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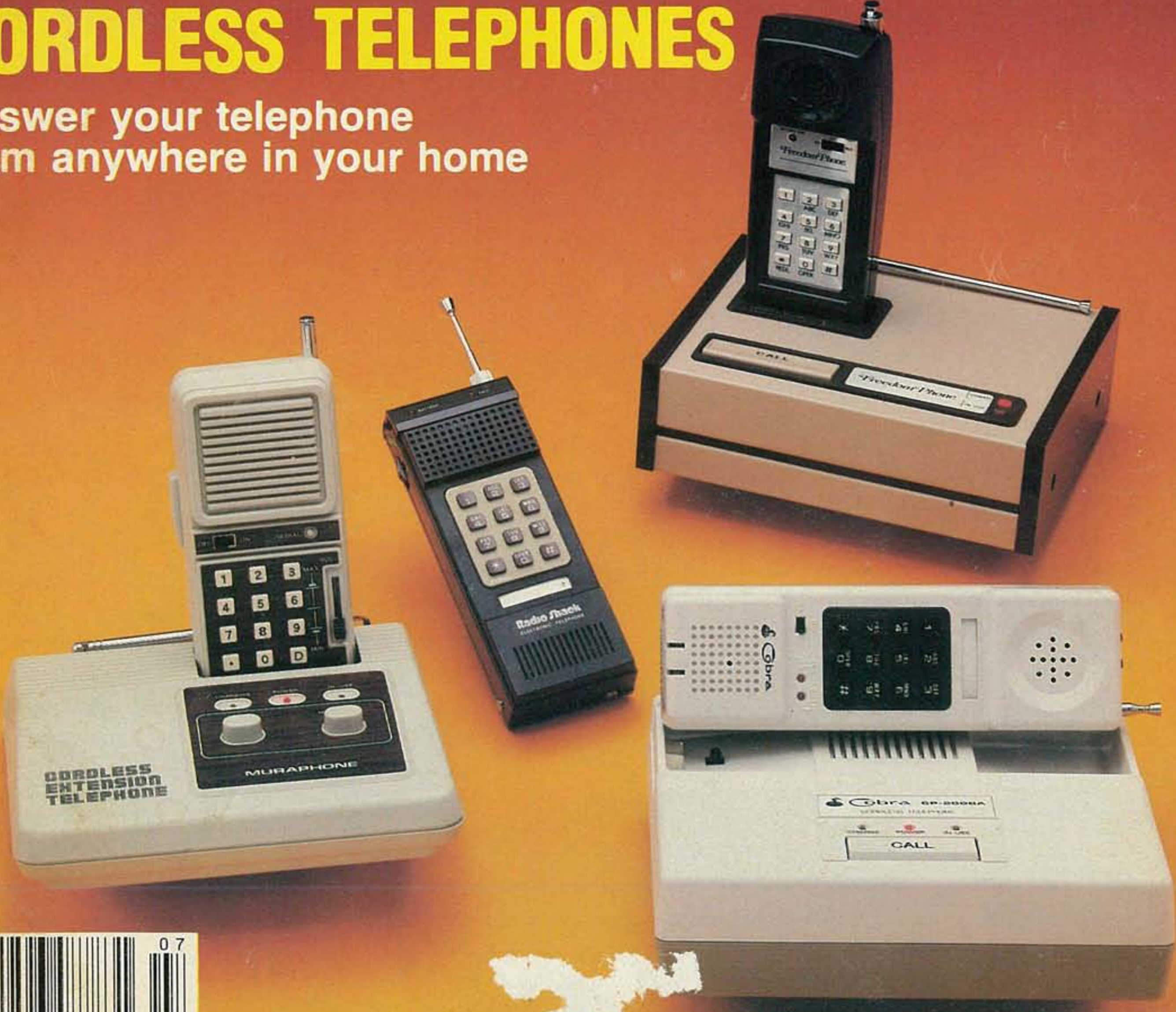

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Radio-Electronics

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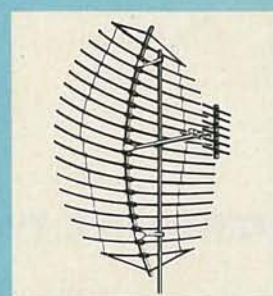
JULY 1981 Vol. 52 No. 7

ON THE COVER

Cordless telephones offer all the conveniences—and then some—of the wired kind. For a detailed description of what they have to offer and how they work, turn to page 31.

WE HAVE BEEN DELUGED by requests for plans for a negative ion generator. At long last we have one for you. The project starts on page 36.



UHF-TV PROGRAMS OFFER a lot and would have a larger audience if the stations could be received better. The survey starting on page 39 can help you pull in their sometimes-elusive signals.

Due to space restrictions, the second part of the article on Solid-State Microwave Devices, scheduled to appear this month, will appear in the August issue.

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looking ahead

ALL-IN-ONE

A new generation of color-TV newsgathering and production equipment has arrived with the development of lightweight, high-quality, all-in-one camera/VCR combinations designed for the simplicity and flexibility of the film camera, but with all the advantages of the videotape medium. Two versions have been announced; both are scheduled for availability around this year's end, and both use completely new tape-recording formats based on ½-inch consumer cassettes.

RCA and Matsushita (Panasonic), working together, created a 22-pound single-piece combination that uses what is claimed to be a new type of tape packed in a standard VHS cassette. But instead of recording for two, four, or six hours, the new system uses a much faster tape speed, it also has an undisclosed recording format that is claimed to provide picture quality better than current ¾-inch U-matic recorders and equivalent to 16mm film. The new camera component uses three half-inch pickup tubes. Camera/VCR combinations using the new format are being offered by both RCA and Panasonic. Meanwhile, Sony has developed a similar approach using a Beta cassette and its own non-standard format, also getting 20 minutes on a cassette. However, Sony's system uses a single-tube camera ("high-band SMF Trinicon"), cutting weight even further—it's down to 15 pounds. Both new approaches make possible field recording using just one person.

HOME MINI-VCRS

In the consumer field, the drive to shrink to VCR is in full swing. Less than a year ago, Technicolor introduced its 7-pound VCR using a ¼-inch tape cassette. Now its size and weight are being challenged by home portable recorders accommodating standard ½-inch cassettes. Sony's new Beta portable weighs 9¼ pounds and, thanks to a new tape-wrap system, is just about the same in volume as the Technicolor, measuring 8½ × 12 × 3 inches. Sanyo introduced a portable Beta weighing only 8¾ pounds but at 10¾ × 10½ × 4 inches it's 50 percent larger than the Sony or the Technicolor.

