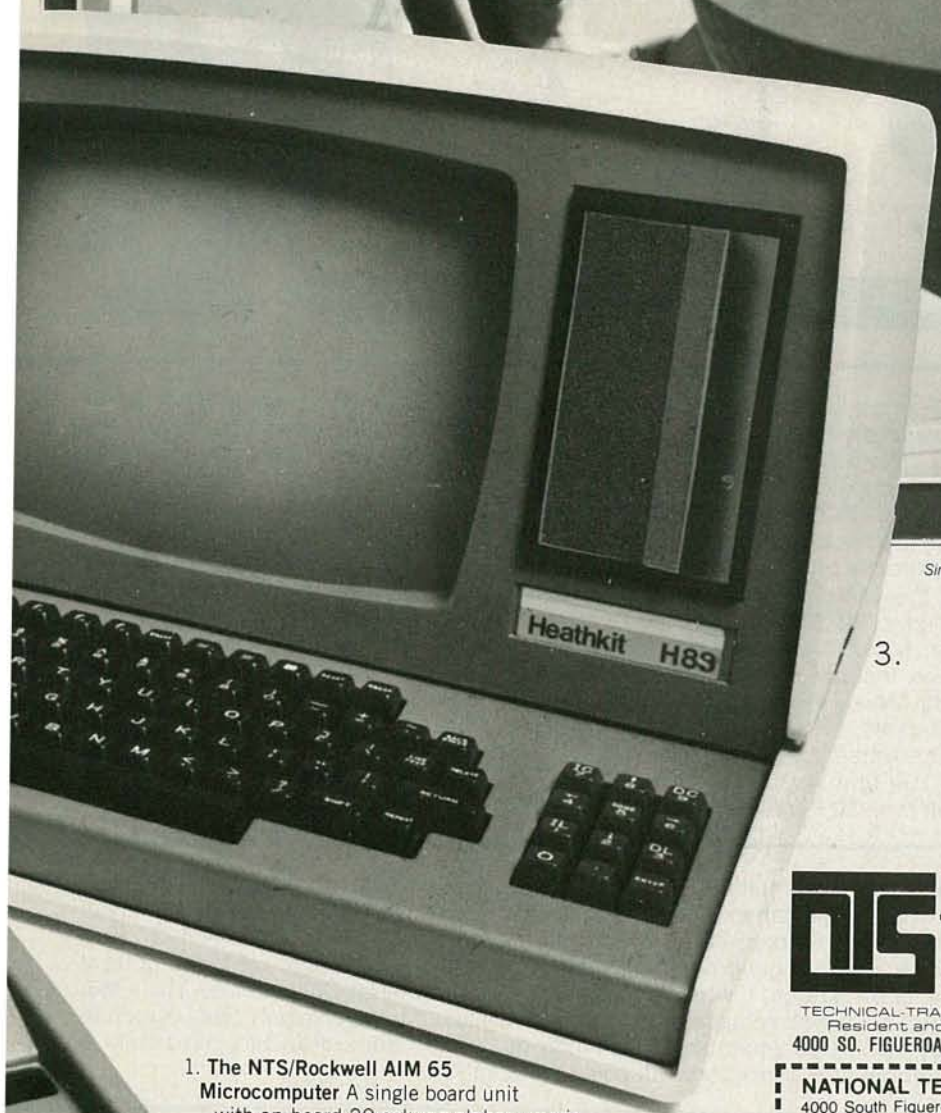


Simulated TV Reception

4.



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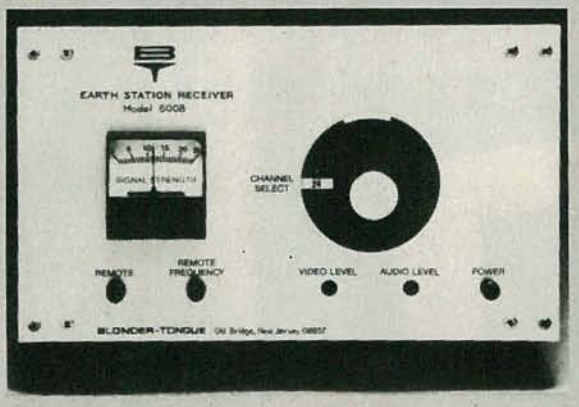

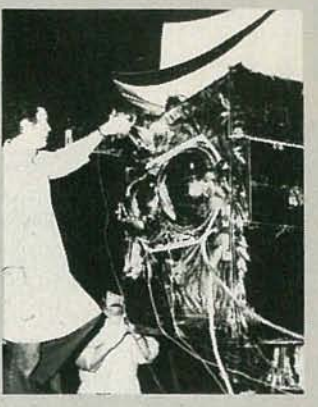

NEW TVRO EQUIPMENT

Blonder-Tongue Laboratories has introduced its first TVRO earth-station devices, intended especially for the master-antenna TV market (see left-hand and center photos above); it includes three antenna systems (3, 3.65, and 4.6 meters), three low-noise converters, and receiving equipment. B-T's new LNC's (*L*ow-*N*oise *C*onverters) allow satellite signals to be carried from the antenna to the receiver over UHF-type coaxial cable. The LNC is a combination low-noise amplifier and block downconverter and is mounted directly on the antenna. Satellite signals from the LNC are low-noise amplified, and the entire 500-MHz band is block-converted down from 3.7- to 4.2-GHz, to frequencies in the 270- to 770-MHz range for input to the receiver. (Blonder-Tongue Labs, One Jake Brown Road, Old Bridge, NJ 08857.)

Downlink Inc. has developed a $2650 *EP-2000 Electronics Package* that includes everything for a TVRO except the antenna. The equipment group includes remote-control console, 120° LNA, RF modulator, and cabling. In addition, Downlink is selling a *Skyview I* system for $3595, a package of devices which includes a 12-foot parabolic antenna. The firm also has a new *Skyview III* modular fiberglass parabolic antenna. (Downlink Inc., 30 Park St., Putnam, CT 06260.)

SATCOM III-R READY FOR LAUNCH

RCA Americom is completing plans for the launch of Satcom III-R (see right-hand photo above), the 24-transponder bird that will become the primary satellite for cable-TV programming. Satcom III-R will be placed in geosynchronous orbit at 132° West longitude, and will, in general, have transponder assignments identical to the current assignments on Satcom I, which is currently RCA's CableNet One satellite. The 2385-pound satellite, which replaces the bird that was lost in space shortly after launch in December 1979, was scheduled for launch in October aboard a Delta 3910/PAM-D rocket. Satcom III-R's footprint will cover all 50 states.

COMING UP

USA Network and Home Box Office, both carried aboard Satcom I, are joining the trend toward 24-hour-per-day programming. USA Network was scheduled to begin full-time transmission in October, and add three new series, "Better Homes and Gardens Idea Notebook," "Scholastic Sports Academy" and "The Wall Street Journal Evening News." HBO will expand to 24-hour daily service on January 1, after Satcom III-R is in place. At that time, HBO will shift its western time-zone feed to transponder 13 on the new satellite.

Satellite Syndicated Systems, which now transmits Satellite Program Network on Westar III transponder 9 and retransmits Superstation WTBS on Satcom I, has taken lifetime leases on three transponders on Southern Pacific Communications' hybrid Spacenet I satellite, due to be launched in 1984. SSS's lease on Spacenet calls for three fully protected 36-MHz transponders for the life of the satellite. The programming will probably be some form of special interest shows.

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LETTERS

TELEVISION MODULATION

In reference to two letters you published on television modulation (Mr. Davis, January 1981; Mr. Rogers, May 1981): Neither letter is correct, although I would give Mr. Rogers credit for coming close.

Mr. Rogers stated that tip of peak sync is 100% modulation. That is incorrect. Tip of sync is 100% of peak carrier level, which is also 0% modulation. Thus, 100% of peak carrier level corresponds to 0% modulation and −40 IRE units; 75% of peak carrier level (blanking level) corresponds to 25% modulation and 0 IRE units; 12.5% of peak carrier level (reference white) corresponds to 87.5% modulation and +100 IRE units, and 0% of peak carrier level (carrier cutoff) corresponds to 100% modulation and +120 IRE units. Increasing depth of modulation of the luminance signal beyond 87.5% (i.e., below 12.5% of the peak carrier level) is prohibited by FCC regulations. That's Title 47 CFR, Section 73.682 (a) (13), in case you're interested.

Mr. Rogers properly points out the confusion between the IRE scale (which runs from 0 to −40 IRE units and 0 to +120 IRE units, with 0 being clamped at the blanking level), and the percent scale. However, one must also differentiate between percent of peak carrier level and percent modulation; they are complements of each other.

Mr. Roger's comments on television output power are well taken. For an all-black picture, the ratio of peak power to average power for an NTSC system M television signal is 1.68 to 1; but for an all-white picture the ratio is different; it changes to 5.99 to 1.

DANE E. ERICKSEN,
FCC Field Operations Bureau,
San Francisco, CA

"ILLEGAL" DEVICES

In response to D.T. Horn's letter in the June **Radio-Electronics,** wherein he deplored the manufacture and possession of devices like radar detectors and pay-TV decoders, I wonder if he would also include VCR's that can play back a tape without generating royalties. And what about "commercial-killer" devices? Once you start on that kind of list, it's hard to stop.

Yes—probably some rules do need changing. But where some rule-changes, like baseball's "designated hitter" rule, are intended to enhance the game, others are just "oh-poor-me" reactions, like casinos excluding card-counters (dear me, they're likely to win!) or restrictions on imported cars.

Not that we should all be lawyers, but perhaps **Radio-Electronics** can keep us posted on these interminable issues.

ALEX ESTEVE

THE "FREEDOM PHONE"

I just finished the July 1981 issue of **Radio-Electronics** and was, of course, pleased to see the cordless-phone cover feature with the inclusion of material

about Electra's "Freedom Phone."

However, there's a technical error in the story that needs correction. It is absolutely *not* true that "Freedom Phone" cordless phones use "one channel in the 49-MHz band...". That implies, of course, that Electra's phones are of the low-cost simplex variety. Not true! Electra uses 1.7 MHz and 49 MHz for its "Freedom Phone" phones, just like all other full-duplex systems on the market.

The big news we've been trying to tell is the development of a brand new cordless phone with full-duplex operation within the 49-MHz *band* using two frequencies. The significance of that breakthrough is that it eliminates the limitations of 1.7 MHz in terms of range and noise. That technological feat was totally lost in the story, I'm afraid.

ROBERT A. HANSON, Vice President,
MicKinney/Mid America

SUBSCRIPTION TV

I admire your editorial on "subscription" TV (**Radio-Electronics,** December 1980) and public ownership of the airways. However, I believe that one further logical step remains to be stated in your development of that issue. If, indeed, the airways belong to the public (which I most certainly believe), then those using the airways do so with the "consent" of the public. Therefore, is it not those (subscription-TV broadcasters) who charge for the use of the public airways that are guilty of theft of service? Are not those broadcasters the real "pirates" rather than the decoder builders and the microwave receiver builders? Maybe "we, the people" should prosecute them (subscription-TV broadcasters) instead of they us.

MELVIN L. WILLIS, Jr.
Mesquite, TX

OOOOOOOOPS!

In reference to the article entitled "The Incredible Shrinking IC" in the August 1981 issue. I believe that the caption for Fig. 2 is incorrect. The circuit is indeed TTL logic, but it is an open-collector three-input NAND gate. The schematic (Fig. 1) for

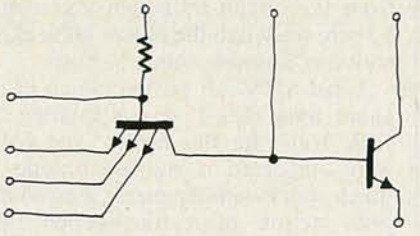


FIG. 1

that circuit is shown here. Note that the base of each transistor is brought out for external connection to bonding pads. That was common in early circuits, especially experimental ones, as transistor parameters varied widely and were often measured to provide better quality control in manufacturing.

BARRY L. ORNITZ
Kingsport, TN

CABLE TV

Although I see the advantage of a cable-ready TV with its built-in converter and decoder (editorial, **Radio-Electronics,** June 1981), I do not share your hope that the cable companies will necessarily reduce their subscription fees, just because they no longer have to supply such equipment themselves. Do telephone rates go down because one is able to buy a telephone set from other manufacturers than Ma Bell?

As for the consumer having a "choice," the problem is not whether the converter comes with the TV set or from the cable company—or whether the cable company attaches some gizmo to the subscriber's set. The problem arises from the manner in which free competition for the viewer's dollar is hindered by local governments which give monopoly rights to cable companies in their jurisidictions. Such cable companies should no more have monopolies on rights to sell electric signals than *McDonalds* have to sell hamburgers.

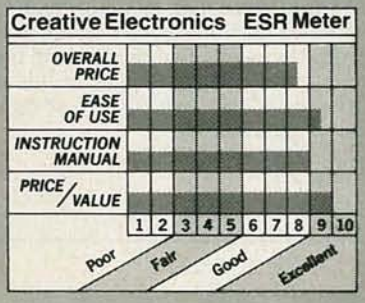
In my view, the only consumers who now have a real choice are those who construct their own decoders and intercept signals from pay-TV, because they recognize that the idea of a private company charging a fee for picking up electromagnetic waves from the air, which is public property, is not too different from the idea of allowing some private profit-making firm to set up toll booths along interstate highways.

BUD DAMNJANOVITCH,
Utica, MI **R-E**

EQUIPMENT REPORTS

Creative Electronics ESR Meter

CIRCLE 101 ON FREE INFORMATION CARD



WHETHER IT IS A CAPACITOR, INDUCTOR, or something else, every electronic component causes a voltage drop across it when it is used in a circuit. That means that every component has a measurable resistance associated with it (in addition to its capacitance, inductance, etc.). The *ESR Meter* from Creative Electronics uses that resistance, called ESR (*E*quivalent *S*eries *R*esistance), as the means of testing electrolytic capacitors.

This is *not* just another capacitor tester: It is one of the few really new pieces of test equipment to be introduced in many years. Perhaps the best way to explain the advantages of using a component's ESR for troubleshooting is to quote a few lines from the unit's instruction manual:

> "...We have yet to find an electrolytic capacitor with normal ESR whose circuit failure was due to capacitance change alone... The real problem with electrolytics isn't capacitance change, it's ESR change!"

The *ESR Meter* will uncover circuit defects resulting from defective electrolytic capacitors that might otherwise go undetected, and can be used without removing the component under test from the circuit (although you should be sure to switch the power off to eliminate any possible shock hazard).

I had a TV set on the bench at the same time that I was evaluating the *ESR Meter* for this report. The symptoms indicated a bad electrolytic. A quick check with the meter showed that one section of a four-section filter capacitor was bad. (How would you like to try finding that by trial and error!) Bridging an electrolytic into the circuit eliminated the problem, confirming what the meter had indicated. What could be easier? The meter had successfully discovered the problem in a minimal period of time, and I didn't even have to turn the set on!

The meter can also be used to check a capacitor for loose leads. Simply connect the suspect component to the meter and flex the capacitor's leads. A loose connection will be revealed by a change in the capacitor's ESR reading. The meter will also detect and reveal a "dry" electrolytic.

The *ESR Meter* has a range of 1 to 10,000 μF. Its circuit uses two IC's and two transistors, and is constructed on a single epoxy-glass PC board mounted in a case measuring 6¼ × 3¾ × 2½ inches; a schematic diagram is included with the instructions. The layout is not crowded, and that should make servicing a snap—if it's ever required. The unit requires two "C" cells for operation and the expected battery life is about 200 hours.

The device is covered by a 60-day guarantee. It is quite easy to use, but, as with any other new piece of equipment, be sure to read the instructions carefully first so that you get the most out of it.

If you're in the market for a capacitor tester, be sure to keep this one in mind. While the way it tests capacitors may be unconventional, it works, and works well. Once you discover this little device, it is sure to become one of the most useful instruments on your workshop or service bench.

The *ESR Meter* sells for $99.00 and is available only from the manufacturer: Creative Electronics, 1417 N. Selfridge, Clawson, MI 48017. **R-E**

Realistic Model TV-20 High-Fidelity TV Tuner

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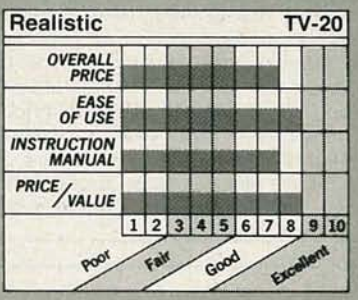
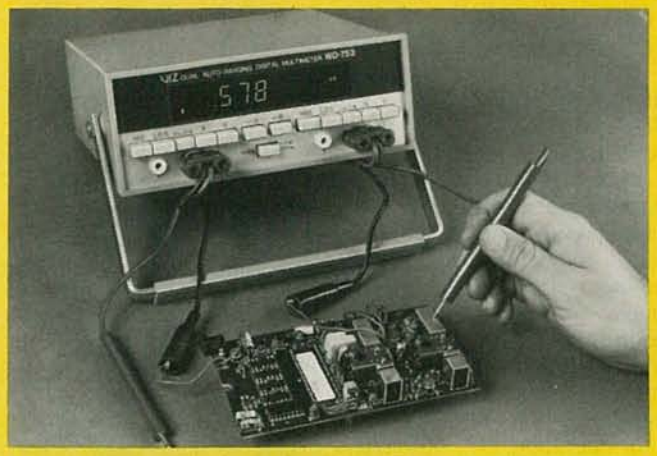


TELEVISION VIEWERS HAVE LONG HAD to endure the poor sound-quality that is typical of most home receivers. While most TV sound is now transmitted with the same frequency response as FM radio, reproducing that sound faithfully has not been a prime concern of most manufacturers. A new product from Radio Shack (1400 One Tandy Center, Fort Worth, TX 76102) now offers you an alternative. Intended as an addition to your home component-sound-system, the Realistic *model TV-20* is a complete 12-channel high-fidelity monophonic tuner.

Its circuit consists of a bipolar VHF-TV turret tuner with an active mixer (most TV tuners use a simple diode mixer) followed by a 41.25-MHz IF stage. Two ceramic filters shape the IF passband, and an LA1150 FM limiter/discriminator IC detects the audio for a single-stage preamplifier.

The tuning knob is located on the front panel. A fine-tuning ring lets you center the sound carrier for a TV channel much as you would adjust for the sharpest picture on a standard TV. The 41.25-MHz IF provides a 500-kHz AFC holding-range and a signal-to-noise

continued on page 28



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EQUIPMENT REPORTS

continued from page 26

ratio of 60 dB (using a 1-millivolt input on channel 8). Primary image rejection on channel 8 is 58 dB; IF rejection is 45 dB. The IF limiter's AM suppression is rated at 46 dB.

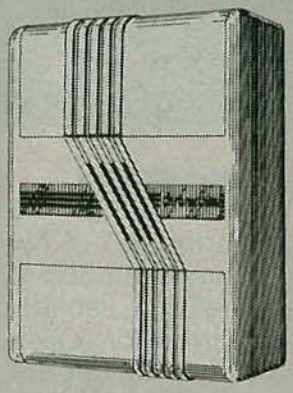
Distortion from the unit is claimed to be less than 0.5% within 3 dB. IHF (*I*nstitute of *H*igh *F*idelity) sensitivity is rated at 7 microvolts, with a 3-dB limiting sensitivity of 3 microvolts. Maximum signal-handling capacity is given as 200 millivolts. A front-panel OUTPUT LEVEL control varies the audio-output level from zero to 1.5 volts for a 1-millivolt input.

Rear-apron terminals include two F-type TV connectors for coaxial cable; screw terminals are also available for twin-lead. Don't be mislead by the separate left-channel and right-channel output jacks— this is not a stereo unit. The jacks are connected in parallel and merely assure that the input signal to your amplifier is balanced.

Housed in a wood-grain-finish plastic cabinet with an anodized-aluminum front panel, the unit measures 6½ × 2⅞ × 5½ inches and weighs 2½ pounds. It requires 117-volts AC for operation.

If you are interested in high-quality television audio, the Realistic *model TV-20* merits your consideration. It sells for $79.95, and is available at Radio Shack. **R-E**

Chromatics Chroma Chime Electronic Door Chime



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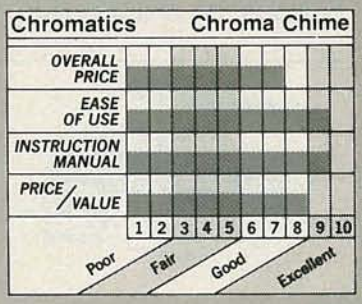

THE *CHROMA CHIME* ELECTRONIC DOOR chime does a lot more than its name implies, as I recently discovered when my old doorbell gave up the ghost and had to be replaced.

It doesn't just go "ding-dong," like my old one (that one actually only went "clunk", which is one reason I replaced it), but can play several bars of any of 24 different melodies—from the standard Westminster chimes to "God Save the Queen" ("My Country 'tis of Three") or Rossini's "William Tell Overture"—with 21 more still to choose from.

The *Chroma Chime* also features two inputs; it will play one tune if there's someone ringing at the front door, and a different one if there's someone at the back.

It can be operated from two nine-volt batteries ("standby" current drain is less than 0.5 μA) or, if a 12-to-16-volt bell transformer is already available—as would probably be the case if an old unit were being replaced—that power source can be used. If the *Chroma Chime's* built-in speaker isn't adequate for you (and I can hear it throughout

continued on page 32

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Heathkit

continued from page 28

my house), an external speaker is available as an option.

How it works

The heart of the *Chroma Chime* is a Texas Instruments TMS1000 microprocessor. That IC not only provides the logic needed to play the tune that is selected, but also carries all 24 tunes in its on-board ROM.

When a doorbell button is pressed, the microprocessor checks the melody-selector switches to see which tune is required. Having determined that, it then looks up the selected tune in its ROM and generates the appropriate audio output.

That signal is then amplified and processed to remove some of its square-wave characteristics and make it sound more like a chime or other musical instrument.

The user can select the tempo of the melody (how fast it will be played) and, by means of the DECAY control, how quickly the tones die away. The tempo circuitry also enriches the sound by generating a tremelo effect.

The audio output can be made to sound like anything from the output of a signal generator to a sharply-plucked violin string. I've set mine to approximate the sound of a harpsichord.

The microprocesor automatically shuts off the device when the selection is ended, whether or not the doorbell button is still depressed. There is an exception to this, though. Several pieces ("The Star Spangled Banner," for example) have an "extended-play" option—if the button is still depressed, a few more bars will be played. *Then* the microprocessor shuts the unit off, extending battery life.

Design and assembly

Although the *Chroma Chime* is available as an assembled unit, I chose to build the kit version.

The assembly manual is better written than average, and is well illustrated. The PC board is screened with the outlines of the components, to make things still easier for the builder.

Although the IC used is manufactured by TI, the unit itself was designed, and the manual written, in England. Here are a few hints that may simplify matters for those unfamiliar with life abroad:

First, English technology sometimes differs from our own. For example: a "skeleton pot" is a trimmer pot. Those pots are referred to as "RV1," "RV2," etc. "RV" probably stands for "resistor, variable."

Also, transistor pinout is frequently "CBE" or "ECB," while ours is usually "EBC." It's possible that any of several transistors may have been included in your kit (all the types are illustrated) and it's necessary to check the part numbers against the pinouts shown in the manual to make sure that you're installing the components correctly.

(My kits contained several transistors whose numbers were identical, *except* for the last letter. Naturally, I ignored that letter and installed everything backwards. Fortunately, no harm was done. The transistors were removed and reversed, and the unit functioned as promised.)

The switches used to select the tunes are a bit unusual. The switch contacts are part of the PC-board foil pattern, and are contacted by spring-loaded wipers. Although unorthodox, the system works well.

The case is white plastic with concealed, but easily accessible, adjustment and battery compartments, and will blend in with most decorating schemes. Installation instructions are detailed and easy to follow.

The *Chroma Chime* is a clever application of LSI technology and, whether you buy it "ready to go," or as a kit, is

continued on page 36

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EQUIPMENT REPORTS

continued from page 32

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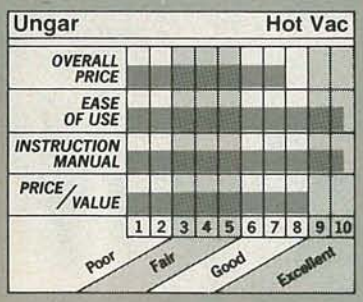

A TOOL-HAPPY TECHNICIAN LIKE MYSELF always enjoys finding something that really does the job. The *model 4000 Hot Vac* desoldering system from Ungar (Division of Eldon Industries, Inc., PO Box 6005, Compton, CA 90220) is just such a device. In operation, the solder is first melted, and then sucked into a reservoir by a built-in vacuum pump. The whole operation is very fast, and speeds up bench work considerably.

The system consists of two units: a small cabinet that houses the vacuum pump and motor, and the desoldering gun. The gun is connected to the cabinet by the vacuum line and the control wiring. The gun's heating element is set to the desired temperature by a control knob on the front of the cabinet.

The gun's screw-on tip is hollow. To desolder, simply place the tip of the gun over the solder you wish to remove, and when the solder has melted, push the button on the left side of the handle. That button starts the vacuum pump, and the solder is removed very quickly. In a second or two, you're left with a clean lead and pad.

The melted solder goes through the tip of the iron into a reservoir at the top of the gun. The reservoir has a clear "window" on each side of the gun so that you can tell when it needs emptying. The maintenance required for the unit is minimal. A cotton ball is used to catch most of the solder in the reservoir. When it becomes clogged, all you do is unscrew a cap on the rear of the gun and remove and replace the ball—the unit comes with an ample supply of them. The gun tip should be cleaned after every 50-60 desoldering operations (that should cover a couple of days' average work) using a rod (more on that later) supplied with the unit. Cleaning, which serves to remove any solder not caught by the cotton ball, should be done with the tip hot. A secondary filter, near the cabinet in the vacuum line, should be cleaned with alcohol once a week.

Five different-sized tips are included with the unit. The tips can be changed even when hot—but I recommend using a pair of pliers, not your fingers! Everything you need to use the desoldering system comes with it: extra cotton balls, a spare fuse (3 amps), a cleaning sponge, and a kit of the cleaning rods. The cleaning rods (one for each tip size) and a small file are stored in a metal case that is attached to the cabinet by a chain, so that the rods are always there when you need them.

Using the *Hot Vac* is simple. The same knob is used to turn it on and to set the operating temperature. A red pilot light on the cabinet's front is lit when the unit is on. When you first turn the unit on, set the operating temperature to maximum and let the iron heat up for about 10 minutes; then select the temperature range you require. When the gun is not in use, it is slipped in the ceramic-lined holder on the side of the cabinet.

The only thing that is the least bit tricky about using the desoldering system is tht you have to be careful not to hold the vacuum control-button down too long. If you do that, the air stream cools off the tip, and you have to wait until it heats up again before going on. One quick push is all you need; try it for yourself and you'll see.

Of course, the only way to see if something really works is to try it out. I set up the *Hot Vac* on a bench and located a discarded PC board from a junked TV-set. I was able to remove about 80 components in 45 minutes. They included everything from transistors and capacitors up to a couple of controls and a heavy-lugged transformer. I did have some trouble with the transformer; its lugs were ¼-inch

continued on page 95

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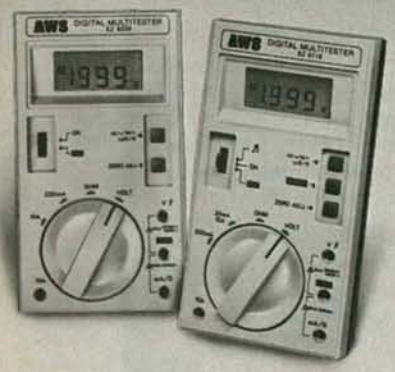

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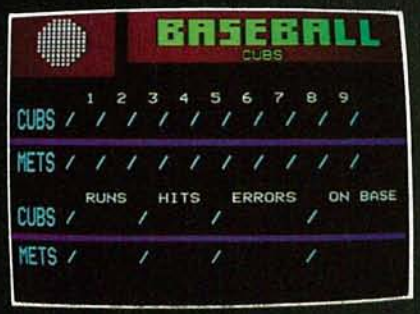
IN CASE YOU HADN'T HEARD, WE'VE BEEN CAUGHT UP IN AN INFORMATION revolution. We've already become accustomed to receiving news from around the world—and even from beyond it—instantaneously on our television sets via satellite. Fifteen years ago that was almost a miracle.

In many parts of the country we are becoming a wired society—with news, movies, sporting events, etc. available to us on any number of television channels, 24 hours a day. Only a few could conceive of such a thing just ten years ago!

Those of us with home computers can now avail ourselves of all sorts of information utilities—news, data bases, whole libraries of information. Farmers can get the latest on soybean futures; investors, the current state of the stock market. *Five* years ago, that was just the beginning of a dream.

Today, as you read this, there is more information, on more subjects, available more rapidly and readily through electronic communications to anyone with considerably less than a thousand dollars to spend on personal computing equipment than was available to the President of the United States not too long ago.



In the next few years all that information—and more—will be accessible, in one form or another, to anyone who cares to do more with his TV set than just watch movies. The name of the game is: videotex.

"Videotex" is a term applied to any system that uses several of the "unused" lines of a video field (actually the vertical blanking-interval—the dark band you see when your TV picture starts to roll) to send information that can be decoded to appear as text or illustrations on a TV screen. If you were to watch it, a line used for videotex would appear to sparkle as the data was transmitted on it.

Perhaps the closest thing to videotex with which we are familiar is the closed-captioning service for the deaf currently provided by the ABC, NBC, and PBS television networks. Closed captioning provides deaf viewers with subtitles for selected programs. The information is transmitted

FIG. 1—BY REQUESTING THE APPROPRIATE page number, you can receive detailed weather and travel information—including weather maps.

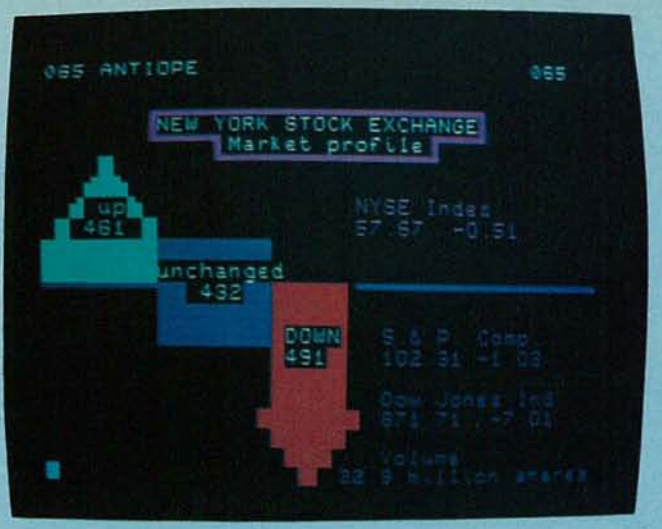


FIG. 3—ANTIOPE, THE FRENCH videotex system, uses a parallel-attribute system that permits higher-quality graphics.

on one of the unused lines in the TV picture and, through a decoding device, is superimposed over the image being viewed.

Videotex uses several lines from the vertical blanking-interval to carry both video and textual information in digitized form for decoding and use by viewers equipped with devices designed to extract that information and display it on the screen. How it is done will be described in detail in the second part of this article.

What makes videotex different from closed captioning is the fact that the data is transmitted at a much more rapid rate—typically 5.727272 MHz—and is not tied into the "real-time" image normally seen. Not just one or two lines of text are available, but whole *pages*—up to several hundred of them—can be selected by a viewer with a videotex decoder. And that includes not only text, but pictures, as well; detailed weather information (Fig. 1) is as easy to receive as the words "RAIN TOMORROW."

Through videotex, the viewer can have over-the-air access to local or international news; information of special interest to him, such as weather or financial reports; or even local shopping information. The Sears catalog, currently being distributed in test areas on videodisc, could be available nationwide by means of videotex.

And that last item leads us into the other application of videotex, for, if the system is interactive, the user can not only look at the items in the catalog, but also *purchase* them.

As we described videotex originally, any one of a number of "pages" could be selected for viewing, for the information of the user. While, in many instances, that type of service would be all that was required, it would frequently be convenient for the user to be able to respond to the information he received.

For example, let's say that you wanted to know who had flights from your airport to New York (or from New York to somewhere else) on a given date, and what the rates were. With videotex that would be easy.

Suppose that you found a flight that was convenient for you and wanted to make a reservation. With *interactive* videotex, you could request a reservation on that flight, pay for it with a credit card, and receive a confirmation...all in a minute or so!

Similarly, you could look through a catalog, or the video flyer from a local market, and make your purchases—for delivery, or to be picked up later when it was more convenient for you.

Interactive videotex

Obviously, you can't talk back to your TV set—otherwise you'd have done it long ago! Even with a simple videotex decoder, the best you can do is select the page(s) of information you want. What's needed is something more.

Fortunately, digital-computer communications created the need for a device known as the *modem* (for *MO*dulator/*DEM*odulator). That device allows

FIG. 2—THE BLACK LINES between different-colored areas are characteristic of the serial-attribute system used by Prestel.

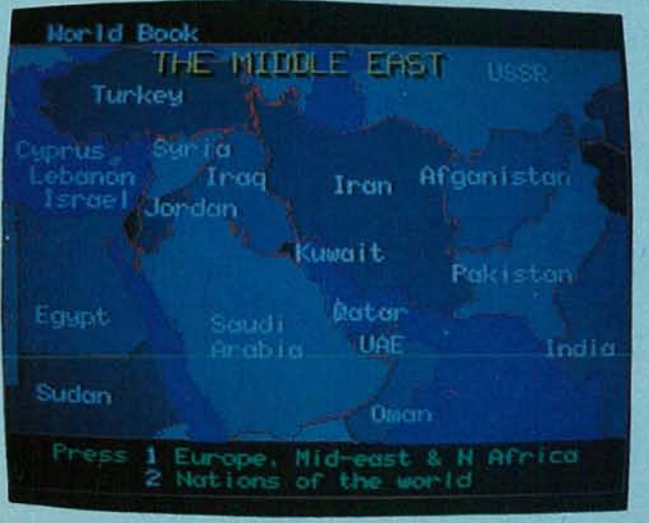


FIG. 4—TELIDON ALLOWS shapes and special character-sets to be defined and then recalled by a single command.

you to transmit digital information over telephone lines as audio tones. So, by adding a keyboard and modem to your videotex setup, you can talk back to a computer connected to a videotex system.

For example, if you find a flight to New York that meets your requirements, you can dial a telephone number connecting you with your nearest videotex center and request a reservation on that flight...and receive immediate confirmation. And, if that flight is booked-up, you can make the next-best choice. All on the spot.

Perhaps that sounds a bit familiar to you—like the two-way *Qube* system currently in use over cable-TV in the Columbus, OH area. *Qube does* allow viewer response, but only to a limited degree—both as regards the degree of response and the subjects to which you can respond. Also, it is available *only* over cable. *Qube* is pre-programmed to look for simple "yes" or "no," or numerical, responses. Videotex can offer a lot more.

Equipment needed

To receive non-interactive videotex the only thing that needs to be added to your existing TV receiver is a *decoder*. The decoder can be considered to have five main sections: a data-acquisition unit, RAM (*R*andom *A*ccess *M*emory), ROM (*R*ead *O*nly *M*emory), a video generator, and a means for the user to control the decoder. A representative videotex system is shown in Fig. 5.

The data-acquisition unit performs two functions. First, it "tunes in" on the vertical-blanking lines carrying the videotex information—acting like a very selective TV receiver, as it were. Second, it takes that information and translates it from the analog format used to send it over the air (or cable) into a digital format (a series of logic-1's and 0's) that can be used by the decoder's digital circuitry.

In the process it also converts the incoming data from serial to parallel format. (That is necessary because, while the data is originally in parallel format—with all the bits making up a single character or picture element (*pixel* or *pel*) arranged side-by-side in one block—the bits have to be sent serially, one after the other, if they are to be transmitted on a video line.)

The RAM is used to store the data, since it is received at a rate different from that at which it will be displayed on the TV screen.

The ROM is pre-programmed with the information necessary to translate the digital information containing the characteristics of a character or pixel into a video image. In more sophisticated units, it may also contain a program for overall control of the entire decoder. In that context, a microprocessor would be involved.

The video generator takes the data output by the character/pixel-generator ROM and turns it into a composite-video signal, similar to that from a TV camera. The signal can either be fed directly to a video monitor, or can be superimposed on a carrier generated by a RF-modulator and fed to the antenna terminals of a TV receiver.

Finally, the controller, usually in the form of a numeric keypad in receive-only installations, allows the user to select which page of videotex information he wishes to see.

While it sounds complex, an installation of that sort would fit easily into a case the size of a cable-TV translator.

A two-way installation would not require much more. The added element would be a communications interface —and possibly a typewriter-style keyboard—that would allow the user to become more than a viewer and talk back to the system in more than simply "Show me page such-and-such" terms.

With an over-the-air videotex system, that communication would have to be via telephone. Such an arrangement would require a modem, the device that allows digital information (as opposed to speech) to be transmitted over telephone lines. The modem would allow the videotex user to interact with the information he had requested from over-the-air transmissions through his decoder.

By dialing a phone number and giving his access code to a computer, he could say, in effect, "*I see that flight 901 is open to San Francisco. Please book me one first class seat on that flight.*" The airline-booking computer would accept his request, make the reservation (if it were still available), and charge the flight to his credit card. If the flight were booked up, the computer might suggest several alternates.

Most cable-TV systems whose applications are under consideration today will provide two-way communications, when they are put into service. A dedicated cable channel (or over-the-air channel) can transmit enormously more videotex information than can a few lines of the vertical blanking-interval.

The cable-system operators are aware of what the future holds, and the communities whose franchises they are competing for also know that they will want more than just piped-in entertainment. They will want to have the ability to use their cable systems to get information *out* of their homes as well as into them.

What's available today

To date, videotex systems are still in the testing stage, with much of the testing having been done outside the United States. A number of tests have taken place, or are now under way in this country, as well. Among the TV stations involved are WFLD in Chicago, WETA in Washington, DC, and KCET in Los Angeles.

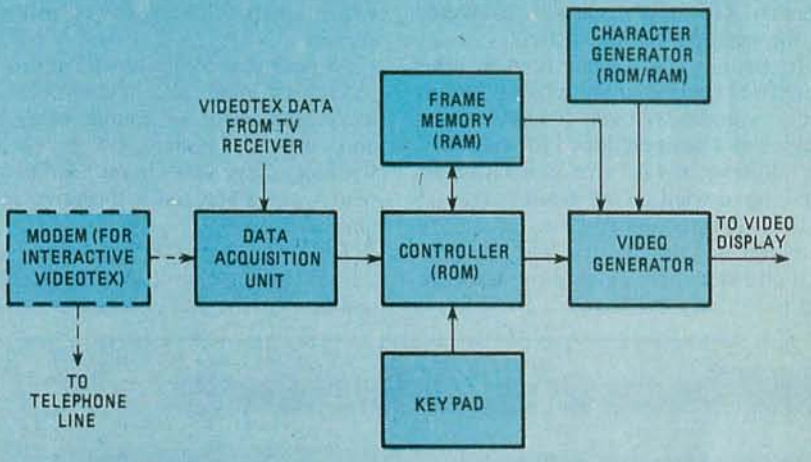


FIG. 5—THE MODEM shown at left is required for interactive videotex using telephone lines lines. Tow-way cable service would use an interface between the user's keypad or keyboard and the cable line.

There are three major systems competing for acceptance, with several others in use in various parts of the world such as Germany and Japan. All offer one-way or interactive service, but differ in the way information is transmitted, decoded, and displayed on the video screen.

The British *Prestel* (*PRES*s *TEL*ephone) uses what's called a *serial attribute* system (no relation to the serial-transmission format referred to earlier). It can transmit both text and images. The images, however, are rather low in resolution (see Fig. 2), being made up of rather large pixels. A version of Prestel, called Picture Prestel allows full-color still video-frames to be transmitted. (Other systems also have this capability. The drawback, as

we'll see later, is the length of time it takes to transmit the picture.)

Antiope, from France, uses a *parallel-attribute* system. It permits somewhat more detailed images, without some of the limitations inherent in the Prestel system. An example of Antiope is shown in Fig. 3.

The third system, *Telidon* (from a combination of Latin and Greek for "distant image"), was developed in Canada, and is more flexible than either of the others. It also uses a parallel-attribute system but, instead of relying on shapes stored in the decoder's ROM, can *download* (transmit from the system's master memory to the memory of the user's decoder) specific shapes that can be used for the application at hand and called up by a single command. An example of Telidon's capabilities is shown in Fig. 4.

Detailed descriptions of the formats of each of those systems will be covered in the next part of this article.

In Britain and France (and in other countries related to them by culture or video standards) over 100,000 households have been equipped for videotex. In addition, *public* videotex terminals have been tried on a limited basis.

Both Prestel and Antiope have been sampled in this country, but the general and specific results of the tests are yet to be fully evaluated.

The Canadian Telidon system is just starting to make its presence known here, although it has seen use in other parts of the world. Trials of Telidon are underway by organizations such as Time, Inc., the Times Mirror Cable Co., and AT&T. The first intends to make as many as 24 "magazines" available over the system. AT&T has petitioned the FCC to make the Telidon system the U.S. videotex standard.

Currently the EIA (*E*lectronic *I*ndustries *A*ssociation) is developing a set of standards which it hopes will be adopted for use in this country. The FCC is expected to start evaluating that proposal this year.

What's coming

While it was probably conceived with the general public in mind, most applications of videotex to date have been directed to the businessman, who, it was felt, could well afford its services.

As personal computers have proven, though (through the introduction and increasing use of the Source, MicroNet, and other, smaller, computer networks), there are many *individuals* who want and need interactive information utilities.

The "magazine" format would seem to indicate the response of large organizations to the public's wishes. Also, banks, whose managers previously felt that their computers might be "invaded" by personal computers, are beginning to open their doors to videotex transactions, seeing the videotex system as a protective buffer between their systems and the users'.

Along those same lines, owners of personal computers will soon be able to use local videotex systems (in both the interactive mode and the *creative* mode—where data, and not just responses, can be entered into the system) with a simple addition to their own systems. Norpak of Canada has announced a plug-in board for the *Apple II* computer for Telidon. Even better, there should be a module available soon for Radio Shack's *TRS-80 Color Computer*, since it uses the same microprocessor (the 6809) as the terminal that was originally designed for the Telidon system. You may soon be able to walk into your local Radio Shack store and walk out with a plug-in videotex system for under $500!

As it proliferates, videotex will be the means by which you'll obtain the information *you* need, and transact your personal business—as well as, perhaps, earn your living—without leaving home. It's part of the information revolution.

Next month we'll discuss the technology behind the various videotex systems. **R-E**

What's News

Electricity from coal, without pollution

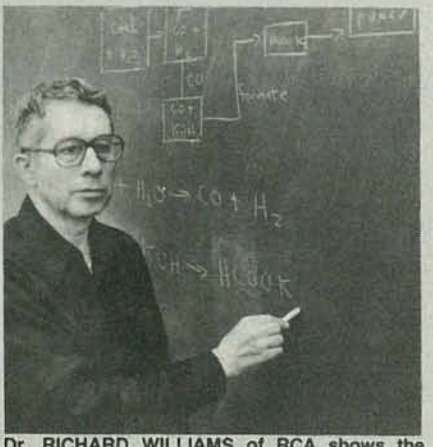
Dr. Richard Williams, Fellow of the technical staff of RCA Labs, Princeton, NJ, has patented a process that uses coal to produce electricity, without burning the coal, eliminating the air pollution that is normally caused by common coal-burning generators.

The conversion is not direct. The process starts with passing steam over hot coal, producing carbon monoxide and hydrogen. (This process is used to make the so-called "water gas" used in many cities.)

The carbon monoxide is then reacted with hot sodium hydroxide to form sodium formate that can then be used in a fuel cell to generate electricity. The remaining hydrogen is also usable in a fuel cell.

Originally conceived about 150 years ago, fuel cells—in which the oxidation of a gaseous fuel produces electricity in a continuous process—have been used to provide energy for spacecraft. Now, because of the energy shortage, they may be able to produce electricity economically for many earthbound applications.

Dr. Williams points out that a coal-fired steam plant can convert only about 30 percent of the coal's energy to electricity, while producing undersirable pollution. The fuel cell can convert as much as 50 percent of the coal's energy to electricity,



Dr. RICHARD WILLIAMS of RCA shows the steps in his method of using steam and coal to produce electricity efficiently.

without producing pollutants during the process.

RCA will grant non-exclusive licenses to use the Williams patent.

Cellular system for mobile two-way phone

The FCC has granted approval to "cellular" mobile radiotelephony. In cellular communication, a service area—such as a city—is divided into small areas, called "cells," each with its own low-power transmitter. Thus, a taxi company or other service would not need to cover an entire city with just one station; instead, it would use several small ones. Each of those stations would be designed to cover its own "cell" efficiently while causing as little interference as possible in adjoining cells. As vehicles move from cell to cell, communications would be switched electronically from one transmitter to the next.

The cellular approach will allow many more telephone calls to be handled at the same time than is possible with the present two-way phone service. Highly successful tests of the cellular system have been carried out under preliminary FCC rules by Illnois Bell in Chicago and by Motorola in Washington, DC.

Radio common carriers are looking forward to the coming system with a mixture of anticipation and concern. Says Bernard Kahn, of a large Chicago communications service: "Cellular is so efficient that by the year 2000—at the least—it will carry practically all forms of portable communications. We've been waiting for this moment for more than 10 years."

Yet he expressed the fear of possible wire-line company domination that is worrying many independent common carriers. "Our greatest concern," he said, "is that the Bell System—directly or indirectly—might be handed a virtual monopoly on cellular systems. The FCC's own Common Carrier Bureau and the Justice Department have also gone on record with the same concern." **R-E**

BUILD THIS

Low Frequency Filter

for your Hi-Fi

As your sound system gets better you can hear more—sometimes more than you want to. This simple, low-cost filter will get rid of rumble and acoustic feedback without affecting the quality of the audio.

By JOSEPH M. GORIN

IMPROVING AUDIO SYSTEMS ELECTRONically is what signal processors are all about; the LFF (*L*ow *F*requency *F*ilter) described here can improve the quality of reproduction from the low-frequency end of your sound system. The LFF helps eliminate three types of low-frequency problems: subaudible (too low in frequency to be heard) rumble, audible rumble, and acoustic feedback. By taking advantage of modern recording practices, and the characteristics of stereo discs, the LFF can filter out those annoyances without affecting the music.

Stereo recording conventions

A stereo phonograph record uses both walls of a groove to carry the right- and left-hand channel information. The continuously-changing positions of those walls relative to the position of the stylus of your cartridge cause it to move and to generate electrical signals which eventually are heard as sound. Figure 1-a shows the cross-section of a groove when only the right channel is modulated. Notice how the left wall remains stationary while the right wall moves. Also note that the stylus not only moves from side to side, but vertically, as well.

In the days before stereo, both walls moved together *horizontally*, as shown in Fig. 1-b. To permit stereo equipment to play monophonic recordings, a monophonic signal was defined as one having equal strength in both channels, causing the left wall to recede while the right wall advanced (and vice versa), moving the groove only horizontally.

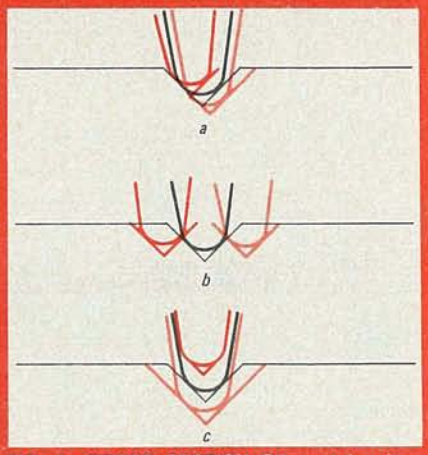


FIG. 1—CROSS SECTION OF a stylus in a record groove during right-channel, horizontal (mono), and vertical (out-of-phase) modulation.

Consider what would happen if the walls were to converge, as shown in Fig. 1-c. A large signal could easily make the groove disappear, or cause distortion when the contact point of the stylus changed as the groove got smaller. Fortunately, that can only happen with large out-of-phase signals, which, because phono pickups are velocity sensitive, tend to occur only at low frequencies.

When high-quality recording techniques—such as direct-to-disc—are used, long-wavelength, low-frequency signals occur only in-phase, since the microphones used are closely spaced in comparison with the wavelength of the sound. Large vertical excursions of the stylus will not take place under these conditions.

When multi-track recording is used, though, many signals having a multitude of phase relationships are mixed together. To eliminate the possibility of out-of-phase low-frequency signals finding their way onto a record produced using multi-track equipment, a circuit similar to that of the LFF is used to make the low frequencies monophonic (in-phase) and avoid that situation. Pure-vertical audio signals are not found on most records.

Vertical noise, though, is another matter. There are two kinds of low-frequency noise on a record—warp and rumble. All records, even the best, are warped to some degree. As the stylus tracks a warped record, it follows the vertical excursion of the warp and passes that on to your system. Much warp energy lies below audible frequencies and cannot be heard (al-

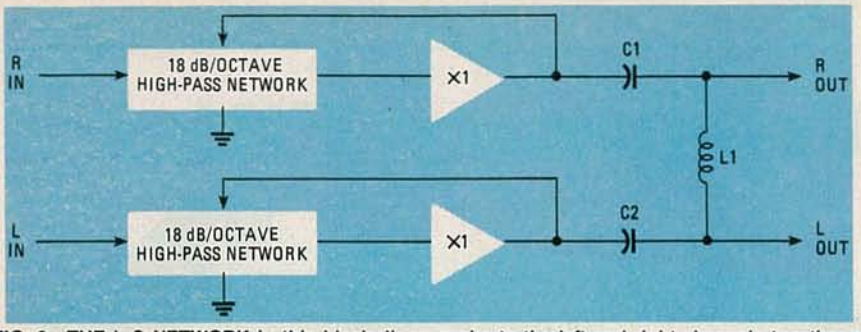


FIG. 2—THE L-C NETWORK in this block diagram shorts the left and right channels together at frequencies below 140 Hz, cancelling out-of-phase signals.

FIG. 3—SPECTRUM ANALYSIS of the "silent" groove of a record with considerable rumble. The upper curve is the input to the LFF, the lower curve is the output.

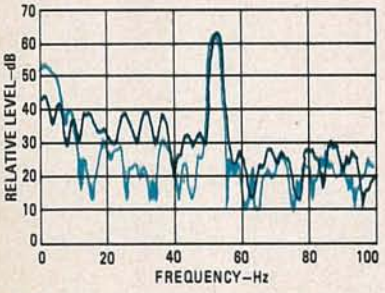


FIG. 4—THIS IS A spectrum analysis of the low-level, low-frequency introduction to a song. The upper curve is the input to, the lower curve the output from, the LFF. Note how audio peak is unchanged by filter.

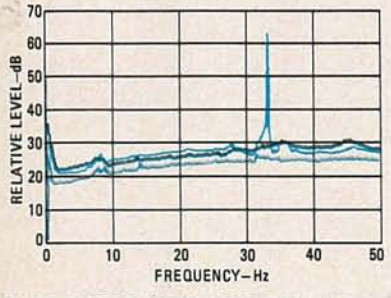


FIG. 5—FREQUENCY RESPONSE OF THE SYSTEM. Note how thoroughly the 30-dB peak (middle curve) is removed by the LFF (upper curve).

though it can affect your speakers), but many warps have an audible component as well.