Both Sony and Sanyo introduced new features with their new portables. Sony's companion camera has a "record-review" button that cues the recorder to re-show the last two seconds of the previous shot through the viewfinder for precise assemble-editing. Another feature on the recorder, "swing-search," makes possible instant forward-reverse jogging for precise location of any segment. Sanyo's new camera, designed as a companion to the portable VCR, contains such remote controls as forward and reverse search, and still-frame on the body of the camera itself as an aid to electronic photography.

INTERACTIVE TV

Now going into production at Pioneer Communications' plant in Japan, and scheduled for use soon in the United States, is a new, more versatile version of the QUBE two-way cable-TV system first introduced in Columbus, Ohio. The new consumer terminal has digital random access and is capable of tuning up to 104 channels. It is designed to provide security on certain channels for special pay-per-view or other programming, and can offer the consumer ten or more choices of responses to material on the screen—as compared with the five options on the current QUBE system. Thus it can be used for teleshopping and other similar interactive uses. The combination of a central computer and the intelligent home terminal constantly shows the cable operator just who's watching what. It can be used for polling and allows the subscriber to transmit and receive many other types of material. It also can accommodate many different types of home-security systems.

BANDWIDTH SAVER

A 1965 patent recently changed hands and its new owners say it will make possible reduction in a TV channel's bandwidth to as little as 1 MHz, or high-resolution transmission in the current bandwidth, within a few years. Known as Variable Velocity Scanning, it uses a transmitted digital signal to speed up scanning when redundancy occurs in the picture, and to slow it down when there are changes from frame to frame. A converter at the set restores the conventional analog signal. The same system, theoretically, could make possible a video recorder which could tape up to 24 hours on a single cassette. According to the owner, Jones VVS Inc., the first use of the Variable Velocity Scanning system will be for foolproof encryption (scrambling) of pay-TV programs. A digital signal, which can be changed daily, weekly, or monthly, would be transmitted along with the picture containing the key to unscramble the transmission. Decoding could also be accomplished by a magnetic card sent in the mail. The code signal contains no clue as to how the picture has been rearranged. The encryption system is planned for introduction this year.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

what's news

Tesla Memorial Society Plans Scholarship

The Tesla Memorial Society is planning to offer a scholarship to a graduate student in the field of electrical engineering. The Society (non-profit, non-political) was founded on July 8, 1979 for the purpose of honoring the genius of Nikola Tesla, the Yugoslav-American inventor of alternating current, and the first man to succeed in transmitting electric power using RF.

Membership in the society is open to all, and may be obtained by making a $10 contribution, which gives the donor full voting priviledges at the annual meeting. (A $25.00 contribution gives the donor the status of patron of the society.) All contributions are tax-deductible.

July 10, 1981 marks the 125th anniversary of Tesla's birth. The society will celebrate that event this year with the cooperation of the United Nations.

Contributions should be sent to the Tesla Memorial Society, 453 Martin Road, Lackawanna, New York 14218.

Insulin pump for diabetics

The electronics assembly for a tiny pump to deliver insulin inside the bodies of diabetics is being developed at RCA Missile and Surface Radar, Moorestown, NJ, as "a spinoff from defense electronics," according to Ron Kolc, leader of the project. The electronic assembly is being developed for Sandia Laboratories, Albuquerque, NM, which has been working for some years to develop a programmed insulin pump for diabetics.

The Sandia system acts as an artificial pancreas, pumping small amounts of insulin into the patient's body as needed—less during sleep and exercise, and more after meals. The diabetic could override the system if desirable, and stop, start, and control the insulin flow.

Hybrid microelectronics are used in the assembly, which has 37 integrated circuits in flat, leadless ceramic carriers. The entire assembly measures only $1\frac{1}{4} \times 2$ inches. The system is powered by a pair of 3.7-volt lithium batteries, with a life of about one year.

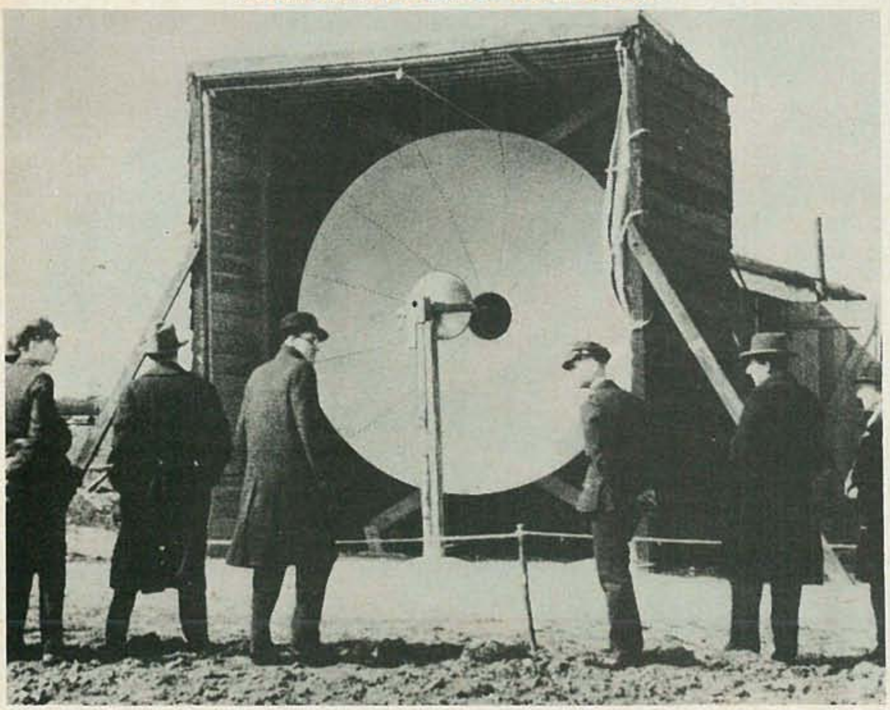
Motorola and Signetics sign pact

Signetics Corp. (a wholly-owned subsidiary of U.S. Philips) and Motorola Inc., have signed a 5-year agreement under which Signetics/Philips will alternate-source Motorola's M68000 microprocessor family in a technology exchange aimed at creating industry's strongest 16-bit product line. Both Motorola and Signetics/Philips will produce software that includes operating systems, language processors, application packages, and development system tools.

While the pact covers the development of circuits, hardware, software, and support tools, "manufacturing, marketing, and sales" will be conducted competitively, according to the agreement.

The program is designed to motivate the companies to exchange independently developed products and to maintain product-line architectural consistency through the coordinated efforts of the participants.

MICROWAVE BORN 50 YEARS AGO



THE FIRST PUBLIC MICROWAVE DEMONSTRATION took place March 31, 1931, when scientists of two ITT companies in France and England beamed signals across the English Channel using directional reflectors and only half a watt of power. The frequency used was 1.7 GHz (18 centimeters). The parabolic reflector, which measured 3 meters (10 feet) in diameter, was set up on the cliffs at St. Margaret's Bay, Dover, to link with a similar antenna at Calais, France.

Satellite communications award

The International Telecommunications Satellite Organization (INTELSAT) and the Italian company Telespazio S.P.A. have joined to offer a new international award for contributions in the field of satellite communications. Telespazio is the organization designated by the Italian government to be the Italian member of the INTELSAT system.

The award is for "an original contribution of significant applicable value in the satellite communications field," and will be open to all university students or researchers of all INTELSAT member countries. It will be known as the Piero Fanti International Prize, in honor of Telespazio's first Director General, who died ten years ago. The $10,000 prize will be presented jointly by INTELSAT and Telespazio every two years during the 1981-1990 decade.

Selection of winning papers will be based on intrinsic value and applicability to satellite communications, technical aspects, and the environment in which the studies have been performed. The papers may be written in English, French, or Spanish, and are not to exceed 20 pages including attachments. They should comprise a detailed description of the discovery, invention, development, or research on which the entry is based; a description of its application to satellite communications, including examples where appropriate, and a description of the environment under which the work was performed. INTELSAT will have full rights to publication of the winning paper. Other papers will be returned to their authors, and publication by INTELSAT or Telespazio will require agreement with the author.

Send papers before September 30, 1981, to: INTELSAT, 490 L'Enfant Plaza, S.W., Washington, DC 20024, attention J. L. Algrett. Final selection will be made before December 31, 1981. For further information, contact Mr. Gavin Trevitt, Public Information Officer, INTELSAT, at (202) 488-2683. **R-E**

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editorial

Digital Audio Is Coming Home

It's been almost two years since we reported on a demonstration by Philips of a "revolutionary" compact all-digital audio disc. (see our "What's News" column in the Sept. 1979 issue.) At that time, the digital audio disc was not expected to be introduced commercially until 1983. But that schedule has been moved up. Now it appears that formal introduction of the system will have taken place by the time you read this. The Philips system was scheduled for introduction at the Summer CES show in Chicago during the first week of June. And the actual hardware should be on retailers shelves soon thereafter.

The Philips CD (Compact Disc) system combines digital technology with laser optics. Each 4-inch diameter disc is recorded on only one side and contains one hour of high-quality stereo sound. The sound is placed on the disc using digital technology. Thus, this marks the first time that an all-digital format intended for home use will be introduced. Presently, because of its cost, digital technology is confined to studio use. Studios have to convert to digital signals to analog for distribution on conventional discs and tape. The only exception is the PCM accessories that are used with a videotape recorder. But even these require that the program material be fed to it in analog form. The Philips system eliminates the analog chain between the studios and the home and provides a digital-only chain with all its inherent benefits.

Philips Compact Disc provides a frequency response that is essentially flat from 20 to 20,000 Hz with a channel separation of better than 90 dB. The signal-to-noise ratio and dynamic range are an incredible 90 dB as compared to the 60 dB currently available on conventional discs. In addition, the Philips player replaces the conventional stylus with an aluminum-GaAs laser, thus eliminating disc wear, surface hiss, clicks, turntable rumble, room vibration and pickup-arm resonances. Considering the elimination of the stylus, another application for the player would be in automotive sound systems.

The Philips player will be introduced in the United States by Marantz. The software, always a sticky point when introducing a new format, will not be handled by Marantz. When questioned about the software, Marantz's only comment was that "Philips has already taken the software problem into consideration." Considering the tremendous power of the Philips organization, we'll venture a guess that the software won't be a problem. Interestingly, within the past few weeks, Matsushita has also embraced the Philips system.

Perhaps this revolutionary new consumer product will be introduced without the standardization problems that have plagued the industry of late. But don't let your hopes rise too high—there are two other systems: the AHD capacitive disc system from JVC, and a mechanical groove-type system from Telefunken.

Art Kleiman

ART KLEIMAN
Managing Editor

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satellite tv news

MUSIC TV CHANNELS

"MTV: The Music Channel" will go into service as a 24-hour all-music circuit August 1 on Satcom I Transponder 11. The Music Channel will be programmed by Warner-Amex Satellite Entertainment Co., the same people who operate The Movie Channel and Nickelodeon aboard that bird. The program package will include varying pop visual and audio features, using a backbone of "video records"—videotaped performances by popular recording artists. Many performers are creating innovative video shorts (including computer-generated graphics, animation, and other styles) as promotions for their latest records—and, of course, Warner Records, a cousin company of WASEC, is one of the largest record companies in the U.S.

"The Music Channel" will be advertiser-supported and offered free to cable-TV operators. Each hour on the channel will contain about eight minutes of commercials.

TWO ANIK BIRDS IN ORBIT

Anik A-2 and A-3 Canadian satellites are now orbitting next to each other in an effort to improve capacity of Telesat Canada's facilities. Each bird has 12 transponders and the co-location will provide greater flexibility of service until Anik D with 24 circuits is launched in August 1982 and Anik C (16 channels) goes into orbit next year. The move of Anik A-2 to a new slot at 114° west longitude took more than a month and involved a drift of 5300 kilometers. The two birds are now actually located a distance of about 90 meters, or about the length of a football field, apart from each other.