All turntables have rumble. It usually results from noisy motor bearings and its vertical component is picked up by the stylus. However, with a good turntable, rumble is usually insignificant and is outweighed by the rumble cut into most records. That rumble exists because it is very hard to move the massive head of the cutting lathe across the master disc (known as the *lacquer*) when it is being prepared. The vertical component of the noise from the bearings in the lathe is transmitted to the cutting head, and to the lacquer. Eventually it winds up as part of your record.

Direct and indirect effects of noise

The direct consequence of the vertical modulation of the record groove that we have been discussing is low-frequency noise that detracts from the quality of the sound (and our enjoyment of it). This direct effect, however, is quite rare. It is noticeable only in high-end systems that are capable of reproducing the bottom octave of the audio spectrum.

The indirect effects arise from the larger-amplitude subaudible signals. They can cause vary large excursions of the speaker system's woofer. When the woofer's cone is displaced significantly, the sensitivity of the speaker changes. The result is intermodulation distortion caused by a mixing of the (normal) audio signal and the subaudible one. The effect is especially bothersome in high-efficiency and/or ported speaker-systems. In high-efficiency systems, the voice-coil/magnetic-field overlap drops quickly as the cone is displaced, causing significant intermodulation distortion. In a ported system, because of the reduced "air load" on the woofer, rumble components below the system's resonant frequency cause very large cone excursions, especially when compared to acoustic-suspension systems.

A second indirect effect is reduced power reserves in the power amplifier. That is because a significant portion of the amplifier's output capability is being used to reproduce the subaudible signal. If the amplifier is driven into clipping, further intermodulation distortion will be introduced.

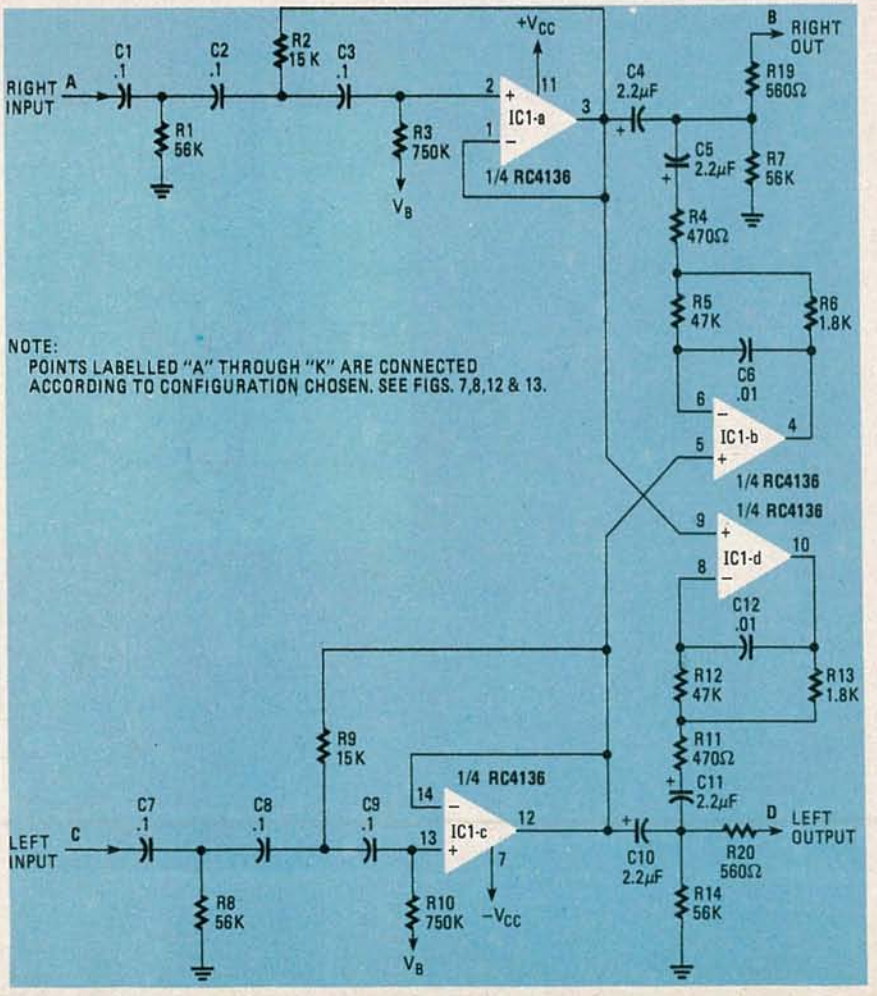


FIG. 6—THE KERNEL section of the LFF contains all of the filter circuitry. It can be installed in an existing piece of equipment, or used as part of a stand-alone unit.

PARTS LIST

Resistors ¼ watt, 5% unless otherwise noted
R1, R7, R8, R14—56,000 ohms
R2, R9—15,000 ohms
R3, R10—750,000 ohms
R4, R11—470 ohms
R5, R12—47,000 ohms
R6, R13—1800 ohms
R15-R17—220,000 ohms
R18—220 ohms
R19, R20—560 ohms

Capacitors

C1-C3, C7-C9—.1 μF, 5%, polyester film
C4, C5, C10, C11—2.2 μF, 10%, tantalum
C6, C12—.01 μF, 10%, polyester film
C13, C14, C17—.1 μF, 50 volts, ceramic disc
C15, C16—10 μF, 25 volts, aluminum electrolytic
C18—220 μF, 35 volts, aluminum electrolytic

Semiconductors

IC1—RC4136 quad op-amp
D1-D4—1N4002
J1-J8—chassis-mount phono jacks
S1-S8—DPDT miniature toggle switch
T1—wall plug transformer, 12-24 volts AC, 100 mA

Miscellaneous: PC board, chassis, hardwood end panels, hardware, wire, etc.

Note: The following are available from Symmetric Sound Systems, 912 Knobcone Place, Loveland, CO 80537. Complete kit, model LFF-1 with unfinished walnut end panels; $50.00 (Canada, $55.00 U.S. funds); model LFF-Kernel with R1-R20, C1-C12, IC1, PC board, and miscellaneous wire and hardware, $15.00; model LFF-PC printed-circuit board only, $7.00. All prices include UPS shipping in the U.S. on prepaid orders. Visa and M/C, add $1.00 handling and all shipping charges. U.S. mail, add $3.00 for the LFF-1 only. Colorado residents, add 3% sales tax.

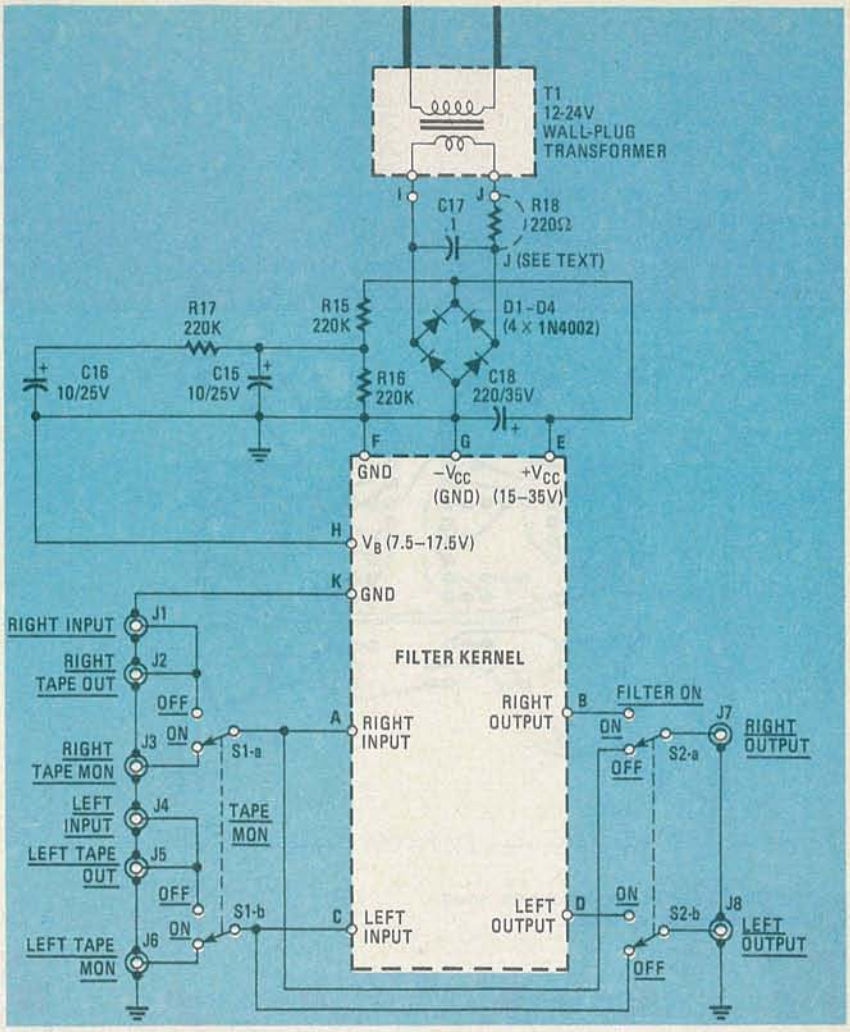


FIG. 7—FULL-WAVE BRIDGE POWER supply for a stand-alone LFF. The bias voltage (half the supply voltage) is connected to pin H of the kernel.

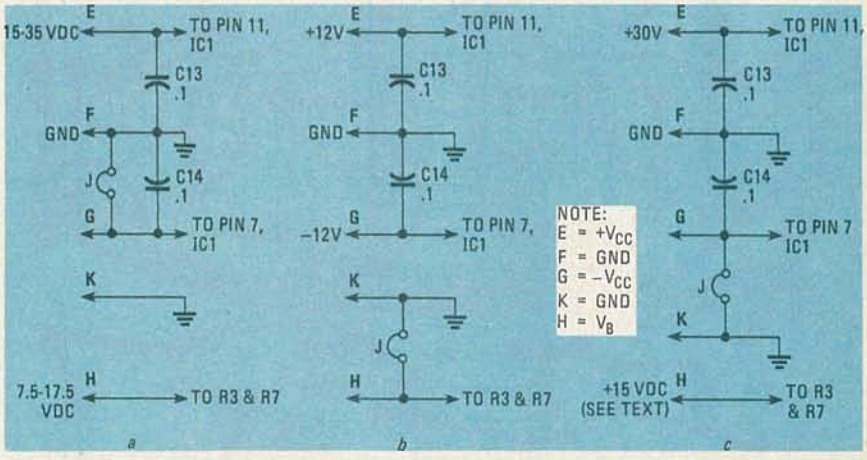


FIG. 8—HOW A POWER SUPPLY is connected to the kernel section of the LFF. Connections for a stand-alone unit are shown in *a*. The LFF can also be built into an ASRU using the connections shown in *b*, or a graphic equalizer using the connections shown in *c*.

The obvious solution

There is a simple remedy for the problems just described—make the system monophonic at low frequencies and, for added protection, roll off its response below the range of normal hearing. This will have no effect on the program material—just on the noise. If the circuit is well-designed, it will not alter the stereo effect either, because a listener's perception of localization (imaging—the stereo effect) is based on frequencies much higher than the ones that will be filtered out. The LFF switches from stereo to mono at about 140 Hz, with a moderately rapid transition.

Figure 2 is a block diagram of the LFF. Both channels have 18-db/octave rapid-cutoff filters for subaudible signals below 15 Hz. The right and left channels are then combined by a network made up of C1, C2, and L1. At low frequencies, the impedance of the capacitors is large and that of the inductor is small, so that the two channels mix into one and out-of-phase signals cancel each other. At higher frequencies, the relative impedances reverse and the channels remain separate. The result is effective filtering of only the noise.

To get an idea of what the LFF does to subaudible noise, remove the grille cloth from one of your speakers and watch the cone of the woofer while switching from stereo to mono. You'll be able to *see* the rumble disappear.

TABLE 1

Crossover frequency:	140 Hz
Subaudible filter:	18 dB/octave below 20 Hz
Frequency response:	20Hz-20 kHz ±1 dB, both channels driven.
Differential rumble rejection:	20 dB @ 20 Hz
Separation:	25 dB above 1 kHz; 35 dB above 3 kHz
Rated output:	.5-volt RMS
Signal-to-noise ratio:	100 dB
Total harmonic distortion, 20 Hz – 20 kHz:	.02%
Maximum output:	Greater than 5-volts RMS; depends on power supply.

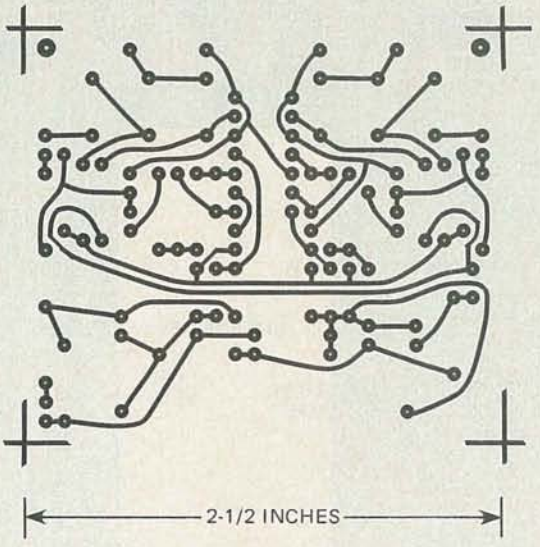


FIG. 9—FOIL PATTERN required for the small PC board is shown here full size.

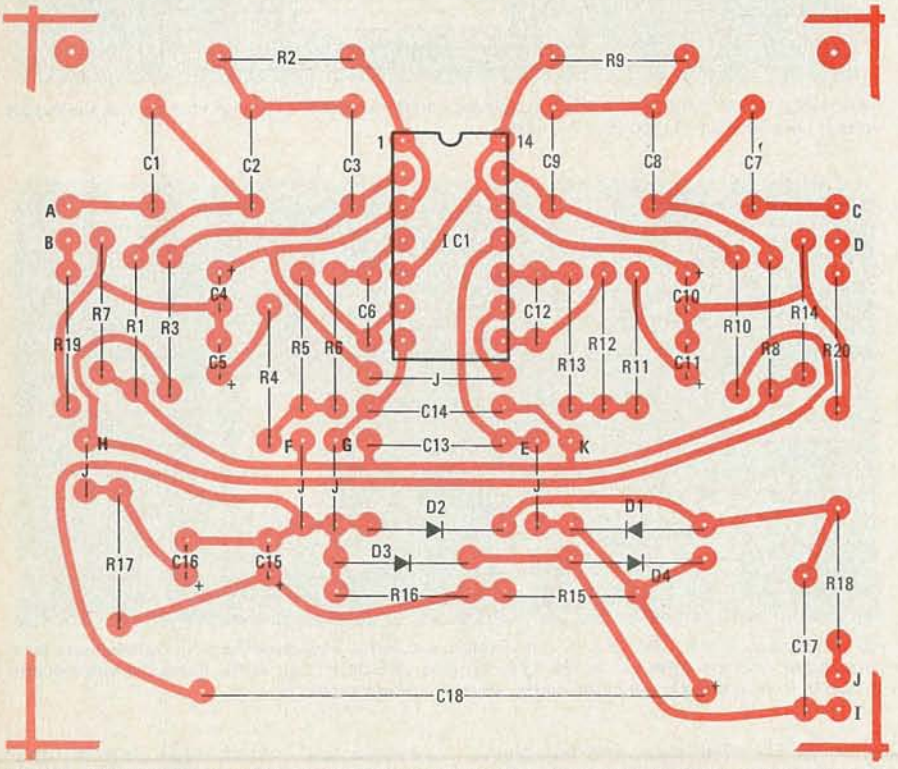


FIG.10—ALL PARTS except the wall-plug transformer, switches, and jacks are mounted on the PC board as shown.

Acoustic feedback

The LFF can also reduce the effects of acoustic feedback. Acoustic feedback is caused by sound from the speakers causing the pickup to vibrate. The vibrations are treated like a signal and are fed back to the amplifier. In serious cases, the system will "take off" and go into oscillation when the volume is turned up. Even when the sound level is well below the point where oscillation would take place, the feedback can cause aberrations in a system's frequency response that result in an "overhang" or "ringing" effect on bass transients and dull their impact and muddy the sound.

The main component is usually vertical and can be reduced by the LFF. You can simulate the effect of the filter by placing a record on your turntable—with the turntable turned off—and lowering the stylus onto the disc. Tap the base of the turntable with your finger as you increase the setting of your amplifier's volume control. Feedback should occur. If you put the amplifier in the "mono" mode, the feedback should disappear.

Performance

Figure 3 shows a spectrum analysis of the signal generated by a "silent" record groove that contains a significant amount of cutting-lathe-induced rumble. The upper curve is the signal input to the LFF and the lower one the output. The difference between the two is quite dramatic.

Figure 4 is another spectrum analysis showing the low-frequency, low-level, introduction to a song. The sound peak is reproduced equally well at both the input and the output; the noise that would normally be bothersome is greatly attenuated by the filter.

The frequency-response curves for a sound system are shown in Fig. 5. The lowest curve shows the results of a measurement made with the volume control turned down. The next higher curve (displaced for clarity) shows a 30-dB peak at the edge of oscillation. The narrowness of the peak implies that the system will ring for *seconds* after the end of the transient. The top curve shows the nearly complete removal of that peak by the LFF.

Table one lists the LFF's performance characteristics.

Circuit description

Schematics for the LFF are shown in Figs. 6 and 7. Figure 6 shows the main circuitry, or "kernel," suitable for installation in existing equipment. A power supply and other circuitry needed to construct a stand-alone unit are shown in Fig. 7. Figure 8 shows power-supply connections to the kernel. Use the connections shown in Fig. 8-a for a stand-alone unit and those shown in Figs. 8-b and 8-c for use as part of another piece of equipment. Those connections will be discussed in more detail later in this article.

The subaudible-noise filter is made up of R1-R3, C1-C3, and IC1-a. The use of three R-C pairs allows a steep 18-dB/octave rolloff; the controlled amount

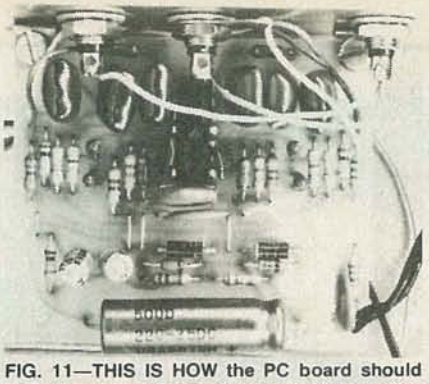


FIG. 11—THIS IS HOW the PC board should look when all components are in place on the board.

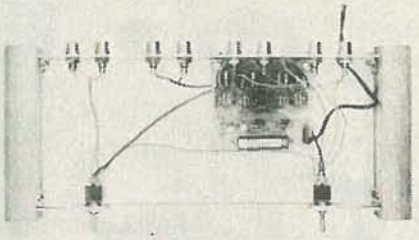


FIG. 12—AN UNDERSIDE VIEW of the LFF stand-alone unit. The kernel board can also be installed inside a piece of existing equipment.

of positive feedback through R2 helps keep the response of the device very flat down to 20 Hz.

Capacitors C4-C6, resistors R4-R6 and IC1-b perform the functions of C1, C2, and L1 shown in the block diagram in Fig. 2. Capacitor C4 is the diagram's C1, and C5 is the diagram's C2. The inductance represented by L1 is supplied by R5, R6, C6, and IC1-b in a circuit configuration known as a *gyrator*. It simulates an inductor with a value of $L = 1/R5 \times R6 \times C6$ between pin 12 of IC1-c and the junction of resistors R4-R6, with a resistance equal to $(R5 \times R6)/(R5 + R6)$ across the inductance. That configuration offers an inductance of 1.2 henries without the typical problems of saturation, poor tolerance, hum pickup, and high cost. The resistance of the inductor, together with that of R4 in series with it, damps the L-C resonant circuit to prevent ringing.

Construction

Figures 9 and 10 are the foil pattern and parts-placement diagram for the LFF. The kernel (on the upper part of the board) is attached to the power supply on the bottom part by jumpers to the holes marked "H," "F," "G," and "E."

Assembly is quite simple. To build a stand-alone unit, refer to Figs. 10 and 11 and mount all the components on the board. Install the finished board in a plain enclosure and wire it to the jacks, switches, and wall-plug transformer as shown in the schematics. Any wall-plug transformer with an output of 12-24 volts AC can be used—short out R18 if the transformer supplies 18 volts or less. Be careful to observe the polarities of the electrolytic capacitors and the diodes, and to position the IC correctly. The completed unit is shown in Fig. 12.

The LFF can be connected to any sound system with a TAPE MONITOR switch. Connect the LFF's inputs to TAPE RECORD or TAPE OUT on your amplifier and its outputs to TAPE PLAY or TAPE MONITOR. Anything that had been connected to these jacks can now be connected to the corresponding jacks on the LFF, maintaining your sound system's full capability and flexibility.

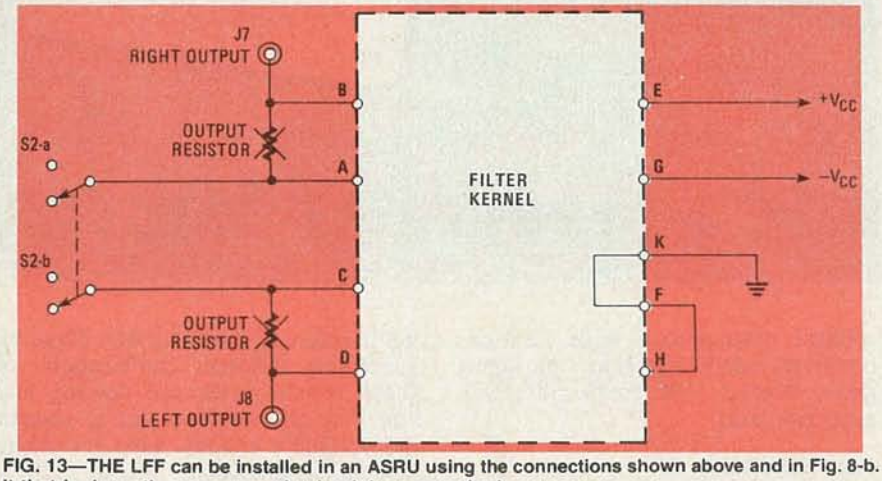


FIG. 13—THE LFF can be installed in an ASRU using the connections shown above and in Fig. 8-b. It that is done, the power-supply circuit is not required.

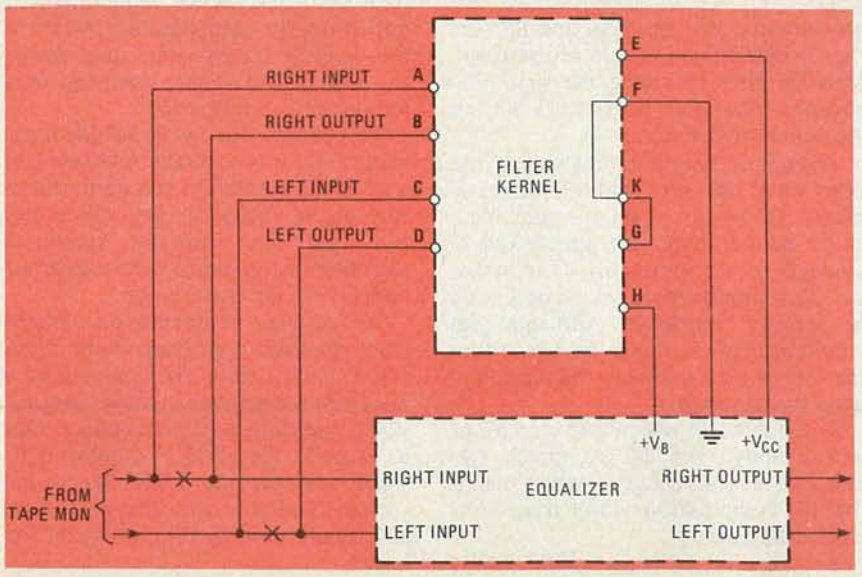


FIG. 14—IF THE LFF IS INSTALLED in a graphic equalizer, be sure to connect the LFF ahead of the equalizer.

Installation in existing equipment

The LFF is such a simple circuit that the overhead of a chassis, end-panels, power supply and switches begins to look ridiculous. The board can easily be installed in existing equipment; the graphic equalizer and ASRU noise-reduction units, which were presented in **Radio-Electronics** in May 1978 and March-April 1981 respectively, will be used as examples.

A dual-supply connection is shown in Fig. 13, which uses the ASRU as an example. The bias voltage, V_B, is connected to ground and op-amp IC1 uses the ±12-volt supplies. Figure 8-b shows the connections to points "E," "F," "G," "H," and "K."

Figure 14 shows how the LFF can be installed in an equalizer with a single-ended power supply. The connections for that arrangement are shown in Fig. 8-c. In that example, V_B (+15 volts) can be obtained from the equalizer. In other circuits, where no V_B exists or can be located, R15-R17, C15, and C16 can be used to derive V_B from V_{CC}. It is important that the LFF be connected *ahead of* the equalizer, since mismatches in the low-frequency band settings of an equalizer produce phase shifts that can reduce the effectiveness of the filter.

There you have it—a simple, inexpensive circuit to help wipe out warps, rumble, and the howl and muddiness caused by acoustic feedback; it is equally effective as a stand-alone unit, or when incorporated into an existing piece of equipment. **R-E**

EXPANDED SCALE

Build an analog voltmeter with a scale equivalent to one 36 inches long! The meter also features reverse-polarity, over- load indicators and protection, and a special circuit for AC.

T. J. BYERS

IS IT POSSIBLE FOR AN ANALOG METER to rival digital accuracy, yet not cost an arm and a leg? Sure—with a nearly forgotten technique known as expanded-scale operation.

As a matter of fact, here's a scale expander you can build for less than the price of the cheapest DVM. Easily constructed and easier to operate, it'll put an ordinary VTVM to shame. Besides being accurate, it's smart. It will tell you if you are "over-ranging" and protect the movement from damage if you are. It will even recognize AC voltage and DC polarity-reversal.

Expanded-scale theory

A major drawback of conventional instruments is the necessity of selecting the most appropriate scale to measure a particular voltage. If you wish to measure 55 volts, let's say, it gets a bit tricky.

The 50-volt scale is too small—the needle pegs—so, you have to switch to the next range—150-volts. Unfortunately that places your reading in the bottom third of the meter—the most inaccurate portion.

Why put up with this, when all you're really interested in is a portion of the scale—not the whole 150-volts worth? Why not start at 50 volts and set the upper limit at 60, for a total range of only 10 volts? In other words, the pointer won't budge until the input exceeds a minimum value, and then will be read against a much more accurate scale?

The always-useful op-amp will permit you to do just that. Using the amplifier in a standard inverting configuration, as shown in Fig. 1, you'll have a voltmeter...nothing fancy, but the basic building block of our unit.

Apply a voltage and the meter will respond. When it gives a full-scale reading, then that's the limit...right? Wrong! We can "zero" the meter and measure higher voltages by a method called junction summing. A summing amplifier is shown in Fig. 2.

The output of a summing amplifier is the algebraic sum of *all* the inputs. So, when the output reaches maximum, we can inject a voltage of the opposite polarity into one of the summing resistors...just enough to make the sum of the inputs equal to zero. Now we can increase the input voltage and still obtain an on-scale meter reading.

After reaching the next plateau, we can connect another summing resistor, re-zero the meter, and be able to read still-higher voltages.

We now have an input voltage three times that of the meter's full-scale capacity; yet we are still using the original, more precise, scale. That can continue indefinitely since the inputs don't interact. (Of course there's a practical limit!)

How it works

Basically that's how our meter works—but we've added a few improvements. Resistors R6 and R7 (see Fig. 3) determine the gain of the stage, with R6 also providing the input impedance. Resistors R1 through R5 are the summing resistors.

The upper limit of our instrument has been set at 120 volts, with 10-volt increments. (150 volts is the absolute maximum; beyond that, you run the risk of damage to the op-amp.) This means that 11 summing resistors are necessary for proper operation. Although that would be true *ordinarily*, we can reduce the component count by taking a hint from binary math.

Resistor R1 is selected to match one unit exactly, and R2 to match two units, of reverse voltage—which means that the combination will be three units (sound familiar?).

Accordingly, R3 is four units, and R4 (which is actually two resistors in parallel—R4 and R5) is eight. (The schematic refers to R4-R5 as R4). Now, by paralleling different combinations of those resistors, we can develop any summing current from one to sixteen units. That's exactly what the range switch, S1, does.

This leaves us with one *small* problem. Let's assume we've input 70 volts and properly compensated for it with the biasing inputs—and then remove the input. Zap! There goes the meter movement...*backwards*!

To prevent that, we'll include a transistor, Q1. It is normally reverse-biased and doesn't enter in the performance. But let the voltage go just a little negative and the transistor saturates—shunting the op-amp's output to ground and saving the meter's life.

We've also protected our monitor from forward overloads with diodes D1, D2 and LED1. As long as the output from the op-amp is under about 2.5 volts, the diodes won't conduct. Once it exceeds the diodes' combined forward voltage, the LED lights—indicating overload—and clamps the output, again rescuing the movement from harm.

Resistors R28 and R11 are for calibration. Potentiometer R27 is mounted on

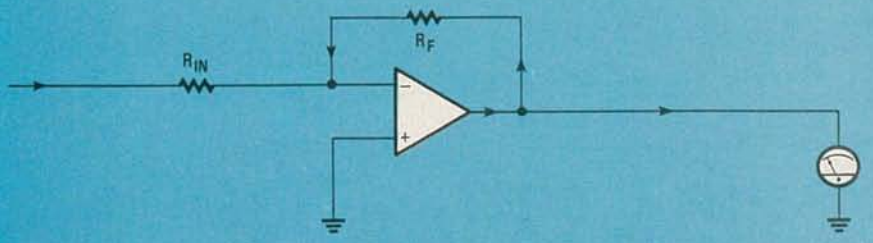


FIG. 1—AN ORDINARY OP-AMP is the heart of the expanded-scale voltmeter. Resistors R_{IN} and R_F set the gain.

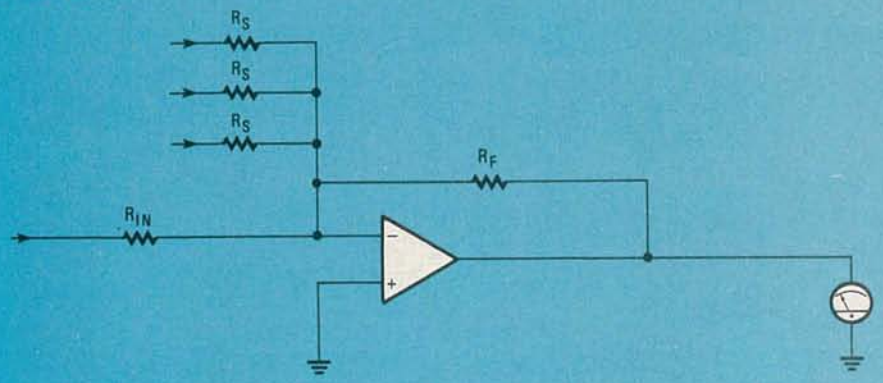


FIG. 2—A SUMMING AMPLIFIER works on the basis that the total input is the algebraic sum of the individual inputs.

VOLTMETER

the front panel and nulls the input amp.

The voltage for the summing resistors is obtained from IC2-b, a Norton amplifier operating from only one supply voltage—positive. Resistor R19 limits the Zener current, which is used to reference the inverting input. Potentiometer R29 controls the output.

In order to educate our machine, an amplifier, IC1-b, is used as a comparator. Resistor R13 provides an input impedance. If the input is negative (negative, in our case, is proper operation), it swings the comparator's output positive—to the limit.

Light-emitting diode LED2 is a special tri-color device with two lamps in one case. Internally, the diodes are connected in parallel with opposite polarities. The device works in the following manner: with current flowing in one direction the unit glows green; reverse the flow and it's red. Light both diodes and it's yellow!

So, we connect the LED so it glows green with a negative input. If we apply a positive input, the comparator swings negative...lighting our red lamp. That signals that the leads are reversed. An AC voltage will cause the LED to glow yellow.

AC too?

You bet! The expanded voltmeter will also measure AC. Our clever clamping device, the transistor, also serves as a rectifier by clipping the negative peaks.

Because the expanded function offsets the input voltage the way it does, it distorts the AC waveform. As the input voltage increases, the half sinewave narrows—you're sampling closer and closer to the top.

A simple solution: Use a peak detector. The peak value is independent of the pulse width, eliminating the problem of the meter's averaging the pulses and giving erroneous readings.

The Norton amp (IC2-a) receives the pulsating DC from the main amplifier through R24, which, in conjunction with R25, sets the gain at unity. As the level of the input waveform rises, so does the voltage across C1, until a peak is reached.

Diode D3 performs two functions. First, it references the output to ground; in other words, it removes the offset voltage...with a little help from R22 and R23 (R31 is zero adjust).

Secondly, it isolates capacitor C1 from the output, allowing it to charge to the peak voltage—but as the input voltage decreases, D3 becomes reverse biased, thus making it impossible for the capacitor to follow the decline. The capacitor remains charged at the peak input voltage and *slowly* discharges through R30 and R26, the calibration resistors which, we should add, are adjusted for RMS—not peak—reading.

That fact requires the addition of another bias supply for the summing resistors, since our range per step has changed—it's 1.4 times that of the indicated value on the AC ranges. The AC-bias supply is IC2-c and works in the same way as the DC supply. (Zener diode D5, R21, and R32 are the associated parts.)

Because the forward voltage on the base of the transistor must be exceeded before clipping begins, AC voltages in this area are non-linear. (That only happens on the first portion of the lowest range.) A transistor was selected instead of a diode because once the transistor saturates, it effectively shorts the signal to ground while a diode would still carry the forward offset voltage, permitting the output to dip below ground.

Construction

Layout isn't critical, so you can duplicate the unit in almost any manner that pleases you. A printed-circuit board layout and parts placement diagram are shown in Figs. 4 and 5 for those wishing to go that route; however, the prototype was fabricated on perforated construction board.

If you elect not to use the PC board, try to keep the calibration pots along the edges for easy access. The case is large enough so that crowding isn't a problem. We suggest using sockets for the IC's.

Even though IC1's input impedance is *fairly* high (about 1 megohm), it might not be high enough to satisfy your requirements. Unplug the 1458 IC and replace it with an LF353N—it has FET inputs. Change R15 to 2 megohms and R16 to 10 megohms. You may have to change (reduce) the value of R7 to restore the original amplification. Voila! This is liable to out-perform any voltmeter you'll run across for some time!

Resistors R4 and R5 are two 750K units in parallel to obtain the non-standard value of 375K. Any combination will work: 300K and 75K in series, 360K and 15K in series, etc.

The meter mounts on the front panel, and is then bolted to the foil side of the circuit board, so make sure when positioning it that everything lines up. Speaking of meters, the accuracy of the system is limited only by the meter.

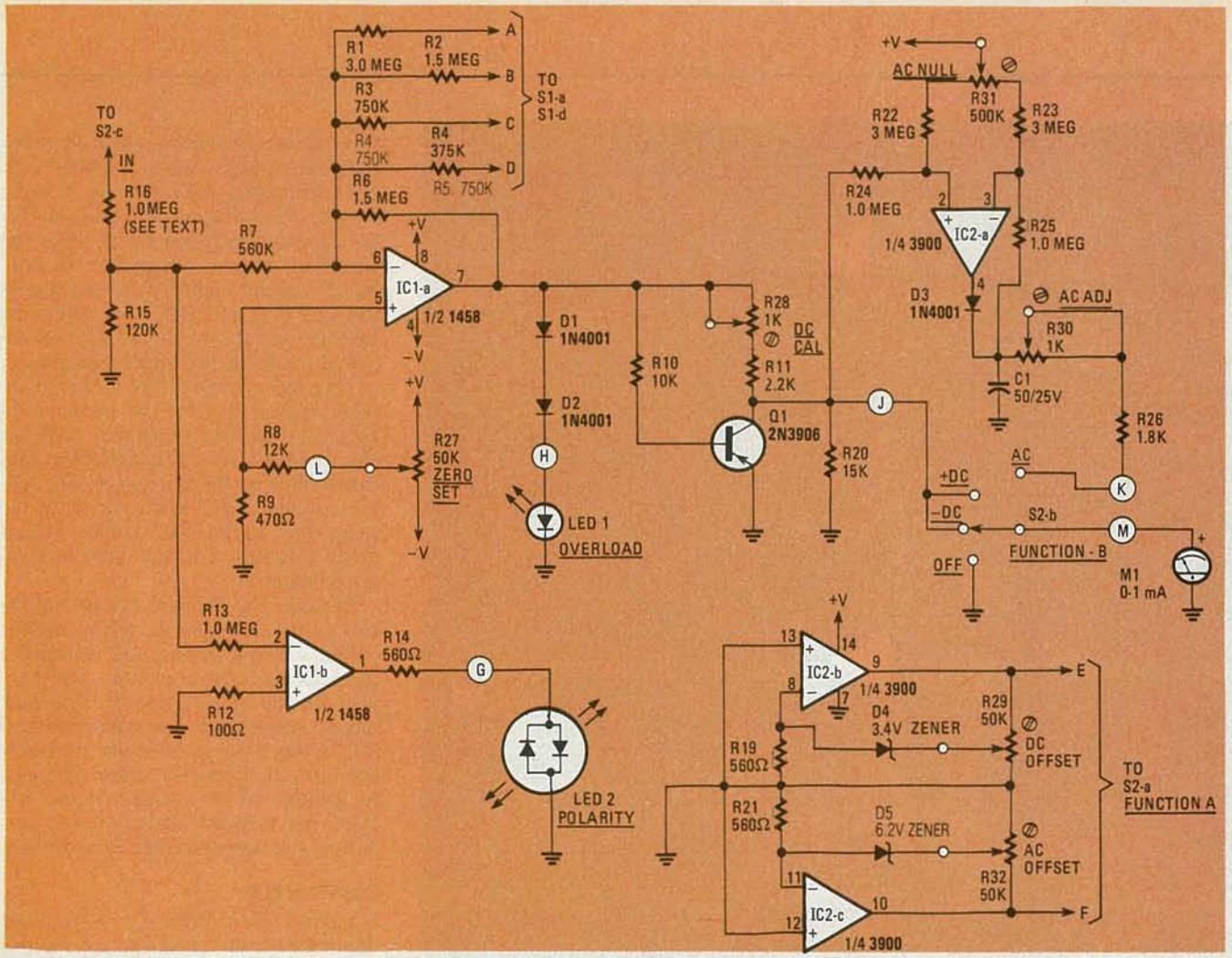


FIG. 3—SCHEMATIC OF EXTENDED-RANGE VOLTMETER. Circled letters refer to connection points on board.

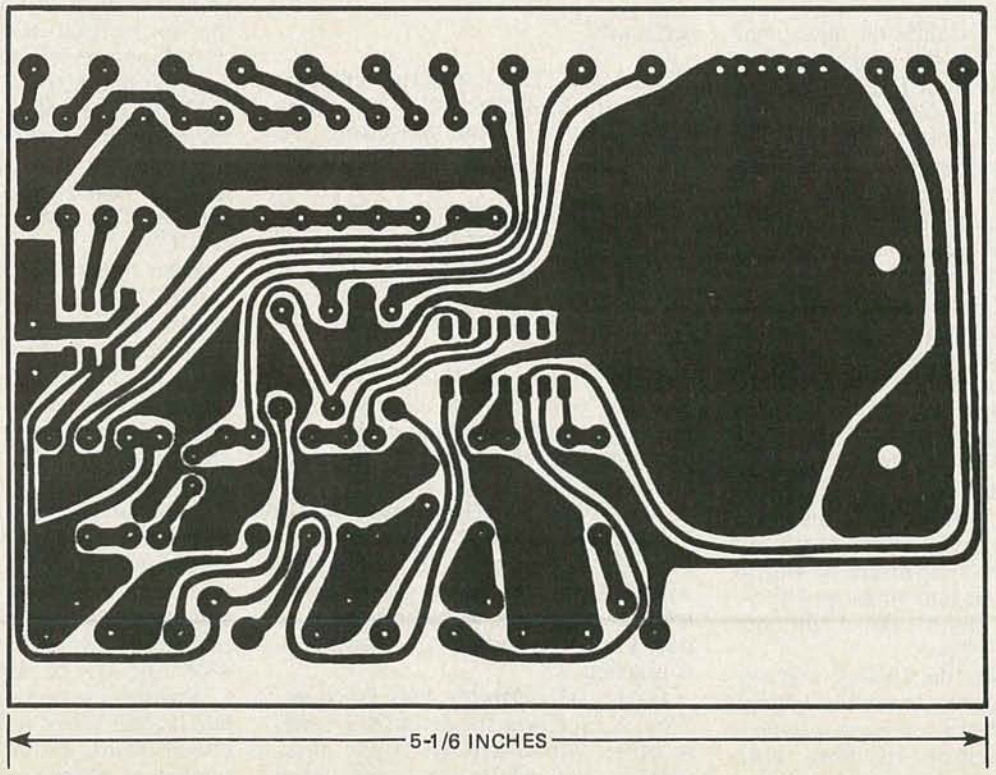


FIG. 4—PC BOARD will fit comfortably in a 6¼ × 3¾-inch box.

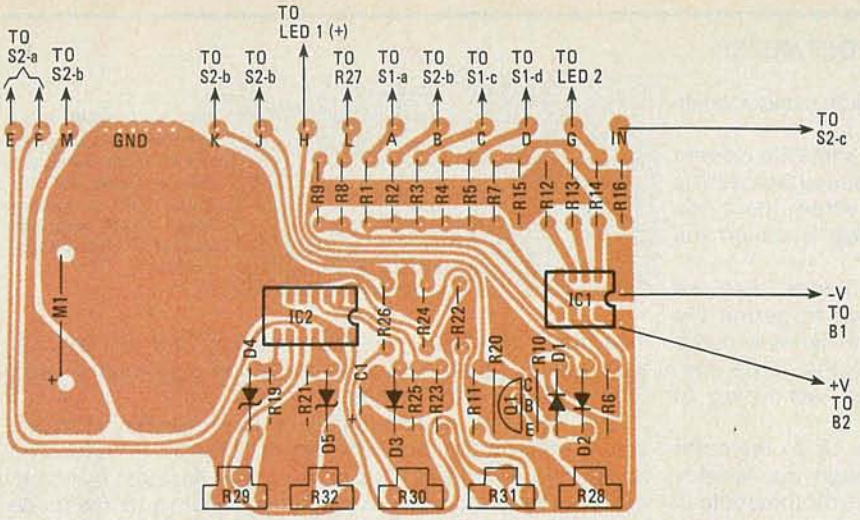


FIG. 5—MOUNT TRIMMER POTS R28-R32 so they can be adjusted from outside of board.

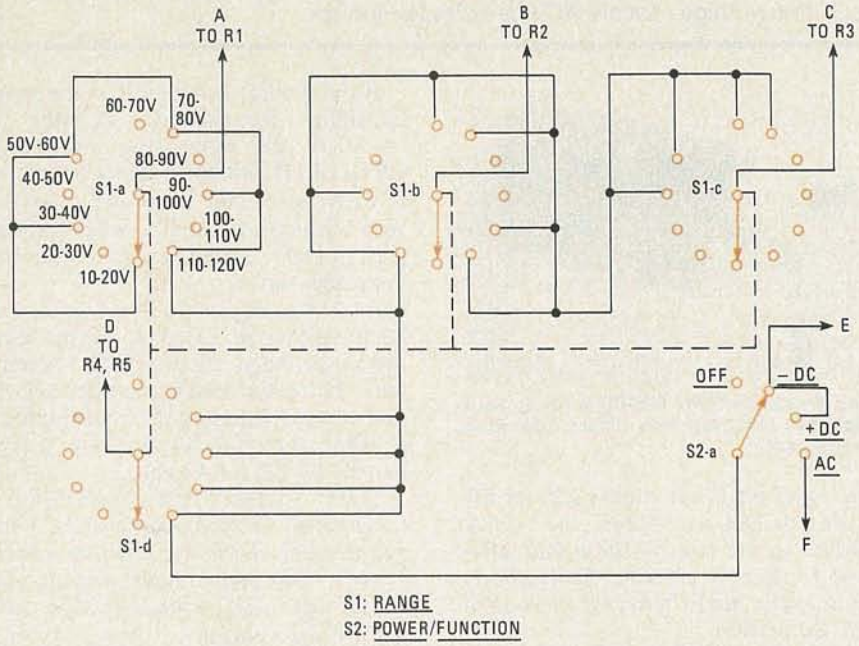


FIG. 6—WIRING FOR SWITCH S1 and one section of S2. Switches are mounted on enclosure and connected to points A through F on PC board.

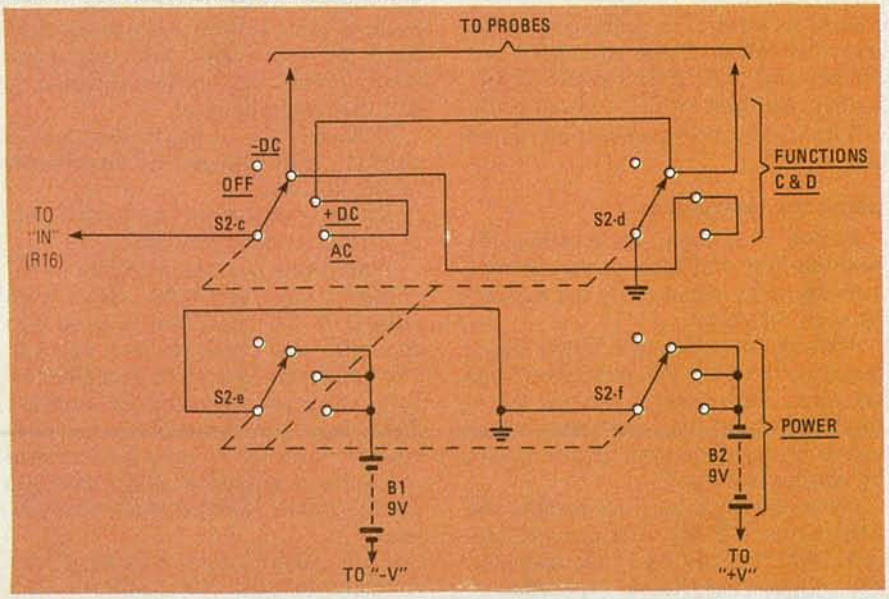


FIG. 7—WIRING FOR FOUR of the six sections of switch S2. This switch is used to select mode of operation and to turn unit on and off.

The movement specified is a standard panel unit, but any equivalent can be substituted. Resolution is limited only by the meter you select and your pocketbook! (Taut-band, mirrored-scale devices don't come cheap.)

Switch wiring is shown in Figs. 6 and 7. When routing the wires to the panel controls, use ribbon cable. It definitely makes for a neater package and there's less chance of committing an error. The LED's are placed in holders and the leads spliced. Slip a piece of spaghetti or shrink tubing over the exposed splices.

Observe diode and capacitor polarity, and follow good work habits in general when soldering. Figure 8 shows the completed board. Keep the input wire to a minimum to avoid noise. Either run a ground wire alongside it, if you're using ribbon cable, or use coaxial cable to reduce stray coupling.

The instrument is powered by two 9-volt batteries; mercury cells should be used since their voltage remains stable throughout their useful life. The ON/OFF switch is incorporated into the function selector, S2.

Calibration

Familiarize yourself with the calibration controls. Potentiometer R27 is the overall zero-set and is mounted on the front panel. DC calibration is done using R28, and R30 is the AC-adjust. Potentiometer R31 is for AC null, or zero. The bias offset, the function which gives our instrument its expanded scale mode, is controlled by R29 and R32—DC and AC respectively.

First you must zero the instrument. Switch the function selector to +DC VOLTS and the range to the lowest scale, 0-10 VOLTS. Adjust R27 for zero. (Of course, you've already *mechanically* zeroed the meter before applying power.)

Apply 10-volts DC to the input. Since that is the most critical adjustment, the accuracy of the instrument will directly depend on how precise your reference is. Adjust potentiometer R28 for full-scale deflection.

Move the RANGE switch to the next range (10-20 VOLTS). Now, turn pot R29 until the meter again indicates zero, and that's it! Well, the DC part anyway. You may have to strain your eyes a little to insure that your initial calibration is right on the button—as the ranges progress, any small error will be significantly magnified.

Assure yourself the meter is nulled and switch to the AC function. Set the RANGE switch to the lowest range. Using R31, zero the meter; it's imperative you set the overall zero in the DC position prior to trimming the AC pot—they are *two* different amplifiers with *two* offsets!

Place a 10-volt RMS sinewave across

A SIMPLE EXPANDED-SCALE VOLTMETER

A SIMPLE EXPANDED-SCALE METER CAN BE MADE USING A ZENER diode. (As shown in Fig. 9.)

The diode is normally reverse-biased and little current flows in that mode. However, as the voltage across the Zener is increased, a point is reached where the diode begins conducting—heavily. This voltage is called the breakdown voltage.

When breakdown occurs in normal diodes, they are destroyed. But, Zeners are heavily doped to permit the reverse conduction. A resistor is placed in series with the regulator to limit the current flow. Once the diode conducts, the series resistor drops voltage according to Ohm's law—*minus* the Zener voltage!

Suppose the Zener is rated at 10 volts. Up to the point of 10-volts input, no current flows through the resistor and no voltage is developed. After the 10-volt threshold is reached, and the Zener conducts, the current through the resistor generates a voltage.

A meter across the resistor will measure that voltage.

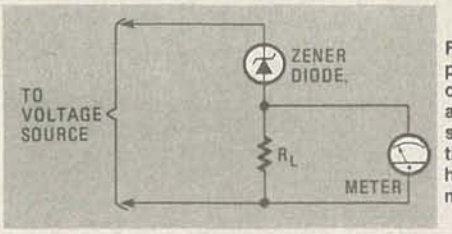


FIG. 9—A SIMPLE expanded-scale voltmeter can be made using just a Zener diode and a resistor. Add a conventional diode and you have an AC line-voltage monitor.

The meter can have any scale desired—if it is a 0 to 10-volt meter, it becomes a 10- to 20-volt meter when used with a 10-volt Zener diode.

The Zener is, unfortunately, a low-impedance device and it takes a tidy sum of current to begin to induce an avalanche condition. This more or less restricts its use to power-supply monitors. By inserting a conventional diode in series with the Zener, you rectify the input-voltage—making the meter particularly attractive as an expanded-scale AC line-voltage monitor.

PARTS LIST

All resistors ½-watt, 5%
R1, R22, R23—3 megohms
R2, R6—1.5 megohms
R3-R5—750,000 ohms
R7—560,000 ohms
R8—12,000 ohms
R9—470 ohms
R10—10,000 ohms
R11—2200 ohms
R12—100 ohms
R13, R16, R24, R25—1 megohm
R14, R19, R21—560 ohms
R15—120,000 ohms
R20—15,000 ohms
R26—1800 ohms
R27—50,000 ohms, potentiometer, panel-mount
R28, R30—1000 ohms, trimmer potentiometer, vertical-mount
R29, R32—50,000 ohms, trimmer potentiometer, vertical-mount
R31—500,000 ohms, trimmer potentiometer, vertical-mount
Capacitor
C1—50 μF, 25 volts, electrolytic
Semiconductors
IC1—LM1458 or LF353N dual op-amp (see text)
IC2—LM3900 quad Norton amp
Q1—2N3906
LED1—jumbo red LED
LED2—tri-color LED (also known as bi-polar LED)
D1-D3—1N4001
D4—3.4-volt Zener diode
D5—6.2-volt Zener diode
M1—0.1 mA panel meter (Radio Shack 270-1752 or equivalent)
S1—4-pole, 12-position rotary switch (Centralab PA-2012 or equivalent)
S2—6-pole, 4-position rotary switch (Centralab PA-2021 or equivalent)
Miscellaneous: IC sockets, binding post, enclosure, two 9-volt mercury batteries, battery clips, ribbon cable, LED holders, solder, etc.