COMSTAR D-4 IN ORBIT

Comstar D-4 is expected to have gone into service May 1, according to the schedule which has been progressing ever since the newest domestic satellite was launched in mid-February. The 24-transponder bird, located at 127° west longitude, will be able to reach all 50 states and Puerto Rico with its beams. AT&T and GTE Satellite Corp. expect to use the newest Comstar satellite primarily for telephone, data, and other communications services they provide—although some of the circuits will be turned over to video as part of a plan to integrate them with the existing terrestrial network.

The new Comstar supplements the two original Comstar birds, which are still in service. Those older satellites will soon be co-located at 95° west longitude and operated as a single satellite in order to reduce their power load and conserve their batteries, thereby extending the life of the two birds.

$900 AGILE RECEIVER

Automation Techniques Inc. has sold more than 1,000 of its *GLR 500* frequency-agile satellite receivers priced at $899 each. The device includes an imageless mixer design that eliminates image-frequency noise or interference and also includes a separate remote tuning module so that it can be located near the LNA. A hot carrier FET clamp avoids black "key streaks" on weak signals or vertical blanking tilt of diode-transistor clamps. For more information, write: ATI, 1486 North 106th East Ave., Tulsa, Oklahoma 74116.

MODULAR SATELLITE PRODUCTS

Downlink Inc. is selling what it calls the first "modular satellite TV" system—aiming to become "the Apple Computer of satellite TV." The package includes a compact control console with receiver mounted at the antenna, a 12-foot spherical antenna, 120° LNA, feedhorn and rotor with bracket assemblies, and 100-foot cables with connectors. Downlink Inc. is a subsidiary of Black & White Enterprises Ltd, PO Box 33, Putnam, CT 06260.

AROUND THE SATELLITE CIRCUIT

"The Independent Producer's Handbook of Satellite Communications," a 128-page guide to program distribution via satellite, has been published by the National Endowment for the Arts. The handy $3 reference volume includes substantial background material about satellite usage, although its primary emphasis is on how program producers and distributors can use satellites to expand their reach. The book is available from the Association of Independent Video and Filmmakers, 625 Broadway, New York, NY 10012, or the American Film Institute, Kennedy Center, Washington, DC 20566.

Western Union has asked the FCC for permission to launch a sixth Westar satellite, scheduled for orbit after 1982. The new bird would be a high-powered satellite with about 3.5 times the radiated power of current satellites and a footprint covering the entire continental U.S. as well as Hawaii and Alaska.

Rick's Video Service (Davis, California; 916-758-2623) has prepared a videocassette on how to install a private earth station, including site preparation and construction, according to Richard Walton.

GARY ARLEN
CONTRIBUTING EDITOR

letters

CABLE-TV MONOPOLIES

In his letter in the February **Radio-Electronics,** Richard Johnson makes some mistakes. The first is denying that cable-TV companies are monopolies. He points out that there are hundreds of cable-TV companies (forgetting that there are also hundreds of telephone companies) and seems to think that that is relevant.

It isn't. You can only buy telephone service, *or* cable-TV service, from *one* of the hundreds of companies that exist. That is what "monopoly" means: *one* seller. Each company has its own franchise area, and no one else in that area is allowed to sell to you. You have no choice; the fact that other companies exist, and that you might prefer what some of them have to offer, means nothing. Nor does the fact that many of the companies are not connected to each other have anything to do with it. Where *you* are, there's only one cable-TV source, and "monopoly" is exactly the right word to describe the situation.

Mr. Johnson also speaks of compatibility and quality-control problems. He seems to think that those things do not show up in the transmit-receive telephone network, but only in the receiver-only cable-TV systems. Wrong; they do.
JAMES E. HENDERSON,
New York, NY

PROJECTION TV

Your brief item in the "Looking Ahead" section of the March 1981 **Radio-Electronics** on projection TV overlooks one major U.S. manufacturer: Heath.

Our Healthkit *Model GR-4000* projection TV was introduced in 1979, and we are proud of its pioneering improvements in performance. We were the first manufacturer to use the brighter F 1.0 lenses—a major improvement in picture quality. That, combined with a wider IF bandwidth (required for quality projection), internal UHF/VHF splitter, and direct inputs and outputs for video and audio, have made the model *GR-4000* a popular set.

As with so many other things, small, innovative companies like Heath have made advances in the past that larger companies are beginning to adopt only now. We certainly don't mind that, but we hope that you and your readers will remember where some of those good ideas came from originally.
MIKE ROCKWELL,
TV and Audio Product Manager,
Heath Company, Benton Harbor, MI

NOISE-REDUCTION

Perhaps Mr. Joseph M. Gorin, author of the article, "Noise-Reduction Techniques" in your February issue, was unaware of our Source Noise Suppressor; or perhaps he thought that we were no longer in business. At all events, he did not mention our device.

If I may, I'd like to bring you and him up to date on this system, which is far more effective than any other in the presence of severe surface noise, tape noise, and FM noise. It was designed (in 1975) to be effective with the very high degree of surface noise that is characteristic of

shellac 78-rpm records, reproduced with flat (unequalized) treble; and it works very well, with a bare minimum of audible side effects. None of the products described in your article come near its performance in that respect. As you would expect, given its ability to cope with such massive noise, it is almost totally unobtrusive (much more so than the others) with modern source material.

Source Engineering products do not have wide distribution, but we're making the products; and among those who know of them, they're regarded much more highly than the dynamic-filter and notch-filter types.

We've been quiet lately because of other things, such as a line of psychological test instruments that we make. And we've learned that our particular point of view, which is that of the dedicated music lover, isn't a good match for the typical dealer or what he sees as his typical customer. But we're a long way from being dead!
C. F. KERRY GAULDER,
Source Engineering,
Wilmington, MA

OOOOOOPS!

When the April issue of **Radio-Electronics** arrived, my brother and I happened to be trying to interface the AY-3-8910 programmable sound generator to our *8080A*, and found your article helpful in getting it working. However, I noticed an error in Table 1 of the article. The "BC1" and "BC2" labels on the columns are reversed. The chips won't be enabled correctly if those lines are confused.
JOHN FILION

RELATIVISTIC MASS REAFFIRMED

I was astonished to see the letter by Marty Nagel, M.S. (Physics) entitled "Einstein Not Contradicted" in your May 1981 "Letters" department. Mr. Nagel's attempted refutation of my letter on charged capacitor contradiction in the January issue is not only pseudoscientific and unbelievable; he even contradicts the letter's heading by rejecting the relativistic variation of mass!

There are, indeed, "special relativity considerations which must be applied to the electromagnetic fields of the capacitor", as he says—but they have *no connection* with my paradox.

Mr. Nagel's belief that there is no such thing as relativistic mass can only be considered a personal eccentricity. He claims it to be an "ubiquitous misconception" that mass increases relativistically. He says: "...mass does not vary with speed...it is the observed momentum that becomes infinite at the speed of light...No reputable physicist today would consider the mass of an object to increase with speed."

That should be news to physicists, physics students, and authors of books on relativity. Mr. Nagel further cited a reference that he had misinterpreted. A basic equation of special relativity for the variation of mass with speed is

$$m' = m/\sqrt{1-v^2/c^2}.$$

It can be found in any relativity book. The equation for the relativistic "observed momentum" is that equation above, multiplied by v. Yes, the "observed momentum" *does* become infinite at light speed—but why? Because (you guessed it, reader) the mass part of the equation becomes infinite. (Sorry about that, Mr. Nagel, but that's the way it is.)
ANTHONY HANS KLOTZ,
Babylon, NY

NON-STANDARD "STANDARDS"

I liked your editorial, "Non-Standard 'Standards'" (**Radio-Electronics,** April), showing how the consumer has lost in the electronics battles of the recent past.

Regarding the new videodisc systems: I shall wait patiently until the winner is obvious, and continue to use my RCA VHS VCR system until then.

However, I'd like to say that I did purchase a 4-channel system (Panasonic) and really enjoyed it for many years. The 4-channel turntable gave me some trouble, and rather than continue to pour money into it, I purchased a direct-drive turntable (Panasonic). That is excellent, and just as useful as the other, because my amplifier has the unique feature of taking 2-channel sound and converting it to 4-channel sound whenever I desire. I was told by a salesman that my system is now quite rare. Thus, I feel that I was *not* a loser after the 4-channel craze died down.

I think that RCA will win out in the present-future videodisc battle.

I really enjoy your magazine; keep up the good work.
GABRIEL CURTIS, MD.
New York, NY

R-E

B+K Precision Model 2845 *DMM*

CIRCLE 101 ON FREE INFORMATION CARD

ONE OF THE NICEST HANDHELD DIGITAL MULTIMETERS on the market today is the *model 2845* recently introduced by B+K Precision division of the Dynascan Corporation (6460 W. Cortland St., Chicago, IL 60635). This compact meter incorporates several features usually found in higher-priced units as well as the usual functions and ranges found on DMM's in its price range.

A four-bit microprocessor makes it possible to offer autoranging on this low-priced and compact meter. Autoranging allows the *model 2845* to select automatically the range that will offer the greatest resolution, regardless of whether resistance, voltage, or current is being measured. There is also an Auto-Skip feature that allows the meter to switch immediately to the 200-volt range if the initial input is in excess of 25 volts. That feature lets the *model 2845* select the range more quickly by not having to switch through more than two voltage ranges. The range can also be locked by the operator when desired. That will reduce the delays usually inherent in DMM's. Overrange is indicated on the display by blanked digits and flashing decimal points.

A large (half-inch) 3½-digit LCD readout features high contrast for easy viewing under most lighting conditions. Resolutions of 1 millivolt, 1 microamp, and 1 ohm are possible with a basic accuracy of 0.1%. The accuracy will vary with the function and range and the user should consult the instruction book regarding the specific accuracy for each case.

Resistances between one ohm and 19.99 megohms are measured over five ranges. The meter will automatically select the resistance range offering the highest resolution. When turned on, the *model 2845* will automatically switch to the lowest range. The meter may be locked into that range (or any other) if desired. A continous tone lets you check low-resistance paths without looking away from your work. The tone (buzzer) will sound whenever the circuit resistance measures less than 179 ohms and when the *model 2845* is locked on the lowest resistance range. Since the tone will not sound if the resistance is greater than 179 ohms, it is especially useful in finding intermittents such as a break in a microphone lead and/or connector. Flexing the wires at the suspected point will silence the buzzer at the first indication of the break. There will be no reason to look away from your work to know that the break has been discovered.

Voltages between .001 volts DC and 1000 volts DC in four ranges and AC voltages from .001-volt up to 750 volts RMS, also in four ranges, can be measured. AC-range accuracy on the 2-20-volt range is from $\frac{1}{2}$% at 50 Hz to 2% at 1 kHz, ± 3 LSD. Currents, both AC and DC, from .001 mA up to 1999 mA can be checked using the *model 2845*. Internal RF shielding contributes to the accuracy of the readings when the unit is operated in the presence of strong RF fields. All ranges are protected against overloads and mistakes in function- or scale selection. In most cases, the most serious damage that will be experienced will be a blown fuse.

A minus sign on the display indicates when the voltage measured is negative. Other display features include a resistance-range indicator and a low-battery warning. The low-battery warning lets you know when only 20% of the battery-life remains.

For safety, the front panel jacks are designed to prevent accidental user contact. B+K Precision offers a full line of accessories for the *model 2845* including a battery eliminator for bench use. A carrying case is also available as an option.

A complete instruction manual is supplied with the *model 2845*. It includes operating instructions, complete specifications, a schematic diagram, and service- and user maintenance information. There is also a list of authorized service agencies.

All things considered, we are impressed with the *model 2845*. It does everything that's claimed and, aside from the "thinking time" delays that are inherent in all DMM's (and especially ones with autoranging), we found it fun to use.

The *B+K Precision model 2845* has a list price of $175.00. **R-E**

Nevcom Model CM-100 Wireless Microphone

CIRCLE 102 ON FREE INFORMATION CARD

"AN IDEA WHOSE TIME HAS COME" WOULD appropriately describe the Nevcom *model CM-100 Magic Mike*. With a trend toward product portability and miniaturization, a cordless microphone is most appealing.

The *model CM-100* is actually an FM transmitter operating in the new 49-MHz (license-free) band. An FM receiver plugs into the existing microphone jack on a base-station radio to receive the signals from the microphone and cause them to be retransmitted.

The unit we tested had an operating range of at least 40 feet from a base-station radio, but that distance will probably decrease under adverse conditions, such as when the unit has to energize a radio from outside a vehicle.