An etched and drilled PC board is available from: Danocinths, Inc., P.O. Box 261, Westland, MI 48185 for $9.40 plus $1.25 for postage & handling (order No. HSIF-36). MI residents please add 4% sales tax; allow four weeks for delivery.

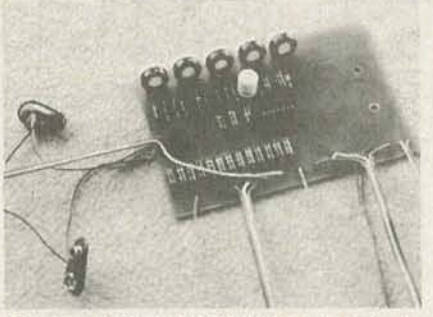


FIG. 8—COMPLETED BOARD ready to be installed in box. Note how ribbon cable keeps things neat.

the input leads and adjust R30 for full-scale deflection. Move the RANGE switch to the next position and adjust R32 for a zero reading. The same requirements apply here as they do in the DC calibration.

The AC amplifier *won't* go below ground—the zero on the meter. Keep that in mind when setting R32. Turn the control to obtain an indication above zero, then back off the pot until it *just* reaches the line. If you retard it any further, you won't know it because you will not get a reverse indication on the meter!

Using the instrument

Button everything up, inserting the batteries first, and apply power. There's nothing tricky about using the expanded-scale voltmeter.

With the RANGE switch in the lowest position, the LED will glow green with no input. Now apply a voltage across the leads. Right away the meter, which is now pretty smart, will tell you quite a bit about your input.

If the polarity is correct, the light will remain green; if not, it changes to red, indicating that the leads are reversed. The situation can be easily remedied by twisting the function knob to the −DC VOLTS setting.

If the voltage is higher than the scale capability—for example, 45 volts on the 0-10-volt range—the OVERLOAD LED, LED1, will glow. Since the meter is fully protected from overloads, it won't be harmed. Simply switch through successively higher ranges until the lamp goes out.

In that example it will go out at the 40-50-volt range, so you know the voltage is between those figures. Merely take the meter reading, in this case 5, and mentally add it to the lower number of the range (40-50) you are using; hence, 40 + 5 for 45 volts.

If the POLARITY LED glows yellow, this indicates that you have an AC voltage present. Turn the function switch to AC VOLTS and proceed just as you would with a DC voltage reading—expanded scale and all!

Below 2 volts, the AC scale is nonlinear—but then, most AC meters are, and special scales are required. If that bothers you, or you wish to measure those low-level signals with this instrument, there's an unused amplifier in IC2 that could be used.

However, for voltages that low, a good AC millivoltmeter would probably be the best bet.

The AC scale has another unique characteristic: it's peak reading.

That means you can measure *any* AC voltage, *any* waveform (yes, even pulses, if the repetition rate is high enough), and obtain a peak reading. The value will have to be multiplied by 1.414 since we calibrated for sinewave RMS. But, you can calibrate for peak voltage by using 10-volts peak instead of RMS as a reference. Zener diode D5 will have to be changed to a 3.4-volt device.

If you calibrate your expanded-scale voltmeter for peak volts, an RMS value can be found easily by multiplying the reading by 0.707. **R-E**

Temperature Measurement—Circuits and Components

JOSEPH J. CARR

It's easy to put together a temperature-measuring circuit if you know a little basic electronics. Here are several ideas to get you started.

WE'VE BEEN ABLE TO MEASURE TEMPERATURE electronically for many years but only recently have the circuits to do that been readily available. In this article, we will discuss some of the more common temperature-sensitive transducers, the circuits needed to make them work, and will introduce you to several integrated circuit temperature-transducer/amplifier combinations. Several semiconductor manufacturers now make two-terminal temperature devices that are very easy to use.

Temperature transducers

There are several different types of transducers that will convert a temperature to either a voltage or a current. Once the conversion is made, we can use amplifiers and voltmeters to process and display the result.

One of the earliest forms of temperature transducer was the *thermocouple*. If we form a junction of two wires of different metals as shown in Fig. 1, we will note a very interesting phenomenon called *Seebeck effect*. When the junction is heated, a voltage proportional to the temperature of the junction is developed across the two wires. That voltage can be measured and used to determine the temperature of the junction.

The voltage produced in a thermocouple is created by the different *work functions* of the two metals. Over the years, certain standard sets of metals have been defined for use in thermocouples and each standard set has its own temperature characteristics and applications.

Another very popular form of temperature transducer is the *thermistor*, or *THERM*al res*ISTOR*. That device has a resistance that is a function of temperature (Fig. 2). There are *positive temperature-coefficient* thermistors, with a resistance that rises with temperature, and *negative temperature-coefficient* thermistors, with a resistance that decreases with temperature. The temperature-resistance curves for most thermistors are not linear (i.e., straight-line). That makes it difficult to use thermistors for accurate temperature measurement unless we use them only over the narrow range in which they are linear, or use an external-resistor *linearizing network* to make the curve straighter.

A typical thermistor electronic thermometer uses a Wheatstone bridge, with a thermistor as one of the bridge legs. The output voltage will be zero under a null condition—usually 0° C — and is approximately proportional to the temperature at other points. A differential op-amp can be used to amplify the small output-voltage, and to scale the voltage to some level that is easy to display on an analog or digital voltmeter, such as 10 mV/°K (Kelvin).

In recent years, semiconductor temperature-transducers have become increasingly important. We know that the voltage across a pn diode-junction, and the current flow through the junction, is strongly affected by temperature. (That property is what causes drift in solid-state amplifiers.) We can demonstrate this with an ordinary silicon diode, say one of the 1N4000 series.

Connect an ohmmeter across the diode (Fig. 3) so that the diode is forward biased. That means connecting the positive terminal of the ohmmeter to the anode of the diode, and the negative terminal of the ohmmeter to the cathode. In case of doubt, the correct connection is the one that shows the lowest resistance on the ×1, ×10, or ×100 scale of the ohmmeter. Note the ohmmeter reading, then apply heat (body heat is sufficient—grab hold of the diode and squeeze it in your palm) and watch the resistance change!

Although diodes are often used as temperature transducers, they are not always the best choice. In many cases, an ordinary bipolar transistor will make a better transducer, especially if it is diode-connected. (The collector and the base are shorted together to form one

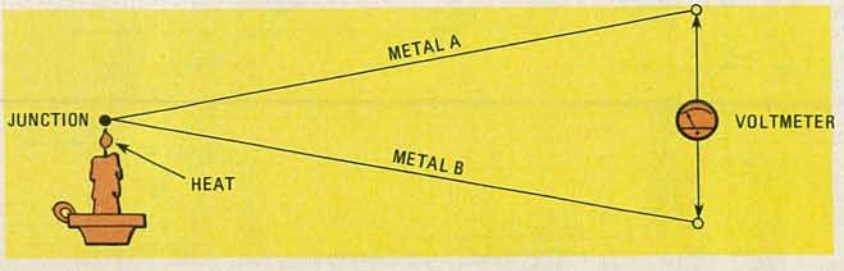


FIG. 1—WHEN A JUNCTION of two dissimilar metals is heated, a voltage that is proportional to the temperature of the junction is created.

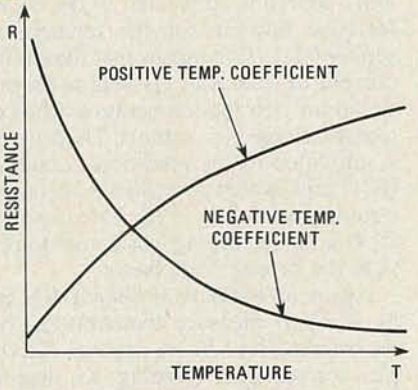
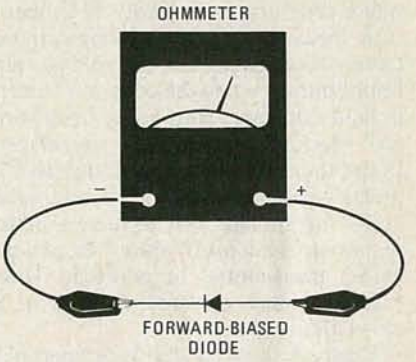


FIG. 2—AS THE TEMPERATURE goes up, the resistance of a positive temperature-coefficient thermistor also rises. The resistance of a negative temperature-coefficient thermistor drops with rising temperature.

FIG. 3—THE CURRENT through a pn junction is dependent on temperature. To demonstrate that, connect an ohmmeter across a diode as shown, grasp the diode in your hand, and note the change in resistance.



terminal of the "diode;" the emitter is the other.)

The base-emitter voltage of a transistor (V_{BE}) is dependent on both the *collector current* and the *temperature*. (If you're interested in the math you can find the formula in any good text on transistors.) Because of that, a transistor can be used to make a very linear temperature transducer that works over a range of approximately −55° C to +125° C.

Transistor temperature transducers

Almost any transistor can be used to make rough measurements of temperature because of the relationship between the base-emitter voltage and temperature, when the collector current is held constant. But, some transistors are better temperature transducers than others. It seems that transistors in metal can-type cases (TO-5 and especially the smaller TO-18) have a better response than most epoxy or plastic-cased transistors. In addition, some transistors have a more linear V_{BE} vs. I_C curve than others.

Figure 4 shows a simple temperature transducer that uses NPN bipolar transistors. In this circuit, a dual transistor (two NPN silicon transistors in a single case) such as a MAT-01 (made by Precision Monolithics, Inc.) is used. The emitters are fed from 1- and 2-mA constant-current sources (it is important to keep the emitter currents *different* for Q1 and Q2) and the output voltage is approximately 59 μV/°K.

A differential op-amp is needed to amplify and scale the output voltage to a usable level. It is particularly convenient to scale the voltage to 10 mV/°K so that a simple voltmeter can be used. To do that for this transducer, the differential op-amp must have a gain of 167. When the output voltage is 10 mV/°K, any 3½-digit DVM can be used to measure temperature.

A solid-state thermometer

The electronic thermometer project shown in Fig. 5 uses a simple op-amp inverting follower circuit and a single—common—transistor such as a metal-case 2N2222. The transistor is used as a temperature probe and needs a suitable enclosure such as an old voltmeter probe grip, a short piece of metal tubing, etc. If the circuit is used to measure the temperature inside some piece of equipment, it can be mounted permanently and does not need a separate enclosure. However used, thermal contact with what is being measured is important. In the case of small-diameter metal tubing, the transistor case should be press-fit inside the tubing to insure that heat is conducted to the transistor's base-collector junction. If the fit is loose, or the enclosure not metal, you should use silicone "heat transfer" grease for the best results.

Two DC reference voltages are needed: plus and minus 6.2 volts. Diode D1 provides the positive 6.2-volts DC reference, while diode D2 provides the negative 6.2-volt DC reference. The +6.2 source is connected to the collector-base terminal of the temperature sensor (Q1). That means that the emitter current of transistor Q1 will be proportional only to the temperature (the collector voltage is *constant*). That current is amplified by an operational amplifier (IC1) and scaled to produce an output potential of 100 mV/°K. Potentiometer R1 is adjusted during calibration to provide the proper scale factor.

Again, an ordinary 3½-digit DVM can be used to measure temperature, but the reading will be in degrees Kelvin. To convert the reading to degrees Celsius, it is important to note that the Kelvin and Celsius scales are the same, but offset by 273 degrees (0° C = 273° K). To read temperature in degrees Celsius, an offset adjustment is needed.

Potentiometer R3 converts the temperature range of the basic circuit from Kelvin to Celsius by summing a countercurrent from the −6.2-volt DC supply with the current from the transistor. The potentiometer is adjusted to produce zero output from amplifier IC1 when the temperature is exactly 0° C.

Calibration

Once the circuit is built it will have to be calibrated. Set R1 and R3 to about the middle of their respective ranges. Turn the circuit on, and wait about 10 minutes for things to stabilize at room temperature. While you're waiting, prepare an "ice-point bath." The ice-point of water is 0° C; (the temperature where ice and water can exist in the same container). Use a regular thermometer to verify that the temperature is 0° C (or 32° F). When the circuit has stabilized and the bath is ready, put the transistor into the water and wait about 30 seconds. When the output voltage of the operational amplifier has stopped

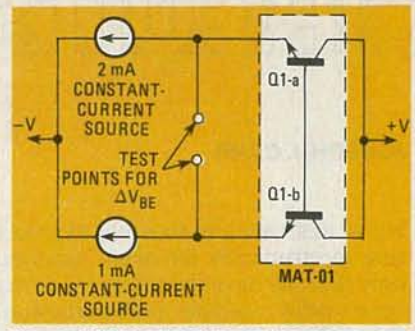


FIG. 4—WHEN THE OUTPUT VOLTAGE of this circuit is scaled by a differential op-amp, an ordinary DVM can be used to read the temperature.

changing, adjust potentiometer R3 for 0.00 volts output. Let the transistor stay in the bath for a few more minutes, while monitoring the bath's temperature with a thermometer (*not* the one you're calibrating) to make sure that it doesn't change. When you are satisfied that the output voltage is reasonably stable (some drift will occur), remove the transistor from the bath and allow it and the thermometer to come to room temperature.

Once both have reached room temperature (indicated by the fact that both the thermometer's reading and the circuit's output voltage no longer change), the last step in calibrating the circuit can be done. Adjust potentiometer R3 so that the reading on the DVM is the same as the reading on the mercury thermometer (ignoring the decimal point and trailing zeros on the DVM). When this is

PARTS LIST—FIG. 5

Resistors ¼ watt, 1% unless otherwise noted
R1—100,000 ohms, potentiometer
R2—100,000 ohms
R3—20,000 ohms, potentiometer
R4—2200 ohms
R5, R6—10,000 ohms, 5%
Semiconductors
D1, D2—LM113 (National) 6.2-volt Zener voltage-reference diode or equivalent
Q1—2N2222 or equivalent, metal case
IC1—CA3140 MOSFET op-amp or equivalent

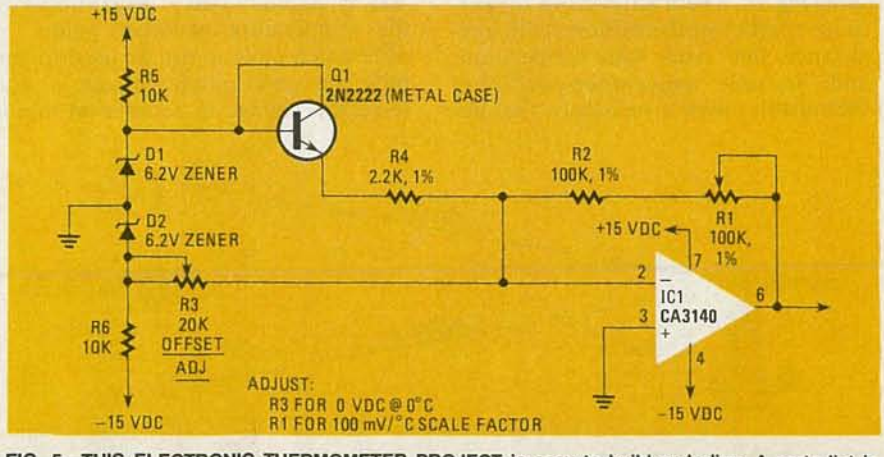


FIG. 5—THIS ELECTRONIC THERMOMETER PROJECT is easy to build and align. A parts list is included in this article for those of you that would like to try it.

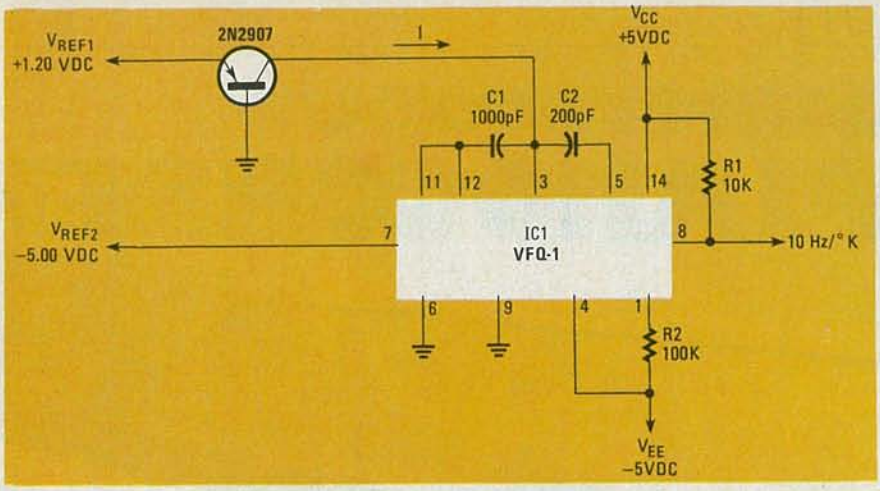


FIG. 6—THE HEART of this temperature-to-frequency converter circuit is a Datel VFQ-1 current-to-frequency converter IC. The 2N2907 is used as the temperature probe.

FAHRENHEIT, KELVIN, CELSIUS AND CENTIGRADE

There are three scales in common use for measuring temperature: Fahrenheit, Celsius (centigrade) and Kelvin.

The Fahrenheit scale, now used only in the United States and a few other English-speaking countries, is based on the freezing and boiling points of water at sea level—32° and 212°, respectively. The zero-point on this scale was probably established by using a mixture of ice and salt—materials commonly used to achieve low temperatures in laboratories at the time the scale was developed.

The Celsius scale, also known as the centigrade scale (it's not capitalized because, while the other three scales bear the names of their inventors—Gabriel Daniel Fahrenheit, Anders Celcius and Lord Kelvin—the term "centigrade" refers to the fact that the scale is divided into a hundred divisions), is used outside the U.S., wherever the metric system is found. On it, the freezing point of water is 0° and the boiling point 100°.

The Kelvin scale is also known as the *absolute* scale because its zero point is *absolute zero*, (−273.16° C or −459.69° F), the point at which all molecular motion ceases and there is—literally—no temperature.

One degree in the Kelvin scale is the same size as one degree in the Celsius scale; therefore water freezes at 273.16° K and boils at 373.16° K. The Kelvin scale is used primarily in applications such as solid-state physics and astronomy.

Incidentally, conversion from Fahrenheit to Celsius, and vice versa, is easier than you may think. To convert from degrees F to degrees C, just subtract 32 from the Fahrenheit temperature and divide the result by 1.8. Going from Celsius to Fahrenheit is even easier—double the temperature, subtract 10%, and add 32.

done, a 0-volts DC output will equal 0° C, a 3.00-volts DC output will equal 30° C, and so on. This happens, of course, because of the 100 mV/°C scaling factor. Alternately, a warm-water bath can be used for this part of the calibration procedure. Prepare the warm-water bath by mixing hot and cold water, and follow the steps that were outlined above for calibrating the thermometer circuit at room temperature.

The precision, and amount of drift, of this electronic thermometer depend on the quality of components used. The resistors, except for possibly R5 and R6, should be 1% precision-types with a low temperature-coefficient of resistance. The Zener diodes should be temperature-compensated reference types, such as National Semiconductor LM113's. The op-amp should also be a low-drift type, although acceptable performance can be obtained with an RCA CA3140, especially if it is heat-sinked. An ordinary TO-5 heatsink (the kind made of thin metal) will work nicely.

Other devices

There are a number of IC voltage-to-frequency (or current-to-frequency) converters on the market. An example of an IC that does both is the Datel VFQ-1. That IC is shown in a temperature-to-frequency converter circuit in Fig. 6. In the circuit, we are using the VFQ-1 as a current-to-frequency converter; the current is supplied by the collector of a PNP transistor that is used as a temperature transducer.

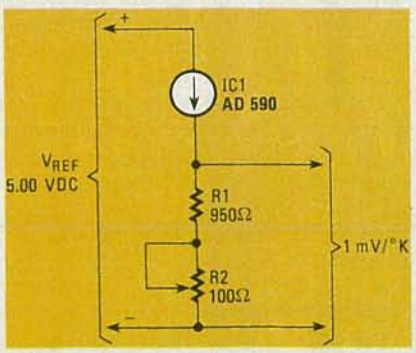


FIG. 7—A TEMPERATURE-SENSITIVE current source, the AD590, is used to measure temperature in this simple circuit.

This circuit's output frequency will have a scaling factor of 10 Hz/°K. We can, therefore, expect an output frequency of 2730 Hz at the freezing point of water (273° K, or 0° C), and a frequency of 3730 Hz at the boiling point of water (373° K or 100° C). This type of circuit can be used to record the temperature data from an experiment on magnetic tape, or to transmit the temperature via radio telemetry from an amateur rocket or model aircraft. Unfortunately, the Datel IC is still a little expensive (although it is one of the lowest cost converters on the market) and is not generally available through hobbyist outlets.

Another special temperature-measurement semiconductor device is the AD590 (Analog Devices, Inc.) It is a two-terminal IC that is available at low cost in either a TO-18 case or a special two-terminal flat-pack. The device is a temperature-sensitive current source and is scaled to approximately 1 μA/°K. If we pass the current from the AD590 through a 1000-ohm resistor, the result (using Ohm's law) is a voltage change of 1 mV/°K.

There are several ways that we can use the AD590 device. One is simply to connect it as shown in Fig. 7, in series with approximatley 100 ohms of resistance. This configuration is called a *one-temperature*, or *one-point*, circuit. We adjust potentiometer R2 so that the output voltage agrees with a mercury thermometer at some specific temperature. Slight nonlinearities in the device, as in all semiconductor devices, will cause some error at points far removed from the calibration point.

Another method is to connect the AD590 directly between a +5.00-volt DC precision reference source and the inverting input of an op-amp. The scale factor of the thermometer can be set by the feedback resistor (R_F) using the formula: $V_O = (1\,\mu A/°K)(R_F)(T)$.

We can also use the AD590 in a *two trim-point* circuit that uses an op-amp as described above. An offset current is summed with the AD590 current at the inverting input of the op-amp. We can then use *two* potentiometers, one for offset and one for gain, to adjust the circuit at two different temperatures, thereby reducing the error.

Electronic thermometer projects are easy to build and calibrate, and they can be put together by anyone who knows Ohm's law and the basic principles of op-amp circuits. Just remember to use precision components that don't drift with—you guessed it—temperature! **R-E**

ALL ABOUT

Superscope's PIANOCORDER

What ever happened to the old-fashioned player piano? It's back, with an electronic facelift—a facelift you can perform yourself.

WARREN BAKER

IN THESE HIGH-TECHNOLOGY TIMES, IT'S rather surprising that no one has marketed an updated version of the old-fashioned player piano. That is, of course, until recently. Superscope has developed an all-electronic version, the *Pianocorder Reproducing System*, for Marantz pianos. The *Pianocorder* is also available as a kit *(model P-100)* that can be installed in your own piano. That kit is the subject of this article.

Before we go any farther, let's see just what the *Pianocorder* is, and how it differs from the air-operated units of many years ago. Old-fashioned player pianos used paper rolls about the size of kitchen waxed-paper rolls with music "recorded" on them: the recording took the form of holes and slots in the paper. Among the problems with that system was that those rolls were rather fragile and difficult to store.

Contrast that with the *Pianocorder* system that uses ordinary audio cassette tapes. While you can purchase prerecorded tapes for the *Pianocorder* system, you can also record your own piano music. At this point you may be thinking: "So what, my cassette recorder can do that already." There is a very important difference, though: The *Pianocorder* does not record the music itself, but, rather, the *individual piano-key strokes*. The music you hear does not come from a speaker; it comes from the piano itself. For the dyed-in-the-wool hi-fi purist, you can't get more faithful reproduction from any other music system!

How it works

The system uses eighty solenoids with push rods attached to the upper parts of their moveable cores. (The top and bottom 4 keys of the standard 88-key piano keyboard are not used. Many old-fashioned player pianos had only 80 keys and since those extra 8 keys are seldom used, no provision is made for them.) The solenoids are positioned so that each of the push rods extends through slots in the keybed and comes in contact with the underside of one of the keys. Because each piano key is actually a lever with a fulcrum at its center, when you press a key down, its other end moves up. When the solenoid for any key is energized, its core moves upward, moving the push rod at the same time. The effect of the push rod's striking the bottom of a key is the same as your striking the top of the key at the keyboard.

A rail with 80 very sensitive switches mounted on a PC board is used when recording music; the rail is installed under the front part of the piano keys as shown in Fig. 1. When the rail is properly installed and adjusted, one switch is located directly under each key. If a key is struck, the switch under it is closed. The switch closure lets the system know which key has been struck, and that information is recorded on tape. Switches attached to the "sustain" and "soft" foot petals work in a similar fashion, and the information from them is also recorded by the player piano.

Of course, there's more to a piece of piano music than just striking the keys in a particular sequence. The player's "expression" (how softly he strikes the keys, for example) is also taken into account. A small microphone mounted on the "record" board picks up the relative acoustic pressure in the lower part of the piano and converts it to a signal that, when the recording is played back, helps the *Pianocorder* reproduce the piece of music faithfully. That feature often makes it difficult to tell a recording from the original rendition.

The electronics used in this recording system are quite exotic when compared to those found in most other consumer items. Even though a microprocessor is not used by this player piano, in many ways the system can be compared to a dedicated computer.

Logic and encoding

The system uses sixteen 8-bit words to encode each note (or chord), and to indicate the intensity with which each key is struck and the use of the foot pedals. Timing is derived from a master clock. Figure 2 shows how the bits are assigned in the encoding scheme.

In examining the system, perhaps the best place to start is word 15, the "sync" word. That is the last in the sequence and can best be compared to the sync pulse of a composite TV signal since it establishes the proper relationships for all of the other words. Word 15 consists of 6 lows, 1 high, and 1 low (ØØØØØØ1Ø); if there is a malfunction and any other bit sequence appears for word 15, the system will not work.

Two bits of word zero (the first word in the sequence) are used for the foot pedals. Five of the remaining six bits of that word are used for bass intensity (more on that later); the leftover bit (bit two) is not assigned. The notes are handled by words 2 through 6, and 9 through 13; each bit represents one of the 80 notes (10 words of 8 bits each give 80 notes).

As pointed out earlier, expression is an important variable in the recording

FIG. 1—HIGHLY SENSITIVE SWITCHES mounted under each key are used to record your own performances.

system. The signal from the microphone on the "record" board is applied to the bass and treble registers' active filters, and then to a digital-to-analog converter (DAC) for inclusion into the respective bass or treble counters and registers. On playback, the process is reversed, and the information used to "modulate" the action of the solenoids. Bass intensity is handled by 5 bits of word Ø; treble intensity is handled by 5 bits of word 8. The inclusion of the intensity information helps to combine the *Pianocorder* and the piano into a system that, according to the manual, "...truly reflects the touch of the pianist."

The digital information generated by the logic as just outlined is first fed to a parallel-to-serial converter, and from there goes to a bi-phase converter that generates tones which can be recorded on tape. A 2250-Hz tone is used to represent a logic-0 and a 4500-Hz tone a logic-1. That principle is similar to that used by home computers for storing data on cassette tape and, in fact, both tapes sound similar when you play them back on an ordinary cassette recorder.

During playback, the signal from the recorder is fed to the playback logic-board (shown in Fig. 3) through an opto-isolator that segregates the cassette recorder's circuitry from the 5-volt circuitry used by the balance of the system. The audio signals are routed to the board's decoders and counters, and the resulting logic-level control voltage goes to the appropriate solenoid-driver board (see Fig. 7). The 170-volts required to drive the solenoids is switched by power transistors that are located on the driver boards.

To reduce heat build-up, a special circuit allows full current-flow to the solenoids only when they are first energized. The current is then reduced to a level just sufficient to hold the solenoids' slugs in position, and held at that point until the solenoid is de-energized.

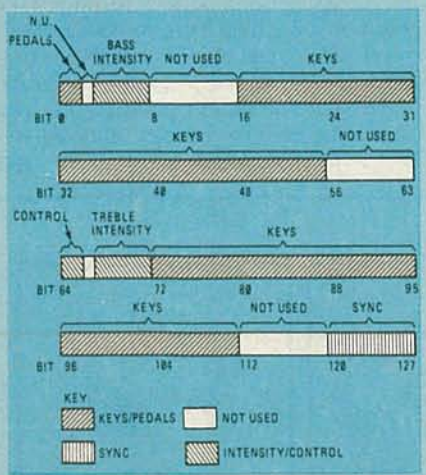


FIG. 2—BIT-ASSIGNMENT used by the *Pianocorder's* encoding system. Each key or pedal depression results in a 128-bit string.

Power supply

The power supply is quite straightforward and provides the three DC voltages (+5, +12, and +170 volts) that are required by the system. Power for the solenoids is derived from a bridge rectifier. An interlock switch mounted on the playback logic-board prevents the solenoids from being activated if the front of the piano is removed. That feature is included for safety.

The 5- and 12-volt supplies are taken from a step-down transformer. The 5-volt supply uses a 723 regulator. It should be noted that the system uses three separate ground connections. One of those, the system ground, ties together all of the metal parts of the *Pianocorder* and the piano, and connects them to the power-line neutral (the "green" prong of the three-prong power-line plug). That can cause some problems when troubleshooting or testing the *Pianocorder* if you use an oscilloscope (or other piece of test equipment) that is grounded to the power-line neutral. The instructions suggest that you use battery-operated test equipment or an isolation transformer when testing or servicing the system. Otherwise, your common-ground connection should be chosen with great care.

Before you begin

Needless to say, installing the *Pianocorder* in your piano should be done with care. Superscope has made several assumptions about your knowledge and equipment. It is assumed that you have a well-equipped shop with all the usual hand and power tools, and that you know how to use them. Some of the tools used by piano technicians would also be handy to have but it really does not pay to buy them for a one-time project such as this. You can do very well without them, although the job may prove to be a little more difficult. There are also certain parts of the project where a "helper" will make things a great deal easier; perhaps a family member can be pressed into service in those instances.

Superscope also assumes that you have a "fair" working knowledge of how pianos operate. Don't let that scare you, though, because the installation manual covers all the working parts of the typical piano, in great detail. In general, the instructions are extremely elaborate. There are warnings throughout the instructions (where needed) that urge the installer to be absolutely certain that he understands the step being described before carrying it out. Be sure to heed those warnings!

Before beginning the installation, some measurements have to be made to determine whether or not you will be able to install the *Pianocorder* in your piano; those measurements are completely explained in the instruction manual. Although a number of measurements are required, only a few have any serious bearing on the end result, even though some may seem to indicate that you will not be able to install the unit. In some cases further instructions show you how to overcome the problem, while in other cases, (depending upon your abilities as a technician) you may be able to find your own way out of dilemma.

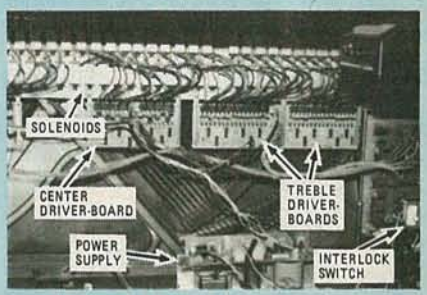


FIG. 3—MOST OF THE ELECTRONICS are installed in the lower part of the piano. Shown here are the solenoids, three of the five solenoid-driver boards, the playback-logic board, and the power supply.

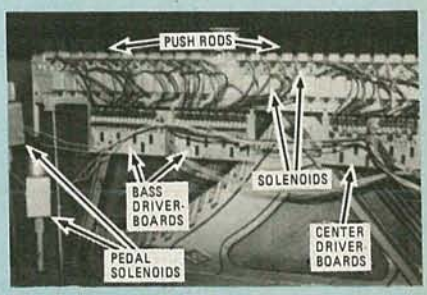


FIG. 4—DURING PLAYBACK, the piano keys are operated by the solenoids which, in turn, are controlled by the appropriate driver boards. The solenoids at the far left operate the "soft" and "sustain" foot pedals.

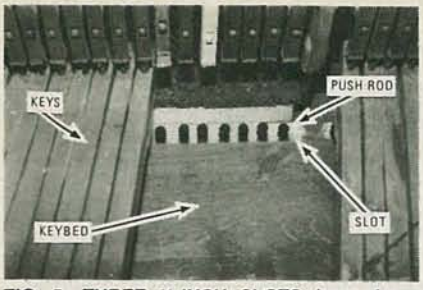


FIG. 5—THREE ½-INCH SLOTS (one shown here) had to be cut into the keybed so that push rods connected to solenoids mounted on the underside keybed could operate the keys. Seven keys were removed here to show detail.

Modifying your piano

The modifications that have to be made to the piano will vary with the type of piano you own. In my case, probably the biggest one was cutting three ½-inch-wide slots through the keybed; those slots let the solenoids that are installed on the underside of the piano operate the keys (see Fig. 5). In addition, I had to modify the mounting bracket that connected the "harp" frame to the keybed. (I cut it down.) The pedal "trap" mechanism also had to be remounted to provide clearance for the pedal solenoids. Although that was easily done for my piano, the same may not be true for other units. The instructions for this part of the project leave the details entirely up to you and plainly state that the examples provided are only representative of some of the methods that can be used.

Installation

It is important that the solenoid push-rods contact the underside of each key

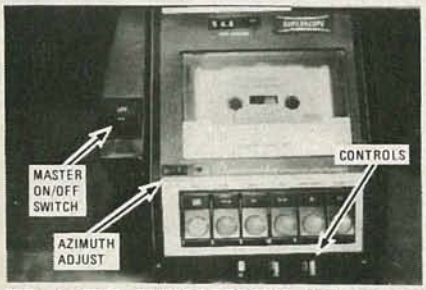


FIG. 6—THE *PIANOCORDER'S* cassette tape recorder looks much like a regular one. The master ON/OFF switch is at the left.

as cleanly as possible. A locating "stick" has to be prepared, and is used to determine those contact points; it must be marked accurately. The positions determined by the stick are used to place the solenoids in their proper positions on the solenoid rail. If you are sloppy when you position the solenoids, you may have the nasty and time-consuming problem of making individual adjustments after the assembly has been installed in the piano. (In my case, one solenoid was misadjusted; that error caused two of the keys to sound at the same time.)

Since the *Pianocorder* uses cassette tape, it also needs a cassette recorder/player. That unit, shown in Fig. 6, looks like a ruggedized version of a standard portable one. It runs at a speed of 3¾ inches-per-second. In use, the recorder/player swivels out from under the right-hand side of the keyboard. The master ON/OFF switch and other operator controls are also located on the recorder assembly. Some pianos (mine included) may have a slight rim at the front of the cabinet, in the area where the recorder is to be mounted. The modification needed in that case is simple: A half-inch spacer is used to give the recorder enough room to clear the rim.

Since, for some reason, someone had previously modified the piano I used for this project, some of the situations I ran into should not be considered typical. For instance, it appeared that sometime in the past the entire keyboard (and key-

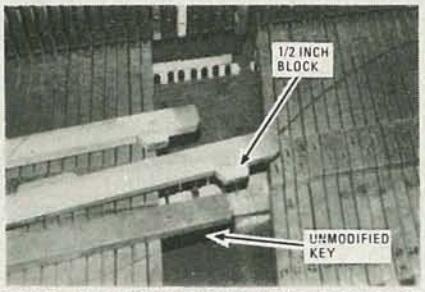


FIG. 7—ADDING A HALF-INCH block of wood to the bottom of each key made it possible to install the *Pianocorder* in my piano. The lower key is shown unmodified.

bed) had been raised a full inch above their normal position. Since the solenoid push-rods could not reach the underside of the keys because of that increased elevation, it at first appeared impossible to install the *Pianocorder*. Fortunately, I was able to solve that problem with a little ingenuity. Gluing half-inch-thick pieces of wood to the underside of each key (see Fig. 7) made up for the increased height and, when the project was completed, the player piano worked perfectly.

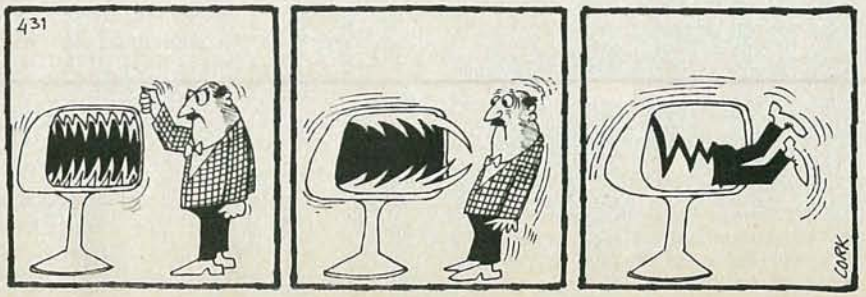
It is interesting to note that the above modification also could have saved me considerable work in cutting the mounting bracket. As mentioned earlier, I had shortened the bracket so the solenoid rail could be placed closer to the keybed and allow the push rods a longer throw; the added pieces on the keys served the same purpose.

From the point where the solenoid rail is installed in the piano, the work consists mostly of drilling pilot holes for the screws used to mount the various parts of the *Pianocorder*. Surprisingly, however, most of the system's components are connected to each other, and very little is actually attached to the piano. In fact, only the power supply and the playback logic-board (with the piggy-back-mounted "expression" board) are actually secured to it. With the exception of installing the record key-switches (more on those later), all the work is done in the lower section of the instrument.

The instructions are phrased for use by piano technicians who, in all probability, are not too familiar with the electronic parts of the reproducing system. Because of that, it may seem to some readers that the instructions have been too simply written at times. Bear with them, however; they will lead you through the project, and help insure that the piano will produce wonderful music when you're finished.

As you may have guessed by now, installing the *Pianocorder* in your piano is not a one-night project. However, if you decide to undertake the job, the time you spend will be justified by the entertainment this system can provide. The completed player piano will amaze your friends and neighbors, and provide untold hours of family fun. There are tapes available that cover just about every musical taste or period and in addition, you will have the pleasure of being able to record *your own* performances for posterity!

Installing the *Pianocorder* in my piano has been one of the most enjoyable construction experiences that I've had in a long time. Coming from an electronics "builder," that statement means quite a bit. In closing, it should be reiterated that this kit is *not* something for an inexperienced person to undertake without some help from someone with a good knowledge of tools and their proper use. Yet, if you use good common sense and follow the instructions, you should be able to complete this satisfying project. **R-E**



CX Noise Reduction for Phono Records

A new noise-reduction system for records from CBS provides 20 dB of noise reduction, yet discs made using it suffer no loss in quality when played without a decoder.

LEN FELDMAN
CONTRIBUTING EDITOR

MOST OF THE NOISE-REDUCTION SYSTEMS used in high-fidelity circles during the last few years have been geared primarily to tape recording and playback. For example, Dolby noise reduction, while sometimes used by FM stations to increase their noise-free coverage area or to improve the dynamic range of their musical programs, is confined mostly to tape-recording applications. Specifically, *Dolby B* noise-reduction encoding and decoding has found its widest application in stereo cassette-tape decks.

To date, the only companding type of noise-reduction system that has been applied to phonograph records has been the one developed by dbx, Inc. In that system, program material is first compressed by a ratio of 2:1 for cutting the master disc, and then expanded by a ratio of 1:2 during playback of records manufactured from that master. While the system is startlingly effective, both in terms of noise reduction and in terms of increased dynamic range capability, a dbx decoder is required to play the discs. If they are played back without the decoder, they sound—to say the least—strange.

Now, CBS has come up with a new companding system for discs, designated *CX*, that is said to offer several advantages over any earlier one. Among them are:

1. Compatibility—encoded recordings can be listened to with or *without* a decoder.
2. A 20-dB reduction in perceived surface-noise.
3. Excellent transient response.
4. Little or no audible pumping (audible variations in the volume of the background noise due to the action of the filters) or switching of noise in the companded state.
5. Relatively independent signal levels.

To get the most out of the system a decoder costing about $100 is required, but what sets the *CX* system apart from the others is that a *CX*-encoded record can be played on ordinary equipment without the decoder and still sound good. With most musical selections, the undecoded record is comparable in sound quality to a conventional record containing the same program material. Of course, with no expansion during playback, there is no noise reduction. With the decoder, the quality is nearly indistinguishable from the original master tape, whether analog or digital.

Why stop at 20 dB?

The *CX* system works by adding 20 dB to the dynamic range of a recording. This expansion is added at the "quiet" end of the range—the area where record surface-noise begins to present problems.

The reason CBS settled for just 20 dB is interesting. The new system is obviously designed to serve as a stop-gap measure until true digital phonograph-records become available. (The records that are called "digital" today are simply analog discs that have been mastered from digital-audio tapes.) Now that tape hiss is no longer a limiting factor in mass-produced phonograph records (thanks to digital master-tapes) the new limiting factor becomes the surface noise of the disc itself. A professional-type digital tape recorder has a maximum effective dynamic range of about 95 dB per channel. After a 24-track mix-down, it can be shown that the randomly added noise introduced will reduce this to about 81 dB. That is still about 20 dB better than the 60-dB dynamic range available on the best modern vinyl records. Hence, by choosing a 20 dB companding system, and adding the 20 dB of dynamic range at the "bottom," CBS has, in effect, permitted today's vinyl records to equal multi-channel digital tape-recordings as far as dynamic range and quietness are concerned. Sounds that were previously masked by record surface-noise can now be heard clearly.

Wide-band companding

Record-surface noise has a frequency spectrum similar to that shown by the broken line in Fig. 1: it is relatively strong at bass and treble frequencies. However, sensitivity of the human ear decreases at low and high frequencies, as is shown by the constant loudness-contour curve (the solid-line) in that figure. If the value of the constant loudness-contour curve is subtracted from that of the record surface-noise curve, it can be seen that the perceived noise is nearly flat as a function of frequency. From that, CBS concluded that noise reduction should be uniform at all frequencies. That differs from the approach used by Dolby for tape and FM broadcasting, largely because the noise spectra for those media are not the same as the surface-noise spectrum of a phonograph record.

The wide-band compression/expansion function shown in Fig. 2 was chosen by CBS for its system. The compression curve has a 2:1 gain for signals from above 0 dB reference level (5 cm/second lateral stylus-velocity at 1000 Hz) down to −40 dB. Since compression below −40 dB is not desirable because it would tend to raise the level of the background noise of the master tape above that of the surface noise of the record, the compression slope is rapidly changed to 1:1 below −40 dB.

If digital tape is used as the mastering source for a record, the perceived signal-to-noise ratio is *reduced* by the 20-dB compression, making it roughly

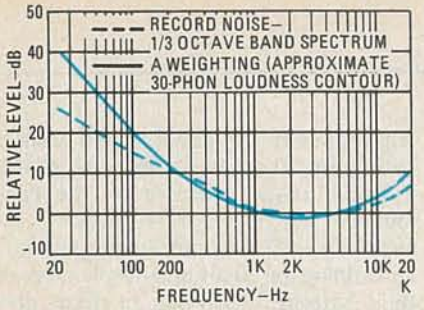


FIG. 1—WHILE RECORD SURFACE-NOISE is greater at bass and treble frequencies, the sensitivity of the human ear is reduced in those ranges. The overall subjective response is essentially flat.

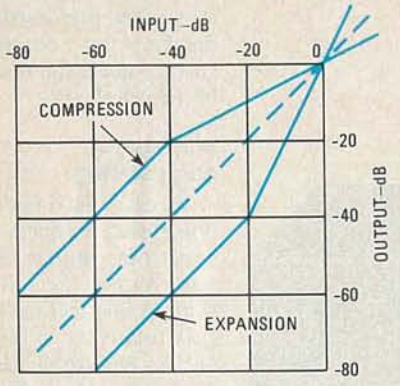


FIG. 2—COMPRESSION AND EXPANSION curves for the CBS noise-reduction system. The curves are complementary so that a processed signal will closely match the original program source.

equal to that of a conventional (unencoded) record. If an encoded record is played back without the benefit of a corresponding expansion circuit, changes in the dynamic gain of the master tape's noise tend to be masked by the continuous record-surface noise, making them all but inaudible to the listener. That effect is aided by carefully choosing the time constants that are used in the control circuitry of the system (more on that later).

Figure 2 also shows the expansion curve of the system. That curve is complementary to the compression curve so that a signal that undergoes the entire process of compression and expansion will match the original program source closely, but with 20-dB less noise. For proper operation, the system requires reasonably accurate tracking by the phono stylus. Not all phono cartridges deliver exactly the same level of output for a given stylus velocity in a record groove and for that reason it is possible for the reproduced signal to differ somewhat from the source material.

According to CBS, however, that effect has been found to be virtually unnoticeable for mismatches of up to 6 dB between the expansion and compression curves. Some of the *CX* expanders on the market offer a calibration adjustment so they can be used with virtually any stereo cartridge.

Expander

A block diagram of the *CX* expander is shown in Fig. 3; a representative schematic is shown in Fig. 4. Left- and right-channel signals from a *CX*-encoded record are fed directly to their respective variable-gain amplifiers. At the same time, those signals are processed by a control circuit whose output is the control voltage for the variable amplifiers. The control circuit consists of three distinct sections: a rectifier circuit with a preset threshold-voltage, a filter circuit, and a time-constant circuit.

Rectifier circuit

In the rectifier circuit, the combined left- and right-channel inputs are full-wave rectified before being passed on to a maximum-signal selection output. For signal values above the present threshold, V_C, the control circuit's output varies in direct proportion to the input-signal level. These changes control the amplification factor of the variable-gain stage. Together with the changing signal-levels at the variable-gain stage, the combined effect is an output that increases or decreases at a 2:1 ratio with respect to the input, when the level of that input is above V_C.

When the signal level falls below V_C, the control circuit's output no longer changes. Under those circumstances no expansion takes place between the input and output.

Filter circuit

The main filter-circuit (IC2-a, D6, R10, R11, and C3 in Fig. 4) is relatively fast, with an attack time-constant of about one millisecond and a release time-constant of about 10 milliseconds. Those time constants allow for rapid action of the control signal.

If the output of the main filter-circuit were used by itself as a control signal, the results would be unacceptable because noise, distortion, and pumping would occur. To avoid those effects, the multi-filter, multi-time-constant, circuit shown in Fig. 3 is used.

Multi filter/time-constant circuit

This circuit consists of four filters whose outputs are added together to form a single control-signal. Filter 1 is high-pass filter with a "dead band" (the filter ignores signals below a certain level) and a positive-peak rectifier; the filter has a time constant, T_1, equal to 30 milliseconds. Filter 2 is a low-pass type with a time constant, T_2, of 2 seconds. Filter 3 is a low-pass type, with a dead-band and a positive-peak rectifier; that filter's time constant, T_3, is 30 milliseconds. Finally, filter 4 is another low-pass type, with a dead band and a negative-peak rectifier; it has a time constant, T_4, of 200 milliseconds.

Filter operation

Filter 2 is used to insure minimum audible noise and signal modulation in steady, low-level, signals. If it were used alone, it would suffice for that purpose but would not respond adequately to rapid changes in musical content. That is the function of the remaining filters.

Filters 3 and 1 are used for musical-transient signals of short or medium duration. Filter 3 allows a fast attack to pass, and then begins its 30-millisecond decay. Even with good filtering ahead of this stage, its DC input will contain some ripple. If the ripple component is

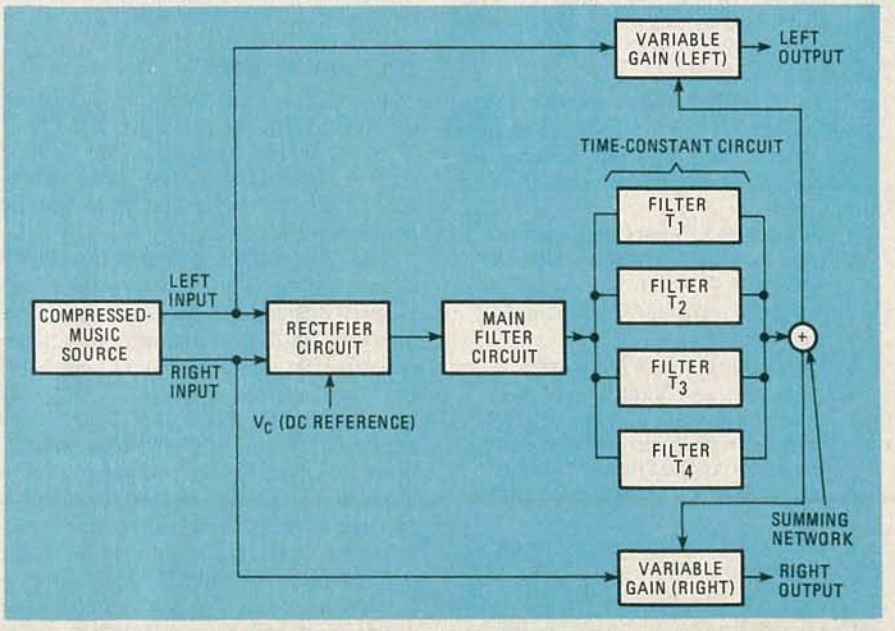


FIG. 3—BLOCK DIAGRAM of a *CX* expander unit. The input signal is fed to both variable-gain amplifiers and to a control circuit. The output of the control circuit (which consists of rectifier, main-filter, and time-constant circuits) is the control current for the variable amplifiers.

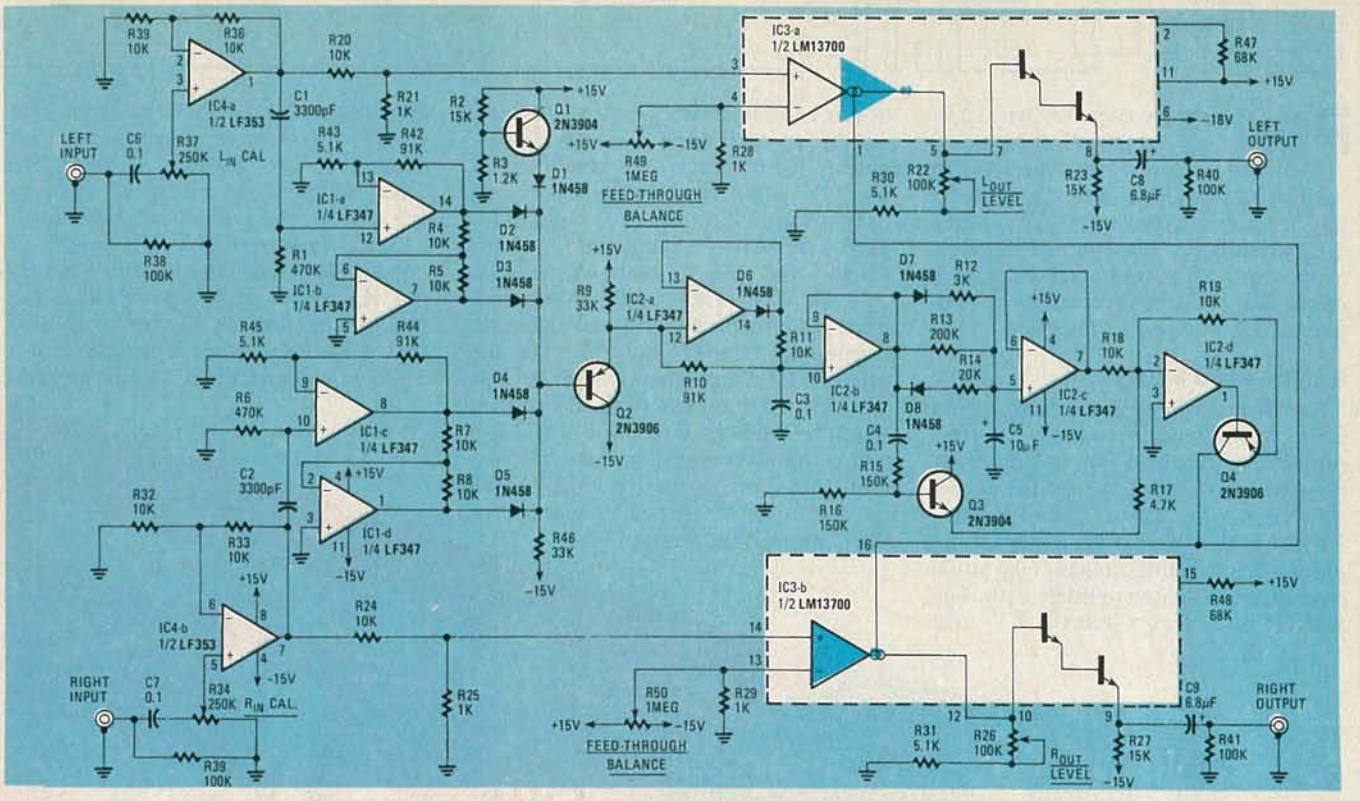


FIG. 4—THE OUTPUT of the time-constant circuit is buffered by IC2-c, and then summed by IC2-d and Q4, a voltage-to-current converter. The control current for the variable-gain amplifiers (IC3-a and IC3-b) is taken from the collector of Q4.

not removed, audible distortion will occur in the transient. Listening tests have confirmed that the human ear is not particularly sensitive to such distortion if its duration is less than 30 milliseconds. So filter 3 passes only the first 30 milliseconds of the attack-transient. If the signal continues for longer than 30 milliseconds, filter 1 takes over. It is a low-pass filter with a 30-millisecond time constant. When a sudden transient signal occurs, that filter will ignore the signal for the first 30 milliseconds, but will allow what comes after that length of time to pass. It will also remove nearly all of the ripple from such signals.

Filter 4 is used to control sudden decreases in signal levels. If such sudden decreases were not controlled, pumping or "breathing" would be heard. It's been demonstrated that the human ear is not sensitive to pumping during a rapid decay of not more than 200 milliseconds. Filter 4 allows the circuit to track the decay for that length of time. After that period, at the time when the listener would begin to notice the decay, control is taken over by filter 2. That filter, thanks to its two-second time constant, keeps the noise-level relatively steady.

According to CBS engineers, the overall combination of the four filters allows their system to operate effectively with music signals that would be considerably more difficult for other noise reduction or companding systems to handle.

An obvious advantage of the system is the compatibility claimed for it. If the encoded version of a given piece of music is indeed virtually indistinguishable from the conventional pressing of the same material, CBS Records, or anyone else using the *CX* system, will have to produce only one type of recording in the future. The casual music listener can then listen to that recording on his ordinary phonograph or hi-fi component-system as he normally would. The more serious audiophile, on the other hand, will be able to add a relatively inexpensive expander accessory to his stereo system and enjoy the full benefit of an additional 20 dB of noise reduction.

It is interesting to note that CBS has proposed that its new companding system be incorporated in any multi-channel TV-audio system that might be approved by the FCC in the future. Transition to stereo audio (or multilingual audio), regardless of which of the proposed systems is chosen, is bound to result in some degradation of audio signal-to-noise ratios for many viewers within a TV station's service range. The incorporation of a companding system at the outset would help to offset that degradation. Furthermore, since the CBS system is claimed to be compatible, those viewers who continue to watch the future "stereo" TV programs over their mono TV receivers would not notice any difference in audio quality. Other noise reduction systems that have been suggested for TV stereo-audio include a modified, compatible form of the linear *dbx* companding system and the newly developed *Dolby C* noise-reduction system (see the May issue of **Radio-Electronics**) from Dolby Laboratories. **R-E**

"Mmmmm—what smells so good?"

Synthesized RF Generator

GARY McCLELLAN

In the concluding part of this article we'll finish building the Programma 2 synthesized RF generator, calibrate it, and present some hints on using it.

Part 3 IN THIS PART WE'LL FINish up the Programma 2, calibrate it, and put it to use. All the hard work is already done, so all that's left are a few easy things like stuffing the switch board, and putting the electronics in a case. Let's get started by discussing the circuitry on the switch board before we put it together.

Switch board theory

Surprisingly enough, the switch board isn't absolutely necessary in this project! A three-position switch could be used in its place to select the proper VCO, serving as a "bandswitch." However that isn't a very elegant approach to selecting ranges, and you'd have an extra switch to fiddle with. Top that off by realizing that the IC's cost about the same as a decent switch, and you'll want to build the board.

Basically, the switch board, whose schematic is shown in Fig. 13, is nothing but a decoder circuit. It plugs into J101 on the control board, and decodes the BCD signals from the 10-MHz and 1-MHz positions on the switches. The decoded signals then turn on one of three transistors on the VCO board, applying power to the correct VCO circuit.

In operation, BCD data from the 1-MHz switch position is supplied to the switch board, and drives display decoder IC301. Although the IC was designed to drive an LED display, it can decode in other ways, too. When binary-coded-decimal inputs of "3" or "4" are applied to the decoder, the "b" and "g" segment outputs are high, while the "e" segment is low. Gates IC302-a and -b detect those conditions, and the output at pin 1 of the IC goes low. Since those conditions also apply to a "9" input, gate IC304-a detects that condition via the "D" input, and prevents decoding of that value. Pin 1 of IC302-b drives inverter IC304-c, which puts a logic "high" on gate IC303-b whenever a "3" or "4" switch input is decoded. That "high" passes through the gate, turning on transistor Q302. On the other hand, if any other number besides "3" or "4" is applied to the decoder, it won't be decoded, and pin 1 of IC302-b will be high. That goes to gate IC303-a, and turns on transistor Q301. That takes care of the decoding scheme for the 1-MHz switch position.

Decoding the 10-MHz switch position is easier. Gate IC304-b detects a logic "high" on either the "A" or "B" inputs. When that happens, as it would if the switch were set to "1," "2," or "3," the output of IC304 goes low. That shuts down gates IC303-a and -b making transistors Q301 or Q302 turn off. At the same time, the pin-4 output of IC304-b is inverted by IC304-d, turning on transistor Q303. Thus, the 10-to-30 MHz VCO is selected.

The remaining components on the board are strictly for protection, and can save the IC's if the cable to the control board is plugged in backwards.

Switch board construction

Assembling this board is easy, and the whole thing should take little time. The foil pattern is shown in Fig. 14. Note that all the parts are common, and should be easy to get if you don't have them. That makes this phase of the project a good candidate for a Sunday afternoon when all the stores are closed. Refer to Fig. 15 for details as you stuff the board.

Start by positioning the board as shown. Then begin by installing the 16-pin IC socket at IC301. Position the notch indicating pin 1 pointing up. (Do that with the rest of the sockets, too.) Then install the three 14-pin sockets. Check to be sure you've soldered all connections.

Continue with the resistors. Install six 100K units at R301 through R306 as shown, near the left side of the board. Then install a 10K resistor at R307. Bend the leads as shown, and insert into the board. Below it, install another resistor at R308. Finish up by installing a 10K unit at R309. Again, bend the leads as shown, and then insert them into the board. Note that "spaghetti" tubing over the leads is unnecessary.

Note that the two jumpers run between the ICs. Use leftover resistor leads for the jumpers, if you wish. Install the jumper that runs horizontally between IC301 and IC304. Bend the wire into shape first, and then insert it into the board. Pull the wire tight against the board before soldering. After that, install the vertical jumper in the same

manner. Be sure to pull it tightly against the board so that it can't touch the first jumper.

Now for the transistors. Note that they are all 2N3904's, and that they all mount facing in the same direction. Mount Q301 first, with the flat side in the case pointing up. Then mount Q302 below it in the same manner. Finally, mount Q303 near the bottom of the board, with the flat side pointing up.

Install a 1N4148 diode at D301 as shown, with the banded end pointing toward the center of the board. Then install a 0.1 μF disc at C301 between the transistors. That takes care of the component installation on the board.

Finish up with the cables, starting with the input cable—the one with the plug on it. Cut about a six-inch piece of 8-conductor ribbon cable, and prepare the ends. Then prepare the 8-pin DIP header PL101. Solder the wires to it in order, and snap the cap in place.

Connect the other end of the cable to the board as shown in Fig. 15. (You may want to check out the connections with an ohmmeter.) Once the input cable has been installed, you can procede to the output cable. Cut about an eight-inch length of 3-conductor ribbon cable, and prepare the end. Install the wires in the holes near the transistors as shown in Fig. 16. You should make a note of where the wires go, for future reference. That completes the board wiring.

At this point you can install the IC's. Refer to Figs. 15 and 16.

Final assembly

The time has come to install the boards in a case and to connect the cables. But first, a few comments about the cabinet you should use. The prototype used a leftover cabinet from a piece of medical equipment. It's not available commercially but you can probably do just as well with an "off the shelf" product. When you shop for a cabinet, look for one that is at least 3 inches by 8 inches wide by 7 inches deep. That was the size of the prototype's cabinet, and is just right to hold the boards. Also, it should be all metal for shielding. If you use a plastic cabinet, the unshielded electronics may interfere with sensitive measurements. Knowing those two requirements, you are all set to visit your electronics supplier and make a selection. You might even want to use a plain chassis box to keep costs down. If painted and labelled carefully, the box can look better than most cabinets!

Once you have a suitable cabinet you can lay out the boards and controls. Probably the best arrangement is the simplest, so you might want to copy the layout shown in Fig. 17. Otherwise, just be sure to space the control and VCO boards as close together as practical; the rest isn't critical.

Here are some tips to make the board layout easier. The only areas to be concerned about are the front panel and the bottom. Since the front panel holds only five parts, it's not a problem. That leaves the bottom of the cabinet. Position all three boards on it to determine where to mount them; then use the boards themselves as templates to mark the mounting holes.

Be sure to allow extra room at the front of the cabinet for the switches. About three inches of clearance should be the minimum. Also, if you can, mount the switch board near the front on the bottom of the cabinet. That allows easier access to the control board, which was partly covered by the switch board in the prototype—not such a good arrangement from a service standpoint. With those suggestions, board placement should be easy to determine.

The next step is to machine the cabinet. You can start with the bottom of the cabinet by drilling out the mounting holes for the boards. Then drill a hole in the rear panel for the power cable. It may be necessary to enlarge it so that a grommet can be installed to protect the cable. (We used a plastic strain-relief salvaged from a junked appliance.) You can now drill the front panel. Generally, it will be necessary to clamp the panel in a vise so the holes can be drilled accurately. Be sure to protect the panel's finish by placing a piece of cloth between it and the jaws of the vise. When it comes to making the cutout for the FREQUENCY SET switches, probably the best way is to drill small holes around the

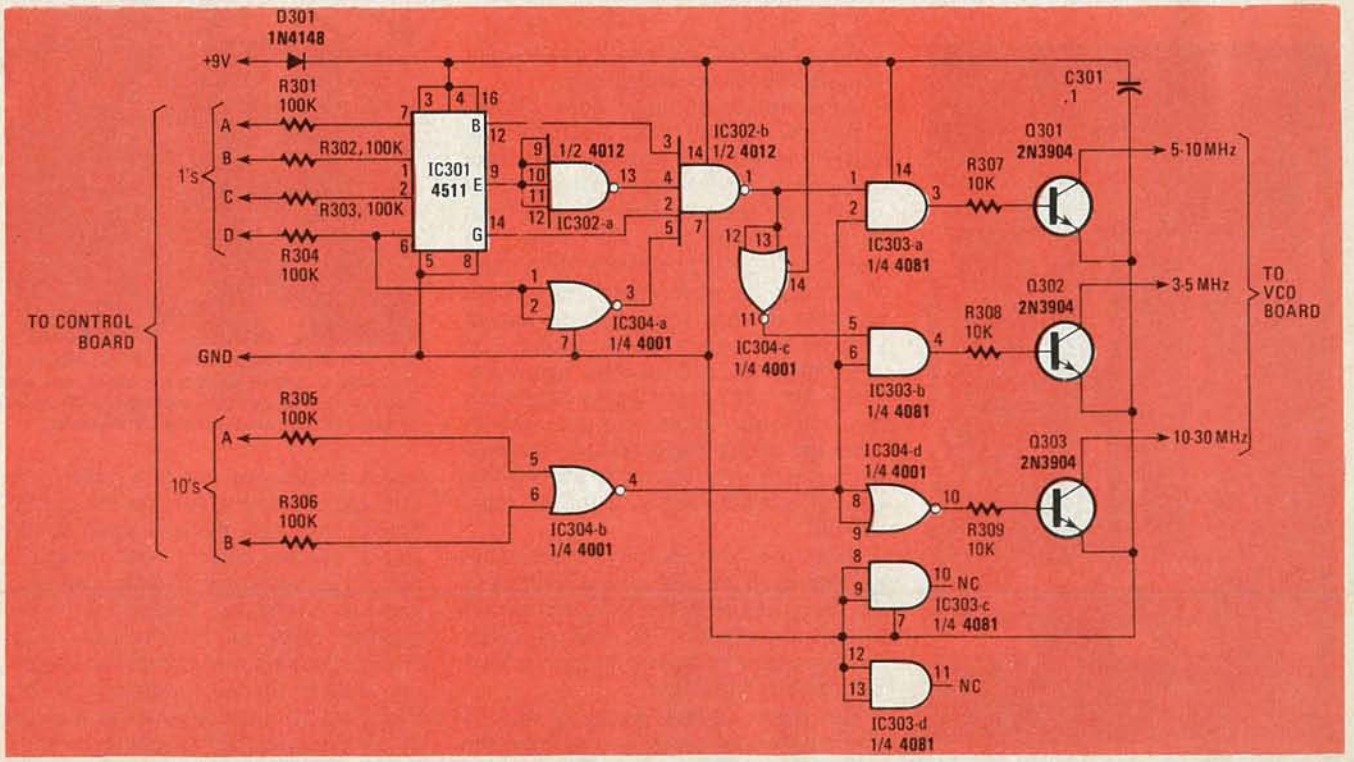


FIG. 13—A SEVEN-SEGMENT LED DECODER, IC301, is put to a rather unorthodox use on the switch board. Its segment-output states determine which of the generator's VCO's will be active.

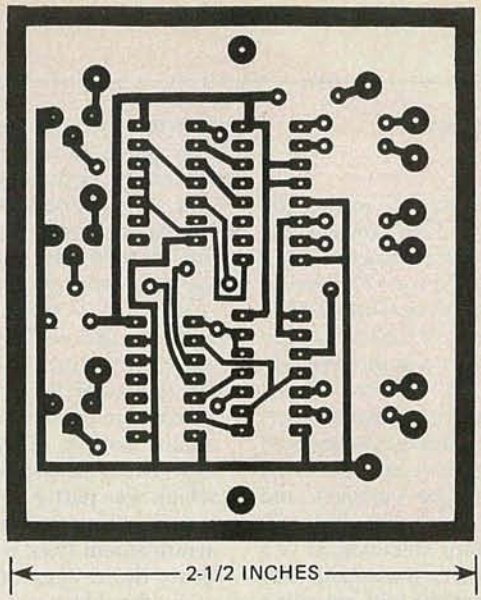


FIG. 14—FULL SIZE FOIL PATTERN for the switch board. Large pads are used to make off-the-board connections.

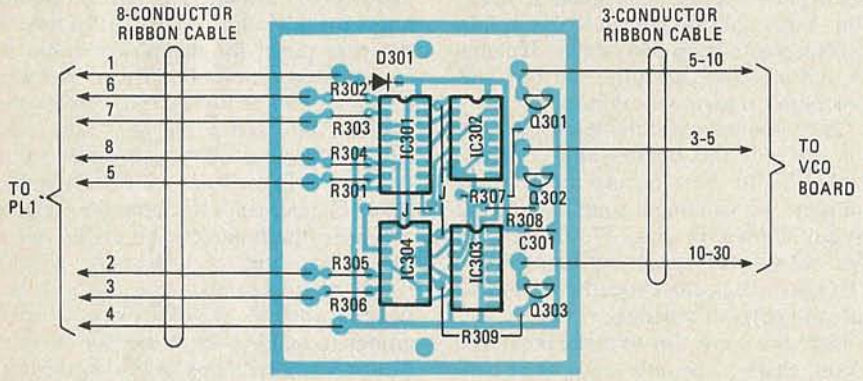


FIG. 15—EIGHT-CONDUCTOR RIBBON CABLE is used between the board and PL1. The plug itself is an 8-pin DIP header. If you can't locate one, cut down a 14- or 16-pin header.

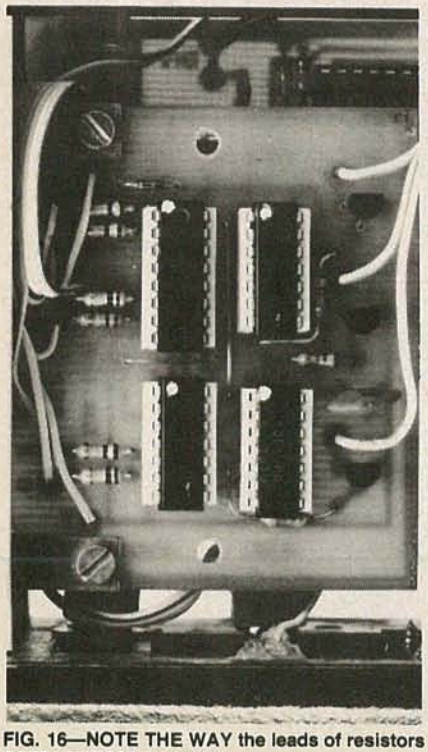


FIG. 16—NOTE THE WAY the leads of resistors R307 and R309 are bent.

inside of the outline, knock out the center, and file the opening to size.

After the holes have been drilled, scrub the cabinet with detergent and water to remove any grease. Then rinse and rub it dry. Next, label the front panel with press-on letters, label tape, or anything else you care to use. We used press-on letters successfully, and you can do the same. One thing, though, and that is when you get to the RANGE switch, use *several* labels. Include 3-30 MHz below HI, and 0.3-3 MHz below LO. The extra labels make the RANGE switch easier to use. Other than that, simply label the controls according to the prototype. Be sure to cover the labels with a coat of acrylic spray so that they don't rub off.

Once the spray is dry you can install the boards in the cabinet and hook them up. You can install the VCO and switch boards immediately, but hold off on the control board because a few wires must be connected to it first.

Cut three six-inch pieces of RG-174 50-ohm coaxial cable, and prepare the ends. Don't substitute ordinary mike cable for this miniature coax—it's too

PARTS LIST—SWITCH BOARD

All resistors ¼-watt, 5%
R1—5000 ohms, potentiometer, linear taper with switch
R301-R306—100,000 ohms
R307-R309—10,000 ohms
Capacitor
C301—0.1 F, 16 volts, ceramic disc
Semiconductors
IC301—CD4511 CMOS 7-segment latch/decoder/driver
IC302—CD4012 dual 4-input CMOS NAND gate
IC303—CD4081 quad 2-input CMOS AND gate
IC304—CD4001 quad 2-input CMOS NOR gate
Q301-Q303—2N3904 or equivalent
LED1—jumbo red LED
D301—1N4148 or 1N914
S5, S6—SPDT toggle switch
T1—wall-plug transformer, 12 volts, 600 mA
PL1—8-pin DIP header
J1—BNC connector, chassis-mount
Miscellaneous: PC board, IC sockets, ½-inch threaded standoffs, metal enclosure (see text), knob, RG-174 coax, ribbon cable, etc.

A complete set of three boards for the Programma-2 is available for $22.00 ppd. from: Technico Services, PO Box 20HC, Orangehurst, Fullerton, CA 92633. CA residents please add 6% tax; foreign orders please add $3.00 for shipping. Order No. SSG-1.

A complete set of *parts*, excluding boards, crystal, transformer and case, is available for $112.00 ppd. from: Circuit Specialists, Inc., PO Box 3047, Scottsdale, AZ 85281. Order No. KT-5. Phone orders (800) 528-1417; all other inquiries (602) 966-0764. AZ residents please add tax.

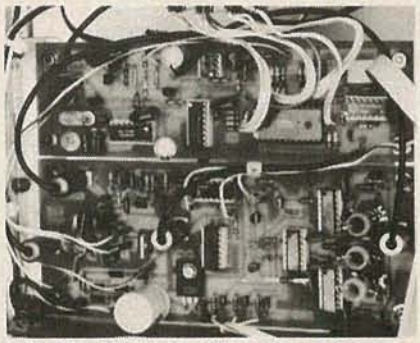


FIG. 17—CONTROL AND VCO BOARDS are mounted side-by-side. Switch board, not seen here, sits above coils at lower right. BCD thumbwheel-switches are visible at top of photo.

lossy. Solder one end of a cable to the VCO pads (below Q101) on the control board. Note that there is a pad for the shield of the cable, even though it doesn't go anywhere. That is intentional and not a mistake. Solder one end of another cable to the DIV pads (near C101). Connect one end of the remaining cable to the MOD pads (near R128). Finish up by cutting two six-inch pieces of hookup wire, and stripping the ends. Solder one wire to the PWR pad (above C106), and the other to the −2V pad (at

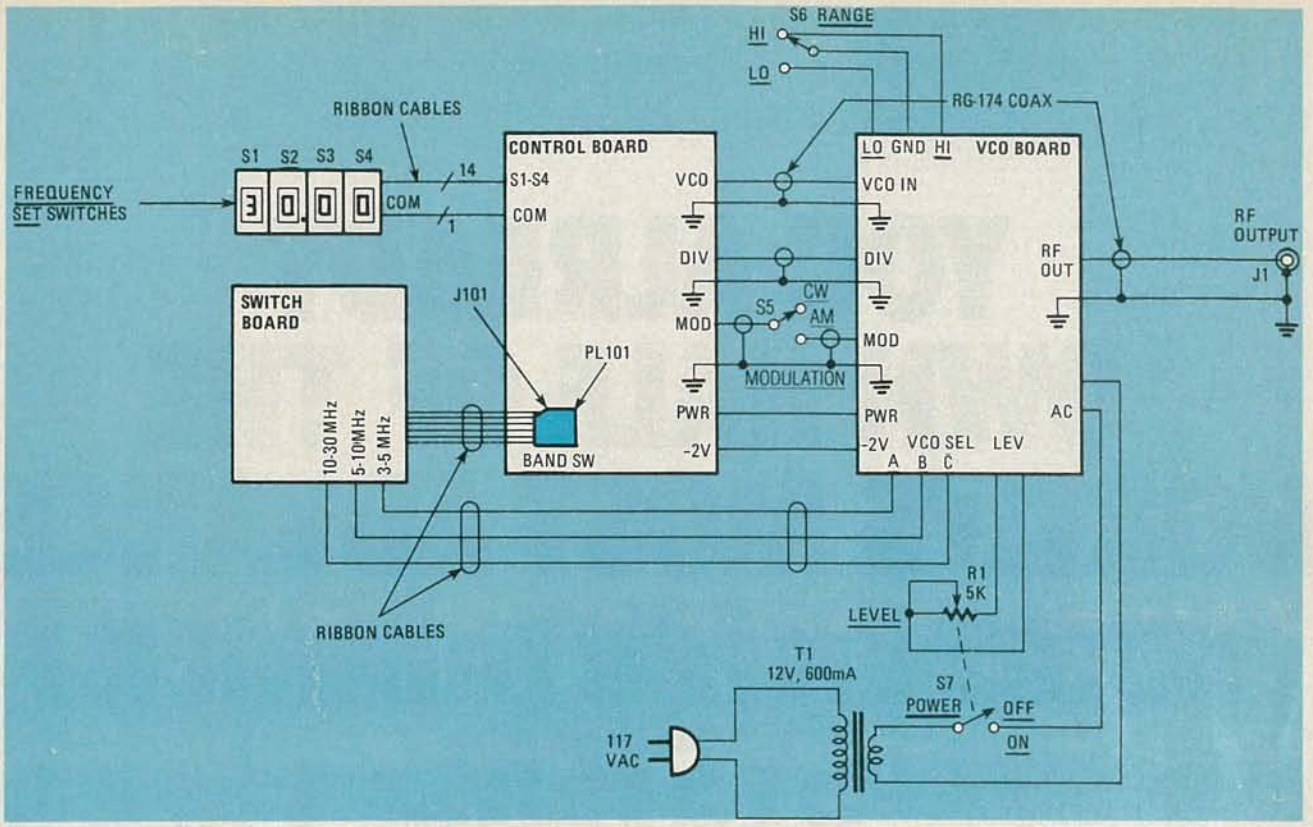


FIG. 18—INTERCONNECTIONS between *all* boards. Extensive use of color-coded ribbon cable keeps things neat and makes circuit-tracing easy.

R127). That takes care of the control board, and you can now mount it in the cabinet.

The last construction step is to interconnect the boards. Refer to Fig. 18 for details as you make the connections. Start by attaching RCA-type phono plugs to the ends of the coax cables from the control board. Then plug each one of them into the appropriate jack on the VCO board. Next, connect the leads from PWR and −2V pads on the control board to the appropriate terminals on the VCO board. Double-check to be sure they go to the right places; otherwise you may damage the control board. Connect LEVEL pot R1, and power switch S7. Wire up the pot first, using hookup wire to connect it to the board. Then wire up the power switch. If you use an external wall-plug type transformer, all that's necessary is to wire the switch in series with the VCO board and transformer. If you can't find such a transformer, and use an internally-mounted unit, switch the transformer's primary instead.

Next is the RF OUTPUT jack. Cut a piece of RG-174 coax long enough to reach from the jack to the RF OUT jack on the VCO board. Then attach an RCA plug to one end of the cable and plug it into the VCO board. Solder the other end to the jack, and *be sure to make a good ground connection.* That is important because that connector is the *only ground* in this project! Connect the RANGE switch, S6, by running three pieces of hookup wire from it to the VCO board. (Ribbon cable is great for that!)

Finish up with the switch board connections. Plug PL101 into the 8-pin socket on the control board, and then connect the three wires to the corresponding pads on the VCO board.

That completes the construction. Double-check your work and correct any problems you find before applying power.

Calibration

In all probability, the Programma 2 will work pretty well the first time power is applied, without any calibration. Still, a few adjustments are required to insure that you can get all frequencies set by the switches, and to set the modulation level and get the best accuracy. To make the adjustments you'll need either a receiver with 10-MHz WWV capability, or a frequency counter. For tools you'll need a hex alignment-tool for the coils, and a small screwdriver.

The first step is to set the frequency range of the VCO's. That means that the coils must be adjusted so that the VCO's cover 3-5 MHz, 5-10 MHz, and 10-30 MHz. The front ERROR lamp will show when the coils are adjusted properly.

Make the adjustments in this order: Set the switches to "03.00" and turn on the power. The ERROR lamp may be lit or flickering. If it isn't, adjust L203 on the VCO board until it shows some sign of life. Then adjust the coil until the lamp goes out, and keep turning the core for about ½-turn more. Switch to "04.99," and check the lamp; it should blink and go out. If not, back off the core slightly. The lamp should now blink and go out for switch settings of "03.00" through "04.99."

Set the switches for "05.00." Again, the ERROR lamp may be lit or flickering. If not, adjust L202. Then adjust the core until the lamp goes out, and turn the core about ½ turn more.

Now switch to "09.99," and check the lamp. It should blink, and then go out. If not, back off the core slightly. The lamp should blink and go out for switch settings of "05.00" through "09.99."

Set the switches for "10.00." The ERROR lamp may be lit or flickering. Adjust L201 for some indication. Then adjust the core so that the lamp goes out, and turn it about ½-turn farther. Switch to "30.00" and check the lamp. It should blink and go out. If it doesn't, back off the core slightly. The lamp should blink and go out for switch settings of "10.00" through "30.00" MHz.

That takes care of the VCO frequency-range adjustments. Now for the modulation-level adjustment. It can be made with an ordinary AM table-radio. Otherwise, you can use a shortwave receiver set to about 3 MHz. Here's how to make the adjustment:

Set your receiver to a clear frequency. Set the FREQUENCY SET switches to the same frequency. Then flip the MODULATION switch to AM. Connect a piece of

continued on page 77

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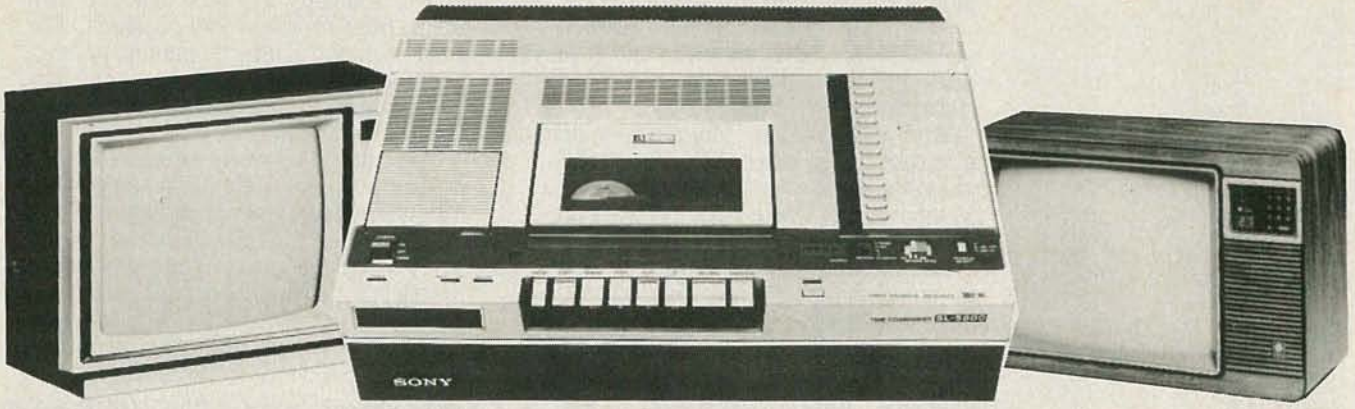

How to Connect your VCR to More than One TV

A MATV system can be used to distribute program material from a VCR. Here are some suggestions for getting the most out of a combination of the two.

JAMES E. KLUGE

THERE'S LITTLE DOUBT THAT VCR'S (*VIDEO CASSETTE RE*corders) are here to stay. With their tremendous popularity (sales of over one million units are expected this year alone), VCR's are appearing in more and more homes and places of business.

In most cases a VCR is connected to a single television set, but what happens when you want to connect more than one set to a VCR? Since a VCR both accepts and generates signals that are equivalent to those used by TV receivers, it can generally be connected to an MATV (master antenna) system. Here are several recommendations for integrating a VCR into an MATV setup.

Connecting a VCR to a single TV set

Most VCR's offer a choice of output on either channel 3 or channel 4 (some also have channel-5 or channel-6 outputs); the output channel you choose will depend on the channels not in use in your area.

The VCR is most likely to be located next to the most-used TV set in the house. VCR's usually have a built-in VHF/UHF tuner; the VHF input is 75 ohms, and the UHF input is 300 ohms. The VHF hook-up is made by connecting the 75-ohm VHF antenna lead to the VCR's input and the unit's switched-output (tape or off-the-air) to the TV-set's VHF antenna-terminals.

While most VCR's also accept UHF signals, there sometimes isn't any provision included for bypassing the video cassette recorder so that you are able to view those signals directly. In that case, you will need to use a signal splitter as shown in Fig. 1.

MATV hookup

If you wish to connect additional sets to a VCR, the best way to go about it might be to tie the VCR and the sets into an MATV system. That will provide extra benefits, including the option of restricting the VCR signals to only certain outlets or TV sets.

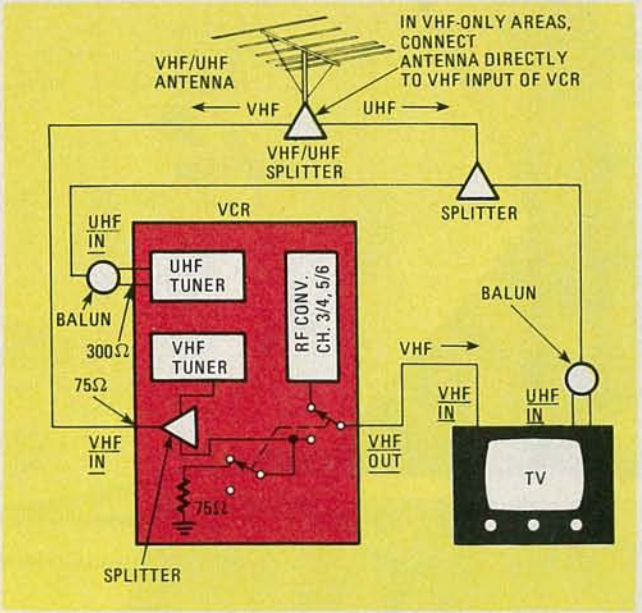

FIG. 1—THIS IS HOW a VCR is connected to a single television set. In the case of some VCR's the UHF signal must be split as shown if you wish to watch it directly.

A small MATV/VCR system is shown in Fig. 2. First of all, the output from the VCR should be injected at the headend (the point where the signal enters the system—the lead from the antenna in this case) instead of being connected directly to the TV receiver as was the case in Fig. 1. If there is a blank channel in your area that corresponds to the VCR's RF-converter frequency (and does not have an occupied channel adjacent to it), then a simple two-way splitter connected in reverse is adequate to combine the VCR- and off-the air-signals at the headend.

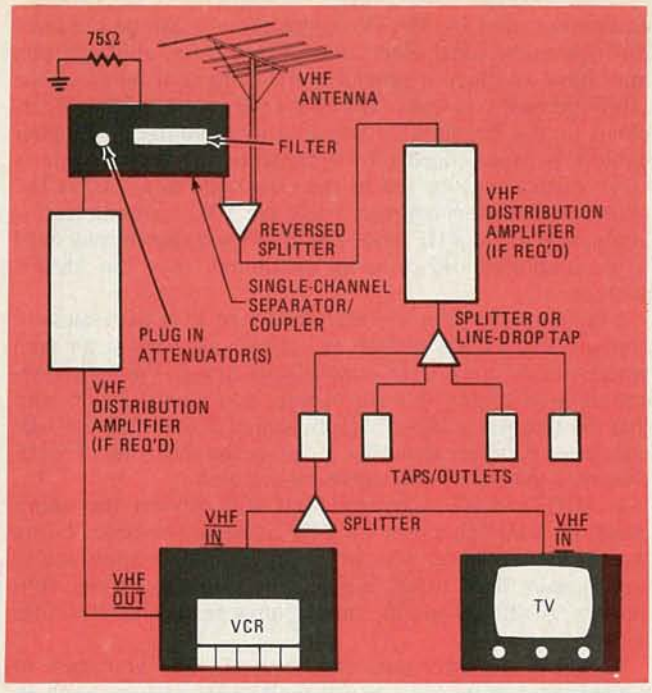

FIG. 2—IN A SMALL MATV/VCR SYSTEM, the output of the VCR's RF converter should be injected at the headend. The setup shown here is recommended if there is an adjacent-channel interference problem.

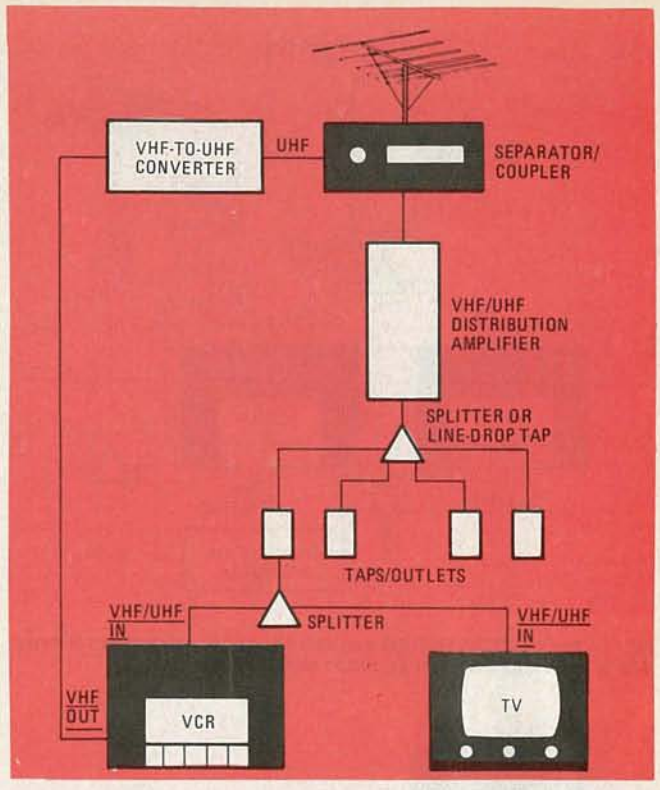

FIG. 3—A VHF-TO-UHF CONVERTER can be used in situations where a co-channel interference problem exists. In areas where UHF channels are in use, make sure that the output of the converter is higher in frequency than any of those channels.

Adjacent channels

If you have an *adjacent-channel* situation, where an off-the-air signal may interfere with that from the VCR—or vice versa—a single-channel separator/coupler with a plug-in filter tuned to the VCR's RF-converter frequency, and isolated from the adjacent-channel source by a two-way splitter, will be required. That is the set-up shown in Fig. 2. In a typical example, channel 4 might be in use in the area and the VCR's output selected to be on channel 3. The channel-3 bandpass filter will confine the sideband energy of the channel-3 signal so it will not interfere with the channel-2 or channel-4 signals arriving at the TV tuner. The isolation provided by the splitter will reduce adjacent-channel loading of the filter. It will also serve to minimize any possible radiation of the VCR signal by the antenna, something the FCC frowns upon.

In the system shown in Fig. 2, instead of going directly to the TV receiver, the VCR's output goes back to the headend through a distribution amplifier. The receiver gets its signal from a wall outlet or wall tap via a splitter which is used to feed both the VCR and TV-receiver inputs. To minimize losses, the splitter is located between the wall outlet and the TV equipment. If the VCR's output were split and sent to both the receiver and the headend, that would mean an additional splitter in the circuit. The insertion loss of that splitter, coupled with the loss from the VCR's internal splitter, might weaken the signal enough to produce a snowy picture. Furthermore, programs could not be viewed off-the-air while the VCR was in the play mode.

The signal level from the wall tap or outlet must be high enough to overcome the 3 ½-dB insertion loss of each splitter. For the system shown in Fig. 2, the signal must survive the losses caused by the splitter inside the VCR, and by the splitter between the wall outlet and the VCR—a total of 7 dB—and still be strong enough to provide an adequate signal level at the VHF tuner of the VCR. A distribution or line amplifier may be required after the headend, and/or at the output of the VCR, to overcome the losses introduced by the splitters.

Another important point to keep in mind is that optimum adjacent-channel reception is possible only when the signals on the adjacent channels are equal in level. In many cases, in-line or plug-in pads (attenuators) will be required to balance things out.

Co-channel problems

Suppose you live in an area where both channel 3 and channel 4 (or 5 and 6) are in use. What do you do when your VCR also uses those channels for output to a TV receiver? That is known as a *co-channel* problem and can be handled only by converting the VCR's channel-3 or channel-4 output to a UHF channel, which requires a VHF-to-UHF converter as shown in Fig. 3. The converter is a common piece of

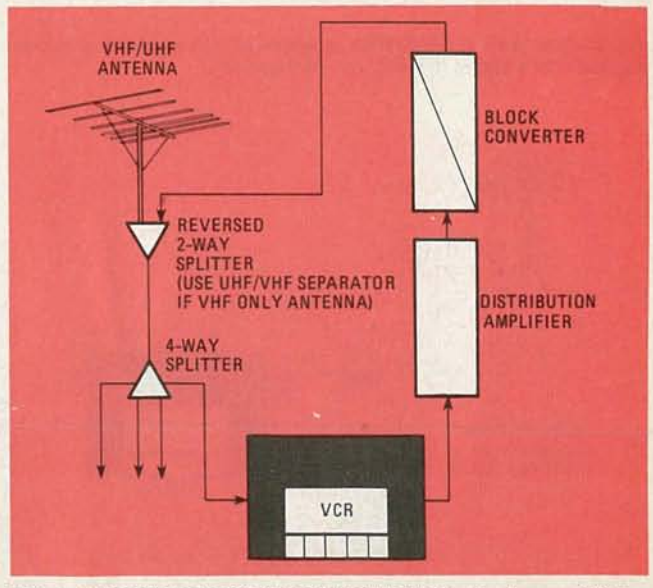

FIG. 4—IN SOME CO-CHANNEL INTERFERENCE situations, a VHF-to-UHF block converter is more economical to use than several single-channel converters.

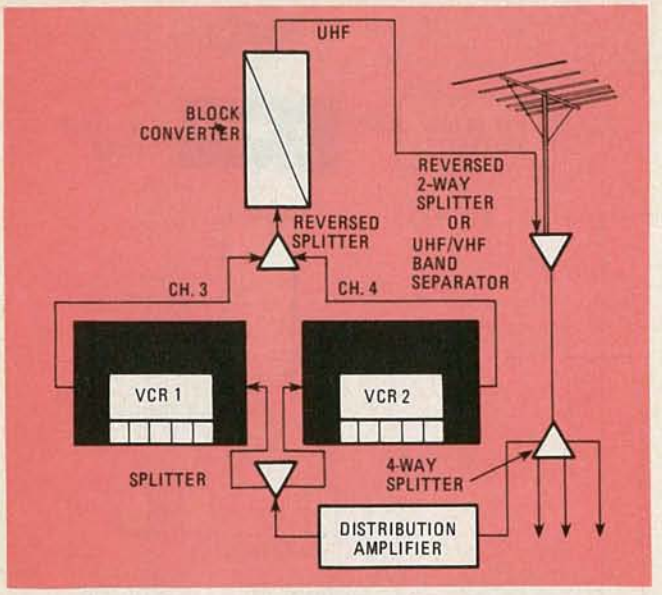

FIG. 5—BLOCK CONVERTERS can also be used to connect two or more VCR's to an MATV system as shown here.

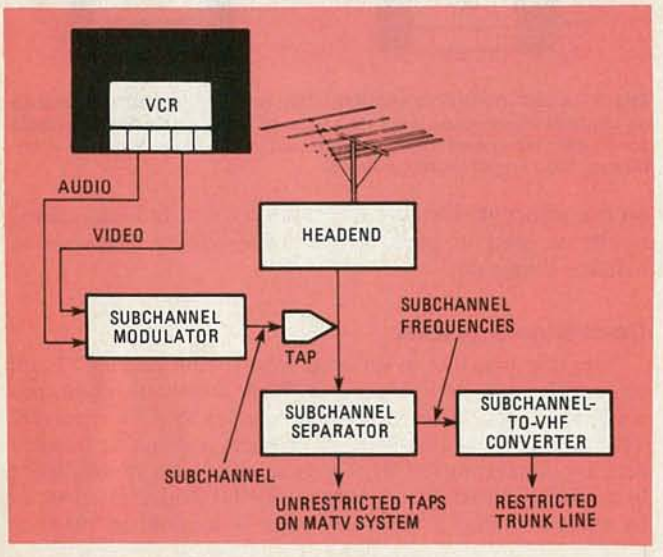

FIG. 6—ONE WAY TO RESTRICT reception of VCR programs is to convert the VCR's output to a subchannel frequency.

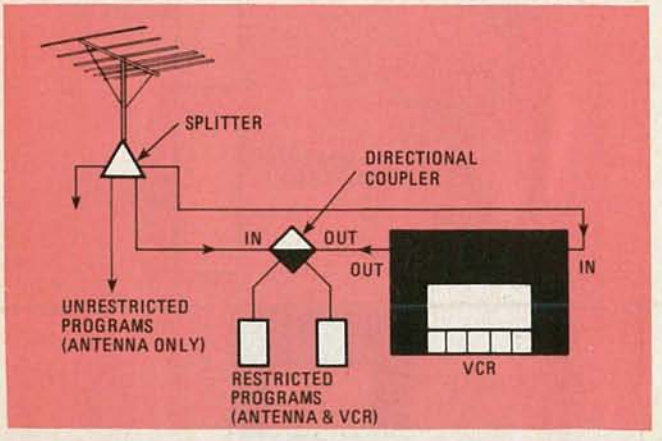

FIG. 7—A DIRECTIONAL COUPLER can also be used to limit who can watch VCR programs. In the arrangement shown here, only the sets connected to the coupler's taps can receive the signal from the VCR.

equipment used by MATV contractors. It can be obtained through many local electronics distributors, although you may have to place a special order to have it tuned to the UHF channel you want. The converter should be located as close to the headend as possible to minimize the higher cable-loss experienced at UHF frequencies. The converter's UHF output may be fed to the UHF-side of a VHF/UHF splitter (separator)-coupler, while the VHF antenna-lead is connected to the VHF-side. The combined signals may need to be amplified before being distributed over the MATV system.

You may run into a situation where it is necessary to convert the VCR's output to a UHF channel in an area where one or more UHF channels are in use. For maximum coupling-efficiency in such a case, you should make sure that the frequency of the output-channel of the VHF-to-UHF converter is higher than that of any of the over-the-air UHF channels that reach the separator-coupler.

A VHF-to-UHF converter that will convert the entire block of VHF channels to UHF is also available. Using that block converter may be a less expensive approach in some cases than using factory-tuned single-channel converters. A setup using the block converter is shown in Fig. 4.

A block converter can also be used when you want to connect two or more VCR's to the MATV system. Such an arrangement is shown in Fig. 5.

Restricted programs

Now that we have discussed some of the interference problems that you may encounter, let's consider the case where you may want only one or more selected TV sets on the MATV system to be capable of receiving programs from your VCR. There could be many reasons for needing that capability. In an industrial or commercial setting, it may be for security; at home, there might be movies or programs unsuitable for younger members of the family. In either case the basic solution is the same, although there can be variations depending on the particular situation.

One approach is to put the VCR program-material on a *subchannel* frequency. To do that, the audio and video outputs of the VCR (*not* the RF-output) are fed to a subchannel modulator to provide a modulated RF signal on one of three HF—*H*igh *F*requency—channels (channel A: 18-24 MHz; channel B: 30-36 MHz, and channel C: 42-48 MHz). Then—as shown in Fig. 6—at some point ahead of the TV sets that are intended to receive the VCR program, a subchannel separator picks off the subchannel program from the MATV trunk-line and applies it to subchannel-to-VHF converters that feed only those TV sets intended to receive the VCR programs.

Another approach is to convert the VHF output from the VCR to a UHF channel. Then, either place traps tuned to eliminate that channel in the line that feeds the sets that you do not wish to receive the VCR signal, or disable the UHF tuners in those sets. If there are only a few sets involved, traps tuned to the VCR's *VHF* output-channel can be placed in the lines feeding the TV sets you do not wish the VCR signal to reach.

A directional coupler can also be used to restrict viewing. An arrangement using such a coupler is shown in Fig. 7. Signals from the VCR are applied to the feedline *output* of the coupler; signals from the antenna are fed into the input. Approximately 30 dB of isolation prevents the VCR's signals from reaching the input jack, but TV sets connected to the coupler's taps will be able to receive those signals, as well as those from the antenna. No other sets in the MATV system will receive signals from the VCR.

How you eventually set up your MATV/VCR system will, of course, depend on your specific requirements. But whatever form the system takes, you can be sure that following these suggestions will help you get the most out of it. **R-E**

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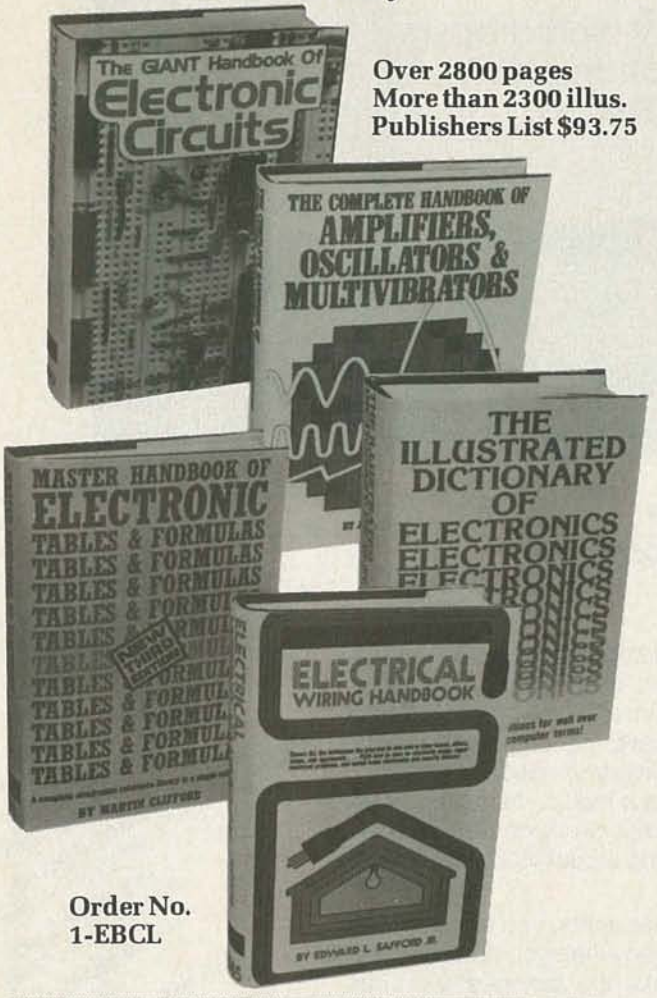

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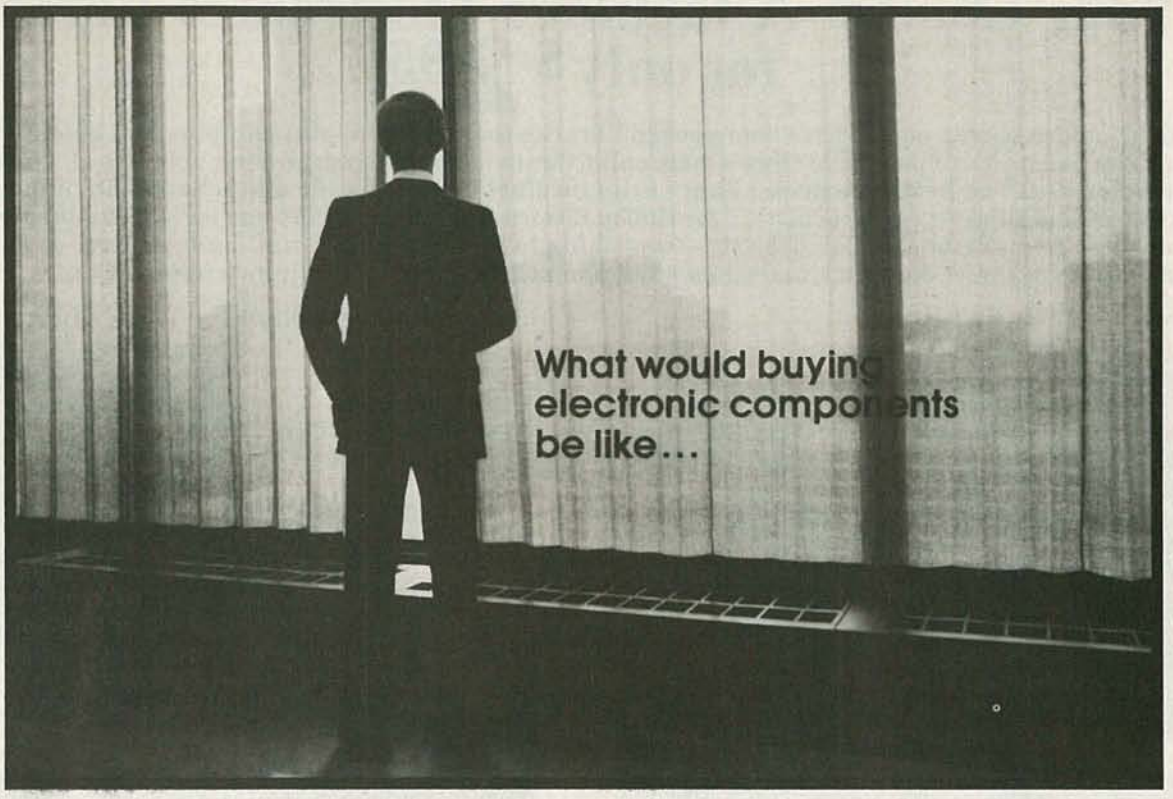

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RF GENERATOR

continued from page 69

wire to the RF OUTPUT jack, and advance the LEVEL control. Tune in the signal on your receiver carefully. Adjust the pot on the control board for a clean-sounding tone, then turn the pot until the tone sounds rough. Back off the adjustment so that the tone sounds clean again. That completes the modulation adjustment.