Many applications for this device come to mind. For example, an emergency medical team or law-enforcement officer can use the little mike to key up a powerful mobile unit rather than rely on a bulkier low-power (and much more expensive) hand-held transceiver. Several wireless mikes could be carried by different people, any one of whom could operate the mobile (or base-station) equipment by remote control.

The units are lightweight, low-cost, and are powered by an inexpensive 9-volt battery (not included). The circuits are well designed and the component layout is professional.

Earlier units had some problems, all of which are now corrected. The operating range was very limited—a few feet at best. According to a Nevcom spokesman, that was done to assure compliance with FCC restrictions on radiation limits. Fortunately, the range of the newer units is considerably better without exceeding FCC restrictions.

Early units also suffered from an echoic audio quality; it sounded as if the user were talking from inside a barrel. That was because of a problem in the size of the mike element, but now the sound is crisp and clear.

The wireless mike and matching receiver are shipped in a tough cardboard container, and some mounting hardware is included. The receiver unit requires a 12-volt source—normally the car battery in a mobile installation. A microphone plug (not included) connects the transceiver and the *model CM-100* receiver. The unit comes with a booklet that shows microphone pin arrangements for the majority of CB radios, and a companion sheet provides some tips on installation and adjustment. After reading the instructions, we felt that it would be extremely difficult for an inexperienced user to install the wireless receiver. A technician's services should be sought by a non-technical user. We have been assured that the manual is being revised. In the meantime prospective buyers should be aware of the shortcomings in the instructions.

All in all, performance was better than expected. The freedom of movement (as well as the novelty) was quite a pleasure. Since the *model CM-100* receiver can be adjusted for microphone audio level, modulation can be controlled, providing some possible signal improvement. (Be sure not to *over*modulate, however!)

The *model CM-100* wireless microphone sells for $44.50 and is available from Nevcom, 3360 S. Decatur Avenue, Las Vegas, NV 89102. **R-E**

Hamtronics Out-Of-Band Converters

CIRCLE 103 ON FREE INFORMATION CARD

ONE OF THE MOST FREQUENT COMPLAINTS about scanners among their users is the scanner's restricted frequency ranges. A great deal of communication takes place outside the frequency limits of programmable scanners.

Hamtronics, well known for its amateur accessories, has developed a series of six out-of-band converters designed to extend the frequency range of programmable scanners. The *model CVR72* covers 72-76 MHz. The other models in the series are the *model CVR135* (135-144 MHz), the *model CVR216* (216-225 MHz), the *model CVR240* (240-270 MHz), the *model CVR400* (400-420) MHz, and the *model CVR806* (806-894 MHz).

The units require 12-volts DC at 30 mA, and power may be taken from the rear DC receptacle found on most scanners used for mobile operation. (Modern scanners equipped for both fixed and mobile operation have a rear-apron quick-disconnect jack for 12-volt power. When the scanner is plugged into an AC receptacle, unregulated DC (12-20 volts) appears at that jack. Although the DC is well filtered, voltage will fluctuate with the accessory load. Normally, loads of 100 mA or so may be taken from this point without overheating the scanner's power-supply components. Under load, voltage may vary from 12-16 volts.)

While subtle variations exist among the various models, UHF circuit-features that are common to all the converters include shielded coils, double-sided epoxy PC boards, low-noise microwave RF transistors, and double-balanced mixers. The circuitry is enclosed in an all-metal cabinet for optimum shielding.

Conversion gain varies somewhat from model to model, but on the 135-144 MHz version, for example, center-frequency gain (138 MHz) is approximately 10 dB, dropping to 0 dB (unity gain) at the band edges.

The converters operate by translating the incoming signals to frequencies that fall within the bands commonly found on programmable scanners. These typically include high-band (150-174 MHz) and UHF (420-512 MHz).

We discovered that while the converters functioned quite satisfactorily, metropolitan users should expect some IF feedthrough from users of the scanner conversion frequencies. For example, while listening to 400-420 MHz signals, some interference from 152-153 MHz mobile-telephone tones may be expected. A good tunable filter helps stubborn cases.

The Hamtronics converters are equipped with chassis-mount BNC low-loss connectors. A special version of the converters featuring Motorola connectors is also available. The modified converters may be ordered at no additional cost from Grove Enterprises, Brasstown, NC 28902.

The out-of-band converters have a suggested selling price of $79.97 each. From Hamtronics, 65F Moul Rd., Hilton, NY 14468. **R-E**

Sony Model ICF-2001 Receiver

CIRCLE 104 ON FREE INFORMATION CARD

WHILE NEWS OF A PORTABLE MULTIBAND radio is generally nothing to get excited about, this new product from Sony (9 West 57th

Street, New York, NY 10019) is an exception.

About the size of a cassette recorder, the *model ICF-2001* is a radical departure from other low-cost consumer radios. The new receiver features direct frequency selection (using a keypad) and an LCD readout. Continuous-coverage reception from 150 kHz-30 MHz (AM/CW/SSB) and 76-108 MHz (FM) is provided by a microprocessor-controlled superheterodyne circuit featuring double conversion below 30 MHz. The *model ICF-2001* uses up-conversion (66.35 MHz first IF) to eliminate primary images. An all-FET front end reduces intermodulation, cross-modulation, and spurious signal generation.

A frequency-calibrated BFO control lets you adjust CW/SSB signal-tone for best listening. Stable CW and SSB reception is assured by a drift-free, quartz-crystal, phase-locked-loop frequency synthesizer.

Among the more innovative features is a six-channel memory, allowing the user to program his six favorite frequencies for instant recall. Automatic scanning with programmable limits is another of the receiver's features.

The absence of tuning knobs can be disconcerting to the veteran who is used to tuning across the dial of a general-coverage receiver, but after a few minutes of use, the keyboard will win over even the most stalwart sceptic! Rapid or slow tuning is a snap.

While the *model ICF-2001* does not have an S-meter, a five-step LED light-bar is used as a SIGNAL STRENGTH indicator. Antenna-circuit peaking is accomplished with a thumbwheel control.

A custom crystal filter provides medium selectivity in order to accommodate broadcast listening as well as monitoring of narrow-band communications. Although, Sony does not publish detailed specifications, bench tests are revealing.

Our lab tests

While RF sensitivity varied somewhat throughout the shortwave spectrum, average sensitivity appeared to be approximately 1 microvolt.