The last step is to adjust for the best frequency calibration. You can either use a counter for that, or station WWV at 10 MHz. Here's how to do it:

Put the MODULATION switch in the CW position, and the RANGE switch to HI. Then set the FREQUENCY switches to "10.00." Connect a piece of wire to the RF OUTPUT jack for an antenna if you are using a receiver for calibration; otherwise, connect a frequency counter to the jack.

If you are using a receiver for calibration, tune in WWV at 10 MHz. Advance the LEVEL control on the RF generator until you can just hear its carrier beating against WWV's 10-MHz signal. Then adjust the trimmer on the control board for the lowest-pitched beat note. There may be a slight warble in the project's carrier; that is a normal characteristic of synthesized RF-generators, and some care will be required to find zero beat.

If you are using a counter, simply adjust the trimmer on the control board until you read 10.000 MHz.

Using the Programma 2

Using this RF generator is a snap because there are so few controls. A few comments on the key controls, though, are in order.

Remember that the range of the FREQUENCY SET switches is "03.00" to "30.00" (MHz). If you exceed those limits, the ERROR lamp will come onto remind you that the frequency is wrong.

The RANGE switch selects direct, or divided-by-10, output frequencies. Use the HI position for outputs of 3 to 30 MHz, and LO for 300 KHz to 3 MHz. Typically, the HI position will be used for RF-stage and mixer-alignment of receivers, while the LO range will be used for IF alignment.

The ERROR lamp serves as a visual reminder that the output frequency is *not the same* as that indicated by the FREQUENCY SET switches. In normal operation, it should blink once when the frequency is changed. If a value is selected outside the range of the FREQUENCY SET switches, it will stay lit, alerting you to your mistake.

To use the Programma 2, simply select the desired frequency and range. Then adjust the LEVEL control as necessary. If you are working on a receiver, tune in the signal on the receiver first; then adjust the LEVEL control as required.

If you must work with low-level signals, insert a 50-ohm attenuator at the RF OUTPUT jack and then set the attenuator for the desired output level. That may not always be necessary, as the RF output of this project with a 50-ohm load ranges from 10 mV to 300 mV. **R-E**

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EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

JUDGING BY THE MAIL, THERE IS AN increasing interest in, and concern about, the weather—what it is, what it was, and what it will be. One reason for that concern may be the high cost of energy for heating and cooling, and how weather effects those costs. In any event, I've received many questions concerning electronic weather-instruments recently.

Your questions seem to indicate that the main problem is devising sensors or detectors. Most of you know how to evaluate a signal and display the result, but you need something that will generate the signal in the first place.

The first thing that I think of when I hear the words "weather instrument" is an anemometer (an instrument that measures wind speed and force) whirling around. There are, of course, several types of devices that can be used to indicate how hard the wind is blowing. Some of them are shown in Fig. 1.

A simple wind paddle attached to the shaft of a potentiometer is shown in Fig. 1-a. When the wind blows, its force pushes the paddle back, turning the shaft of the pot. That, of course, raises (or lowers) the resistance betwen the wiper and one end of the pot. The harder the wind blows, the higher (or lower) the resistance. It's a simple matter to measure the resistance from a remote location.

Figure 1-b shows a propeller attached to the shaft of a small permanent-magnet motor. The wind turns the propeller, causing the motor to act as a generator and produce a voltage. The faster the propeller turns, the higher that voltage. Again, it is fairly easy to measure the voltage from a remote location.

The same motor is used in the devices shown in Figs. 1-c and 1-d. In Fig. 1-c, cup-shaped air scoops are attached to the motor's shaft as shown. Those scopes can be easily made from ping-pong balls that have been sliced in half or from panty-hose containers. A similar device using vertical disc-shaped airfoils in place of the scoops is shown in Fig. 1-d.

In the device shown in Fig. 1-e, air scoops are used to rotate a free-turning shaft mounted in a roller-skate wheel. A counterbalanced crossbar with a permanent magnet on one end is attached to the shaft as shown. Each time the magnet passes a reed switch, that switch closes. The number of switch closures can be counted with a frequency counter or similar circuit and translated into wind speed.

A phototransistor can be used in place of the reed switch in Fig. 1-e. Replace the permanent magnet with a bit of reflective material. The phototransistor will generate a pulse each time the material passes it. (Of course, the sensor will not work at night unless you provide some illumination.)

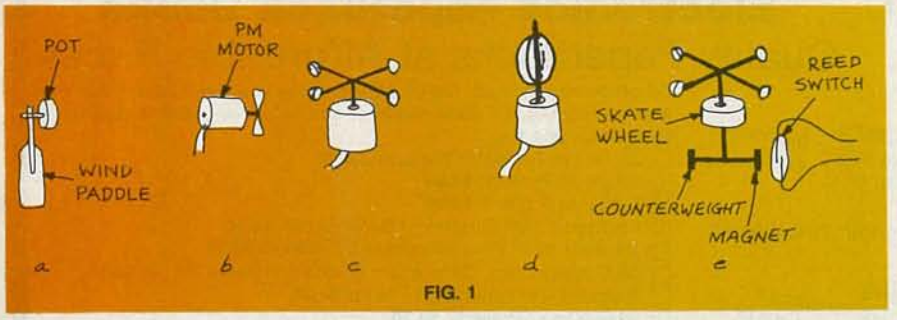

FIG. 1

Calibrating those devices can be a bit of a problem. The task is easy enough if you have access to a similar unit that is already calibrated—just match your readings to the ones it shows. But, since you probably won't be able to find a calibrated anemometer, you'll have to find another way. Perhaps the best method is to take the device for a ride in your car.

Pick a calm day, and get a friend to do the driving. Hold the sensor out the window, and drive up and down a road at several different speeds, calibrating your anemometer against the car's speedometer. To cancel the effect of any wind that may be present, drive both ways at each speed and average the readings you take. Using that method, you can calibrate your anemometer sensor at several wind speeds, and interpolate at others.

One more point before we go on. The sensors shown in Figs. 1-a and 1-b must be set on a vane so that they face into the wind. That could present a problem because the wires may wrap around the support and, for that reason, the other designs are more frequently used.

The next type of sensor, shown in Fig. 2, is used to determine wind direction. A standard wind vane, mounted on the shaft of a potentiometer, is shown in Fig. 2-a. The pot's resistance is used to indicate the wind direction. If you use that design, be sure the pot you choose can be taken apart so that the stop can be removed—you'll want the shaft to turn without restriction. Use a skate wheel as a thrust bearing.

The design shown in Fig. 2-b is similar to the one shown in Fig. 1-e for measuring wind speed. The difference is that this time there is a circle of reed switches; as before, one of the switches will close when the crossbar-mounted magnet is in its vicinity, thus indicating the wind direction. It's a simple matter to connect each switch to an LED or lamp to make a remote readout.

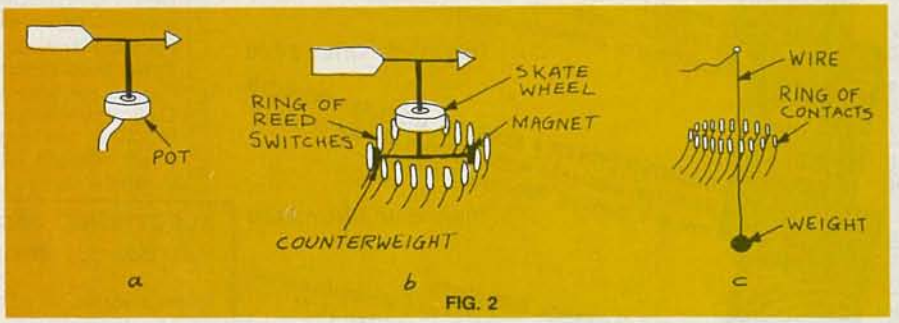

FIG. 2

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A less reliable—but less costly—way to determine wind direction is shown in Fig. 2-c. The weight is connected to a piece of bare wire that passes through a ring of contacts. When the wind blows, the wire will touch one of the contacts, completing a circuit.

The most expensive way to determine wind direction would be to use a pair of selsyns (DC remote-control devices that use the angular position of a shaft in the transmitter to control the position of an indicator in the receiver). Perhaps you can find surplus units.

Using a barometer to determine air pressure is the easiest of all. Since the pressure is the same inside the house as outside, a remote-reading instrument is not needed. Just keep a store-bought barometer on the shelf with your other weather equipment.

Designing a remote-reading rain gauge is quite another matter; the job can get quite involved. One possible design is shown in Fig. 3. A counterbalanced arm is mounted on the shaft of a potentiometer. A spring is used to hold an empty cup in the "zero" position. When it rains, water runs into the cup through the funnel. The weight of the water in the cup causes the pot's shaft to turn, changing the resistance of the pot, and the resistance measured can be converted into "inches of precipitation."

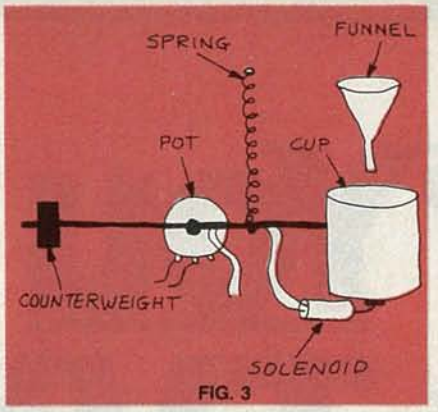

FIG. 3

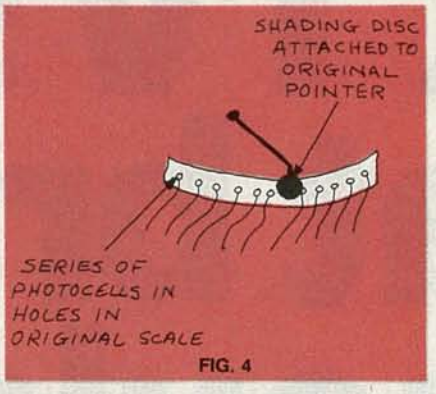

FIG. 4

The solenoid is used to empty the cup; it opens a drain hole in the bottom when a voltage is applied. Another way to empty the cup from a remote location is to use a solenoid to tilt the counterbalanced arm. In either case, this is a real "Rube Goldberg" affair. Perhaps you'd be better off just using a standard rain gauge and walking outside to read it.

Measuring air temperature is straightforward and many articles have been written about building remote-reading thermometers. In addition, many manufacturers offer electronic kits for that purpose. There is also the older, nonelectronic, type of remote-reading thermometer that has a capillary tube running outside.

A remote-reading hygrometer for measuring humidity is another instrument that will require some jury-rigging. About the best I can suggest is shown in Fig. 4. Take a standard dial-type hygrometer, replace the dial with photocells as shown, and attach a disc to the pointer. The disc will shade a photocell when it passes in front of it, making it possible to determine the pointer's position from a remote location.

An instrument that measures the amount of sunlight over a given period of time is shown in Fig. 5; it consists of a photoresistor connected to a counter through a threshold circuit. Whenever the sunlight reaches a predetermined level, the counter runs, giving you the hours (or any other convenient time

unit) of sunshine since the last time the counter was reset. For accurate measurements, be sure to keep the photoresistor clean.

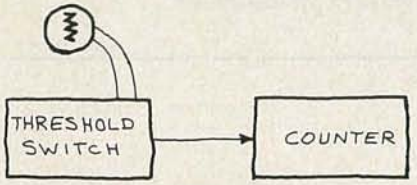

FIG. 5

That should keep you meterologists busy for a while. If you come up with any other ideas, or improvements on the ones presented here, let me know and I'll pass them along.

Electronic hobby kits

The people at OK Machine and Tool Corp. (3455 Conner St., Bronx, NY 10475) have come up with five low-cost electronics kits that I'm sure you will find quite interesting. You'll wind up with a useful device, and have an opportunity to learn something about electronics in the process.

The kits available are named: Quick Reaction (a game), Electronic Organ, Digital Roulette, Electronic Dice, and Morse Code Practice (an audio oscillator); each one sells for less than $15.00, and comes complete with everything except batteries and tools. The plastic packages the kits come in double as cases for the projects. The instructions are detailed and clear, and even a first-time builder should have little trouble completing any of the kits.

Do you know a young person who you would like to nudge into electronics? You won't find a better way than to present him (or her) with one or more of those kits. An assembled kit may be appropriate for a younger child. The roulette and dice devices can be used with other games, and seeing the internal parts is sure to arouse the child's curiosity. **R-E**

"Sometimes I wish you collected stamps, like other men."

COMPUTER CORNER

Looking for a computer

KATHY TEKAWA*

BUYING YOUR FIRST MICROCOMPUTER can be an incredibly complex task. Once you begin your search you'll quickly encounter confusing terminology, a seemingly endless variety of systems, smooth-talking salesmen, and —most confusing of all—a constant barrage of new equipment and programs, and enhancements to existing ones. It will be enough to make you want to stick with paper, pencils, and filing cabinets.

But don't despair—you don't have to tackle it *all* at once. Approach the matter in small, logical stages. The first, and most important, step is to task yourself what you intend the computer to do for you. How do you plan to use it to improve your operation? What parts of your day-to-day workload will benefit from increased efficiency due to the computer?

For large and complex business operations, that task is best undertaken by a system analyst—a professional consultant trained in analyzing work procedures determining which should be computerized and exactly how that should be done.

For smaller operations, you can probably save the expense of hiring such a consultant by doing your own detailed study of what, *exactly*, you want your computer to do. Collect as much information as you can. If you intend to prepare a payroll using the computer, determine how many checks will be written each pay period. Make a list of all the categories that will be involved (gross pay, federal tax, state and local taxes, Social Security, other income to withheld or added, etc.). If you're going to be keeping an inventory, how many classes of items will be involved; how many categories (in stock, shipped, in transit, etc.). The more detail you can provide when you visit a computer store, the better the salesmen will be able to help you to determine your hardware and software (program) needs.

Finally, think not only in terms of what you intend to do with the system when it's installed, but also what you would like to do with it in the future.

Once you have a good idea of your requirements, your next concern is to find the best buy. That does not necessarily mean the cheapest price. Careful shopping for price is fine, but that's an area requiring a good deal of judgment: a "bargain" computer could turn out to be a costly mistake. You should also consider such things as the reputations of the dealer and manufacturer, availability of service, and the capability of your system to expand along with your understanding of it. Not only should your computer be able of handling your immediate needs—it should also be able to handle them one or two years from now.

Some representative products

To get you started thinking, and to give you an idea of some of the basic systems available, we've prepared a list describing a few of the wide array of products on the market. Prices range from as low as $400 up to approximately $2000. (Depending on the options purchased and the dealer you buy from, prices can vary considerably; therefore they have not been included here.)

Bear in mind that this list is just a sampling of what's available, and is not intended as an endorsement of any of them, or to indicate that they are the cream of the crop. The computer mentioned are simply a few of the most prominent and widely-distributed systems, from a handful of manufacturers. The system you ultimately purchase will depend largely on your individual needs.

Apple: The *Apple II* and *Apple III* computers are similar in design, but differ in their capabilities. The *Apple II* (shown in Fig. 1) is intended more for home use; the *Apple III* for business. Both systems store about 140K bytes (1K byte equals 1024 characters) of information on 5¼-inch floppy disks. Both use a TV set or video monitor for color or black-and-white display.

Both systems have full-size keyboards. The *Apple II* supports from 16 to 48K bytes of memory, and the *Apple III* supports up to 128K. The *Apple III* also has a 10-key numeric pad.

As business software-packages flourish, those computers are becoming increasingly recognized as suitable machines for business—as well as for home-use.

Apple Computer, Inc., 10260 Bandley Dr., Cupertino, CA 95014.

Atari: Atari manufactures two personal computers: the *model 400* and the *model 800*. The first has a memory capacity of 16K, a touch-switch keyboard and RF output for use with a TV

FIG. 1

*Managing Editor, Interface Age Magazine

set. It has excellent color graphics capability but is suited more for home use than for business.

The *model 800* supports up to 48K of memory, has a full-size, typewriter-style keyboard and can be used with a TV set. Up to eight 5¼-inch disk drives, each capable of storing 163K, can be connected to the computer. Although originally designed for home use, the *Atari 800* is beinning to find its way into the business world as well.

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

Commodore: Commodore International offers a wide range of computers. The company began by manufacturing calculators and then progressed into the personal-computer marketplace. Its newest computer is the *VIC* color computer. That system is a single unit with the keyboard/computer using a TV receiver for display.

The *CBM 2001* and *8032* computers offer up to 32K of memory with a 25-line by 40-column display available on the former and a 25-line by 80-column display on the latter. Both have built-in video monitors and full-sized keyboards with ten-key numeric pads.

Commodore International, 950 Rittenhouse Rd., Norristown, PA 19401.

Radio Shack: The first mass-market microcomputer was this company's *TRS-80 Model I*. Since it was introduced, the *TRS-80* family has grown to include four more models.

The *Model I* is no longer in production. The *Model II* is a self-contained system with a full-size keyboard and numeric keypad. It can hold up to 64K of memory and comes with a built-in 8-inch disk drive. The integral video display provides 24 lines of 80 columns.

The *Model III* also is an integrated unit, and is capable of running software written for the *Model I*. It features a full-sized keyboard with a 10-key numeric pad, a video-display screen, up to 48K of memory, and has provision for two built-in 5¼-inch disk drives.

The *TRS-80 Color Computer* is designed for direct connection to a TV receiver and cassette recorder. Its features include color graphics, sound-generation capability and 4K of memory (expandable to 16K). For elaborate game playing, joysticks (control devices) can be added.

The *Pocket Computer* is a calculator-size device with 1.9K of memory and a 24-character liquid-crystal display. A cassette interface for loading or storing programs is optional, and a small printer is available.

Other systems

The list just presented is by no means exhaustive. Some other personal computer manufacturers whose products are well worth looking into are: Heath/Zenith Data Systems, Ohio Scientific, North Star and—believe it or not—IBM.

Shopping for a computer for your home or business need not be a grueling, frustrating task. If you do your homework—know exactly what tasks you want your system to do, talk to other users and keep up by reading system reviews and evaluations—you will invest your time wisely and be in a good position to know which system will suit you best.

Next month we'll take a look at computer software, discussing language options, operating systems, and how to select the software best suited to your applications. **R-E**

"I was a successful TV serviceman until my mirror broke."

NEW PRODUCTS

For more details use free information card inside back cover.

SPEAKER, *System 500,* features a 1-inch soft-dome tweeter working in conjunction with a 2-inch rear-firing direct radiator. The back driver reflects high-frequency energy off the back wall to supplement the dispersion of the front-firing high-frequency driver, producing a more uniform pattern of high-frequency energy throughout the listening area.

CIRCLE 131 ON FREE INFORMATION CARD

The soft-dome high-frequency driver has an impregnated linen diaphragm, a high-temperature voice coil that permits high output levels, and a damped rear acoustical chamber that isolates the driver from the low-frequency system.

The midrange driver is also acoustically isolated. The 5-inch molded cone with high-compliance vinyl surround is mounted in Jensen's tuned isolation chamber. The 12-inch acoustic-suspension driver has a variable-density molded cone supported by a high-excursion polyurethane foam-surround for tight, accurate bass, even at high-power levels. The driver has a high-power epoxy-cored voice-coil assembly and a high-energy monolithic strontium-ferrite magnet.

The *System 500* features a wide-range control system with separate high-frequency and midrange controls. Each has a 10-dB range of adjustment. It is priced at $290.00. — **Jensen Sound Laboratories,** 4136 North United Parkway, Schiller Park, Il 60176.

MOTO-TOOL KIT, *model 2501,* contains a *model 250* constant-speed (30,000 rpm) Moto-Tool with a 0.8-amp, 115-volt, 60-Hz AC series-wound motor, and 24 accessories, all housed in a tough, lightweight, polyethylene storage/carrying case with a snap-lock cover.

The *model 250* with accessories gives the do-it-yourselfer, hobbyist, and model maker a high-speed, multi-use power tool for carving, cutting, drilling, polishing, grinding, sanding, sharpening, and much more. It has a shatterproof molded nylon housing and is shaped to be held comfortably in the hand while being used. The smooth-running 30,000 rpm motor is quiet and has lifetime-lubricated bronze sleeve bearings. A built-in hanger permits the user to hang the Moto-Tool near the work project when not put away in the

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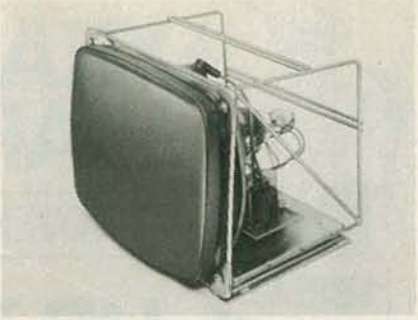
storage/carrying case. The Moto Tool is 10¼ inches long and 6¾ inches in diameter. The unit comes with a 3-wire grounded cord.

The price of the *model 2501* Moto-Tool Kit is $54.95. — **Dremel, Division of Emerson Electric Co.,** 4915 21st St., P.O. Box 518, Racine, WI 53406.

DISPLAY MONITOR, *model NDC-90,* is a 9-inch unit that provides high definition and reliable image presentation. The unique features of the display are a wide video bandwidth of 25 MHz; excellent linearity; uniform focus characteristics across the entire screen; a horizontal retrace time that is usually less than 7 microseconds, and electrical and mechanical compatibility with Ball Brothers and Motorola monitors. A specially designed PC board and electronics are incorporated in the monitor to achieve performance levels previously impossible with devices of this kind. Separate horizontal drive, vertical drive, and video-signal inputs, as well as one for composite video, have made it possible to provide



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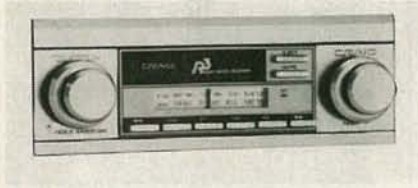
simple interface circuitry.

The *model NDC-90* has a minimum mean time between failures of 10,000 hours with a 90 percent confidence level. The unit is delivered with P4 phosphor as standard. (Available options are P31 and P39 phosphors, as well as a power-supply module that is compatible with nearly any standard power source used today.)

The *model NDC-90* is priced at $215.00. — **TSD Display Products, Inc.,** 35 Orville Drive, Bohemia, NY 11716.

CAR STEREO, *model T691,* features road-rated performance and a Powerplay amplifier for greater power and cleaner sound. The system also includes separate bass, treble, balance, and fader controls;



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local/distant, mono/stereo, and FM mute pushbuttons; loudness control; automatic power antenna switching; dial-light dimming; line-level output jacks, and power-off eject. The *model T691* is priced at $169.95. — **Craig Corporation,** 16 East 52 Street, New York, NY 10022.

COMPUTERIZED WEATHER STATION for households offers twelve functions plus memory, for use by homeowners, farmers, hobbyists, or anyone else interested in receiving specific regional weather information.

The weather station is quite simple to install; cable and wall mountings are attached directly to the full-sized display panel which mounts on your wall. It displays hour and date for high and low readings and its "smart" clock remembers how many days are in each month, so that no resetting is necessary.

The digital display shows wind chill, rainfall, humidity, maximum and minimum temperature, time, degree days, heating and cooling, date, barometer, wind direction, and wind-speed readings. Readings are displayed in standard or metric scales, and knots or miles-per-hour for wind speed. The weather station operates on AC, with a battery pack that will hold all memories in case of power failure. It also includes for assembly: rain collector, temperature sensors with cable attached, display unit, mast-arm assembly with cable attached, and remote chassis with line cord.

An automatic select button allows you to have the display hold each function for a four-second interval, and then move on to the next automatically. The *Computerized Weather Station* is priced at $995.00, plus $15.00 for packing and guaranteed delivery. — **Edmund Scientific,** 7082 Edscorp Building, Barrington, NJ 08007.

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DMM, *model 461-2R,* is a compact, hand-portable digital multimeter that reads true RMS on AC voltage and AC current ranges. The RMS-reading instrument has a high frequency-response—up to 50 kHz. It will respond to the RMS value of any wave shape, thus providing accurate measurements of noisy or complex AC-voltage waveforms.

The *model 461-2R* meets UL-1244 requirements, and is UL-listed. It has a bright 0.3-inch, 3½-digit LED display, 100-μV resolution, and 0.1% basic accuracy.

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Performance is assured by a 100% double burn-in and supported by a one-year factory warranty. It measures 2 × 5.6 × 4.6 inches, weighs 1½ pounds, and operates 8-hours on a single charge of its batteries. It can be operated from AC while the batteries are being charged. There is also a full line of optional accessory probes that will expand the unit's capabilities. It comes with nickel-cadmium rechargeable batteries, an AC charger/adaptor, color-coded UL-approved test leads, and an instruction manual.

The *model 461-2R* carries a suggested retail price of $216.00. — **Simpson Electric Company,** 853 Dundee Ave., Elgin, IL 60120.

TUNER, *model NAT 301,* is designed to provide the most listenable signal possible. On both FM and AM (including international long wave), several self-adjusting systems select the optimum receiver bandwidth for the particular input signal automatically, taking into account interference from adjacent channels and the noise levels present.

On AM, two separate receiver signals—

continued on page 88

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Intensity modulation	Over 5Vp-p
• Vertical deflection	5mV/div ~ 5V/div ± 5%, DC ~ 15MHz, −3dB
Sensitivity and bandwidth	1mV/div ~ 1V/div ± 6%, DC ~ 5MHz Typ, −3dB (Using x5 amplifier)
Rise time	24ns
Dynamic range	More than 4div at 15MHz
Input R and C	Direct 1M Ohm, approx. 30pF
Maximum input voltage	600Vp-p or 300V (DC + AC peak)
Display mode	CH1, CH2, DUAL, ADD, DIFF
X-Y operation	DC ~ 500 kHz, 5mV/div ~ 5V/div Phase difference DC ~ 10kHz 3°
• Horizontal deflection	Auto, NORM, TV (+), TV (−)
Sweep mode	TV sync-separator circuit
TV synchronization	Over 1 div (V sync-signal)
Internal	Over 1Vp-p (V sync-signal)
External	

Trigger sensitivity	Frequency	Internal	External
	20Hz ~ 2MHz	0.5div	200mV
	2 ~ 15MHz	1.5div	800mV

Trigger slope	±
Sweep time	0.2μs/div ~ 0.2s/div ± 5%, 19 calibrated steps
Sweep-time magnifier	10 times (± 7%)
Max. sweep rate	100ns/div
• Amplitude calibrator	1kHz ± 10% Typ, Square wave
Waveform	0.5V ± 3%
Voltage	100V (120/220/240V) ± 10%
• Power requirements	50/60Hz, 40W
• Dimensions	Approx. 275(W) x 190(H) x 400(D)mm
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MODEL V-152B WITH 2 YEAR MFG. WARRANTY

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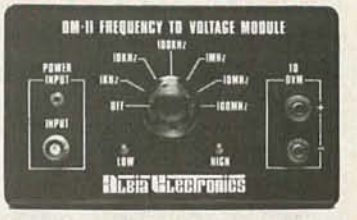
FREQUENCY METER MODULE "5Hz to 100MHz", DM-11



Measure frequencies from 5Hz to 100MHz on your digital voltmeter with a resolution of 3 1/2 digits — easy to use — perfect for field service — lab testing — home hobbyist! Connect the DM-11 to your DVM, set the DVM to the 2VDC range, connect a signal to the DM-11 via a BNC cable (not included) and measure the frequency of any source. Hi Lo Range LED's insure fast accurate readings.

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  100 Hz ~ 60MHz<30MV
  >60MHz<70MV
- Size 6.25" x 3.75" x 2"
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The features are many on this quality Albia test instrument; will detect low rep. rate pulses (up to 1.5 MHz); detects low, high or pulsed logic levels with a minimum detectable pulse width of 300 nsec. Easy-to-interpret 3 LED readout. Built-in over-Voltage and reverse polarity protection.

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INPUT IMPEDANCE 300,000 Ohms; **THRESHOLD** Logic 1 thresholds (HI-LED) 70% Vcc Logic 0 thresholds (LO-LED) 30% Vcc; **MIN DETECTABLE PULSE WIDTH** 300 nanoseconds; **MAX. INPUT SIGNAL FREQUENCY** 1.5 MHz; **PULSE DETECTOR (PULSE LED)** High Speed pulse train or single events (+ or − transitions) activate 1/10 second pulse stretcher. **MAX. INPUT VOLTAGE** ±50V continuous 120VAC for less than 15 seconds. **POWER REQUIREMENTS** 5 Volt Vcc 30 Ma 15 Volt Vcc 40 Ma 25 Volts max. with power lead reversal protection. **OPERATING TEMPERATURE** 0 to 50°C **PHYSICAL SIZE L x W x D** 5.8x1.0x0.7" (147 x 25.4 x 17.8 mm) **WEIGHT** 3 oz. (85g) **POWER LEADS** 36" (61 cm) with color coded insulated clips.

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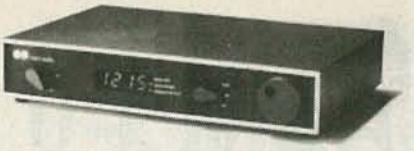
NEW PRODUCTS

continued from page 85

one wideband and one narrowband—are provided. The receiver selects the best mode of operation and then sends a signal to the external AM antenna box, tuning it for optimal reception at the desired frequency. The *model NAT 301*, potentially, can deliver AM sound to rival that from the FM section.

On stereo FM, the receiver section maintains the optimum signal-to-noise ratio by reducing stereo separation gradually, and finally limiting the bandwidth of the tuner as required by the quality of the signal being received.



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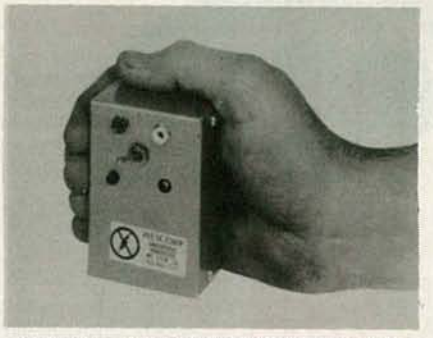
The digital display brightens when the receiver finds the center frequency and locks on to the incoming signal. That visual feedback has the effect of teaching the user those frequencies that he or she uses most often. On FM, a sophisticated muting circuit is activated automatically until this center frequency is located, the receiver has found a listenable station, and the AFC has locked onto the signal. Similar muting takes place on AM; however, the user may tune off the center frequency, shifting the signal into such a position that any beats or whistles caused by adjacent channels are eliminated.

The *model NAT 301* is priced at $3,500. — **Naim Audio, Ltd.,** (England); U.S. Distributor: **Audiophile Systems, Ltd.,** 6842 Hawthorn Park Dr., Indianapolis, IN 46220.

STATIC-ELECTRICITY ALARM, *model WA-1,* gives a visual and audible alarm when ambient static electricity reaches predetermined levels.

Static electricity can ruin the microprocessors that are the basis of many new electronic products, and can be a safety problem in many industries, such as ordnance, chemical processing, and papermaking. It is also a peril in surgical operating rooms, and, because static electricity can make a surface dust-attractive, it can cause serious quality-control problems in such industries as graphic arts, photographic processing, and precision assembly.



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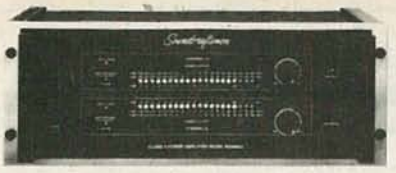
A wire serves as the *model WA-1's* antenna. The sensitivity of the alarm is a function of the length of the wire, making it easily adjustable to the user's individual requirements. For example: An 18-inch wire will detect 240 volts at a distance of one foot. A three-position switch has settings for the red-light warning, the high-pitched alarm, or off. The unit measures 1 × 3.25 × 2 inches.

The *model WA-1* is priced at $69.96. — **Wescorp,** 1155 Terra Bella Ave. Mountain View, CA 94043.

POWER AMP, *model MA5002A,* is designed to provide instantaneous internal electronic compensation for intermittent or continuous 2-ohm operation, without actuating any of its protective circuitry and without current limiting.

The *model MA5002A* is rated at 250 watts stereo at 8 ohms, 20 Hz-20 kHz with less than 0.09% THD; the same specs apply for 375 watts-per-channel at 4 ohms. TIM is less than 0.02%, slew rate greater than 50, IM less than 0.05% (typical 0.02%), and dynamic headroom better than 2 dB. All specifications are continuous operation, FTC sinewave power ratings, with no shutdown during test procedures. The Class "H" fully-complimentary circuitry features low operating wattages for conserving energy, and allows use without a fan under all normal operating conditions.

Protective circuitry is four-way. Short-circuit protection is provided by an ex-



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clusive-design dual-purpose auto-crowbar circuit with automatic reset and front-panel LED indicator. There is also thermal sensing with automatic reset and front-panel indicator, as well as external fusing protection. The chassis has a 16-gauge steel mainframe structure, with modularized construction throughout for easy access to all component parts.

The *model MA5002A* is priced at $849.00. — **Soundcraftsmen,** 2200 So. Ritchey, Santa Ana, CA 92705.

BUS INTERFACE, *model 4380-488,* is a new IEEE-488 bus interface unit that allows connection of the Bird directional RF *Power Analyst* wattmeters to a GPIB (General Purpose Instrumentation Bus) for automatic measurement and recording of data. Digital *Thruline* wattmeters equipped with a bus-compatible output can now become talkers and listeners via GPIB central control.

Typical applications include periodic measurement of one to nine RF-signal

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parameters; hard-copy printout of data for logging; scope, graphic terminal, or curve-plotter feed for dependent variables display (such as attenuation or SWR vs. frequency, power vs. time, etc.); alarm or warning functions of performance levels, and automatic testing of equipment or components.

The *model 4380-488* is priced at $975.00. — **Bird Electronics Corporation,** 30303 Aurora Rd., Cleveland (Solon), OH 44139.

LOUDSPEAKER, *Wharfedale E-90 PRO,* is a high-power speaker system for professional and semi-professional users, designed for use in small club, disco, or concert-hall environments where increased sound-pressure levels without distortion are important.

The *model E-90 PRO* uses two 10-inch moving-coil bass drivers, two 4-inch high-flux moving-coil midrange drivers, and a 1-inch compression-drive horn-loaded tweeter. Its minimum power requirement is 30 watts, and its power-handling capacity is 300 watts of program material. Its sensitivity is 95 dB (1 watt/1 meter). Nominal impedance is 8 ohms. Typical frequency response is 45 Hz to 18 kHz, ±3 dB.

There are two contour controls. The upper is continuously variable in a range of 2 kHz to 20 kHz; the lower is continuously variable in the 200-Hz to 2-kHz range. The crossover type is a 6- and 12-dB/octave, 14-element network, resistant mounted. Crossover points are 150 Hz,

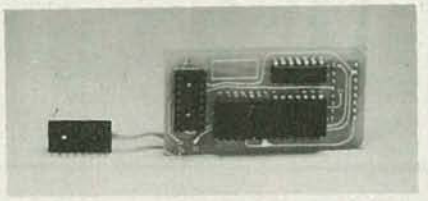
CIRCLE 141 ON FREE INFORMATION CARD

800 Hz, and 7 kHz. System and treble circuit breakers protect the speakers against misuse or accidents. The reset button for the circuit breaker is located on the front of the speaker cabinet.

The cabinet is a computer-optimized reflex type, made of high-density particle board incorporating crush-resistant steel rails and corner caps. The finish is an abrasion-resistant black vinyl. The grille is semi-opaque, acoustically transparent woven steel mesh. There is a grab handle, as well as recessed transportation handles. External dimensions are 45¼ × 15¾ × 16¾ inches.

The *Wharfedale E-90 PRO* carries a suggested retail price of $900.25 each. — **Rank Hi Fi, Inc.,** 260 North Route 303, West Nyack, NY 10994.

TYPE-AHEAD BUFFER, *model 150,* features a 40-character type-ahead capability, eliminating the need to wait for computer prompts before entering the next command or data. It is compatible with all *Apple II* computers and software.



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No software patches, cuts, or jumpers are required, and the simplified design allows for nearly effortless installation. The *model 150* is priced at $49.95. — **Vista Computer Co.,** 1317 E. Edinger, Santa Ana, CA 92705. **R-E**

NEW IDEAS

Headlight Alarm

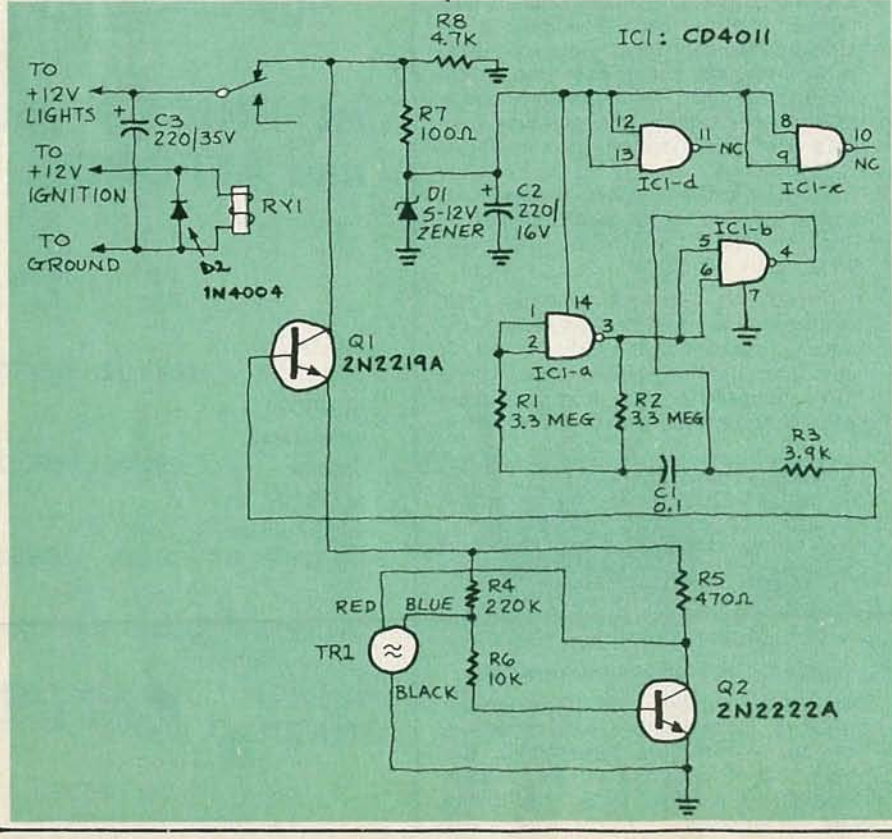
HAVE YOU EVER FOUND YOUR CAR battery dead because you had left your headlights on after shutting off the engine and walking away? Before long your battery is totally drained, and you have to start looking for a passing good samaritan or a service station. It is a frustrating experience, as you know if it has ever happened to you.

This circuit is designed to give off an alarm anytime that the lights are on but the engine off. The device is easy to build and almost any technique can be used. Installation is also simple and just two connections to your car's electrical system, and one to its chassis, are required for proper operation.

The circuit for the project is shown in Fig. 1. An SPDT relay, RY1 (Radio Shack 275-003 or equivalent), and diode D2 (IN4004 or equivalent) supply power to the rest of the circuit only when the headlights are on and the ignition switch is off. A circuit made up of R7 and D1 regulates the voltage to IC1. The IC is configured as an oscillator, and is used to supply pulses to Q1, which is used as a transistor switch. Each time a pulse from IC1 reaches it, Q1 supplies power to TR1's driver circuit (TR1 is a piezo-buzzer element, Radio Shack 273-064 or equivalent), sounding the alarm.

The connections to your car are fairly straightforward. The lead marked TO +12V LIGHTS should go to a line that carries +12 volts whenever the headlights are on (the one for the dashboard lights is a good choice). The lead labeled TO +12V IGNITION should go to one of the lines that power the car's accessories (radio, cigarette lighter, etc.). Make those connections to any point that is easily accessible; typically that will be at your car's fuse box. The lead labeled TO GROUND can be made to any convenient point that's connected to the car's chassis.

Of course there are times when you wish to use your headlights while the engine is off. All that needs to be done to silence the alarm in those instances is to turn the ignition switch to the ACCESSORY position. —*James Griggs*



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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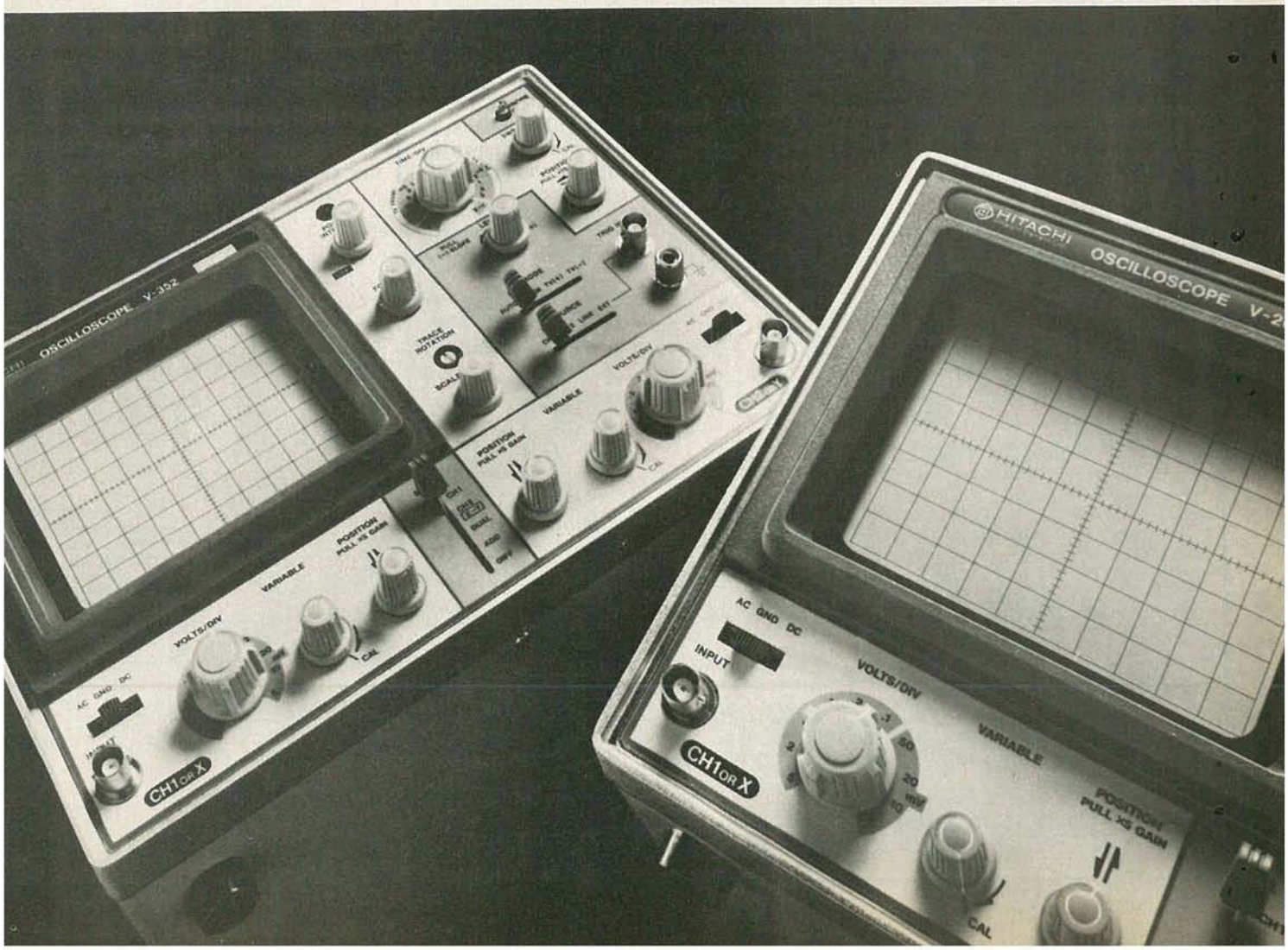

SERVICE CLINIC

A closer look at high-voltage shutdown circuits

JACK DARR, SERVICE EDITOR

I'VE NOTICED SOME NEW TV CIRCUITS IN the last year or so. Actually, they aren't really new—they just do things a little differently! When activated, they cause the picture to flicker on and off at regular intervals, or cause the sound to go "putt, putt" (like a motorboat). I've gotten quite a few letters from confused technicians who were facing those symptoms for the first time.

The cause of all that activity is quite simple—it's the high-voltage shutdown circuit in operation! I first ran into that type of circuit while going through an Admiral Service Newsletter (looking for something else, of course). The shutdown circuit in the Admiral 4K10/4M10 chassis (and others) causes the raster to flash on and off about once a second, while the sound makes a "tweet" at the same rate.

What happens here is that if an arc, or anything else, trips the shutdown, the circuit tries to reset itself after about a second. If the fault was momentary, the set will come on again and work properly. If the fault is still there, the circuit will shut down the set again (and again, etc.).

Any of the usual problems will cause the shutdown circuit to trigger. Run the regular series of tests to find the specific cause. Start with the DC voltage: Plug the set into a variable-output transformer and turn the line voltage down. Monitor the regulated B+ and bring the line voltage up until the B+ is at the correct value. If the set now works, check the regulator; if it doesn't, look elsewhere.

The same type of shutdown circuit is used in other sets; among them are those in the new Magnavox 13C2 power-supply series. Although the shutdown circuit in the Magnavox sets is different from the one in the Admiral, it works in pretty much the same way, only faster.

The heart of that shutdown circuit is op-amp "Z" in IC322, located on supply module 704191; the op-amp is shown in Fig. 1. The output from the op-amp goes, via diode D1, to the duty-cycle modulator of the switching regulator (Fig. 2). As long as everything in the set is normal, the output of the op-amp is high. The slow-start circuit shown in Fig. 1 delays set turn-on and high-voltage buildup. When the set is turned on, there's an instant when the +12-volt supply is low. If it is below +8 volts, a control transistor,TS2, is off, and TS3 conducts. That causes capacitor C330 to be charged, pulling the output of op-amp Z low. That, in turn, pulls the output level of the sawtooth oscillator (see Fig. 2) so low that the duty-cycle modulator is cut off, shuting down the set. When the supply voltage rises above +8 volts, the opposite takes place; the transistors turn the op-amp off, causing its output to go high. When that happens, the duty-cycle modulator works again.

That is what happens during shutdown. There are, of course, other situations that can trigger the circuit including low B+, high B+, and excessive current drain. In every case, the output of op-amp Z goes low, cutting everything off.

All of the voltages monitored are found on supply module 704191. The DC voltage developed from the AC line comes from rectifier module 704192. The horizontal oscillator drives both the switching-mode regulator and the

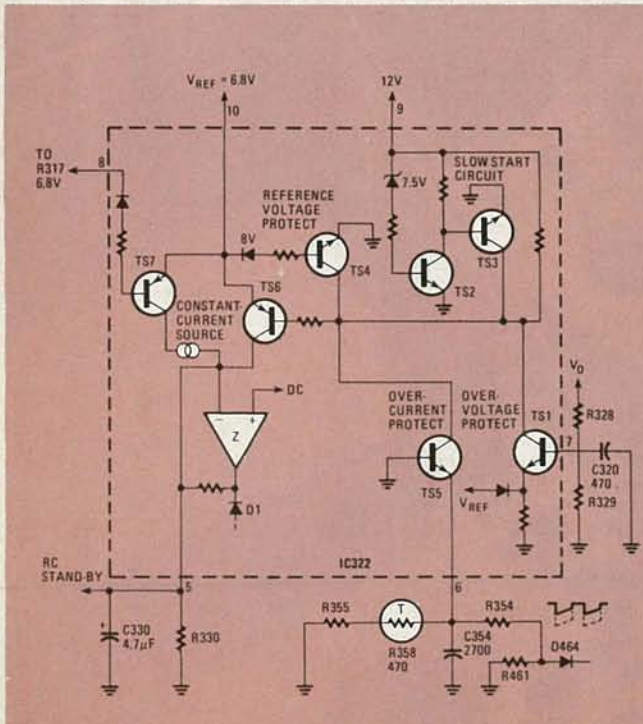

FIG. 1

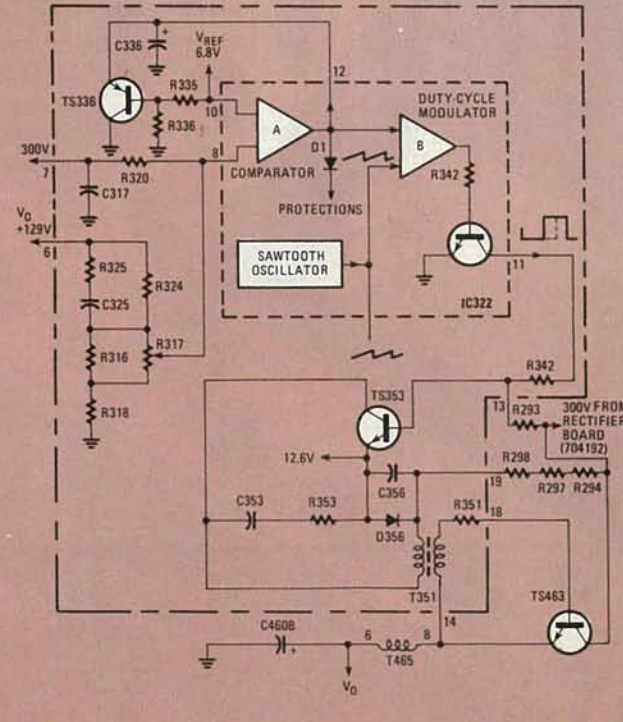

FIG. 2

horizontal-output tube, so they are always in sync. The operating DC voltages come from the flyback. The switching-mode transformer drives the horizontal output transistor, which in turn drives the flyback.