The IF selectivity on our sample was −6 dB at 6 kHz and −60 dB at 17.5 kHz. That makes it a little broad for serious communications use, but, then, the *model ICF-2001* is not intended for that.

Slow or fast tuning and scan-rate control can be adjusted for 1-kHz or 10-kHz steps below 30 MHz, scanning either up or down in frequency. On the FM-band the scan rate can be in 100 kHz or 200 kHz steps.

While the receiver will operate on either AC or batteries, batteries are required for the microprocessor circuit. The RF, IF, and audio circuitry draw quite a bit of current, limiting continuous battery operation to a few hours before the batteries must be replaced.

The audio circuit provides rich, crisp sound even when driving the built-in 4-inch speaker. Audio output is 1.6 watts. Frequency response is adjusted by separate bass and treble controls.

The custom-LCD displays a variety of information to the user including frequency in kilohertz (megahertz on FM), numbers of preset channels in use, scanning-limit indicators, a TRY AGAIN message in response to improper commands, and a sleep-timer setting indicator. The display is backlighted for visibility at night.

General comments

We were very impressed with the performance of the *model ICF-2001*. Even with the built-in telescoping whip antenna, worldwide reception of both broadcast and utilities communications was very good. Frequency drift was virtually non-existent, and frequency readout was accurate to within 1 kHz.

With an outside antenna, reception improved tremendously. Surprisingly, no problems with strong-signal overload were encountered below 30 MHz although some users have reported FM-band overload problems in metropolitan areas.

The Sony *model ICF-2001* has a suggested retail price of $329.95. **R-E**

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CIRCLE 10 ON FREE INFORMATION CARD

ware from which to choose. Even so, *Some Common BASIC Programs* from Osborne/McGraw-Hill would be a useful addition to almost anyone's software library.

This cassette tape for the Commodore *PET* computer is based on the 76 programs contained in the book of the same name by Lon Poole and Mary Borchers.

To begin with, the idea of 76 programs on one tape is quite unusual. The programs are labelled with numbers corresponding to the pages where their description and listings are found in the source text. Originally tested on the Wang *2200* computer, the programs have been modified to run on the *PET*. The changes consist mostly of adjustments to scale the CRT display of some programs for the *PET*'s 40-character line size. Apparently because of the general intent to make those programs machine independent, graphics are avoided except for the plotting routines that use universally available characters.

Computer hobbyists interested in any of the programs will find the absence of the pain of entering and debugging the programs well worth the tape's purchase price. The tape format also encourages you to try programs that may at first not seem to be your cup of tea.

The tape will give you a fast start toward justifying the expense of your machine. In particular, the math section is very helpful. The programs cover topics ranging from simple algebra and geometry through complex chi-square distributions and N^{th}-order regression. One program will solve a large set of simultaneous equations.

Other areas covered include finance, the home, and "general interest." Financial and math programs are by far in the majority.

The financial programs calculate mortgage amortization tables and the future values of an investment. Recipe-cost calculations, an alphabetizing routine, and a day-of-the-week program round out the collection.

The map check program, for example, takes the measurements found on a deed (angles, length of side, etc.) and calculates the land area. The day-of-the-week program may be useful to biorhythm enthusiasts who want to create something more complicated, using that program as the starting point.

Studying the programs will expand the knowledge of the beginning and intermediate level BASIC programmer. The purchasers should also seriously consider buying the book since it contains sample runs, suggestions, and remark statements that have been eliminated from the taped programs.

Some Common BASIC Programs—also available for the *TRS-80*—is recommended to intermediate-level computer hobbyists and to others who want a handy source of problem-solving routines. It sells for $15 and is available at local computer stores, or directly from the publisher, Osborne/McGraw-Hill, 630 Bancroft Way, Berkeley, CA 94710. **R-E**

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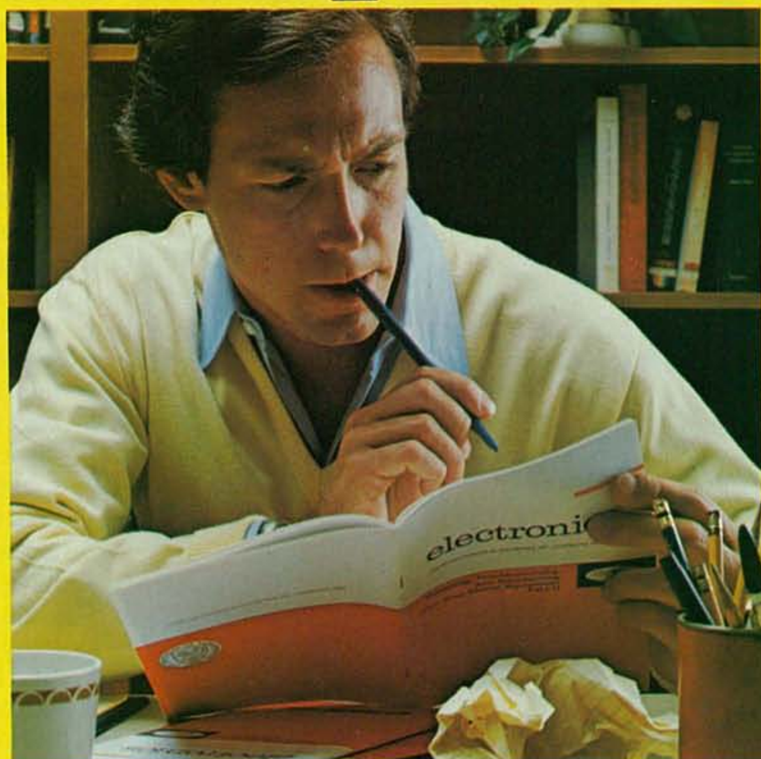

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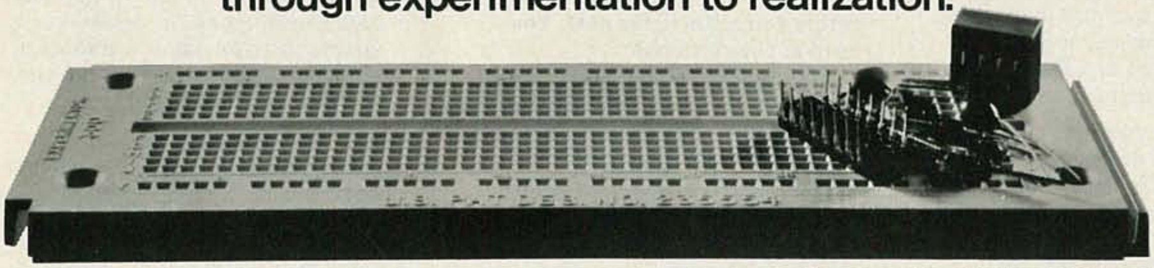