For troubleshooting, the +129-volt DC supply is the key. Pull the horizontal-yoke plug; that disconnects the horizontal-output circuit. Now check the +129-volt DC supply. If it is OK, check the horizontal-output circuitry, the horizontal-output transistor, and all of the low-voltage rectifier diodes coming from the flyback. If the +129-volt DC supply is puslating, or too high or low, try a new supply module.

If you'd like more information on how the Magnavox shutdown circuit works, refer to the July and October 1980 issues of the Magnavox Service News. **R-E**

SERVICE QUESTIONS

CAPACITOR SUBSTITUTES

Bill Stiles, CET, of Hillsboro, MO has sent in some information on using Sprague polypropylene capacitors as substitutes for others. A Sprague PP16-S18 is a substitute for a Zenith 22-4001, a .0018 μF capacitor rated at 1600 volts. A PP16-S11S is a substitute for a Zenith four-legged capacitor. That capacitor comes with a data sheet that says that it is an exact replacement for two Zenith, and one Admiral, part numbers.

Fuji-Svea, Inc. lists an assortment of Sprague capacitors, assortment number KF-34, as Sprague series 715P (note that all of the individual part numbers start with PP). Those capacitors are exact replacements for polycarbonate-film capacitors in critical commutating and S-shaping circuits, with high AC-current carrying-ability. The kit includes 18 different values, including 1.75 μF at 100 volts (a yoke-return capacitor), and others at ratings of 600, 800, 1200, and 1600 volts. The last two ratings are for .0033-μF and .0039-μF capacitors.

Thanks Bill; this is information that I've been trying to get for quite some time.

SMEARY PICTURE

The picture on this Quasar TS-938 was very smeary. The focus control worked normally, but did not help the problem. The picture tube heater-voltage was low; replacing the JA panel (flyback power-supply) helped, but not enough. The sharpness is still below normal. Any ideas?—G.S., Red Bank, NJ

Trying inputing a color-bar signal, and checking it with an oscilloscope all the way from the video detector on through the video stages. If you have a three-bar function on your bar/dot generator, it will give you three nice square-wave signals.

Look for a point where the signal is sharp at the input of the stage, but distorted (rounded corners, slanted, etc) at the output. When you find that stage, check the DC voltages and so on. One common cause of this problem is a leaky transistor; try a new one.

(Feedback: "Thanks! You hit it! The 1st video transistor was leaky. I replaced it and now the picture is 300% better.")

TRIPLER TROUBLES

I've got a problem with an RCA CTC92K. It came in dead—bad tripler, bad output transistor, and an open fusible resistor. I replaced all of those and got sound, but no raster. The high voltage and raster voltages out of the tripler are all OK. I have no screen voltage on the picture tube; that comes from a tap on the tripler. All of the series resistances check out. Any ideas would be appreciated.—L.C., Sacramento, CA

Well, you may have one of two problems. Either the wrong tripler, without the screen tap, or an open circuit between the tap and the screen controls. I was going to tell you to bridge the

215,000-ohm fusible resistor in the circuit, but you've already done that. There is another resistor in that circuit, 100,000 ohms, and it has a habit of opening up under load. If you are getting high voltage and focus voltages, but no screen voltages at all, even right at the tap of the tripler, that almost has to be the wrong tripler!

NO BOOST VOLTAGE

The problem is no high voltage in this Magnavox T-960. The boost voltage is only about +260 volts instead of +540 volts. Also I get just −23 volts on the grid of the 38HK7. Everything else checks out, but I must be missing something.—B.T., Delta, IA

Well, you do have a *little* boost voltage; the 260-volt B+ means that the stage is trying to work. What you're overlooking is the very low voltage on the grid of the 38HK7. That voltage should be −42 volts, and since it is developed by the drive signal from the horizontal oscillator, that drive is probably very low (it is normally 140 volts peak-to-peak). Try a new 6GH8 in the oscillator stage, and check all of the DC voltages.

THIN VERTICAL LINE

Here's some feedback on the GE 10JA chassis. The symptom was a thin, fuzzy, vertical line on the right side of the screen. But before I got your response, I found the cause. Replacing the horizontal driver transformer cleared up the problem.

Thanks to Danny Davis, Moundville, AL, for that helpful information.

DOUBLE PICTURE

I've got two complete pictures side-by-side on this Zenith 19DC22. All of the tubes and transistors check out OK. Can you help?—T.W., Lafayette, LA

That sounds like an old Zenith problem. The horizontal-hold control is a tunable coil. The coil has a stop, but if the control knob is pulled out a little too much, the stop can be missed. If that happens it is possible to turn the knob too far—far enough, in fact, to make the oscillator run at half speed, 7875 Hz. Turn the knob until the picture returns to normal. From experience, you'll have to turn the knob counterclockwise; turning it clockwise will increase the inductance, making the oscillator run even slower.

6HU8 TUBE

Can you tell me where I can get a 6HU8 tube, or a substitute for it that I can use by rewiring the socket? I've looked everywhere, but had no luck.—E.S. Corydon, IN

You've opened up a real can of worms! I've looked everywhere and come up with what you did—nothing! I finally did run down something in an old RCA tube manual, a listing that read "6HU8/ELL80." The "ELL80" notation indicates that this is a European type with the "PRO-Electron" numbering. It is a dual power-output pentode with a 2-watt output, a 6.3-volt heater, and a 9-pin base. No substitutes are listed, but the load impedance is 10,000 ohms. You should be able to find two common single-configuration miniature tubes with the same load impedance and run them side-by-side—any impedance from 8,000 to 10,000 ohms should work. You'll have to do some juggling, and mount another socket, so be prepared for a lot of work.

STEREO DISTORTION

I've got a Sanyo DC434 stereo receiver with bad distortion. Everything seems to check out OK, but if I go back from the output and touch coupling capacitor C429, the distortion stops. I need help!—A.C., Howard Beach, NY

I think that you may have already found it. Chances are good that C429 is either leaky or opening up intermittently. That capacitor is a low-voltage electrolytic, and I've grown to suspect them in any circuit with problems. Try a new one and see if that's the case here.

LOW SOUND

I've got a sound problem in this AMC 5CP-301. I've tried a new speaker, changed both transistors, and changed the sound-IF IC with no luck. I get very little signal at the collector of Q301, the driver. Any ideas?—E.S., Zion, IL

I don't think that you are really getting anything out of Q301—just some signal leakage. This is a common-emitter stage; the emitter is bypassed. If the bypass is open, you'll lose practically all of the gain. Use an oscilloscope to check the collector, base, and emitter. If the signals on the base and emitter are nearly the same, the bypass is open. There should be no signal at all on Q301's emitter if the bypass is good.

(Feedback: "You hit the nail on the head. Capacitor C317, the .22 μF bypass capacitor was open. I replaced it and the set now works fine.")

HORIZONTAL-FREQUENCY PROBLEMS

When this Sony KV-1511 was first turned on, the horizontal frequency was completely out of the range of the horizontal-hold control. After 5 to 10 minutes, the frequency drifted back slowly and would lock in at the end of the control's range. Thinking that the component's value had changed and that heat was partially correcting the problem, I tried cooling spray; it had no effect. Voltages seemed to be close enough to what they should be, and didn't drift during warm-up.

In this set, the frequency is controlled by a DC voltage. The horizontal-hold control sets the DC-voltage level that biases the AFC. An oscilloscope showed horizontal pulses across that control. I traced the pulse back to the B+ line, and finally to C533, a 100 μF filter capacitor. Replacing the capacitor fixed the problem.

Thanks for this to Vic Spacek of Bloomfield, CT

VIDEOTAPE COLOR

I wrote you about a problem in a Sony videotape recorder. It would play back previously-recorded material in perfect color, but would not record in color. Although you said that you didn't know anything about that machine, you did suggest a few things to try, including cleaning the record/playback switch's contacts. After finding the thing (the switch on this unit works through a series of levers; the contacts themselves are on one of the circuit boards), I cleaned the contacts with a spray cleaner. The videotape recorder now works perfectly. I just thought that you'd like to know.

—Lloyd Hust, Brigham City, UT

TWO HINTS

Here are a couple of hints for your files. The first deals with the vertical-output fuse in the Zenith 23FC45 that keeps failing. The only way to repair that problem is to replace the vertical-driver transistor (the one with the TO-126 flat-pack case). The transistor seems prone to failure under load. The problem is intermittent, and heating or freezing does not reveal it.

The second hint involves the Zenith 25CC50 and similar chassis. The symptom is poor focus even if the focus voltage is normal. Even though the CRT will test out as good (at least on my testers) the CRT must be replaced anyway. That has shown up recently on 25VACxx and 23VAQ CRT's. **R-E**

EQUIPMENT REPORTS

continued on page 36

wide and I could not get quite enough heat from the desoldering gun. Holding the tip of a second soldering iron to the other side of the lug melted the solder, and the *Hot Vac* did the rest.

The desoldering system is a well-made piece of equipment; I've used Ungar products for many years, and I've liked them. The instructions are very complete, and include a parts list, service information, and clear illustrations. The *model 4000 Hot Vac* is priced at $399.00. There is also the *model 4000E* for 220-volt operation that sells for $555.55. **R-E**

NEW LIT.

For more details use free information card inside back cover.

REPLACEMENT BATTERY BROCHURE is an illustrated 8-sheet foldout showing and describing all the batteries presently offered by Gould. The clearly-printed, easy-to-read chart gives needed information on volts/ampere hour capacity, Gould part numbers, maximum battery dimensions, battery description, and typical application. There is also a brief instruction on how to make the best use of the brochure. Free upon request.—**Avex Electronics Corp.,** 121 Coulter Avenue, Ardmore, PA 19003.

CIRCLE 111 ON FREE INFORMATION CARD

ELECTRONIC HARDWARE CATALOG, two-color, 44 pages, 8½ × 11 inches, combines previous catalogs and includes many newly-released products. It contains complete specifications and ordering information on a full range of DIP, transistor and IC sockets; adaptor plugs and covers; cable sockets, plugs and jumpers, and the industry's most comprehensive line of strip-connector products. The latter include socket and terminal strips ("snap strips") and cable-strip connectors. Free upon request. —**Samtec, Inc.,** 810 Progress Blvd., PO Box 1147, New Albany, IN 47150.

CIRCLE 112 ON FREE INFORMATION CARD

COLOR BROCHURE, *Land Mobile Radios and Accessories,* is 12 pages, 8½ × 11 inches, and describes a broad line of two-way business radios, pagers, repeaters, and accessories in layman's language.

Rugged, slimly styled dash-mount mobile radios are available with up to four channels in power ranges from 20 to 75 watts. The trunk-mount radios feature a two-channel, mini-control head and transceiver capable of being mounted in any convenient place in the vehicle-trunk, under a seat, or under the dash.

Handheld UHF radios have a transmitter output of 3.5 watts, and VHF models have a full 5-watt capability. All models have six-channel capacity and weigh less than two pounds. Several models are rated intrinsically safe.

Pocket pagers are available in VHF and UHF models. All are rated intrinsically safe. Repeaters, designed to extend business-radio signals over greater distances, are available in both VHF and UHF models.

A complete line of accessories, including antennas, power supplies, external loudspeakers, microphones, crystals, tone devices, batteries, and chargers support the two-way radio line. Free upon request.—**Standard Communications Corp.,** PO Box 92151, Los Angeles, CA 90009.

CIRCLE 113 ON FREE INFORMATION CARD

RADIO-PRODUCTS CATALOG is 40 pages, 2-color, 5½ × 8½ inches, and features a new 5-channel, 10-watt VHF FM transceiver; new COR and CWID modules for repeater builders, and new accessories, such as RF-tight enclosures for repeaters and power supplies. Also featured are the new T51 (VHF) and T451 (UHF) FM exciter

modules. Many new ranges of transmitting and receiving converters have been added, as well as a series of receiving converters to extend the frequency coverage of scanners to new military, satellite, and commercial bands. The catalog also includes the full line of Cushcraft and Larsen VHF/UHF antennas. Free upon request. —**Hamtronics, Inc.**, 65F Moul Rd., Hilton, NY 14468.

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THERMISTOR BULLETIN, 5-pages, 8½ × 11 inches, is a "technical data" bulletin which provides information relating to the testing of thermistors and includes material such as: RT testing; resistance measurement; temperature control; unbalanced thermocouple voltage-error; self-heating errors; determining bridge-supply voltage; accuracy of measurement, and other associated topics. Free upon request.—**Fenwal Electronics,** 63 Fountain Street, PO Box 585, Framingham, MA 01701.

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DIGITAL INSTRUMENTATION CATALOG, is a 2-color, 16-page reference brochure, 8½ × 11 inches, describing a broad range of digital instrumentation. Included are: 5½-digit and 4½-digit multimeters; 4½-digit portable/bench DMM's; 3½-digit hand-held portable DMM's; DC voltage/current standards; analog multiplexer; 488 interface; frequency counters; capacitance meter, and thermometer. A complete range of options and accessories is also included. Free upon request.—**Data Precision Corporation,** Electronics Avenue, Danvers, MA 01923.

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THIS MONTH, 32 pages, 8½ × 11 inches, is an illustrated catalog of electronics equipment. A recent issue features audio-visual materials, compressors, fans/blowers, lenses, CCTV, magnets and accessories, motors and accessories, power supplies, pumps and compressors, relays, solenoids, tools, TV/CCTV equipment, valves and gauges, video-tape, and innumerable other items. Free upon request.—**Herbach & Rademan, Inc.,** 401 East Erie Avenue, Philadelphia, PA 19134.

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ELECTRONICS CATALOG, 142 pages, 5½ × 8½ inches, is fully illustrated and lists a wide variety of equipment, including test instruments, digital portable multimeters, tool kits, soldering stations, outlets and outlet strips, tubes, antennas, assorted components, TV accessories, kits, microphones, TV games, personal computers, auto accessories, and video connectors and cables. Free upon request.—**Fordham Radio,** 855 Conklin Street, Farmingdale, NY 11735. **R-E**

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NEW BOOKS

For more details use free information card inside back cover.

THE HOME VIDEO HANDBOOK, Second Edition, by Charles Bensinger. Video-Info Publications, PO box 1507, Santa Barbara, CA 93102. 304pp.; 5½ × 8½ inches; softcover. $8.95.

This is much more than a second printing of the popular first edition; there are 100 additional pages and 80 new photographs and graphics. The aim of this second edition, however, remains the same as that of the first: It is designed to unscramble the confusing data and claims surrounding home-video equipment and to provide clear and visual explanations of technical jargon and popular video systems.

There is a detailed treatment of popular home color cameras, videocassette recorders, videodisc systems, large-screen TV projectors, home-satellite TV receivers, and ½-inch industrial-video systems.

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Photographs, drawings, and cartoons illustrate the easy-to-read text; there is a list of home-program sources, educational sources, and popular video books, as well as an 11-page glossary of technical terms and a list of manufacturers' addresses.

CIRCLE 121 ON FREE INFORMATION CARD

HOW TO REPAIR CB RADIOS, by Lawrence E. Schultz. Gregg/McGraw-Hill, 1221 Avenue of the Americas, New York, NY 10020. 184pp.; 5⅜ × 8 inches; softcover. $9.95.

This book is written from a service technician's point of view and uses a hands-on approach. Theory is dealt with only when the material is peculiar to CB radios and the reader needs it as a support to trouble-shooting techniques. None of the techniques and hints in the book are theoretical, however: They have all been tested and proved effective on the service bench.

The introduction describes the many types of CB radios and their accessories. Then we get into basic troubleshooting techniques. Chapters 3 to 8 cover "Developing Signal Frequencies," "The Receiver," "The Transmitter," "Power Supplies," "Antennas and Transmission Lines," and "Single-Sideband Circuitry." The book is fully illustrated with photographs, diagrams, tables, and charts.

CIRCLE 122 ON FREE INFORMATION CARD

MICROCOMPUTERS FOR EXTERNAL CONTROL DEVICES, by James A. Gupton, Jr. dilithium Press, P.O. Box 606, Beaverton, OR 97075. 279pp., including appendices and index; 5½ × 8¼ inches; softcover. $13.95

This book deals with the ways in which a microcomputer can be used to control devices in one's home, one's business, or

elsewhere. Many manual functions that are frequently subject to human error can be accomplished faster, with greater accuracy, greater repeatability, and lower cost through a computer.

After an introduction to data acquisition and conversion, and a discussion of the principles involved, the reader is introduced to remote control, microprocessors, and one-IC microcomputers, then shown how the microcomputer is used as a programmable controller.

The reader will learn about computer systems for automating his or her home, microcomputer-controlled robots, and the use of robots in emergency situations, among other operations and processes. There are many photographs and diagrams, glossaries, and review questions at the end of each chapter.

CIRCLE 123 ON FREE INFORMATION CARD

30 PROJECTS TO IMPROVE YOUR STEREO SYSTEM, by David B. Weems. Tab Books, Inc., Blue Ridge Summit, PA 17214. 240pp., including appendices and index; 5 × 8¼ inches; softcover. $7.95.

While almost any system can be improved, there are two areas where small changes can pay big dividends in better sound: at the antenna and at the speaker. That is why there are more antenna and speaker-related projects in this book than any other kinds. Some improvements, while real enough, are very expensive. The projects outlined here have all been chosen with one eye upon performance and one eye upon cost.

The 10 chapters deal with FM antennas, antenna projects, an amplifier project, crossover networks, crossover-network projects, speaker-enclosure projects, speaker-improvement projects, more speaker-improvement projects, high-frequency improvement projects, and stereo-equipment cabinets. Each chapter is fully illustrated with photos, clear line illustrations, or both.

CIRCLE 124 ON FREE INFORMATION CARD

A CONSUMER'S GUIDE TO PERSONAL COMPUTING AND MICROCOMPUTERS, second edition, by Stephen Freiberger and Paul Chew, Jr. Hayden Book Company, 50 Essex St., Rochelle Park, NJ 07662. 198pp.; 7 × 9¾ inches; softcover. $8.95.

The authors of this book assume that the reader has had no previous experience with, or knowledge of, either computers or microcomputers. Thus, the first section, chapters 1 through 5, introduces the reader to fundamental principles and definitions, with photos and charts.

Chapters 6 through 10 constitute a product guide, reviewing over 100 microcomputer products from over 60 manufacturers. They include a selection-and-sources section to assist the reader in reviewing, selecting and purchasing microcomputer products; summary charts of major microcomputer products, offering a quick rundown of specifications for a given product, and comment sections covering the advantages and disadvantages for each microcomputer product, as well as best-buy tips.

CIRCLE 125 ON FREE INFORMATION CARD

34 *MORE* TESTED, READY-TO-RUN GAME PROGRAMS IN BASIC, by Delton T. Horn. Tab Books, Inc., Blue Ridge Summit, PA 17214. 224pp., including appendices and index; 5⅛ × 8⅜ inches; $7.95.

Computers are mainly for serious business, but they can be fun, too—and that is what this book is about. It presents a collection of games, gags, brain-teasers, and non-games, and even sneaks in some programs that educate while they entertain the user.

For a single player there are not only such familiar games as "Craps," "High/Low", "Go Fish", and "Tic Tac Toe", but also new ones with such fascinating titles as "Hangman," "There's Gold in Them There Skyscrapers," and "What Comes Next?"

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Non-games, such as "Surprise Poem," and "Favorite Song," are dealt with in chapter 4, and the book closes (chapter 5) with entertaining helpful programs: "Binary/Decimal," "Day of the Week," "Ohm's Law," and "Fahrenheit/Celsius." The appendix presents notes on programming in BASIC.

CIRCLE 126 ON FREE INFORMATION CARD

PASCAL PROGRAMS For Scientists and Engineers, by Alan R. Miller. SYBEX, 2344 Sixth Street, Berkeley CA 94710. 374 pp., including appendices, bibliography, and index; 7 × 9 inches; softcover. $16.95.

This book has the twofold purpose of helping the reader to develop proficiency in using Pascal, and in building a library of programs that can be used to solve problems frequently encountered in science and engineering. The programs presented will prove valuable to practicing scientists and engineers but are also suitable for a junior- or senior-level course in numerical methods.

The reader must have a working knowledge of an applications language such as Pascal, FORTRAN, or BASIC. Experience with vector operations and with differential and integral calculus would be helpful.

There are 11 chapters, starting with "Evaluation of a Pascal Compiler." That is followed by "Mean and Standard Deviation," "Vector and Matrix Operations," "Simultaneous Solution of Linear Equations," "Development of a Curve-Fitting Program," "Sorting," "General Least-Squares Curve Fitting," "Solution of Equations by Newton's Method," "Numerical Integration," "Nonlinear Curve-Fitting Equations, and a final chapter on "Advanced Applications." The appendices cover reserved words and functions and a summary of Pascal. The book is cleanly printed and clearly laid out. **R-E**

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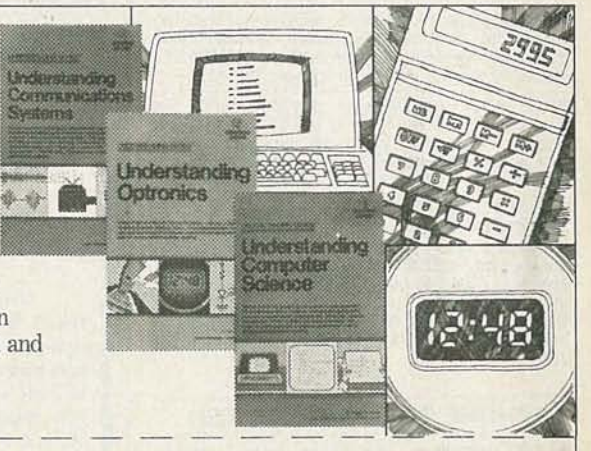

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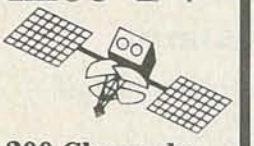

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LM311CH	.85	LM709CH	.59	LM1496CN-14	1.38
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LM318CH	1.67	LM723CN-14	.48	LM3081DC	1.67
LM323K	5.34	LM725CN-8	1.22	LM3403N-14	1.19
LM324N	.48	LM733CN-14	1.36	LM3524PC	3.30
LM339N	.48	LM739CN-14	1.69	LM3900N	.98
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7447AN	.65	74278N	2.38	74LS08N	.22	74LS258N	.56
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7451N	.29	74283N	1.10	74LS10N	.22	74LS260N	1.25
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7454N	.29	74298N	.84	74LS12N	.24	74LS273N	1.19
7472N	.36	74351N	2.20	74LS13N	.29	74LS275N	4.69
7473N	.38	74365AN	.69	74LS14N	.39	74LS279N	.48
7474N	.36	74366N	.69	74LS20N	.22	74LS280N	1.96
7475N	.42	74367AN	.58	74LS21N	.28	74LS283N	.78
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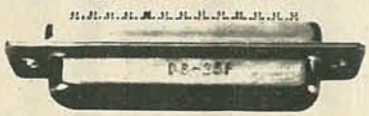

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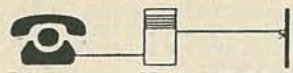


NEW!

FEATURES

Replaces monotonous telephone ringer bell. Easily connects to any standard phone. Use alongside regular phone or replace remote ringer elsewhere in building or outside. FCC approved. Use on any phone system — worldwide. Use different tune to identify extension phones. Microprocessor controlled. Adjust. vol. control and variable tune speed control. Operates on 2-9V batteries or AC Adapter (not incl.).

PT030 Phone Tunes $49.95
AD30 AC Adapter $8.95

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:

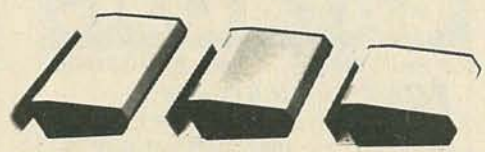
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 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)

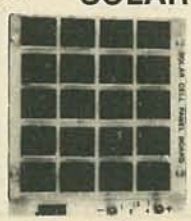
JE200 Reg. Power Supply Kit (5VDC, 1 amp) . . $14.95
JE205 Adapter Brd. (to JE200) ±5,±9 & ±12V. . $12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp. . $19.95

DESK TOP ENCLOSURES



DTE-8 (Pictured) $31.95
DTE-11 (Pictured) 34.95
DTE-14 (Pictured) 36.95
DTE-HK (Case for JE600) 47.95
DTE-AK (Case for JE610) 52.95

NEW! Sun Power Your Electronics! SOLAR CELL PANEL KIT



- **Output: 10VDC, to 100mA in Series 5VDC, to 200mA in Parallel**
- **Panel may be easily connected for Series or Parallel out**
- **Over 11 square inches of active cell surface**
- **Voltage line tap @ 0.5V increments**
- **Provision for charging batteries**
- **Overall panel size: 4¾"L x 4½"H x ½"D**

The JE305 Solar Cell Panel Kit contains 20 ea. solar cells. On the panel board are power line taps which allow the user to select voltages (1 voltage at a time) from 0.5VDC to 10VDC. The applications of each panel can be further expanded by coupling additional panels in series for more voltage or in parallel for more current. The premium grade solar cells provide the current necessary for the operation of most portable transistor radios, small battery powered cassette tape players & unlimited experimental solar projects.

JE305 .....$39.95

LS Schottky

74LS00	.55	74LS109	.75
74LS02	.55	74LS123	1.49
74LS04	.69	74LS138	1.29
74LS08	.55	74LS139	1.29
74LS10	.55	74LS154	1.95
74LS14	1.09	74LS157	1.19
74LS30	.55	74LS161	1.29
74LS32	.69	74LS174	1.19
74LS38	.69	74LS175	1.19
74LS42	1.29	74LS192	1.49
74LS47	1.29	74LS193	1.49
74LS48	1.79	74LS221	1.49
74LS73	.75	74LS244	1.89
74LS74	.69	74LS245	3.49
74LS75	.75	74LS367	.89
74LS85	1.49	74LS374	1.95
74LS90	.89	81LS97	2.29

SOCKETS

Low Profile		Wire Wrap	
8 pin LP	2/.59	14 pin WW tin	.75
14 pin LP	2/.69	14 pin WW gold	1.09
16 pin LP	2/.79	16 pin WW tin	.79
18 pin LP	2/.89	16 pin WW gold	1.19
20 pin LP	2/.99	24 pin WW gold	1.69
22 pin LP	2/1.09	40 pin WW gold	2.75
24 pin LP	.79	14 p. plug/cover	1.29
28 pin LP	.82	16 p. plug/cover	1.39
36 pin LP	.99	24 p. plug/cover	1.95
40 pin LP	1.19	Also, The Molex Line	

DIODES & TRANSISTORS

IN751	2/.59	2N2219A	2/1.19
IN757	2/.59	2N2222A	2/.89
IN1188	2.69	2N2907A	2/.89
IN3600	5/.99	2N3055	.99
IN4001	4/.59	2N3772	2.25
IN4004	4/.69	2N3904	2/.69
IN4007	4/.79	2N3906	2/.69
IN4148	10/.99	2N4401	2/.79
IN4733	2/.69	2N4403	2/.79
IN4734	2/.69	2N5129	2/.69
IN4735	2/.69	2N5139	2/.69
IN4742	2/.69	2N5210	2/.79
IN4744	2/.69	2N5951	2/1.29

CAPACITORS

Dipped Tantalum		ELECTROLYTIC	
.1mfd@35V	2/.89	1mfd@50V	3/.69
.47mfd@35V	2/.89	4.7mfd@50V	2/.59
1mfd@35V	2/.89	10mfd@50V	2/.69
2.2mfd@25V	2/1.09	22mfd@50V	2/.79
3.3mfd@25V	2/1.19	47mfd@50V	2/.89
4.7mfd@25V	2/1.39	100mfd@50V	.59
10mfd@25V	1.19	220mfd@50V	.69
33mfd@25V	3.95	1000mfd@25V	1.19
100V MYLAR		2200mfd@16V	1.39
.001-.01mfd	4/.79	**50V CERAMIC**	
.022mfd	4/.89	10pf-.022mfd	4/.59
.047mfd	4/.99	.047mfd	4/.69
.1mfd	4/1.19	.1mfd	4/.79
.22mfd	4/1.29		

MICROPROCESSORS

Z80A	CPU (4MHz)	13.95
MC6800	8 Bit MPU	8.95
8080A	CPU	6.95
8212	8 Bit I/O Port	3.95
8216	Bi-Directional Bus Driver	4.49
2513/2140	Character Generator	12.95
8T97	Tri-State Hex Buffer	2.25
AY-5-1013	30K Baud UART	6.95
AY-5-2376	88-Key Keyboard Encoder	11.95
2114-2	4K Static RAM (200ns)	3.95
MK4116	16K Dynamic RAM (250ns)	3.95
2708	8K EPROM	5.95
2716	16K EPROM (+5V)	9.95

Function Generator Kit

Provides 3 basic waveforms: sine, triangle and square wave. Freq. range from 1 Hz to 100K Hz. Output amplitude from 0 volts to over 6 volts (peak to peak). Uses a 12V supply or a ±6V split supply. Includes chip, P.C. Board, components & instructions.

JE2206B $19.95

PLANS & KITS

CABLE TV converters and equipment. Plans and parts. Build or buy. For information send $2.00. **C & D ELECTRONICS, PO Box 21, Jenison, MI 49428**

BUILD light fountain from miniature Xmas lights. Beautiful Xmas display. Plans, including schematic for light sequencer, useful for any moving light display. Send $8.00 to: **F & M ELECTRONICS,** Box 363, Grafton, IL 62037

SUBSCRIPTION TV plans: 2300 MHz microwave downconverter plus bonus UHF system, both for only $10.00. Best systems available, no internal connections to TV! Parts and kits available, MC/Visa accepted on parts purchases. Send SASE for more information on these and other unique plans. COLLINS ELECTRONICS, Box 6424, San Bernardino, CA 92412

PORTABLE digital capacitor meter with 1% accuracy range 1pF to 10,000μF uses readily available CMOS IC's. Build for under $25.00. Etched PCB and plans $12.95. Calibration components included. **DRISCOLL ELECTRONICS,** 57 Scofield Ave., Bridgeport, CT 06605

END adjacent channel interference on your TV set. Unique device enables your ordinary set to separate all channels completely. Makes new programs available. Complete plans, $5.00. **RELTRON, Box 91103-R2, Cleveland, OH 44101**

SAVE up to 90%! You can afford a computer. Free catalog. **DIGATEK CORPORATION,** Suite E, 2723 West Butler Drive, Phoenix, AZ 85021

DECODE Morse, RTTY, and ASCII signals from airwaves with new **Code*Star.** LED readout or connect with your computer/printer. Keyboard, other items also available. Kits or assembled. **MICROCRAFT,** Box 513R, Thiensville, WI 53092 (414) 241-8144

PRINTED circuit boards from sketch or artwork. Kit projects. Free details. **DANOCINTHS INC.,** Box 261, Westland, MI 48185

WHERE to buy transistors, capacitors, resistors, transformers, etc. List $1.00 and SASE. Specify part needed. **BAYNE ASSOCIATES,** P.O. Box 394, Oil City, PA 16301

EXPERIMENTERS 25 projects kit. $4.95. Filters, multivibrators, temperature sensor, oscillators; more. Some experience necessary. Includes: 10 resistors, 6 capacitors, potentiometer, LM3900N quad operational amplifiers, 2 transistors and manual. Postage: 65¢. Order through **ELECTRALL,** Box 326R, Hillsdale, NJ 07642

AUDIO kits. Equalizer—twelve bands/channel $100; 24, $225; noise reducer/expander, $110; LED meter, $42; see **R-E** cover stories 5/78, 3/81, 2/80, or send stamp for catalog. **SSS,** 912R Knobcone, Loveland, CO 80537

PROJECTION TV . . . Convert your TV to project 7 foot picture. Results equal to $2,500 projector. Total cost less than $20.00. Plans & lens $16.00. Illustrated information **free.** Credit card orders—24 hours. (215) 736-3979. **MACROCOMGC,** Washington Crossing, PA 18977

MICROWAVE TV super performing downconverter kit special $55.00 + $1.50 shipping. Complete kit systems from $144.95 to $194.95. Free catalog. **LAB-TRONICS,** P.O. Box 171RE, Rogers, MN 55374

MICROCHROMA 68 expansion board. Includes 32K DRAM, two 12K banks EPROM software selectable. Board like motherboard, includes wire wrap area, edge connector. A&T less EPROMs $555.00. Bare board plus two ICs, $95.00. Texans add 5% sales tax. Or write for details. **WHITE ROSE ELECTRONICS,** P.O. Box 19571, Austin, TX 78760.

AUTOMOTIVE electronics! Complete catalog, replacement ignitions, voltage regulators, digital accessories, alarms, chargers, inverters, mileage aids, test equipment, also many kits. Send $3.00 (refundable) **AUTOMOTIVE, 1435 Exchange, Richardson, TX 75081**

MICROWAVE television education manual! New publication explores concepts, antennas, downconverters: $16.25. Information package on microwave and other exciting television products: $2.00. ABEX, P.O. Box 26601-RM, San Francisco, CA 94126

PCB. 15¢ sq-in. Free drilling. Satisfaction guaranteed. **INTERNATIONAL ENTERPRISE,** 6452 Hazel Circle, Simi Valley, CA 93063

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EPROM programming. Reasonable rates, quality work. Free details. **ADTRONICS,** 663 Branch Drive, Port Orange, FL 32019

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GAME cassettes: TRS80 **color computer** 4K—$6.95 spaceship docker, rubout, racetrak 16K—$10.95; **THANX PROGRAMS,** 1100 Arbor Town Circle #1218, Arlington, TX 76011

HEWLETT-PACKARD 608C signal generator 10-480 MHz $250.00. Electronic test equipment catalog 25¢. **EF ELECTRONICS,** P.O. Box 249, Aurora, IL 60507

SUPREME television-radio diagram manuals discounted 60%. Free information. SASE. **SUPREME,** 1760 Balsam, Highland Park, IL 60035

PRINTED circuit boards: Your artwork, quick delivery, reasonable. Quantity discounts. **ATLAS CIRCUITS,** Box 892, Lincolnton, NC 28092 (704) 735-3943

COMPLETE line of **microwave television converters** and accessories to suit your needs. Converters have a one year warranty backed by a 3 year reputation. Call or write for complete specifications and pricing. **Dealer inquiries invited. TRITON MARKETING,** 1933 Rockaway Parkway, Brooklyn, NY 11236 (212) 531-9004

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160 teletypes, 140 PABX's. Best offer over $50. 400 signal generators, power plants: offer over $3. Many others on bid. **(608) 582-4124**

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Featuring this month—our most unique graphic equalizer!

- 11 bands per channel
- 2 channels per band
- Lowest noise, at **any** price
- LED peak indicator
- MIC input
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- Built-in record switching—
- no need to re-patch
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- Regulated power supply

GRAPHIC EQUALIZERS

Description	Kit	Mfg.
31 Band Stereo EQ	☐ $279.56	☐ $544.54
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	☐ $114.94	☐ $230.00
11 Band Mono EQ	☐ $ 75.84	☐ $151.57
11 Band Stereo EQ (As shown above)	☐ $129.50	☐ $249.80
5 Band Stereo EQ	☐ $ 74.50	☐ $148.99
5 Band Mono EQ	☐ $ 49.14	☐ $ 98.27

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)	$52.20	$68.00
Cabinet or Rack Mount:		
20 LED (Mono)	$50.40	$68.00
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Down to – 71dB!

Total frequency response: 10Hz to 100KHz ± .05dB. Unweighted! Band frequencies: 16Hz Band frequencies: 16Hz to 16Hz and 20Hz to 20KHz.

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 _____
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8264 MEMORY 64K	12 .00
4Kx16 MEMORY board w/64 2101 chips	50.00
MPI 8 inch single side disc drive (OK, used)	175.00
MPI 8 inch dual sided disc drive (OK, used)	350.00
SHUGART 8 inch drive 850 FDD (ok, used)	425.00
MOTOROLA MONITOR 9 inch 115 volt	60.00
MOTOROLA MONITOR 12 inch 115 volt	85.00

Above 2 units accept composite video, no case, used.
2 units below accept TTL. Hi volt supply only. Used.

BALL BROS. 12 inch monitor	50.00
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DATA STATION CONSOLE w/keyboard & 9 inch monitor, power supply. Logic boards broken send for details on this one. $80.00

IR SCOPE see in the dark, new, portable.	260.00
IR SCOPE KIT pre-assembled, modular	150.00
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12 inch CRT bonded face plate, new, with specs. Made for computer work. $25 each 5 for $100.00

UNDERWATER HYDROPHONE 200 KC 10.00

WALKY TALKIES Govt surplus used condition. 47-55.4 mc range. With schematics. Govt AN/PRC-6 S25 each 2 for S45. Ant. S5 each

ASCII KEYBOARD parallel S50
RED LED's . . . . . 10 for $1.00
MIN ORDER $10.00

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Shipping extra on all merchandise

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11+ Units **$31.95**

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(Real/Elapsed Time)

- **Battery-Operated: Two Alkaline "D" Batteries**
- **Sound-Activated Module**
- **Sensitivity control**
- **9" Digital Readout**
- **4x4 Printed Circuit Board**

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TERMINALS, TERMINALS!

Daisy Terminals

Featuring 110, 150 and 300 baud, RS 232 I/O. Full KSR, full or half duplex, Diablo Hytype-I printer, plastic Daisy wheel, off-lease and refurbished. 4-way plotting mode under remote or KBD control. Built in KBD, ptr. typing table, power supply and more, with user manual and schematics. Refurbished. . . . . **$999.00ea.**

Add $45.00 for Crate - Pay Shipping on Delivery

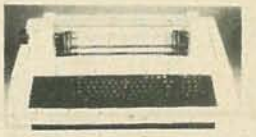
Selectric Terminals

Famous Datel-built "Selectric" I/O terminal. Used, "as-is" cond. (may need minor service). Features 15" carriage Selectric typewriter/printer, KBD/Solenoid assembly, power supply & RS232 I/O circuit board. Speaks IBM "correspondence" protocol. Limited info included.

Used "As-Is" . . . **Only $499.00ea.**

Add $20.00 for Packaging & Handling - Pay Shipping on Delivery

DEC LA-36 Terminals



Off-lease and refurbished, these are the famous DEC dot matrix, 30 character per second RS-232 terminals with such advanced features as 60 cps character catch-up print rate for true 300 baud operation. Built by Digital Equipment Corp. 132 columns, tractor-fed.

Refurbished . . . . **Only $799.00ea.** *Pay Shipping on Delivery*

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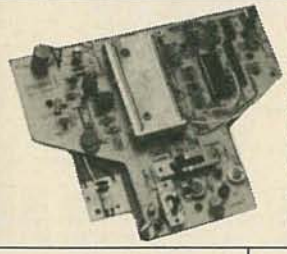

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In just a short time and with a few minor parts, the most novice hobbiest can complete this exciting Tank Battle game. Create a fun-filled evening for the whole family. Two independent tanks rumble thru land mine fields, shoot shells and fragment when 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 6½".

1-9 **$7.50** 50-99 **$6.00**
10-49 **$6.50** 100-UP **$5.50**

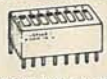
COPPER CLAD BOARD

(Double Side)

Size 9.25 x 10.75
Thickness .062

$2.00 ea.

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.
Movement: 0-6, 0-10, 0-17

$2.50 ea.

SPEAKER

3" Diam.,
8 OHM,
5 Watts.

$2.00 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

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.

TEXAS INSTRUMENT KEYBOARD

Has 3 slide switches, 26 different keys, key pad removable by 4 screws

$1.95 ea. 5/**$8.00**

E. F. JOHNSON S METER

Edge Meter 250 UA, fits in ⅝"x1⅜" 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.
240	@ 300V	1¼" x 3¼"	**$2.00** ea.
50	@ 450V	1¼" x 2"	**$2.00** ea.

24 Volt
POWER SUPPLY
5.4 AMPS

$45.00 ea.

MFG by ACDC Electronics Inc.
Model OEM 24N5.4-1

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.

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.

PROJECT BOX

$1.50 ea.

4⅝" w x 7⅜" l x ¾" to 1½" h

Has a lip for recessed face plate and a felt bottom

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.
40 pin **$1.75** ea.

MUFFIN FANS

MFG By Rotron Inc.
3 Blades 4¾" Square

USED
110 VAC **$5.95** ea.

NEW
230 VAC Model MU3A1

$12.00 ea.

NEW SPRITE FAN

Mfg. by Rotron Inc.
Model SU2A5.
115v AC. 19 amps.
(Impedance protected.)
3¼"x 3¼"x 1¾"

$12.00 ea.

7' POWER CORD

HEWLETT PACKARD TYPE

Molded 3 Prong Plug with molded receptacle
Belden 16 AWG

$3.00 ea.

MAGNETIC CHESS BOARD WITH MEN

Folds in half to carry men
11" w x 11" l x 1' h

$4.00 ea.

COAX CONNECTORS

UG-273/U BNC-F/UHF-M	**$2.50**
UG-255/U BNC-M/UHF-F	**$3.00**
UG-146 A/U N-M/UHF-F	**$4.50**
UG-83B/U N-F/UHF-M	**$4.50**
UG-175 RG-58 Adapt	**$ .20**
UG-176 RG-59 Adapt	**$ .20**
UG-1094 BNC-F/Panel	**$1.00**

SO239 **50c**
PL259 **60c**

COAXIAL CABLE

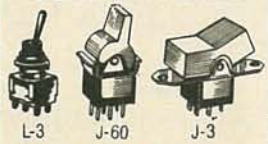
50 OHM-RG 174

$4.95/100' $3.00/50'

75 OHM-RG 62/U

$12.00/100'

C & K SWITCHES



L-3 J-60 J-3

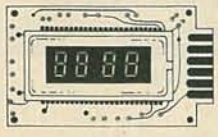
Part #		Movement
J-60	7101	SPDT
J-60	7103	SPDT (center off)
L-3	7108	SPDT (momentary)
J-3	7201	DPDT (special large rocker)

$1.00 ea. **6/$5.00**

TERMS: All material guaranteed unless otherwise stated. If you are not satisfied with our product, it may be returned within 10 days for a refund (less shipping). Please add $4.00 for shipping and handling on all orders. COD's accepted for orders totaling $50 or more. All orders shipped UPS unless otherwise specified. Florida residents please add 4% sales tax. Minimum order, $15.00. Foreign orders – US funds only, add 20% for shipping and handling.

National Semiconductor Clock Modules

12VDC AUTOMOTIVE/ INSTRUMENT CLOCK



APPLICATIONS:
- In-dash autoclocks
- After-market auto/ RV clocks
- Aircraft-marine clks.
- 12VDC oper. instru.
- Portable/battery powered instrumnts.

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 (3.05"W Lx1.75"Hx.98"D) . **$16.95**

CLOCK MODULES

MA1023 .7" Red Digital LED Clock Module	8.95
MA1026 .7" Dig. LED Alarm Clock/Thermometer	18.95
MA5036 .3" Red Digital LED Clock/Timer	6.95
MA1002 .5" Red Digital LED Clock & Xformer	9.95
MA1010 .8" Red Digital LED Clock	7.95
MA1032 CBA .5" Digital LCD Clock	17.95
MA1043 .7" Green Digital LED Clock	8.95

TRANSFORMERS

102-P20 Xformer for MA1023, 1043 & 5036 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: 10VDC, to 100mA in Series 5VDC, to 200mA in Parallel
- Panel may be easily connected for Series or Parallel out
- Over 11 square inches of active cell surface
- Voltage line tap @ 0.5V increments
- Provision for charging batteries
- Overall panel size: 4¼"L x 4½"H 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 user to select voltages (one voltage at a time) from 0.5VDC to 10VDC. The applications of each panel can be further expanded by coupling additional panels in series for more voltage or in parallel for more current. The premium grade solar cells provide the current necessary for the operation of most portable transistor radios, small battery powered cassette tape players and unlimited experimental solar projects.

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

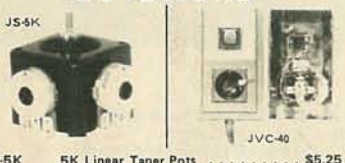
EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact – only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVS-11EL Replacement Bulb $16.95

UVS-11E **$79.95**

JOYSTICKS



JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case	$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 @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 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, ±9 & ±12V.	$12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp.	$19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A-4	CPU	4.95
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	6.95
DP8253	Prog. Interval Timer	8.95
DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	9.95
DP8275	Prog. CRT Controller	39.95
DP8279	Prog. Keyboard/Display Interface	9.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25

6800/6800 SUPPORT DEVICES

MC6800	MPU	7.95
MC6802CP	MPU with Clock and RAM	14.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	17.95
MC6830L8	1024x8-Bit ROM (MC6A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	11.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	13.95
COP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU–4-Bit Slice (Com. Temp. Grade)	19.95
MC5602	MPU w/Clock (6K Bytes Memory)	11.95
INS8035N-4	MPU–8-Bit (4MHz)	7.95
INS8039N-4	CPU–Sgl. Chip 8-Bit (128bytes RAM)	9.95
INS8040N-4	CPU (256 Bytes RAM)	24.95
INS8070N	CPU–64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	9.95
TMS9900JL	MPU–16-Bit	39.95

SHIFT REGISTERS

MM5004H	Dual 25-Bit Dynamic	.50
MM5013H	Dual 50-Bit Dynamic	.50
MM5016H	Dual 100-Bit Static	.50
MM5101H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V (1404A)	1024-Bit Dynamic	1.95
2518N	Hex 32-Bit Static	3.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Band Filter	19.95
AF123-1CJ	Touch Tone High Band Filter	19.95
LM308CH	Super Gain Op Amp	1.15
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM309H	Temp. Comp. Prec. Ref. (.5ppm/C°)	5.00
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch. Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	6.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
2LL02	1024x1 Static	1.95
2111 (8111)	256x4 Static	4.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	3.25
2114L	1024x4 Static 450ns Low Power	3.49
2114-2	1024x4 Static 200ns	3.95
2114L-2	1024x4 Static 200ns Low Power	4.95
745200	256x1 Static	6.95
4136N-4 (UPD416)	16K Dynamic 250ns (MM5290N-4)	2.95
4164N-3	64K Dynamic 200ns	19.95
MM2147J	4096x1 Fast 70ns	7.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.49
MM5280/2307	4096x1 Dynamic	4.95
MM5290N-2 (4136)	16K Dynamic 150ns (UPD416C-3)	3.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290J)	7.95
HM6116-4	16K (2Kx8) Static 200ns	14.95
82S25	64 Bit RAM (16x40C)	3.49
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	9.95
TMS4045	1024x4 Static	9.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	4.95
TMS2716	16K EPROM (-5V, +5V, +12V)	9.95
2716(Intel/2516)TI	16K EPROM (Single +5V)	8.95
2732(Intel TI	32K EPROM	17.95
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM (Hitachi HN462764)	49.95
5203	32x8 PROM	14.95
82S23(74S188)	32x8 PROM (Open Collector)	3.95
82S115	4096 Bipolar PROM	14.95
82S123(74S288)	32x8 Tri-State Bipolar PROM	3.95
82S185	8K PROM	16.95

— Over 30 More PROMS Listed in Our Catalog —

ROM'S

2513(2140)	Character Generator (Upper Case)	9.95
2513(3021)	Character Generator (Lower Case)	9.95

NMOS READ ONLY MEMORIES

MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha, Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

M-Z80	User Manual	7.50
M-COP1802	User Manual	7.50
M-2650	User Manual	5.00

SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP470N	30-Seg.VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53200N	Push Button Pulse Dialer	7.95
MM57409N	96/144-Key Serial Keyboard Encoder	8.95

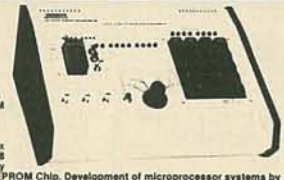
RADIO CONTROL CIRCUITS

Ideal for remote control systems which use pulse amplitude modulation (toy cars, boats, tanks, etc.). Features: five function control, adjustable steering angle, suitable for 27 and 47MHz bands and low power consumption.

KB-4428 TRANSMITTER **$4.25**
Abs. max. rating (TA@25°C). Supply volt.: Vcc1 12VDC. Power Dissipation: PD: 300mW; Temp. range: Oper. 0 – +50°C — Storage -30 — +125°C. Recommended oper. volt.: 7-11V. Crystal or CR Oscillation circuits acceptable.

KB-4429 RECEIVER **$5.95**
Abs. max. rating (TA@25°C). Supply volt.: Vcc1: 11V, Vcc2: 7.5V; Power Dissipation: 600W. Temp. range: Oper. 0 ± 50°C. Recommended oper. volt.: VOP1 7-11V — VOP2 3-8V.

JE608 PROGRAMMER
2704/2708 EPROM PROGRAMMER



GENERAL APPLICATIONS:
- To program EPROMS 2704 and 2708.
- Developmental system for microcomputer circuits
- To read the contents of a pre-programmed EPROM
- To compare EPROM(s) for content differences
- To emulate a programmed EPROM
- To store program in RAMS for alterations
- Three separate Display Registers: 8 LED's for Hex Key entries, 10 LED's (2^0-2^9) for Address Register and 8 LED's for Data Memory Register. The Data Memory Register displays the content of the RAMs from the EPROM Chip. Development of microprocessor systems by means of a ribbon cable from the programmer panel test socket to the EPROM socket on the microprocessor board. Rapid checking verification of programmed data changes. User may move data from a master to RAM's or write into RAM's with keyboard entries. Allows manual stepping manipulation (up and down) at any address location. Stand-alone EPROM Programmer consisting of: A 19-key Hexadecimal Keyboard assembly, Programmer Board assembly with 4 power supplies and a LED/Test Socket Panel Board assembly. The Test Socket is zero force insertion type. Power requirements: 115VAC, 60Hz, 6W. Compact desk-top enclosure: Color-coordinated designer's case with light tan panels and molded end pieces in mocha brown. Size: 3¼"H x 11"W x 8¼"D. Weight: 5 lbs.

The JE608 EPROM Programmer is a completely self-contained unit which is independent of computer control and requires no additional systems for its operations. The EPROM can be programmed from the Hexadecimal 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 pretest a program for a system, prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that rewriting the entire program will not be necessary. The JE608 Programmer contains a Programmer/Board w/25 IC's & includes power supplies of: -5V, +5V, +12V and +26V. The Hexadecimal 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. The adapter provides for adding an address switch for the 2^11 bit and also for selecting the proper power and timing pulses to be applied to the EPROM. Programming and emulating the 2716 (16K) EPROM is done separately to each half (1024x8) 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 of the JE608-16K Adapter Board Kit)	$99.95
JE608A-16K Mod.	Assembled JE608 w/Adapter (JE608-16K) Installed	$599.95

$10.00 Min. Order – U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage—Add 5% plus $1.50 Insurance

Spec Sheets – 25¢
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BOOKS
National Semiconductor — Intersil — Intel

30001	National CMOS Data Book (640 pages) 74C, CD4000, and A/D Converters	$6.95
30002	National Interface Data Book (704 pages) DP, DS8000, DS3600, DS75000, etc.	$6.95
30003	National Linear Data Book (1376 pages) LM, LF, ADC, DAC, LH Series	$8.95
30004	National Series 80 – Board Level Computer (224 pages)	$4.95
30005	National TTL Logic Data Book (624 pages) 7400, LS, L, H, S, and DM8000 Series	$8.95
30006	Buy above (3) 30001,3,5 as a set	$19.95/lot
30009	Intersil Data Book (1074 pages)	$6.95
010400	Intel Component Data Catalog	$10.00
205610	Intel Peripheral Design Handbook (644 pages) Full data sheets, appl. notes for Intel peripheral device components	$7.50

AC and DC Wall Transformers

Ideal for use with clocks, games, power supplies or any other type of AC or DC application.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12 VAC 250mA	$3.95
AC 500	117V/60Hz	12 VAC 500mA	$4.95
AC1000	117V/60Hz	12 VAC 1 amp	$5.95
AC1700	117V/60Hz	9 VAC 1.7 amp	$3.95
DV 9200	117V/60Hz	9 VDC 200mA	$3.25
DC 900	120V/60Hz	9 VDC 500mA	$3.95

CONNECTORS

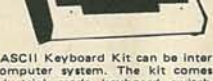
DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
D20418-2	Screw Lock Hdwr. (2) DB25S/P	2/$.99
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
- ★ 8 ea. MM5290 (UPD416/4116) 16K Dyn. Rams (*NS)
- ★ Documentation for Conversion

TRS-16K2 *150NS	$29.95
TRS-16K3 *200NS	$24.95
TRS-16K4 *250NS	$19.95

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 126 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 14½"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 – 3¼"Hx11"Wx8¾"D) **$ 49.95**

NEW! JE212 – Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT
Provides -12VDC from incoming 5VDC . . **$9.95**

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-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 monitored with 9 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. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) **$99.95**

JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) . . **$59.95**

K19 19-Key Keyboard (Keyboard only) **$14.95**

DTE-HK (case only – 3¼"Hx8¼"Wx8¾"D) **$44.95**

PLANS & KITS

POLICE/fire scanners, scanner crystals, antennas, radar detectors. **HPR,** Box 19224, Denver, CO 80219

TELEPHONE or office bugged? Latest detection equipment finds out fast. Literature $1.00. **CLIFTON,** Box 220-M, Miami, FL 33168

FREE speaker catalog! Woofers, mids, tweeters, hardware, crossovers, grille cloth, plans, kits, information, much more. Discount prices. **UNIVERSAL SOUND,** Dept. RE, 2253 Ringling Blvd., Sarasota, FL 33577, (813) 953-5363

ELECTRONIC portable air cleaners eliminate 99% pollen, smoke, dust. Free catalogue. **LECTRONIC SALES,** 3338 Rollingwood Drive, Woodbridge, VA 22192

"TOP secret" Registry U.S. Government Frequencies! 4th Edition! 120 Pages! 50,000 latest scanner listings: FBI, Secret Service, FCC, Customs, military, etc. $9.95 + $1 first class mailing. **CRB RESEARCH,** Box 56-RE, Commack, NY 11725

SAVE! Calculator repairs. Most failures fixed by hobbyist. Troubleshooting/repair guide. $3.75. **12 Sandalwood Rd.,** Dept. R9, P.O. Box C-5525, So. Burlington, VT 05401

RECORDS-tapes! Discounts to 73%; all labels; no purchase obligations; newsletter; discount dividend certificates; 100% guarantees. Free details. **DISCOUNT MUSIC CLUB,** 650 Main Street, PO Box 2000, Dept. 3-1181, New Rochelle, NY 10801

SAVE up to 50% on name brand test equipment. Free catalog and price list. **SALEN ELECTRONICS,** Box 82-F, Skokie, IL 60077

more classified on page 116

SPECIAL FALL SALE

15% OFF ON ALL ITEMS LISTED IN THIS AD with order of $25 of more

Sale is in effect from Oct 15 - Nov 30
Limited to merchandise in stock

INTERNATIONAL ELECTRONICS UNLIMITED

CERAMIC DISC CAPACITORS 50V

1pf	47pf	220pf	.Ø0Ø2mf
5pf	56pf	270pf	.Ø10mf
7pf	68pf	390pf	.015mf
10pf	82pf	470pf	.022mf
18pf	100pf	600pf	.030mf
22pf	120pf	.001mf	.050mf
27pf	150pf	.0015mf	.1mf
33pf	180pf	.003mf	

1pf to .05Ømf

ea	pk-10	pk-100	1000-
$.20	.95	7.00	.06ea

.1mf/50V disc 1/2"d
$.25 1.25 9.50 .09ea

CERAMIC CAPACITOR KIT
5 ea of above $12.50
10 ea of above $20.50

MONOLITHIC CERAMIC CAPACITORS

	ea	pk-10	100-
.1uf/50V	.15"sq	.25	1.50 .13ea
.22uf/50V	.20"sq	.30	2.00 .17ea
.47uf/50V	.20"sq	.35	2.50 .20ea

POLYESTER FILM CAPACITORS 100V ± 10%

	ea	pk-10	pk-100
.001uf	$.15	.95	6.50
.0015uf	.15	.95	7.50
.0022uf	.15	.95	7.50
.0033uf	.15	.95	7.50
.0047uf	.15	.95	7.50
.0068uf	.15	.95	7.50
.01uf	.15	.95	7.50
.015uf	.15	.95	7.50
.022uf	.15	.95	7.50
.033uf	.20	1.00	10.00
.047uf	.20	1.15	10.50
.068uf	.25	1.50	12.00
.1uf	.30	1.75	13.50
.15uf	.35	2.25	14.00
.22uf	.40	2.55	20.00
.33uf	.45	2.75	25.00
.47uf	.50	3.50	30.00

POLYESTER CAPACITOR KIT
5 ea of above $14.95

TANTALUM CAPACITORS solid dip - radial

	1-	10-	100-
.1mf/35V	.35	.30	.28
.22mf/35V	.35	.31	.29
.33mf/35V	.35	.31	.29
1mf/35V	.37	.32	.30
1.5mf/20V	.37	.32	.30
2.2mf/20V	.40	.35	.33
3.3mf/35V	.45	.40	.35
4.7mf/16V	.45	.40	.35
4.7mf/25V	.50	.45	.40
5.6mf/10V	.50	.45	.40
6.8mf/6V	.50	.45	.40
6.8mf/16V	.55	.50	.45
10mf/20V	.65	.55	.50
15mf/6V	.60	.50	.45
15mf/20V	.65	.55	.50
22mf/10V	.65	.55	.50
22mf/16V	.68	.57	.52
33mf/6V	.65	.55	.50
33mf/10V	.70	.65	.60
47mf/6V	.75	.70	.65
56mf/6V	.85	.75	.70
100mf/10V	1.25	1.15	1.00

ELECTROLYTIC CAPACITORS axial leads

	1-	10-	100-
1mf/50V	.15	.12	.10
2.2mf/25V	.15	.12	.11
2.2mf/50V	.15	.12	.11
3.3mf/50V	.16	.13	.11
4.7mf/63V	.16	.13	.11
10mf/35V	.16	.13	.11
10mf/50V	.17	.14	.11
10mf/150V	.18	.14	.14
22mf/16V	.17	.13	.12
22mf/50V	.18	.14	.13
25mf/25V	.18	.14	.12
30mf/25V	.18	.14	.12
33mf/25V	.18	.14	.13
47mf/35V	.18	.16	.13
100mf/10V	.19	.16	.14
100mf/16V	.20	.18	.16
100mf/25V	.22	.19	.17
150mf/25V	.23	.20	.18
220mf/16V	.25	.21	.19
220mf/25V	.27	.22	.20
330mf/16V	.29	.24	.22
470mf/16V	.30	.25	.22
470mf/35V	.34	.29	.26
500mf/15V	.28	.24	.22
1000mf/16V	.90	.85	.80
1000mf/35V	.95	.90	.85
2200mf/16V	1.25	1.15	1.05
2200mf/40V	1.35	1.10	1.00
4700mf/16V	1.35	1.25	1.10
4700mf/50V	1.45	1.30	1.15

radial leads

	1-	10-	100-
1mf/50V	.18	.12	.10
2.2mf/350V	.18	.15	.11
4.7mf/35V	.18	.15	.13
10mf/16V	.15	.13	.12
10mf/160V	.18	.15	.13
20mf/50V	.17	.14	.12
47mf/35V	.18	.16	.14
80mf/40V	.15	.13	.11
200mf/25V	.18	.16	.14
220mf/35V	.25	.22	.20
470mf/25V	.33	.28	.25
1000mf/16V	.65	.80	.75

LEDs

Jumbo diffused .20"d x .34"l

	pk-10	pk-25	100-	1000-
RED	$1.00	$2.25	.08ea	.Ø78ea
CLEAR	1.10	2.50	.09ea	.Ø85ea
WHITE	1.10	2.50	.09ea	.Ø85ea
YELLOW	1.40	3.25	.11ea	.10ea
GREEN	1.40	3.25	.11ea	.10ea

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

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

Subminiature diffused .125"d x .21"l

	pk-10	pk-25	100-	1000-
RED	$1.00	$2.25	.08ea	.Ø78ea
CLEAR	1.10	2.50	.09ea	.Ø85ea
GREEN	1.40	3.25	.11ea	.10ea
YELLOW	1.40	3.25	.11ea	.10ea

LED MOUNTING CLIP & RING For .20" (jumbo) LED

pk-10	pk-25	pk-100	1000-
$1.25	2.75	7.00	.06ea

DIPSWITCHES

	ea	10-	25-
4sw 8pin SPST	$1.65	$1.55ea	$1.49ea
8sw 16pin SPST	2.10	1.95	1.85
10sw 20pin SPST	2.20	2.05	1.95

DIODES

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

SOCKETS low profile - solder tail

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

Wire Wrap 3 level gold plate contacts tin plate tails

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

SOLID STATE BUZZER - 6V

(operates from 4V - 9V)

ea	10-	100-
$1.35	1.10ea	1.00ea

MINIATURE CERMET TRIMMER

Single turn Mepco 8014
.5W ± 20% 100ppm/ºC
.15"high x .250"dia
500ohm 1K 20K 25K 50K
100K 500K 1M

ea	10-	100-
$1.00	$.89ea	$.79ea

UNIVERSAL BREADBOARD IC BREADBOARD

ea	10-	25-
$1.25	$1.05	$.95

TANTALUM CAPACITOR KIT SOLID DIP ±20%

.1uf/35V	2.2uf/20V	10uf/25V
.22uf/35V	3.3uf/35V	15uf/20V
.33uf/35V	4.7uf/25V	22uf/35V
1uf/35V	6.8uf/35V	33uf/15V
1.5uf/20V		

T-S	5ea of above	$27.50
T-SC	5ea supplied in cabinet (15 drawer)	37.50
T-10	10ea of above	49.50
T-10C	10ea supplied in cabinet (15 drawer)	59.50
T-SC or T-10C	shipping	$3.00

ELECTROLYTIC CAPACITOR KIT AXIAL LEADS

1uf/50V	22uf/50V	220uf/50V
2.2uf/50V	33uf/25V	470uf/35V
3.3uf/50V	47uf/35V	1000uf/35V
4.7uf/50V	100uf/35V	2200uf/40V
10uf/50V	150uf/25V	

EAS	5ea of above	$19.50
EASC	5ea supplied in cabinet (15 drawer)	29.50
EA10	10ea of above	27.50
EA10C	10ea supplied in cabinet (15 drawer)	37.50
EASC or EA10C	shipping	$3.00

CARBON FILM ±5% 1/4watt (R.Ohm RZ5) .095"dia x .250"long (body) 1/2watt (R.Ohm RS0) .146"dia X .354"long (body)

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

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

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

METAL FILM RESISTORS 1/4W

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

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

TRANSISTORS

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

IEU PROJECT OF THE MONTH

FUNCTION GENERATOR KIT

Produces sine, triangle and square wave output at o-20V variable amplitude(peak to peak) from 2hz to 200Khz in 5 ranges- a high quality and versitile instrument- ideally suited for the hobbiest and experimenter.

BASIC KIT includes PC Board(1.6" X 3") 8038 IC and all board mounted electronics (switches and pots not included) * 18VDC required $17.50

POWER SUPPLY includes transformer (12V/250ma wall mt.), PC Board (1.6" X 3") and necessary parts to produce * 18VDC $16.50

CASE (Hammond 1591DGY) 2" X 3.15" X 6" and necessary switches, pots, etc. to build a complete instrument.... $19.75

REGULATED POWER SUPPLY KIT Uses +5V and +12V TO-220 regulators Kit includes PC Board(1 11/16" X 3"), Rectifiers, 7805 & 7812 Regulators, , Capacitors & Heat Sinks. Transformer not included. Fits PCB slots of Hammond Case 1591DGY. $4.95ea

PS-2

POWER SUPPLY KIT

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

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

ea $17.50	+ shipping/
10- 16.00	handling -
25- 15.00	$1.50 UPS
	$2.50 Mail

HAMMOND PLASTIC CASES

1591BGY 4.40" X 2.44" X 1.22" grey	$3.25
1591CBU 4.75" X 2.56" X 1.56" blue	4.10
1591DGY 6.00" X 3.15" X 2.00" grey	4.85

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

BEZELS WITH FILTERS

Snap-in BEZELS of black polycarbonate thermoplastic resin. Red slide-in filter. Provides attractive finish for standard panel cut-out and displays.

No. 140-Z	$2.10ea
cut-out 1.156" X 2.375" (up to .062" thick panel) viewing area 3" X .812"	
T-S 5ea of above	$27.50
T-SC 5ea supplied in cabinet (15 drawer)	37.50
T-10 10ea of above	49.50
T-10C 10ea supplied in cabinet	59.50
T-SC or T-10C shipping	$3.00
No. 140-3	$2.50ea
cut-out 1.156" X 3.375" (up to .125" thick panel) viewing area 3" X .812"	
No. 140-4	$2.85ea
cut-out 1.156" X 4.375" (up to .125" thick panel) viewing area 4" X .812"	

74LS SERIES

74LS00	.25	74LS90	.50	74LS181	2.00
74LS01	.25	74LS95	.75	74LS192	.60
74LS02	.25	74LS107	.40	74LS195	.90
74LS03	.25	74LS109	.40	74LS196	.85
74LS04	.27	74LS112	.40	74LS197	.85
74LS05	.27	74LS113	.40	74LS199	.95
74LS10	.25	74LS114	.50	74LS251	.95
74LS11	.27	74LS125	.50	74LS256	.95
74LS15	.35	74LS126	.50	74LS258	.95
74LS20	.25	74LS136	.50	74LS260	.75
74LS22	.25	74LS156	.95	74LS266	.45
74LS26	.35	74LS162	1.00	74LS290	.75
74LS28	.35	74LS163	.90	74LS298	.85
74LS32	.35	74LS164	.90	74LS365	.85
74LS40	.35	74LS165	.90	74LS367	.70
74LS42	.50	74LS168	1.25	74LS378	1.10
74LS54	.25	74LS170	1.70	74LS490	1.75
74LS74	.45				

VOLTAGE REGULATORS

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

EXAR CIRCUITS

XR320N-14	$ .95	XR4136N-14	$1.19
XR2201N-16	.95	XR4202N-16	1.95
XR2203N-16	.95	XR4212N-14	.95
XR2206N-16	4.50	XR4558N-8	.95
XR2207N-14	3.49	XR4739N-14	.95
XR2567N-16	2.49		

2708	8K EPROM 450ns		$4.50
2716	16K EPROM (5V)		7.50
8080A	CPU		7.50
16Ø2B	UART		3.79
5316	Alarm Clock		3.25
7010	Calendar Clock		5.50
2102	1024 x 1 static RAM		.95
5261	1024 bit dyn. RAM		.95
82S23	256 bit PROM		3.25
745200	256 bit PROM t-state		3.75
F93410	256 bit RAM bi-pol		.95
2114	STATIC RAM 1024 x 4 Low Power 200NS		$3.75
4116	DYNAMIC RAM 16K 200NS		$3.75
MM5369	OSCILLATOR/DIVIDER		$2.50
COLOR TV CRYSTAL (3.58 Mhz)			$2.00
2510	dual 100bit stat.S.R.		.75
2511	dual 200bit stat.S.R.		.75
2522	dual 132bit stat.S.R.		.75
2532	quad 80 bit stat.S.R.		.75
5013	1024 bit dyn accum		.75
5016	500/512 bit dyn		.75
8038	function generator		3.79

TTL - 7400

7400	$.18	7464	.30	74155	.50
7401	.20	7465	.30	74156	.64
7402	.20	7470	.48	74157	.60
7403	.21	7472	.32	74158	.75
7404	.22	7474	.22	74160	.70
7405	.25	7475	.45	74161	.70
7406	.20	7576	.49	74162	.85
7407	.20	7480	.35	74163	.85
7408	.27	7482	.25	74164	.85
7409	.27	7483	.58	74166	.85
7410	.20	7485	.50	74170	1.50
7411	.29	7486	.42	74173	1.25
7416	.20	7489	1.75	74174	1.05
7417	.20	7490	.59	74175	.85
7420	.20	7491	.64	74176	.70
7425	.39	7492	.59	74177	.70
7426	.35	7493	.35	74180	.35
7427	.25	7494	.59	74181	1.85
7430	.25	7495	.35	74182	.35
7432	.20	7496	.35	74189	.50
7437	.20	74105	.48	74190	1.15
7438	.20	74107	.35	74191	1.15
7440	.27	74121	.35	74192	.85
7441	.59	74122	.39	74193	.79
7442	.35	74123	.39	74194	.85
7443	.55	74125	.50	74195	.69
7444	.60	74126	.50	74196	.80
7445	.50	74132	.75	74197	.75
7446	.59	74141	.35	74198	1.40
7448	.59	74145	.50	74199	1.25
7450	.18	74148	1.25	745200	3.75
7451	.22	74150	1.35	74279	.65
7453	.18	74151	.50		
7454	.18	74153	.35		
7460	.18	74154	1.45		

9000 Series

9601	.25	9602	.29

CMOS - 4000

4000	$.25	4020	1.14	4050	.45
4001	.39	4021	.95	4051	1.15
4002	.25	4022	.95	4066	.79
4006	.95	4023	.30	4069	.39
4007	.39	4024	.75	4071	.29
4008	.95	4025	.22	4072	.39
4009	.46	4027	.59	4073	.39
4010	.45	4028	.85	4078	.39
4011	.45	4030	.49	4081	.39
4012	.25	4035	.95	4082	.30
4013	.59	4040	1.14	4518	1.25
4014	.95	4041	1.20	4528	1.50
4015	.95	4042	.95	4585	1.50
4016	.44	4043	.85	4901	.59
4017	1.08	4046	1.49		
4018	.95	4049	.45		

LINEAR CIRCUITS

301N-8	$.25	741N-8	.32
307N-8	.32	741N-14	.29
309H	1.05	748N-8	.25
311N-8	.29	1310N-14	2.50
318N-8	1.45	1414N-14	.35
324N-14	.95	1456N-8	1.29
339N-14	.29	1458N-8	.65
376N-8	.30	1496N-14	.89
380N-14	1.09	1800N-16	2.40
380N-8	.45	2208N-8	.79
386N-8	.89	2209N-8	.79
387N-8	.89	3046N-14	1.29
555N-8	.45	3081N-16	1.25
556N-14	.79	3082N-16	1.25
560N-16	2.95	3900N-14	.45
565N-14	.95	75150N-8	.35
567N-8	1.09	75450N-8	.35
703N-8	.49	75453N-8	.35
723N-14	.39	75491N-14	.75
733N	.45	75492N-14	.89

PAYMENT BY CHECK, MONEY ORDER, UPS/COD, MC OR VISA. ADD $1.25 FOR SHIPPING/HANDLING IN U.S., CANADA AND MEXICO. OTHER COUNTRIES ADD $1.50 PLUS 5% OF ORDER TOTAL. CHECKS MUST BE IN U.S.$ DRAWN ON U.S. BANK. ADDITIONAL CHARGE FOR UPS/COD OR BLUE LABEL(AIR). CALIFORNIA RESIDENTS ADD SALES TAX. MINIMUM ORDER $10.00

ORDERS FROM SCHOOLS, GOVERNMENTS AND RATED BUSINESSES (SUBJECT TO APPROVAL) ACCEPTED ON OFFICIAL PURCHASE ORDERS. TERMS: NET 30, FOB SHIPPING POINT. MINIMUM ORDER $20.00.

INTERNATIONAL ELECTRONICS UNLIMITED
435 FIRST ST, Solvang, Ca. 93463
phone 805 688 2747

FUJITECH AUDIO KITS

LATEST AUDIO TECHNOLOGY FROM JAPAN

Model A501 Power Amp

- 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 FED 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

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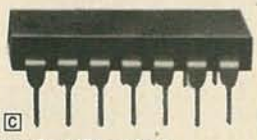

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2114L-250ns. (4045)	6.50	5.95	5.50
2114L-450ns. (4044)	4.75	4.25	3.95
4044 250 ns.	8.95	7.50	6.90
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14	19	.36	.59
16	20	.38	.62
18	24	.59	.84
20	29	.69	.99
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FND501	.500	Red	Comm. Cathode (+1)	99
FND503 (500)	.500	Red	Comm. Cathode	99
FND507 (510)	.500	Red	Comm. Anode	99
FND508	.500	Red	Comm. Anode (+1)	99
FND530	.500	Green	Comm. Cathode	1.49
FND560	.500	Orange	Comm. Cathode	1.49
FND803 (800)	.800	Red	Comm. Cathode	1.75
FND807 (810)	.800	Red	Comm. Anode	1.75
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XAN3064	.300	Red	Comm. Cathode Right DP	1.25
XAN3051	.300	Green	Comm. Anode Right DP	1.99
XAN3052	.300	Green	Comm. Anode Left DP	1.99
XAN3053	.300	Green	Overflow CA, Left DP	1.99
XAN3054	.300	Green	Comm. Cathode, Right DP	1.99
XAN3081	.300	Yellow	Comm. Anode, Right DP	2.10
XAN3082	.300	Yellow	Comm. Anode, Left DP	2.10
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MC10210 .89 79M06	.49
LM339 .79 74157	.49
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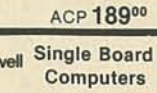

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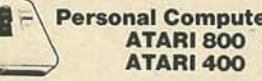

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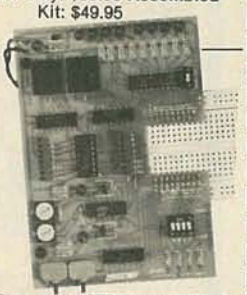

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Range:	20 Hz to 600 MHz
Sensitivity:	Less than 10 MV to 150 MHz Less than 50 MV to 500 MHz
Resolution:	0.1 Hz (10 MHz range) 1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	9 digits 0.4" LED
Time base:	Standard-10.000 mHz, 1.0 ppm 20-40°C. Optional 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

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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

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Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

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MC6850P	$5.41
MC6852P	$5.79
MC6854P	$24.95
MC6860P	$10.89
MC6862P	$12.00
MC6875L	$7.40
MC66710P	$12.50
MC66750P	$12.50

UARTS

PART NO	PRICE
AY51013A	$5.95
TR1602B	$5.95
TR1863	$6.95
IM6402	$7.95

CompuPro™ from GODBOUT ELECTRONICS

10 MHZ 16K A&T STATIC S-100 RAM

GBT-143A

List $349.00

$169.00 Ea

3/$450.00

• Operates up to 10 MHZ (90 ns RAM Chips) • Assembled & Tested • Meets or exceeds all IEEE 696/S-100 specifications (including timing). • Fully static design eliminates the timing problems associated with dynamic memories. • Switch selectable choice of 24 address lines conforming to the IEEE 696/S-100 extended addressing specifications, or 16 address lines as used in older S-100 systems. • Ideal for multi-user installations. • Board is addressable as one 16K x 8 block on any 4K boundary. • Switch selectable PHANTOM disable and write protect. • + 5 Volt operation (requires no other supply voltages). • Low power operation (900 mA typical, 1200 mA maximum). • 1 year Factory Warranty.

S-100 "ANY DIP" has full power and ground planes back to back. Boards accommodates .3, .4, .6, .9" Dips.

1-4	5-9	10-24
$24.67	$22.34	$20.02

Universal Microcomputer/processor plugboard use with S-100 bus. Complete with heat sink & hardware. 53" x 10" x 1/16".

1-4	5-9	10-24
$22.48	$20.37	$18.26

Vector Plugboards

APPLE PLUGBOARD

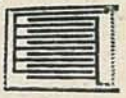
Vector 4609 Peripheral Interface Plugboard for construction of custom circuits. Plug compatible with Apple II, Commodore PET and Super Kim microcomputers. VCT-4609

1-4	5-9	10-24
$20.74	$18.79	$16.84

VCT-8801-1

Same as 8800V except plain, less power buses & heat sink.

1-4	5-9	10-24
$15.67	$14.24	$12.82



VCT-3682 9.6" x 4.5"
$13.63
VCT-3862-2 6.5" x 4.5"
$11.04

Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156

VCT3677 9.6"x4.5"

VCT-3667 96" x 4.5"
$13.33
VCT-3677-2 6.5" x 4.5"
$10.68

Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced .156

VCT-3662 6.5" x 4.5"
$8.69
VCT-3662-2 9.6" x 4.5"
$10.85

P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156

VCT-3690-12 $26.64
CARD EXTENDER

Card Extender has 100 contacts 50 per side on .125 centers-Attached connector-is compatible with S-100 Bus Systems.
VCT-3690 6.5" 22/44 pin .156 ctrs. Extenders . . . $15.66

1/16 Vector BOARD

.042 diaholes on 0.1 spacing for IC's

Phenolic PART NO.	SIZE	PRICE 1-9	10-19
VCT-64P44-X	4.5" x 6.5"	$1.56	$1.40
VCT-169P44-X	4.7" x 17"	$3.69	$3.32
Epoxy Glass			
VCT-64P44	4.5" x 6.5"	$1.83	$1.65
VCT-84P44	4.5" x 8.5"	$2.25	$2.03
VCT-169P44	4.5" x 17"	$4.61	$4.15
VCT-169P48	8.5" x 17"	$9.00	$8.10

TRS-80/APPLE MEMORY EXPANSION KITS 4116's RAMS

from Leading Manufacturers

(16Kx1 200ns)

8 for $20.00

Add $3.00 for programming Jumpers for TRS-80 Keybaord

POWERLINE INSOLATOR

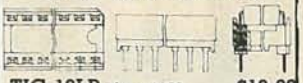
GOF-[illegible]W3
Sh. Wt. 3 lbs.

List Price $59.95
Sale Price
$29.00

A MUST FOR EVERY OFFICE WITH DATA PROCESSING EQUIPMENT

SPECIAL PURCHASE GOLD

16 PIN LOW PROFILE IC. C-95 SOCKETS

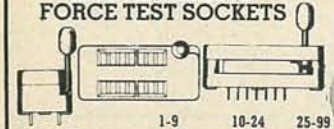


TIG-16LP pkg. of 100 **$16.00**

TIG-16LP pkg. of 1000 **$120.00**

OEMS Stock up at this LOW PRICE

ZERO INSERTION FORCE TEST SOCKETS



	1-9	10-24	25-99
ZIP-16DIP	$ 5.50	$5.35	$4.95
ZIP-24DIP	$ 7.50	$7.25	$6.95
ZIP-400DIP	$10.25	$9.85	$9.50

6 OUTLET MULTI USE CORD REEL

SH. WT. 5 LBS.

GOF-CR1 22 ft. Cord **$24.95**

GOF-CR50 50 ft. Cord **$49.95**

1M-10A List $104.95
SPECIAL
$69.95 with tube

Perfectly balanced fluorescent lighting with precision magnifier lens. Tough thermoplastic shade. Easy lens removal. New wire clip design permits easy installation and removal of flourescent tube. Comes with plastic shield to protect tube from soiling and damage. Colors: Gray, Black, and Chocolate Brown. Comes with one 22 watt T-9 Circline fluorescent tube, 3 diopter lens. 10 lbs.

$69.95

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Hitachi Denshi, Ltd.

Single and dual trace, 15 thru 100 MHz. All high sensitivity Hitachi oscilloscopes are built to demanding Hitachi quality standards and are backed by a 2-year warranty. They're able to measure signals as low as 1mV/division (with X5 vertical magnifier). It's a specification you won't find on any other 15 or 30 MHz scopes. Plus: Z-axis modulation, trace rotation, front panel X-Y operation for all scope models, and X10 sweep magnification. And, 30 thru 100 MHz oscilloscopes offer internal signal delay lines. For ease of operation, functionally related controls are grouped into three blocks on the color coded front panel. Now here's the clincher: For what you'd expect to pay more, you actually pay less. Check our scopes before you decide. All scopes complete with probes.

HITV302B List $995.00

SALE $819.00

- TV sync-separator circuit
- High-sensitivity 1mV/div (5MHz)
- Sweep-time magnifier (10 times)
- Z-axis input (intensity modulation)
- Signal delay line
- Complete with 2 probes
- CH1, CH2, DUAL, ADD. DIFF, Vertical Deflection Modes
- X-Y operation
- Trace Rotation

30MHZ DUAL TRACE OSCILLOSCOPE

Hitachi... The measure of quality.

HITV152B DUAL TRACE 15MHZ (no delay)

LIST $735.00 **SALE $629.00**

HIT-V202
20MHz DUAL TRACE

LIST PRICE: $850
SALE PRICE $775.00

- Dynamic range 8 div.
- TV sync separator circuit
- Built-in signal delay line (V-352)
- X-Y operation
- Sweep-time magnifier (10 times)
- Trace rotation system
- Fine adjusting, click-positioning function

HIT-V352
35MHz DUAL TRACE WITH DELAY

LIST PRICE: $1150.00
SALE PRICE $950.00

- 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

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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SALE
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The HITACHI V550B (50mHz) and V1050 (100mHz) offer all the capabilities you might expect from a lab grade oscilloscope. Capabilities such as 3rd trace trigger view, a bright 6" square CRT, and a max. sweep rate of 2ns/div (V1050) 5ns/div (V550B). Also, features you may not expect like, sensitivity of 1mv/div (V550B) .5m/div (V1050) @ 10mHz, automatic focus correction.

FLUKE® MODEL D804: 1¢ SALE DMM'S

- Nine functions:
  1. dc voltage
  2. ac voltage
  3. dc current
  4. ac current
  5. resistance
  6. diode test
  7. conductance (1-R)
  8. logic level and continuity detect
  9. temperature (K-type thermocouple)
  10. Peak hold on voltage and current functions
  11. Selectable audible indicator for continuity or level detection
  12. 3½-digit resolution
  13. 0.1% basic, accuracy
  14. LCD display
  15. Overload protection
  16. Safety designed test leads

FLU-D800 (Funct. 1-6) **$125.00**
FLU-D802 (Funct. 1-7) **$189.00**
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FLU-D810 (RMS Bench 10A) **$269.00**
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BUY ANY OF THE ABOVE FLUKE DMM AND PURCHASE THE CASE FOR 1¢ WHEN YOU MENTION THIS MAGAZINE AD

FLU C90 (Case for D800, 802, 804 .... **$10.00**
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5¼ DISKETTES

Part No.	Sectoring	Application	# heads	Box/10
VRB-MD525-01	Soft Sector	TRS-80 Apple 40 Track Cert	1	$32.00
VRB-MD525-10	Hard 10 Sector	North Star 40 Track Cert	1	$32.00
VRB-MD525-16	Hard 16 Sector	Micropolis 40 Track Cert	1	$32.00
VRB-MD557-01	Soft Sector	77 Track Cert 100 TPI	2	$56.00
VRB-MD557-10	Hard 10 Sector	77 Track Cert 100 TPI	2	$56.00
VRB-MD557-16	Hard 16 Sector	77 Track Cert 100 TPI	2	$56.00
VRB-MD557-01	Soft Sector	77 Track Cert 100 TPI	1	$48.00
VRB-MD557-10	Hard 10 Sector	77 Track Cert 100 TPI	1	$48.00
VRB-MD577-16	Hard 16 Sector	77 Track Cert 100 TPI	1	$48.00

VRBMD Series comes with reinforced hub ring mounted

8" DISKETTES

VRB-FD32	Hard Sector	Shugart 801R	1	$37.00
VRB-FD34	Soft Sector	IBM 3740	1	$37.00
VRB-FD32-2	Hard Sector	Flippy	1	$66.00
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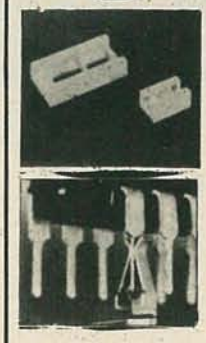
Verbatim 8" Diskettes have all the Datalife Improvements without the hardhole reinforcement rings.
ALL VERBATIM DISKETTES ARE DOUBLE DENSITY CERTIFIED

ROBINSON NUGENT, INC.



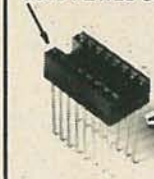
ICN SERIES GOLD 3 LEVEL WIRE WRAP SOCKETS

- 10 inch GOLD Plated Pins
- Deep Chamfered Closewd Entry Contacts
- RN Side Wipe Contact Design
- Phosphor Bronze Contact Material
- Terminal Barbs Allow Self-lock into PC Board
- Rugged Socket Body Design
- Deep Chamfered Closed Entry Contacts

PRICE

PART NO.	PINS	1-9	10-24	25-99	100-249	250-999
RNS08WWG	8	.60	.55	.49	.45	.41
RNS14WWG	14	.75	.70	.65	.55	.50
RNS16WWG	16	.85	.75	.70	.60	.55
RNS18WWG	18	1.00	.90	.80	.75	.71
RNS20WWG	20	1.20	1.05	.96	.91	.87
RNS22WWG	22	1.35	1.25	1.15	1.05	.99
RNS24WWG	24	1.35	1.25	1.15	1.05	.99
RNS28WWG	28	1.70	1.55	1.40	1.34	1.25
RNS40WWG	40	2.20	2.05	1.85	1.60	1.50

GOLD PLATED CONTACTS



NEW! SELECTIVE PLATED PINS THAT WILL SAVE YOU MONEY BY HAVING GOLD ONLY WHERE IT COUNTS! Same as above except pins are selectively plated.

PRICE

PART NO.	PINS	1-9	10-24	25-99	100-249	250-999
RNS08TWW	8	.55	.50	.45	.41	.37
RNS14TWW	14	.65	.55	.53	.47	.45
RNS16TWW	16	.75	.65	.58	.51	.48
RNS18TWW	18	.90	.79	.75	.70	.65
RNS20TWW	20	1.10	.95	.91	.87	.82
RNS22TWW	22	1.25	1.15	1.05	.94	.89
RNS24TWW	24	1.25	1.15	1.05	.96	.89
RNS28TWW	28	1.50	1.45	1.35	1.25	1.15
RNS40TWW	40	2.00	1.80	1.60	1.40	1.30

CCS2422A LIST $425.00 **SALE**
FLOPPY DISK CONTROLLER WITH CP/M VERSION 2.2 **$365.00**
IEEE S-100 COMPATIBLE SINGLE/DOUBLE DENSITY 5¼"/8" DISK DRIVES SINGLE/DOUBLE HEADED ASSEMBLED & TESTED

California Computer Systems

CCS2810 Z80 CPU
2/4 MHZ CPU W/Serial I/O

		List Price	SALE PRICE
CCS2810	A&T	$310.00	$275.00

Shugart SA801R SALE

SHU-SA801R $425.00
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ok PRODUCTS

JUST WRAP KIT

Just Wrap tool for daisy chain wiring. Tool strips as it wraps and cuts. Includes one 50 foot spool of wire.

Part No.	Description	Price
JW-1*	Just Wrap Tool	$14.95
JWK-6	Tool w/4 Spools and JUW1	24.95
R-JW*	50 Ft. Replacement Wire	3.49
JUW-1	Unwrapping Tool	3.49

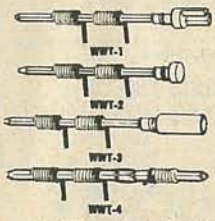
*Specify Color: Red, Blue, White or Yellow.

Regular Wrap

Modified Wrap

HAND WRAP TOOL

Part No.	Description	Price
WSU30	Regular	$6.95
WSU30M	Modified	7.95



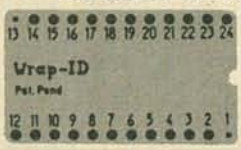
TERMINALS

- .025 (0,63mm) Square Post
- 3 Level Wire-Wrapping
- Gold Plated

25 PER PKG.

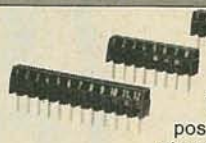
Part No.	Description	Price
WWT-1	Slotted Terminal	$4.98
WWT-2	Single Sided Terminal	2.98
WWT-3	IC Socket Term.	4.98
WWT-4	Double Sided Terminal	1.98
INS 1	Insertion Tool for above	2.49

SOCKET WRAP – ID



Slipped onto socket before wrapping to identify pins.

Part #	Price	Bulk Price	Part #	Price	Bulk Price
14ID	1.49/10	5.50/100	22ID	1.49/5	5.95/50
16ID	1.49/10	5.95/100	24ID	1.49/5	5.95/50
18ID	1.49/10	5.00/50	28ID	1.49/5	6.50/50
20ID	1.49/5	5.00/50	40ID	1.49/5	5.00/25



P.C.B. TERMINAL STRIPS

The TS strips provide positive screw activated clamping action, accommodate wire sizes 14-30 AWG (1,8-0, 25mm). Pins are solder plated copper, .042 inch (1mm) diameter, on .200 inch (5mm) centers.

Part No.	Description	Price
TS- 4	4-Pole	$1.69
TS- 8	8-Pole	2.59
TS-12	12-Pole	3.49
TS6MD	2-Pole Interlocking	3/1.79

DESOLDERING PUMP

Easy one hand operation. Rugged all metal construction. Replaceable TEFLON® Tip. Self cleaning on each stroke. Suction precisely regulated for reliable desoldering without damage to delicate circuitry.

DSPI	Desoldering Pump	$9.95

LOGIC PROBE

Compatible with all logic families using a 4 to 15V power supply. Thresholds automatically programmed. Visual indication of logic levels to show high, low, bad level or open circuit logic pulses.

- 10 N sec. pulse responses
- 120 K input impedence.
- Automatic resetting memory.
- Includes tip with protective cap & coiled cord.

PRB-1 **$36.95**

LOGIC PULSER

Superimposes a pulse train (20 pps) or a single pulse onto the circuit node under test without un-soldering IC's.

- Automatic polarity sensing
- 2 us pulse width
- Finger tip push button actuated
- Includes tip with protective cap & coiled cord.

PSL-1 **$48.95**

VACUUM VISE

Unique vacuum-based light duty vise for precision handling of small components and assemblies. Rugged ABS construction. 1½" (32mm) travel for maximum versatility. Also features screw lugs for permanent installation.

VV1	Vacuum Vice	$3.49

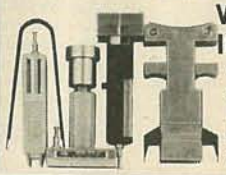
HOBBY-WRAP TOOL BW263

- Auto-Indexing
- Anti-Overwrap
- Modified Wrap

Part No.	Description	Price
BW2630	Tool	$19.85
BT30	#30 Bit (not incl.)	3.95
BT2628	#28 Bit (not incl.)	7.95
BC1	Batteries & Charger	14.95

INSERTION/EXTRACTION TOOLS

Part No.	Description	Price
INS1416	14-16 pin Inserter	$3.49
MOS1416	14-16 pin MOS Safe Inserter	7.95
MOS2428	24-28 pin MOS Safe Inserter	7.95
MOS40	40 pin MOS Safe Inserter	7.95
EX1	14-16 pin IC Extractor	1.49
EX2	24-40 pin IC Extractor	7.95



WK-7 IC INSERTION K

Complete IC Inserter/ Extractor K Individual Components (listed above) $22.95

IC DISPENSER

Allows IC's to be dispensed from their tube 1 at a time and picked up by insertion tools above.

- Dispenses 8-42 pin IC's • Compatable with all IC carrying tubes • Use with WK7 for MOS safe insertion. •

Part No.	Description	Price
MDD1	1 Chan. Dispenser	$21.85
MDD5	5 Chan. Dispenser	83.43
MDD10	10 Chan. Dispenser	160.45

* * *No Discount.

CIRCLE 46 ON FREE INFORMATION CARD

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IDC CONNECTORS

RIGHT ANGLE HEADERS

Size	SOLDER TAIL Part No.	Price	WIRE WRAP Part No.	Price
10	IDH10SRB	$1.20	IDH10WRB	$2.60
20	IDH20SRB	1.90	IDH20WRB	4.15
26	IDH26SRB	2.75	IDH26WRB	5.35
34	IDH34SRB	3.75	IDH34WRB	6.25
40	IDH40SRB	3.75	IDH40WRB	7.35
50	IDH50SRB	4.75	IDH50WRB	9.20

.1" Spacing. Mounts on PC Board & Mates with IDS Socket below. Ejector Bars - 4/1.00.

25 PIN "D" CONNECTORS

Solder Style	Part No.	Price
Male	DB25P	$2.95
Female	DB25S	3.95
Cover	DB25C	1.50
IDC Style		
Male	IDB25P	6.25
Female	IDB25S	6.60
Cover	IDB25C	1.60

Solder Style solders onto cable, IDC Style crimps onto cable with vise. 9, 15, 37 and 50 pin available also.

EDGE CARD CONNECTORS

Size	Part No.	Price
10	IDE10B	$3.95
20	IDE20B	4.35
26	IDE26B	5.00
34	IDE34B	6.05
40	IDE40B	6.90
50	IDE50B	7.50

.1" Spacing. Crimps onto cable with ordinary vise & mates with standard .062" Card Edge.

CABLE PLUGS

Size	Part No.	Price
14	IDP14B	$1.45
16	IDP16B	1.65
24	IDP24B	2.50
40	IDP40B	4.15

.1" Spacing. Crimps onto cable with ordinary vise & plugs into standard IC Socket.

RIBBON CABLE

Size	Solid Color 10 ft.	Solid Color 100 ft.	Color Coded 10 ft.	Color Coded 100 ft.
10	2.90	17.00	4.00	30.00
14	3.40	23.80	5.00	42.00
16	3.70	27.20	5.60	48.00
20	4.40	34.00	7.00	60.00
24	5.00	40.80	8.00	72.00
26	5.40	44.20	8.60	78.00
34	6.80	57.80	11.00	102.00
40	7.80	68.00	13.00	120.00
50	9.50	85.00	16.00	150.00

SOCKETS

Size	Part No.	Price
10	IDS10B	$1.88
20	IDS20B	2.75
26	IDS26B	3.50
34	IDS34B	4.50
40	IDS40B	5.40
50	IDS50B	6.50

.1" Spacing. Crimps onto cable with ordinary vise & mounts to header sold above.

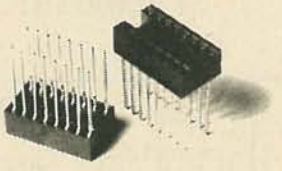
WIRE WRAP SUPPLIES

WIRE WRAP WIRE

#30 Wire Wrap Wire

Length	100/Bag	500/Bag	1K/Bag
2.5"	$1.38	$3.94	$6.81
3.0"	1.43	4.25	7.46
3.5"	1.51	4.57	8.11
4.0"	1.56	4.88	8.73
4.5"	1.63	5.21	9.39
5.0"	1.69	5.54	10.04
5.5"	1.74	5.92	10.69
6.0"	1.82	6.23	11.34
6.5"	2.11	7.08	12.99
7.0"	2.19	7.44	13.68
7.5"	2.29	7.78	14.40
8.0"	2.35	8.12	15.10
8.5"	2.40	8.46	15.80
9.0"	2.46	8.92	16.51
9.5"	2.53	9.15	17.22
10.0"	2.63	9.58	17.91

All lengths are overall, including 1" strip on each end. Choose from colors; Red, Blue, Black, Yellow, White, Green, Orange, and Violet.



Size	Part No.	Each	Tube
08	ICN083WBSG	.44	52x .39 = $20.28
14	ICN143WBSG	.53	30x .46 = $13.80
16	ICN163WBSG	.58	26x .50 = $13.00
18	ICN183WBSG	.78	23x .68 = $15.64
20	ICN203WBSG	1.00	21x .85 = $17.85
22	ICN224WBSG	1.07	19x .92 = $17.48
24	ICN246WBSG	1.09	17x1.09 = $15.98
28	ICN286WBSG	1.43	15x1.23 = $18.45
40	ICN406WBSG	1.85	10x1.60 = $16.00

Selective Plating provides gold in contact where it counts. 3-level wrap. Save by buying sockets by the tube. All gold available at ½¢/pin extra charge.

* * * No Discount

WIRE KITS

Kit No. 1 — $9.95			
250	3"	100	4½"
200	3½"	100	5"
100	4"	100	6"
Kit No. 2 — $24.95			
250	2½"	250	5"
500	3"	100	5½"
500	3½"	100	6"
500	4"	100	6½"
250	4½"	100	7"
Kit No. 3 — $34.95			
250	2½"	500	4½"
500	3"	500	5"
500	3½"	500	5½"
500	4"	500	6"
Kit No. 4 — $59.95			
500	2½"	1000	4½"
1000	3"	1000	5"
1000	3½"	1000	5½"
1000	4"	1000	6"

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Prepaid orders over $50 shipped prepaid via UPS. All others add $3.00 for handling. VISA, MC, COD's and open account orders will be charged freight. $15 minimum order. $100 minimum open account order.

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1000 up	less 25%

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74LS05	$0.20	74LS93	$0.90	Z80A	$5.50
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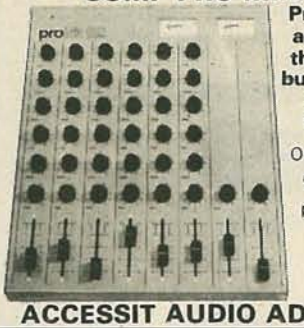

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power supply $50.00

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TMS4030 22 pin 4Kx1 300ns
95¢

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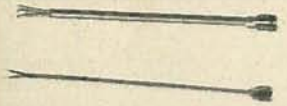

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Arm length 2 3/8
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All below without switch . . . **75c**

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5K Linear	B,C
10K Linear	A,B,C
25K Linear	B,C
50K Linear	A,C
50K Audio	C
100K Linear	B,C
500K reverse audio	B
1M Linear	B
All below with Switch **85c**	
25K Linear/push-pull	B
50K Linear/push-pull	B
500K Linear/turn	B
50K Audio/turn	C

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8 ohms

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12"	12 LA20	50W	$18.00
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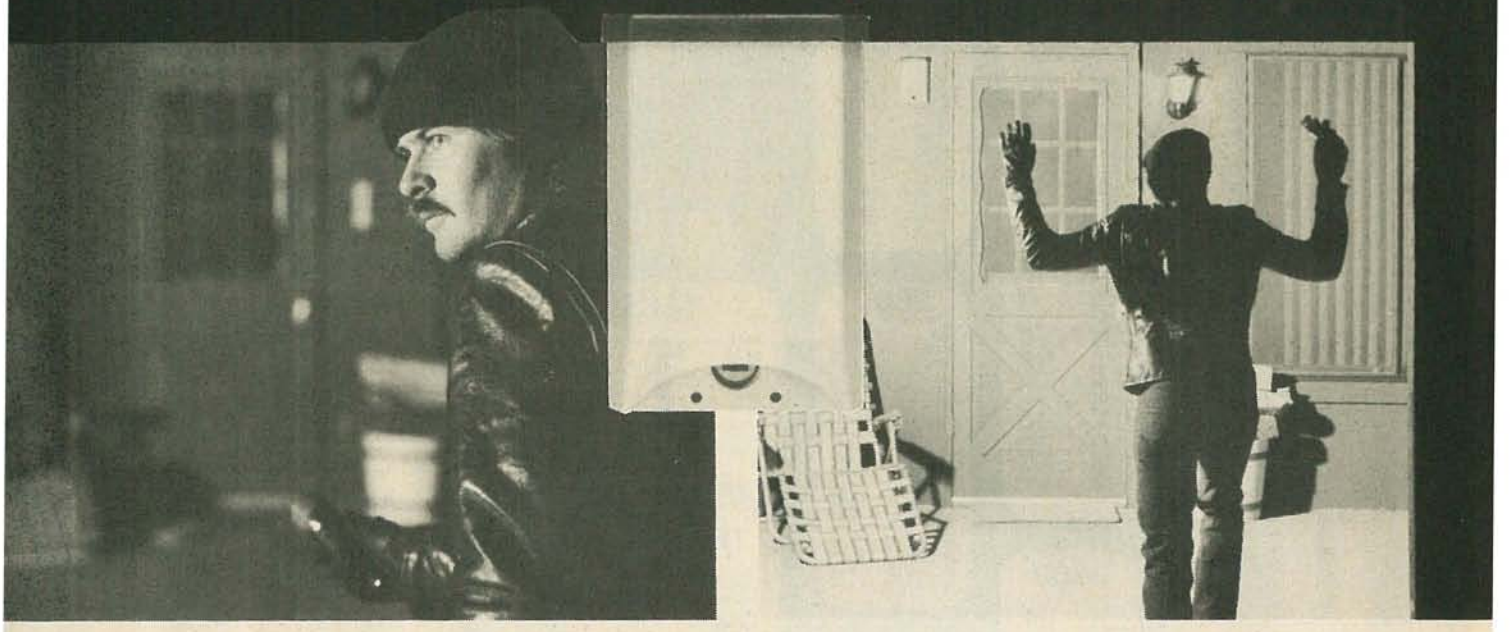
CIRCLE 64 ON FREE INFORMATION CARD

OUTDOOR AUTOMATIC LIGHTING WITH PASSIVE INFRARED

SECURITY LIGHT CONTROL



Amazing infrared device detects and foils intruders, welcomes guests, prevents accidents and saves energy!

Your family is sound asleep. An intruder is stealthily approaching your darkened house. But when he enters the detection pattern, the SLC senses his body heat and ZAP! Your outside lights come on instantly, destroying his cover of darkness before he ever gets to your door. A crime is prevented. And when you finally arrive home that same SLC automatically turns on your driveway and porch lights for a safe, warm welcome.

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SLC NEVER FORGETS

Unlike timers that respond only to preset programs, the SLC reacts to the presence of human beings. It is now possible to have your lights on when and only when you really need them, all automatically. In addition to a reliable security device, the SLC can provide your family with increased safety, convenience and home energy savings. No more stumbling over unseen objects, tripping on dark stairs, or fumbling with your keys. No more wasted energy from forgetting to turn off the lights. And your guests will appreciate the automatic welcome your home always provides.

SAFE, EASY TO INSTALL

The SLC does not emit energy of any kind and is totally harmless to living things. Rugged, weather resistant, UL listed and good looking, a low-cost SLC should be put near every entryway. The sensor is adjustable to cover an area 35 feet by 25 feet. Installing the SLC is as simple as wiring a switch, an easy job for the do-it-yourselfer.

Your home is an important investment, and your family is irreplaceable. They deserve the sophisticated protection of the Security Light Control.

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For my convenience, Colorado Electro-Optics will pay surface shipping charges.

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☐ MasterCard or ☐ Visa

ACCOUNT NO _____

EXPIRATION DATE _____

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74LS32	.35	74LS241	1.85
74LS33	.55	74LS242	1.85
74LS37	.55	74LS243	1.85
74LS38	.35	74LS244	1.75
74LS40	.25	74LS245	2.85
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74LS47	.75	74LS248	1.25
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74LS49	.75	74LS251	1.30
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74LS55	.35	74LS258	.85
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74LS91	.89	74LS295	1.05
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74LS154	2.35	74LS669	1.89
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2758	1024 x 8	(450ns)(5v)	9.95	8.95
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2716	2048 x 8	(450ns)(5v)	5.95	5.50
2716-1	2048 x 8	(350ns)(5v)	12.95	11.95
TMS2716	2048 x 8	(450ns)	9.95	8.95
TMS2532	4096 x 8	(450ns)(5v)	19.95	17.95
2732	4096 x 8	(450ns)(5v)	16.50	15.95

STATIC RAMS

				100pcs
2101	256 x 4	(450ns)	1.95	1.85
2102-1	1024 x 1	(450ns)	.89	.85
21L02-1	1024 x 1	(450ns)(LP)	1.29	1.15
2111	256 x 4	(450ns)	2.99	2.49
2112	256 x 4	(450ns)	2.99	2.79
2114	1024 x 4	(450ns)	8/17.95	2.10
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2114L-3	1024 x 4	(300ns)(LP)	8/21.95	2.45
2114L-4	1024 x 4	(450ns)(LP)	8/18.95	2.25
TMS4044-4	4096 x 1	(450ns)	3.49	3.25
TMS4044-3	4096 x 1	(300ns)	3.99	3.75
TMM2016	2048 x 8	(200ns)	CALL	
HM6116	2048 x 8	(200ns)	CALL	

DYNAMIC RAMS

				100pcs
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4116-200	16,384 x 1	(200ns)	8/17.50	1.95
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LP=LOW POWER

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4 position	.85
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LM309K	1.49	LM748V	.59
LM311	.64	LM1310	2.90
LM317T	1.95	MC1330V	1.89
LM317K	3.95	MC1350V	1.29
LM318	1.49	MC1358	1.79
LM323K	4.95	LM1414	1.59
LM324	.59	LM1458V	.69
LM337K	3.95	LM1488	.99
LM339	.99	LM1489	.99
LM377	2.29	LM1800	2.99
LM380	1.29	LM1889	2.49
LM386V	1.50	LM3900	.59
LM555V	.39	LM3909V	.98
LM556	.69	LM3914	3.95
LM565	.99	LM3915	3.95
LM566V	1.49	LM3916	3.95
LM567V	1.29	75451V	.39
LM723	.49	75452V	.39
LM733	.98	75453V	.39

T=TO-220 V=8 PIN K=TO-3

VOLTAGE REG'S

7805T	.89	7905T	.99
7808T	.99	7912T	.99
7812T	.89	7915T	1.19
7815T	.99	7924T	1.19
7824T	.99		
7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49
7815K	1.39	79L05	.79
78L05	.69	79L12	.79
78L12	.69	79L15	.79
78L15	.69	LM317K	3.95
LM309K	1.49	LM323K	4.95
LM317T	1.95	LM337K	3.95

T=TO-220 K=TO-3 L=TO-92

IC SOCKETS

	1-100	100pcs
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80

WW = WIREWRAP

master charge VISA

New Location

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1224 So. Bascom Ave.
San Jose, CA 95128
800-538-5000 • 800-662-6233 (Calif.)
408-247-4852

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2716 EPROMS 450NS (5V) 8/5.50 ea.

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CMOS

74C00	.35	74C374	2.75	4019	.45	4098	2.49
74C02	.35	74C901	.80	4020	.95	4099	1.95
74C04	.35	74C902	.85	4021	.95	14409	8.95
74C08	.35	74C903	.85	4022	1.15	14410	8.95
74C10	.35	74C905	10.95	4023	.35	14411	9.95
74C14	1.50	74C906	.95	4024	.75	14412	12.95
74C20	.35	74C907	1.00	4025	.35	14419	2.95
74C30	.35	74C908	2.00	4026	1.65	4502	.95
74C32	.50	74C909	2.75	4027	.65	4503	.65
74C42	1.75	74C910	9.95	4028	.80	4508	1.95
74C48	2.10	74C911	10.00	4029	.95	4510	.95
74C73	.65	74C912	10.00	4030	.45	4511	.95
74C74	.85	74C914	1.95	4034	2.95	4512	.95
74C76	.80	74C915	2.00	4035	.85	4514	1.25
74C83	1.95	74C918	2.75	4040	.95	4515	2.25
74C85	1.95	74C920	17.95	4041	1.25	4516	1.55
74C86	.95	74C921	15.95	4042	.75	4518	1.25
74C89	4.50	74C922	5.95	4043	.85	4519	1.25
74C90	1.75	74C923	5.95	4044	.85	4520	1.25
74C93	1.75	74C925	6.75	4046	.95	4522	1.25
74C95	1.75	74C926	7.95	4047	.95	4526	1.25
74C107	1.00	74C927	7.95	4049	.55	4527	1.95
74C150	5.75	74C928	7.95	4050	.55	4528	1.25
74C151	2.25	74C929	19.95	4051	.95	4531	.95
74C154	3.25	74C930	19.95	4053	.95	4532	1.95
74C157	1.75	4000	.35	4060	1.45	4538	1.95
74C160	2.00	4001	.35	4066	.75	4539	1.95
74C161	2.00	4002	.25	4068	.40	4543	2.70
74C162	2.00	4006	.95	4069	.35	4555	.95
74C163	2.00	4007	.29	4070	.35	4556	.95
74C164	2.00	4008	.95	4071	.30	4581	1.95
74C165	2.00	4009	.45	4072	.30	4582	1.95
74C173	2.00	4010	.45	4073	.30	4584	.95
74C174	2.25	4011	.35	4075	.30	4585	.95
74C175	2.25	4012	.25	4076	.95	4702	12.95
74C192	2.25	4013	.45	4078	.30	4724	1.50
74C193	2.25	4014	.95	4081	.30	80C07	.95
74C195	2.25	4015	.95	4082	.30	80C95	.85
74C200	5.75	4016	.45	4085	.95	80C96	.95
74C221	2.25	4017	1.15	4086	.95	80C97	.95
74C373	2.75	4018	.95	4093	.95	80C98	1.20

74S00 SERIES

74S00	.44	74S74	.69	74S163	3.75	74S258	1.49
74S02	.48	74S85	2.39	74S168	4.65	74S260	1.83
74S03	.48	74S86	1.44	74S169	5.44	74S274	19.95
74S04	.79	74S112	1.59	74S174	1.09	74S275	19.95
74S05	.79	74S113	1.98	74S175	1.09	74S280	2.90
74S08	.48	74S114	1.50	74S181	4.47	74S287	4.75
74S09	.98	74S124	2.77	74S182	2.95	74S288	4.45
74S10	.69	74S132	1.24	74S188	3.95	74S289	6.98
74S11	.88	74S133	.98	74S189	14.95	74S301	6.95
74S15	.70	74S134	.69	74S194	2.95	74S373	3.45
74S20	.68	74S135	1.48	74S195	1.89	74S374	3.45
74S22	.98	74S138	1.08	74S196	4.90	74S381	7.95
74S30	.48	74S139	1.25	74S197	4.25	74S387	5.75
74S32	.98	74S140	1.45	74S201	14.95	74S412	2.98
74S37	1.87	74S151	1.19	74S225	8.95	74S471	9.95
74S38	1.68	74S153	1.19	74S240	3.98	74S472	16.85
74S40	.44	74S157	1.19	74S241	3.75	74S474	17.85
74S51	.78	74S158	1.45	74S251	1.90	74S482	15.60
74S64	.79	74S161	2.85	74S253	7.45	74S570	7.80
74S65	1.25	74S162	3.70	74S257	1.39	74S571	7.80

PROMS

74S188	(82S23)	OC	32 x 8	3.95
74S287	(82S129)	TS	256 x 4	4.75
74S288	(82S123)	TS	32 x 8	4.45
74S387	(82S126)	OC	256 x 4	5.75
74S471		TS	256 x 8	9.95
74S472	(82S147)	TS	512 x 8	16.85
74S474	(82S141)	TS	512 x 8	17.85
74S570	(82S130)	OC	512 x 4	7.80
74S571	(82S131)	TS	512 x 4	7.80

7400 SERIES

7400	.19	74128	.55
7401	.19	74132	.45
7402	.19	74136	.50
7403	.19	74141	.65
7404	.19	74142	2.95
7405	.22	74143	2.95
7406	.22	74144	2.95
7407	.22	74145	.60
7408	.24	74147	1.75
7409	.19	74148	1.20
7410	.19	74150	1.35
7411	.25	74151	.65
7412	.30	74152	.65
7413	.35	74153	.55
7414	.55	74154	1.40
7416	.25	74155	.75
7417	.25	74156	.65
7420	.19	74157	.55
7421	.35	74159	1.65
7422	.29	74160	.85
7423	.29	74161	.70
7425	.29	74162	.85
7426	.29	74163	.85
7427	.29	74164	.85
7428	.45	74165	.85
7430	.19	74166	1.00
7432	.29	74167	1.95
7433	.45	74170	1.65
7437	.29	74172	5.95
7438	.29	74173	.75
7440	.19	74174	.89
7442	.49	74175	.89
7443	.65	74176	.89
7444	.69	74177	.75
7445	.69	74178	1.15
7446	.59	74179	1.75
7447	.69	74180	.75
7448	.69	74181	2.25
7450	.19	74182	.75
7451	.23	74184	2.00
7453	.23	74185	2.00
7454	.23	74186	18.50
7460	.23	74190	1.15
7464	.39	74191	1.15
7465	.39	74192	.79
7470	.35	74193	.79
7472	.29	74194	.85
7473	.34	74195	.85
7474	.35	74196	.79
7475	.49	74197	.75
7476	.35	74198	1.35
7480	.59	74199	1.35
7481	1.10	74221	1.35
7482	.95	74246	1.35
7483	.50	74247	1.25
7484	.50	74248	1.85
7485	.65	74249	1.95
7486	.35	74251	.75
7489	4.95	74259	2.25
7490	.35	74265	1.35
7491	.40	74273	1.95
7492	.50	74276	1.25
7493	.49	74279	.75
7494	.65	74283	2.00
7495	.55	74284	3.75
7496	.70	74285	3.75
7497	2.75	74290	.95
74100	1.00	74293	.75
74107	.30	74298	.85
74109	.45	74351	2.25
74110	.45	74365	.65
74111	.55	74366	.65
74116	1.55	74367	.65
74120	1.20	74368	.65
74121	.29	74376	2.20
74122	.45	74390	1.75
74123	.55	74393	1.35
74125	.45	74425	3.15
74126	.45	74426	.85
		74490	2.55

NEED FAST PARTS?

DYNAMIC RAMS

4116	150NS	16K x 1	8/19.95
4116	120NS	16K x 1	8/29.95

STATIC RAMS

2147	55NS	4K x 1	9.95
6116	150NS	2K x 8	CALL
6116	120NS	2K x 8	CALL

EPROMS

2716-1	350NS	2K x 8	12.95
2732A	250NS	4K x 8	25.95
2732A-2	200NS	4K x 8	32.95

MPU's

Z-80B	CPU	6mHz	19.95
Z-80B	CTC	6mHz	17.95
Z-80B	PIO	6mHz	17.95
68B00	CPU	2mHz	10.95
68B21	PIA	2mHz	12.95
68B50	ACIA	2mHz	12.95
8085A-2	CPU	5mHz	16.95

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EXPAND YOUR 48K COMPUTER TO 64K

SUPER RAM • II

- PLUG IN SLOT 0
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- INCLUDES 5 JUMPER OPTIONS
- INCLUDES 5 RAM-ROM OPTIONS
- ENJOY THE BEST OF BOTH WORLDS
- 16K RAM (RANDOM ACCESS MEMORY)
- THIS IS SOPHISTICATED FIRMWARE
- EXPANDS YOUR 48K APPLE TO 64K OF PROGRAMMABLE MEMORY
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- THE SOFTWARE DEVELOPED BY VARIOUS VENDORS FOR YOUR (64K) SHOULD NOW WORK AS THEY ADVERTISED
- THE MOST VERSATILE RAM EXPANSION ON THE MARKET TODAY

UNIQUE 1 YEAR WARRANTEE! $168.00

APPLE FAN

"COOL-IT"

- TAN COLOR
- SAVE DOWN TIME
- LONG LIFE MOTOR
- LOW NOISE IS A MUST
- SAVE REPAIR CHARGES
- INCREASES RELIABILITY
- CLIPS ON—NO HOLES OR SCREWS
- MINIMUM QUIETNESS IS DUE TO THE DRAW EFFECT OF AIR THROUGH YOUR COMPUTER AND A SPECIAL FAN AND MOTOR DESIGN
- THOSE EXTRA PLUG-IN CARDS CAN CAUSE EXTRA HEAT

HOW TO HOOK IT UP

1. Clip it on your APPLE
2. Unplug your 120V cable (you won't need it)
3. Plug short 120V cable from Super Fan II to the back of your computer
4. Plug the supply cable from Super Fan II to your 120V power source
5. Turn on the rocker switch and a built-in red ready light comes on
6. You are all set *"COOL IT"*

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BULLET ELECTRONICS

P.O. BOX 401244R
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Sound Effects Kit $18.50

The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477 Sound Chip,** the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot, and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3¼" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains,** or almost an infinite number of **other sounds.** The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included). **76477 is included.** Available separately for **$3.15** each.

AY3-8910 PROGRAMMABLE SOUND GENERATOR

The AY3-8910 is a 40 pin LSI chip with three oscillators, three amplitude controls, programmable noise generator, three mixers, an envelope generator, and three D/A converters that are controlled by 8 BIT WORDS. No external pots or caps required. This chip hooked to an 8 bit microprocessor chip or Buss (8080, Z80, 6800 etc.) can be software controlled to produce almost any sound. It will play three note chords, make bangs, whistles, sirens, gunshots, explosions, bleets, whines, or grunts. In addition, it has provisions to control its own memory chips with two IO ports. The chip requires +5V @ 75ma and a standard TTL clock oscillator. A truly incredible circuit.

$12.95 W/Basic Spec Sheet (4 pages)
60 page manual with S-100 interface instructions and several programming examples, **$3.00 extra**

MANY OTHER COMPONENTS AND KITS AVAILABLE IN OUR COMPLETE CATALOG. CALL OR WRITE FOR FREE CATALOG.

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Overvoltage Protection Kit $6.95

Protect your expensive equipment from overvoltage conditions. Every computer should have one! **Works with any fused DC power source** from 10 to 20 volts up to 25 amps.

7 Watt Audio Amp Kit $5.95

SMALL, SINGLE HYBRID IC AND COMPONENTS FIT ON A 2" x 3" PC BOARD (INCLUDED). RUNS ON 12VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 5 WATTS. COMPATIBLE WITH SE-01 SOUND KIT.

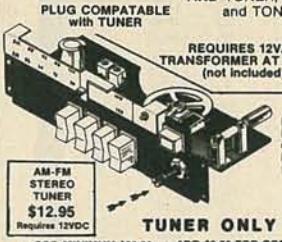
Stereo AMP/Power Supply Board

Takes low level audio and drives 8 ohm speakers ON-BOARD Rectifiers and Filter supply power for AMP **AND** TUNER, VOLUME, BALANCE, and TONE SLIDE CONTROLS

PLUG COMPATABLE with TUNER

REQUIRES 12VAC TRANSFORMER AT 400 MA (not included)

$6.95
AMP ONLY



FEATURES: AM, FM Stereo, Phono Input, Aux Input, AC Cord, 300 Ohm Antenna Input AM Loopstick Antenna, Standard Turntable Plugs.
BUY 3 SETS (Tuner Amp combos) for $50.00

AM-FM STEREO TUNER $12.95 Requires 12VDC

TUNER ONLY

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- **$1.00 HANDLING ON ORDERS UNDER $10.00**
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- **ADD 6% FOR SHIPPING**
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- **CALL (214) 278-3553 TO PLACE CREDIT CARD OR COD ORDER**

SEE SPECIAL FALL PRICES BELOW

(PRICES GOOD THRU DECEMBER 31, 1981)
SHOP EARLY FOR CHRISTMAS

The Super Music Maker
REVISION 2
$24.95
(Basic Kit)
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 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 PROM),** and a drilled, plated and screened PC Board which measures 4" x 4¾". 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 **PROM.** Additional 2708 albums containing popular tunes are available for **$9.95** 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.
- ★ 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)	**2.00/set**
Rotary Switches Two 5 position (For **remote wiring** to PC Bd. to access tunes)	**2.50/set**
Attractive Tan Plastic Case	**6.50**
Wallplug Transformer (For operation on 117VAC house voltage)	**3.00**

FALL SPECIALS: (Good Thru Dec. '81)

1. Super Music Maker with case and two 5-position rotary switches **$32.00**
2. Super Music with one 2716 2K X 8 PROM filled with over 50 selections of additional music (1500 notes) **$32.00**
3. The Whole Ball of Wax! #2 + case and switches. **$39.95**

COMPUTERS
ATARI® 800™ COMPUTER SYSTEM
16k → $750.00
48k → $898.00
"APPLE II Plus"
48k-$1199.00
64k-$1399.00

74 S00

74S00	39	74S138	75
74S02	45	74S140	1 00
74S03	38	74S158	75
74S04	39	74S174	1 35
74S05	39	74S175	1 35
74S10	39	74S182	75
74S15	45	74S189	4 25
74S20	55	74S201	6 75
74S22	55	74S240	2 75
74S30	75	74S244	2 95
74S37	55	74S251	2 75
74S50	65	74S287	2 95
74S51	49	74S288	2 95
74S64	55	74S299	5 75
74S74	65	74S470	9 25
74S86	96	74S471	9 50
74S112	1 95	74S473	9 50
74S132	1 45	74S474	9 50

COMPONENTS

SN7400N	18	SN7482N	30
SN7402N	22	SN7492N	49
SN7404N	21	SN7493N	45
SN7408N	22	SN7495N	50
SN7410N	18	SN7496N	89
SN7412N	20	SN74122N	39
SN7413N	22	SN74136N	95
SN7414N	29	SN74141N	89
SN7416N	27	SN74151N	65
SN7417N	29	SN74153N	55
SN7420N	17	SN74154N	1 25
SN7425N	20	SN74155N	75
SN7430N	17	SN74157N	58
SN7437N	26	SN74160N	89
SN7438N	24	SN74161N	65
SN7440N	18	SN74163N	85
SN7442N	45	SN74164N	87
SN7443N	42	SN74165N	55
SN7445N	64	SN74174N	88
SN7451N	19	SN74175N	79
SN7454N	19	SN74180N	75
SN7474N	27	SN74181N	1 15
SN7475N	35	SN74393N	1 65

74LS00

74LS00	28	74LS158	69
74LS02	28	74LS161	83
74LS03	28	74LS162	89
74LS04	28	74LS163	98
74LS05	22	74LS164	65
74LS08	29	74LS165	65
74LS09	28	74LS169	1 56
74LS10	26	74LS170	1 75
74LS14	89	74LS174	86
74LS20	22	74LS175	85
74LS21	26	74LS190	85
74LS26	40	74LS191	1 25
74LS27	27	74LS195	95
74LS28	37	74LS197	78
74LS30	29	74LS221	1 25
74LS32	31	74LS240	1 65
74LS38	31	74LS241	1 65
74LS42	83	74LS243	1 55
74LS48	77	74LS244	1 56
74LS74	38	74LS245	2 45
74LS75	55	74LS251	1 25
74LS86	45	74LS253	85
74LS90	58	74LS257	85
74LS93	65	74LS259	1 95
74LS95	80	74LS260	55
74LS107	43	74LS273	1 55
74LS113	45	74LS279	45
74LS122	45	74LS290	1 25
74LS123	80	74LS293	1 65
74LS125	89	74LS365	85
74LS126	79	74LS367	75
74LS138	64	74LS373	1 45
74LS139	59	74LS374	1 45
74LS151	49	74LS377	1 25
74LS153	49	74LS669	1 56
74LS157	69	74LS670	1 85

CONT'D

EPROMS

2716 5V 450NS	6.25ea	8 for	5.75ea
TMS2716	5.25ea	8 for	4.50ea
2708 450NS	4 10 ea	8 for	3 95ea
2732	19 95 ea	4 for	16 95ea
4116 300NS	2 00ea	8 for	12.00
4116 200NS	2.35ea	8 for	15.00
2114L 300NS	2.95 ea	4 for	2 75ea
2114L 200NS	3 50ea	4 for	3 00ea
2111 450NS	2 50ea	10 for	2 00ea

CPUs

Z 80	7 95
Z 80A CTC	10 50
Z 80A CPU	10 50
Z 80 002 16 64K	129 00
8085A	13 50
2901A	7 50
MC6800	9 50

MISC

2102 450NS	95		
8038	2 95	1103A	75
NE555	27	UPD765	17 85
AY5 1013A	4 25	floppy disk controller	w spe
1488	1 10	ULN2001	1 95
1489	1 10	TMS4400	1 40
8T26	1 30	MC4008P	1 75
8T28	1 30	MH0026	1 55
8212	2 75	D3624	1 95
8216	2.75	D3001	1 95
IS4109CR	96	D3002	1 95
IT410TRIAC	95		
7905	85		
7908	85		
7915	85		
7918	85		
7805	85		
7806	85		
7808	85		
7812	85		
MC1330A1P	1 60		
MC1350P	1 15		
MC1358P	1 50		
LM380	1 20		
LM565N	95		
LM741	25		
MC1458P	55		
LM720	30		
LM386	1 75		

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8 PIN	10/1 20
14	10/1 40
16	10/1 60
18	10/1 90
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22	10/2 80
24	10/2 80
28	10/3 80
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A14ZT-TI	20	19	18	17
A16ZT-TI	22	21	20	19
A18ZT-TI	29	28	27	26
A20ZT-TI	33	32	31	30
A22ZT-TI	36	35	34	33
A24ZT-TI	37	36	35	34
A28ZT-TI	43	42	41	40
A40ZT-TI	46	45	44	43

Standard Soldertail — TIN

	1-24	25up	50up	100up
A8T	$ 30	$ 29	$ 28	$ 27
A14T	36	35	34	33
A16T	38	37	36	35
A18T	44	43	42	41
A22T	72	71	70	69
A24T	52	51	50	49
A28T	78	77	76	75
A36T	83	82	81	80
A40T	1.08	1.07	1.06	1.05

Standard Soldertail—Gold

	1-24	25up	50up	100up
A8G	$ 38	$ 37	$ 36	$ 35
A14G	55	54	53	52
A16G	63	62	61	60
A18G	69	68	67	66
A22G	81	80	79	78
A24G	91	90	89	88
A28G	1.01	1.00	99	98
A36G	1.41	1.40	1.39	1.38
A40G	1.55	1.54	1.53	1.52

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A10WG	69	68	67	66
A14WG	71	70	69	68
A16WG	73	72	71	70
A18WG	1.01	1.00	99	98
A20WG	1.23	1.22	1.21	1.20
A22WG	1.35	1.34	1.33	1.32
A24WG	1.43	1.42	1.41	1.40
A28WG	1.83	1.82	1.81	1.80
A36WG	1.95	1.94	1.93	1.92
A40WG	2.43	2.42	2.41	2.40

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A14WT-TI	59	58	57	56
A16WT-TI	63	62	61	60
A18WT-TI	67	66	65	64
A20WT-TI	91	90	89	88
A22WT-TI	99	98	97	96
A24WT-TI	1.09	1.08	1.07	1.06
A28WT-TI	1.39	1.38	1.37	1.36
A36WT-TI	1.63	1.62	1.61	1.60
A40WT-TI	1.89	1.88	1.87	1.86

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2.00	HC33	CY2A	8.25	5.068	HC18	CY8B	6.00	18.432	HC18	CY19B	4.75
2.4678	HC33	CY2B	8.25	5.7143	HC18	CB5C	6.00	19.6608	HC18	CY20A	4.75
3.2768	HC33	CY3B	6.00	6.00	HC18	CY6B	6.00	20.00	HC18	CY22A	5.25
3.579	HC33	CY3D	6.00	6.144	HC18	CY6C	6.00	23.684	HC18	CY23B	5.25
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P6502C	21.00	P6512	8.82	P6532	10.82
P6503	8.09	P6512A	9.66	P6532A	11.87
P6503A	8.82	P6513	8.09	P68B20	3.74
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P6504A	8.82	P6514	8.09	P6521A	5.34
P6505	8.09	P6514A	8.82	P68B21	5.34
P6505A	8.82	P6515	8.09	P6522	8.40
P6506	8.09	P6520	3.40	P6522A	11.24
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CA3054	1.54	MC958L	4.43	MC1489L	1.68	MC4044P	5.75	MC7912CT	2.10	MCR103	.79
CA3059	3.34	MC1302P	3.72	MC1489P	1.47	MC4558NCP1	3.18	MC7915CT	2.10	MCR106-2	1.01
CA3079	2.23	MC1309P	2.86	MC1494L	8.53	MC6800P	13.90	MC7918CT	2.10	MCR3918-8	7.74
DAC08CP	3.49	MC1310P	6.29	MC1495L	7.47	MC6808P	13.90	MC7924CT	2.10	MDA100A	2.05
MBD101	.73	MC1330A1P	2.20	MC1496G	2.07	MC6809P	45.39	MC10101P	.92	MDA101A	2.21
MBD102	.88	MC1349P	1.72	MC1568R	13.42	MC6821P	7.33	MC10102P	.92	MDA102A	2.38
MBD201	1.03	MC1350P	1.44	MC1594L	12.74	MC6840P	12.22	MC10104P	.92	MDA104A	2.54
MBD501	1.57	MC1351P	2.10	MC1595L	10.63	MC6844P	45.39	MC10107P	1.00	MDA106A	2.83
MC78L05CP	.66	MC1352P	2.01	MC1710CP	.89	MC6845P	41.20	MC10109P	.92	MDA108A	3.31
MC78L08CP	.66	MC1355P	2.10	MC1733CP	1.30	MC6846P1	39.90	MC10115P	.92	MDA110A	3.80
MC78L12CP	.66	MC1357P	2.19	MC1776CP1	2.07	MC6847P	16.06	MC10116L	1.10	MDA200A	2.21
MC78L15CP	.66	MC1358P	1.91	MC1807P	1.36	MC6850L	14.32	MC10116P	.92	MDA201A	2.38
MC78L18CP	.66	MC1364P	2.01	MC1808P	1.36	MC6850P	6.84	MC10123L	2.39	MDA202	2.54
MC78L24CP	.66	MC1372P	6.48	MC1809P	1.36	MC6852P	7.33	MC10124L	3.01	MJE3055T	1.29
MC78M05CT	1.47	MC1373P	5.19	MC3062L	4.00	MC6854P	32.26	MC10124P	2.52	MPF102	.66
MC78M06CT	1.47	MC1391P	1.44	MC3302P	1.12	MC6860P	12.92	MC10125L	3.01	MPN3402	.76
MC78M08CT	1.47	MC1403UD	4.08	MC3303P	5.80	MC6875L	13.49	MC10125P	2.52	MPS918	1.28
MC78M12CT	1.47	MC1405L	15.28	MC3325P	2.10	MC6881P	8.91	MC10137L	32.36	MPS3638A	.48
MC78M15CT	1.47	MC1408L6	3.84	MC3340P	2.10	MC6882AL	6.13	MC10176P	6.26	MPS3704	.50
MC78M18CT	1.47	MC1408L7	4.75	MC3360P	3.50	MC6885P	2.72	MC10189L	3.27	MPS6514	.68
MC78M20CT	1.47	MC1408L8	6.55	MC3370P	3.72	MC6886P	2.72	MC10195L	2.52	MPS6520	.72
MC78M24CT	1.47	MC1408P8	4.40	MC3403P	1.77	MC6887P	2.72	MC10216L	1.83	MPS6521	.83
MC79L05CP	1.12	MC1413P	1.68	MC3405P	3.60	MC6888P	2.72	MC14411P	17.26	MPS6522	.76
MC79L12CP	1.12	MC1436CU	4.96	MC3408L	3.55	MC6889P	3.14	MC14412VP	15.53	MPS6523	.85
MC79L15CP	1.12	MC1437L	3.99	MC3416L	31.42	MC7805CT	1.65	MC14435VP	8.64	MPS6566	.73
MC79L24CP	1.12	MC1439L	4.62	MC3417L	14.83	MC7808CT	1.65	MC14457P	6.60	MPS8099	.57
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MC835L	2.46	MC1458CL	1.44	MC3470P	12.64	MC7818CT	1.65	MC34004P	3.52	MPSA20	.38
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										MV209	1.13
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										MV2115	2.27
										MV2205	.78
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Z-80-P10	5.90	Z-80A-P10	6.35
Z-80-DART	14.30	Z-80A-DART	15.50
Z-80-S10/0	20.10	Z-80A-S10/0	21.25
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X'former
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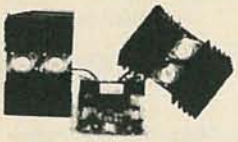
- Input sensitivity: IV max.
- Power supply: ± 40V @ 5 amp
- One channel, needs two for stereo



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$51.95
Power transformer
$24.00 each

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Specifications:
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- Input Impedance: 20K ohms
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- Sensitivity: 1.5V for full rated output
- S/N Ratio: Greater than 95dB
- Speaker Load: 2 ~ 8 ohms
- Voltage Supply: 9 ~ 18V D.C.

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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.
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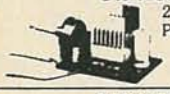

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2 WATT AUDIO AMP

Pre assembled units. All you need is to hook up the speaker and the volume control. Supply voltage from 9~ 15V D.C. measures only 2" x 3½", making it good for portable or discrete applications. Comes with hook up data.

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IN KIT FORM $18.50

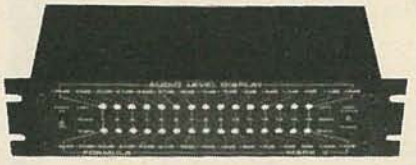
MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

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; G3Hz; 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 a 19" rack mount type metal cabinet.

MODEL TA-2500
$119.00 PER KIT

ELECTRONIC DUAL SPEAKER PROTECTOR

Cutt 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.

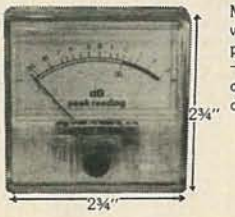
$12.50 PER KIT

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

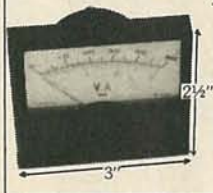
AUDIO OUTPUT dB METER



Meter made of clear plastic with a silver white face plate. Scale reads from −20 +3dB. Meter also comes with an internal dial light.

MODEL: 6F-3
$6.50 EACH

TWO IN ONE PANEL METER D.C. VOLTAGE AND AMP IN ONE



D.C. Volts reads 0-50
D.C. Amp reads 0-3
Meter case made of black plastic with a white scale plate and glass window.

#ST-680 **$12.50 EA.**

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**

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Outside Calif. (includes Mexico & Canada)	15%	10%
Overseas	25%	20%

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Send $1.00 For Detailed Catalogue

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PHONE: (213) 973-1921 ● (213) 679-5162

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LM 380	$2.00	Matching Transformer	$1.40
Sanyo UHF Tuner	$35.00	Tolriod Coils	
Capacitors Set	$12.50	(Set of 4)	$3.00
Resistors Set	$2.00	Speaker Cabinet	$12.95
Trim Pots:		Transformer	
Trim Caps Set	$13.50	18V 800MA	$3.00
Pots and Knobs	$2.00		

We sell you all the above components in a package for **$125.00** and you will receive a free predrilled P.C. board and instructions at no charge!

SANYO UHF VARACTOR TUNER

For UHF CH 14 83

Tuning voltage +1V~+28V D.C. Input impedance 75 OHM. I.F. band width 7~16 MHz. Noise figure 11.5dB MAX. Size 2⅝" x 1¼" x ¾". Supply voltage 15V D.C. Sound I.F. = 58.0 MHz. Video I.F. = 62.5 MHz.

All units are brand new from Sanyo.
MODEL 115-B-405A
$35.00 EACH

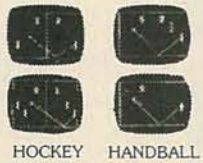
Tuner is the most important part for the circuit. Don't let those $19.00 tuners fool you!

TV GAME BOARD

PLAYS 4 GAMES: TENNIS; HOCKEY; HANDBALL AND JAI-ALAI.

All boards complete with all parts ready to play. Requires 6C size batteries and a small speaker for sound effects. The boards were surplus from a famous game manufacturer. They will play on all US standard black and white or color TV sets. (Regular price for these games were $39.50 each) **OUR PRICE ONLY $6.50 EACH**

PART #57456



TENNIS JAI-ALAI HOCKEY HANDBALL

ELECTRONIC PIN BALL MACHINE

That sounds and plays like the real thing. All units are brand new but without the case. Functions of the game include double flipper control, kicker control, 1-4 players, 3 speed ball control, tilt switch, automatic score, extra bonus cave and many more. All solid state with LED panel, no moving parts. Requires 9V battery to operate, speaker not included.

A perfect gift for yourself or friends.
SPECIAL **$8.99** EACH SPEAKER **$1.25** EACH

ELECTRONIC MUSICAL TELEPHONE REST KIT

This telephone rest can be used as a door charm, an audible indicator and for many other sound projects. The special custom made I.C. is pre programmed with 4 musical tunes. Kit comes with a nice looking plastic case, pre-drilled P.C. board, volume control, special sound I.C. speakers and all electronic components and instructions. Ideal for home or school projects.

BUY NOW!

SPECIAL PRICE! ONLY

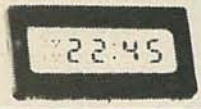
$15.50 PER KIT

MODEL FIH-3000

LCD CLOCK MODULE!

● 0.5" LCD 4 digits display ● X'tal controlled circuits ● D.C. powered (1.5V battery) ● 12 hr. or 24 hr. display ● 24 hr. alarm set ● 60 min. countdown timer ● On board dual back-up lights ● Dual time zone display ● Stop watch function.

NIC1200 (12 hr)
NIC2400 (24 hr)
ON SALE
$16.99 EACH



0.5" LED ALARM CLOCK MODULE

Assembled! Not a Kit!

Features: ● 4 digits 0.5" LED Displays ● 12 hours real time format ● 24 hours alarm audio output ● 59 min. countdown timer ● 10 min. snooze control.

ONLY **$7.00** EACH
SPECIAL TRANSFORMER FOR CLOCK
$2.50

DIGITAL TIMER/CLOCK

- 24 Hour preset time to turn on or off
- 12 Hour green 0.5" display for time
- operated on 12~16V A.C.

The whole timer is self contained in a compact plastic case (as seen in photo). Designed for VTR with push button switch for easy setting. Limited quantity available.

MODEL VEQ 0143

SPECIAL! NOW ONLY $12.94

MATCHED PAIR POWER TRANSISTORS BY MOTOROLA

MJ2955 PNP 2N3055 NPN	150 Watts	BV=60 V I.C.=15 A	**$3.50** per pair
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MJ15003 NPN MJ15004 PNP	250 Watts	BV=140 V I.C.=20 A	**$12.00** per pair

All above parts guaranteed to be prime and come with data sheets.

MUFFIN FANS FOR EQUIPMENT COOLING

These fans are pulled out from used computers. But carefully cleaned by ultrasonic cleaner. All in "like-new" condition. Size 4 11/16" x 1-1/2" x 4 11/16".
MODEL MF505
$9.50 EACH

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED

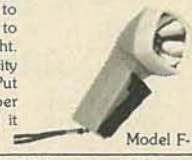
Lights up 8~15 Watt Fluorescent Light Tubes. Ideal for camper, outdoor, auto or boat. Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!

$6.50 Per Kit

PRESS-A-LIGHT SELF GENERATED FLASHLIGHT

EXCLUSIVE! **$3.95 ea.**

Never worry about battery, because it has none! Easy to carry in pocket and handy to use. Ideal for emergency light. It generates its own electricity by squeezing grip lever. Put one in your car, boat, camper or home. You may need it some time!



Model F-179

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

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Send $1.00 For Detailed Catalogue

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PHONE: (213) 973-1921 ● (213) 679-5162

NOW! A 12 HOUR TAPE RECORDER for only $95.00*

LONG PLAY

High quality AC-DC Cassette Recorder provides 6 continuous hrs. of recording & play back of top quality true fidelity, distortion free sound on each side of cassette for a total of 12 hrs. Built-in features incl. • Voice level control • Auto. tape stop • Digital counter • LED indicator, etc. AC Adapter & Cassette incl. Model 1000LP TDK DC-180

PHONE RECORDING ADAPTER

Record incoming and outgoing calls automatically with this all solid state unit connected to your telephone jack and tape recorder. Starts recording when phone is lifted. Stops when you hang up. **$24.50*** FCC APPROVED

VOX VOICE ACTIVATED CONTROL SWITCH

Solid state. Self contained. Adjustable sensitivity. Voices or other sounds automatically activate and control recorder. Uses either recorder or remote mike. **$24.95***

*Add for ship. & hdlg. Phone Call Adapter & VOX $1.50 ea—Recorder $4.00. Cal. Res. add tax. Mail order, VISA, M/C, cod's ok. Qty. disc. avail. Money back guar. Free data. Dlr. inq. inv.

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74C00	.16	74174	.28	DM8599N	1.56	LM3071N	1.00
74L00	.24	74L74	.42	DM8613N	1.00	LM3301N	2.25
74H00	.24	74H74	.42	DM8613SJ	.52	LM3302N	2.25
7401	.16	7475	.40	DM8800H	1.60	LM3401N	2.25
7402	.16	7476	.28	DM8810N	.50	LM3901N	1.25
74L02	.24	74L78	.42	DM8812N	.80	LM4250CH	1.50
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74L03	.24	7492	.35	DM8831N	2.00	LM7521N	1.00
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74L04	.30	74L93	.52	DM8835N	1.80	LM7524N	1.00
74H04	.30	7495	.52	DM8836N	.80	LM7528N	1.00
74S05	.30	74L95	.76	DM8837N	1.50	LM75107AN	.90
7406	.22	7496	.52	DM8864N	1.60	LM75108AN	.90
7410	.16	74100	1.10	DM8880N	1.10	LM75452AN	.40
74L10	.24	74107	.28	DM8895N	1.20	LM75453AN	.40
74S10	.30	74S112	.68			LM75491N	.60
74H11	.24	74122	.32	Linear ICs		LM75492N	.60
7413	.35	74123	.49	LM104AH	3.55	LM75494N	.60
7415	.30	74141	.64	LM171H	6.55	Memories	
7420	.16	74145	.64	LM204AH	2.55	sig2501	1.15
7425	.22	74151	.47	LM211H	3.55	sig25L01	1.75
7426	.22	74153	.47	LM301AH	.25	sig2602	2.50
7430	.16	74155	.52	LM304AH	1.55	sig82123	3.95
74L30	.24	74157	.52	LM305AH	.80	sig8228	3.95
7437	.25	74L157	.78	LM306H	2.60	MM1101AN	1.15
7438	.25	74S157	.85	LM307H	.23	MM5269N	1.25
7439	.35	74L165	.95	LM308CH	.80	MM5261N	1.50
7440	.16	74181	.70	LM309H	1.10		
74H40	.24	74182	.70	LM311CH	.70		
7441	.70	74183	.70	LM312H	1.95	Calculator Chips	
7442	.50	74184	.70	LM319H	1.00	MM5725N	2.25
7445	.60	74173	1.10	LM320K-5.2V		MM5736N	2.25
7446	.70	74174	.70	12V, 15V	1.10	MM5738N	2.25
7450	.16	74175	.70	LM322N	.90		
74H50	.24	74177	.64	LM340K-6V, 8V		Other MOS	
7451	.16	74180	.64	15V, 18V, 24V	1.10	MM5013N	1.25
74L51	.24	74182	.64	LM351N	.40	DH0016CN	3.50
74H51	.24	74188	1.56	LM371N/H	3.25	MH0025CN	3.00
7454	.16	74190	.80	LM376N	2.00	MH0026CG	3.00
74L54	.24	74192	.70	LM380N	.80		
74H54	.24	74193	.70	LM381N	1.25	FSC 9xxx	
7455	.16	74195	.70	LM555CN/H	.35	9000 thru 9005	
74L55	.24	74S200	3.25	LM566N	1.25	9007, 9008, 9016	
74H55	.24			LM567N	.85	9024	.40
7460	.16	NSC 8xxx		LM703AN/H	.70	9324	2.50
74H60	.24	DM76L83J	2.00	LM711CN/H	.60		
7460	.24	DM8098N	1.60	LM723H	.50	Miscellaneous	
74S64	.30	DM8097N	.54	LM741CN	.25	9601J	.50
74L71	.36	DM8123N	1.30	LM748N	.45	9602J	.75
74H71	.26	DM8200N	2.20	LM1304N	.90	sig8490A	1.50
7472	.28	DM8210N	2.75	LM1489J	1.00	sig8470A	1.40
74H72	.36	DM8211N	1.70	LM1845N	1.50	*Large quantities of above 210 types in stock.	
7473	.28	DM8230N	2.60	LM1899N	1.50		
74L73	.42	DM8288N	1.15	LM3067N	1.00		

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Self-scoring IQ test (Retail $9.95) with order over $25.00. (IQ test may be ordered separately: $6.95 each; 10 for $39.95) Guaranteed to be accurate.

Much wider selection of ICs and transistors. 74xx, 74Lxx, 74Hxx, 74Sxx, DMBxxx, LM, MM, AH, DH, LH, NH, 74Cxx. $1 for catalog; free with order or if requested by phone.

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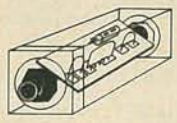
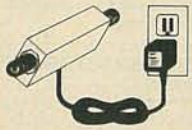
SIMPLE SIMON KITS



NEW STATE-OF THE ART



ZYZZX
VHF-UHF WIDEBAND ANTENNA AMPLIFIER
MODEL ALL-1
50 MHz — 900 MHz
12 dB GAIN ± 0.5dB

SIMPLE SIMON ELECTRONICS INTRODUCES
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.

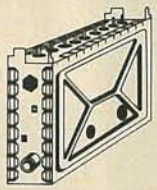
ALL-1 Complete Kit plus Power Supply **$24.95**
ALL-1 Assembled / Tested plus Power Supply **$34.95**

7 + 11 PARTS KITS

MITSUMI VARACTOR UHF TUNER

Model UES-A56F

$34.95



Freq. Range UHF470 - 889MHz
Antenna Input 75 ohms
Channels 14-83 Output Channel 3

KIT NO	PART NO	DESCRIPTION	PRICE
1	VT1-SW	Varactor UHF Tuner, Model UES-A56F	$34.95
2	CB1-SW	Printed Circuit Board, Pre-Drilled	18.95
3	TP7-SW	P.C.B. Potentiometers, 1-20K, 1-1K, and 5-10K ohms, 7-pieces	5.95
4	FR35-SW	Resistor Kit, ¼ Watt, 5% Carbon Film, 32-pieces	4.95
5	PT1-SW	Power Transformer, PRI-117VAC, SEC-24VAC, 250ma	6.95
6	PP2-SW	Panel Mount Potentiometers and Knobs, 1-1KBT and 1-5KAT w/Switch	5.95
7	SS14-SW	IC's 7-pcs, Diodes 4-pcs, Regulators 2-pcs Heat Sink 1-piece	29.95
8	CE9-SW	Electrolytic Capacitor Kit, 9-pieces	5.95
9	CC33-SW	Ceramic Disk Capacitor Kit, 50 W.V., 33-pieces	7.95
10	CT-SW	Varible Ceramic Trimmer Capacitor Kit, 5-65pfd, 6-pieces	5.95
11	L4-SW	Coil Kit, 18mhs 2-pieces, .22μhs 1-piece (prewound inductors) and 1 T37-12 Ferrite Toroid Core with 3 ft. of #26 wire	5.00
12	ICS-SW	I.C. Sockets, Tin inlay, 8-pin 5-pieces and 14-pin 2-pieces	1.95
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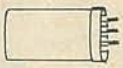
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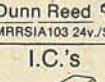
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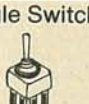

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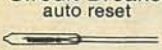
auto reset

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4018	.50	4051	.80	74C02	.27	74C174	1.30
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7404	.24	7480	.45	74173	.75
7405	.24	7483	.50	74174	.65
7406	.33	7485	.65	74175	.60
7407	.35	7486	.42	74176	.75
7408	.27	7490	.45	74177	.75
7409	.24	7491	.45	74180	.75
7410	.17	7492	.45	74181	1.90
7411	.22	7493	.45	74182	.45
7413	.42	7494	.60	74190	.70
7414	.50	7495	.60	74191	.75
7416	.33	7496	.60	74192	.70
7417	.37	74107	.35	74193	.79
7420	.17	74121	.35	74194	.85
7425	.30	74122	.39	74195	.45
7426	.33	74123	.42	74196	.75
7427	.30	74125	.45	74197	.75
7430	.17	74126	.45	74279	.60
7432	.27	74145	.75	74365	.65
7437	.27	74148	1.25	74367	.65
7438	.27	74150	1.10	74368	.65
7440	.17	74151	.50	74390	.90
7441	.85	74153	.40	75324	2.25
7442	.45	75154	1.10	75491	1.05
7445	.70	74155	.50	75492	1.05
7446	.75	74157	.50	8T98	1.20
7447	.65	74160	.85	9312	.60
7448	.75	74161	.65	9601	.75
7450	.17	74162	.60	9602	.75
7472	.35	74163	.60		

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200	.80	1.30	2.20
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74LS04	.22	74LS113	.45	74LS241	.89
74LS05	.22	74LS114	.55	74LS242	.89
74LS08	.20	74LS123	.59	74LS243	.89
74LS09	.22	74LS125	.45	74LS244	.89
74LS10	.20	74LS126	.45	74LS245	1.50
74LS11	.22	74LS132	.50	74LS247	.75
74LS12	.22	74LS136	.45	74LS248	1.10
74LS13	.45	74LS138	.48	74LS251	.55
74LS14	.40	74LS139	.48	74LS253	.55
74LS15	.35	74LS151	.40	74LS257	.55
74LS20	.18	74LS153	.40	74LS258	.55
74LS21	.18	74LS155	.60	74LS259	1.25
74LS22	.25	74LS156	.70	74LS266	.36
74LS26	.35	74LS157	.48	74LS273	1.15
74LS27	.28	74LS158	.48	74LS279	.48
74LS28	.45	74LS160	.70	74LS280	1.80
74LS30	.18	74LS161	.58	74LS283	.75
74LS32	.35	74LS162	.70	74LS290	.72
74LS37	.30	74LS163	.58	74LS293	.38
74LS38	.30	74LS164	.58	74LS365	.52
74LS40	.40	74LS168	1.25	74LS366	.52
74LS42	.44	74LS169	1.75	74LS367	.52
74LS47	.69	74LS170	1.50	74LS368	.52
74LS51	.20	74LS173	.59	74LS373	1.25
74LS54	.20	74LS174	.45	74LS374	1.25
74LS73	.35	74LS175	.40	74LS377	1.25
74LS74	.35	74LS181	1.95	74LS386	.50
74LS75	.35	74LS190	.72	74LS390	.98
74LS76	.45	74LS191	.72	74LS393	.98
74LS83	.75	74LS192	.65	74LS670	1.60
74LS85	.85	74LS193	.60	81LS97	1.10
74LS86	.40	74LS194	1.10	81LS98	1.10
74LS90	.39	74LS195	.90		
74LS92	.45				

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LM301 748	.30	LM358	1.50	710	.45
741CV	.25	LM361	1.75	711CH	.40
741C	.35	LM377	1.60	733	.95
747	.50	LM380	1.25	LM1808	1.75
1456	.80	LM382	.80	LM1889	1.95
1458	.50	LM383	2.50	CA758	1.75
4136	.85	LM386	.80	CA3018	1.95
3900	.45	LM387	1.25	CA3046	.85
LM307	.30	LM553	2.25	CA3078	1.50
LM308	.75	LM555	.45	CA3080	.95
LM324	.65	LM556	.85	CA3086	.95
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LF355	1.25	565	.95	LM2901	.95
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LM311	.50	567	.85	N5936A	1.50
LM318	1.00				

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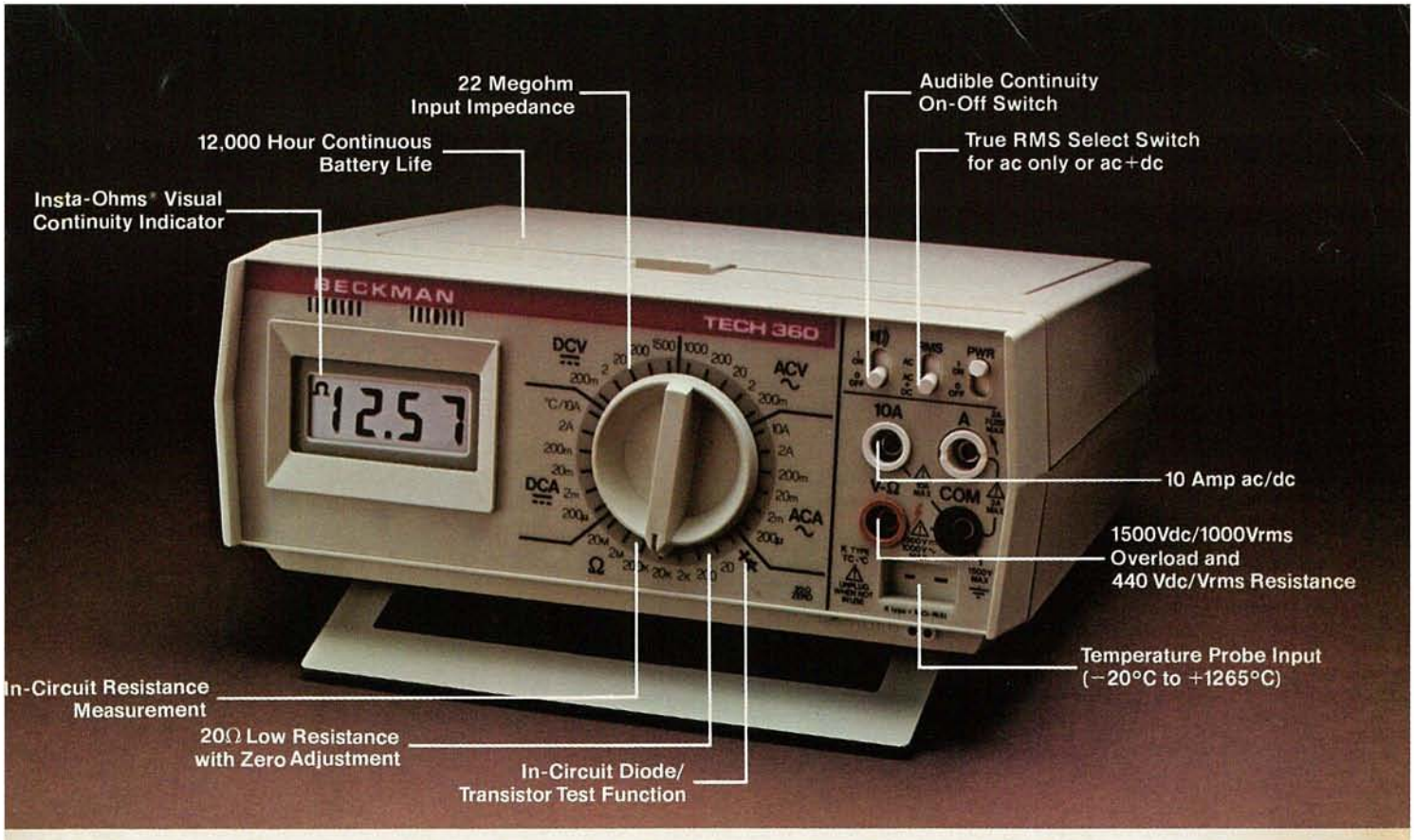

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