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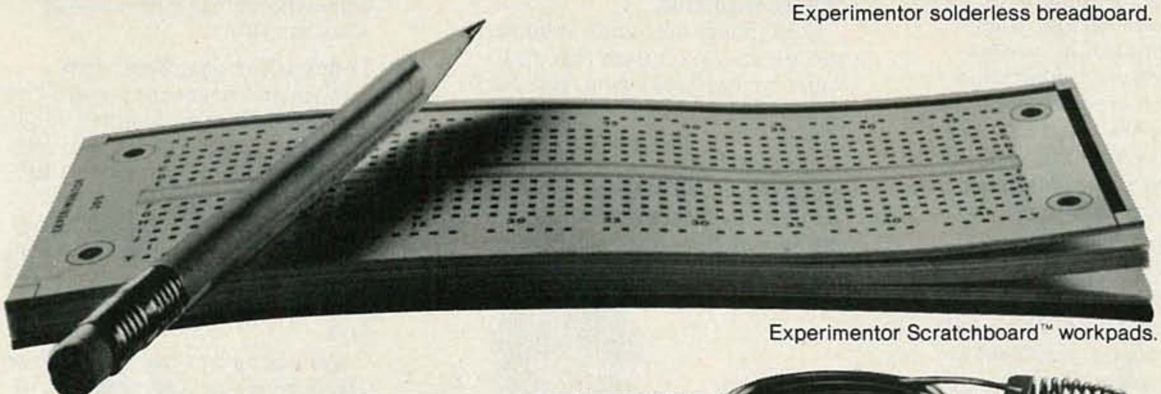

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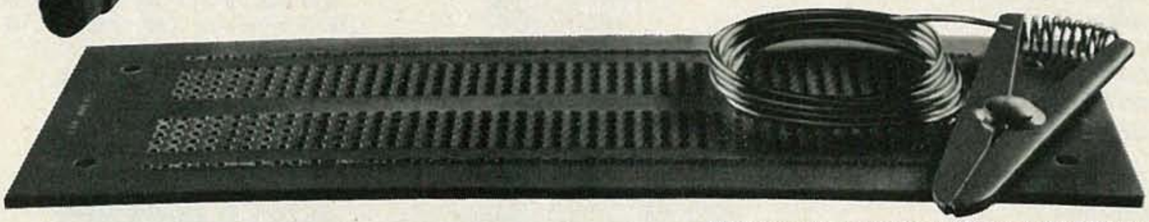

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CIRCLE 32 ON FREE INFORMATION CARD

Cordless Telephones

If you've ever missed a telephone call because you were unable to reach your phone in time, you'll understand why cordless phones are so popular. Here's an in-depth look at how they work.

ROBERT F. SCOTT

THE CORDLESS PORTABLE TELEPHONE IS one of the latest conveniences available for use in the home, business, or industry. It is portable and lets you take telephone calls while you are anywhere within 300 feet of the base telephone. Just think of the convenience and advantages of being able to answer the telephone while you are mowing the lawn or out shoveling snow.

Some of those little cordless telephone extensions are for incoming calls only. Other, more sophisticated, systems offer all the features of a full-service telephone. You can make calls as well as take them; you get push-button operation on any type of phone line—either *Touch-Tone* or rotary dialing. And in some of those units, the remote one has an automatic re-dial feature. You simply press a button and the internal memory recalls the last number entered and re-dials it automatically. Some, like the Rovafone *Rovette*, also have an intercom function.

The cordless telephone

The basic system consists of two parts; an AC-powered base unit that plugs into the telephone line and a hand-held portable unit that lets you answer your telephone from almost anywhere within a range of about 300 feet. The portable unit operates from rechargeable nickel-cadmium batteries that can be recharged by a charger built into the base unit.

The cordless telephone operates as a "low-power" device authorized under sections of Part 15 of the FCC Rules and Regulations. Modulation may be either AM or FM. Some systems have duplex operation (you talk and listen in a normal manner) while others use simplex operation—like CB and other two-way radio systems; push-to-talk, release-to-listen.

In addition to the voice transmissions, each cordless telephone unit transmits one or more control tones that perform such functions as bringing up dial tones, alerting the remote unit to an incoming call, and "hanging up the phone" when the call is completed.

The frequencies available for cordless telephones are four channels in the 1.6- to 1.8-MHz band (each 30 kHz apart) and five channels in the 49-MHz band. For example, the Radio Shack *model ET-300 DUōFONE* and the *Cobraphone model CP-15S* (from the Dynascan Corporation) are pre-set at the factory to one of four channels. To provide duplex operation, each channel has one frequency in the 1.7-MHz band and one in the 49-MHz band. Base-station transmit-frequencies are 1.665, 1.695, 1.725, and 1.755 MHz while corresponding portable-to-base frequencies are 49.830, 49.845, 49.875, and 49.890 MHz. On the other hand, the *Freedom Phone* from Electra transmits and receives on the same frequency. One channel in the 49-MHz band is used.

In the *Muraphone* (Mura Corporation) series of cordless phones both base and remote units also transmit and

receive on the same radio frequency—49.860 MHz. The designers have developed a unique simplex system that gives the remote unit priority. The party using the portable telephone controls the functions of both stations.

Now, let's look at some of the unusual circuit applications in the Muraphones. The Muraphone Cordless Extension Telephone is available in two systems: the *MP-100/101* answer-only system and the *MP-300/301* full-feature dial-out system. The circuits covered here are those in the *MP-100/101*.

The *MP-101* base station connects to the telephone line and plugs into a standard 117-volt, 60-Hz AC outlet. The *MP-100* portable is a battery-powered hand-held unit small enough to fit into a pocket or clip onto a belt.

How the cordless phone operates

The *MP-100/101* system can be operated in three modes: 1) Answer-only telephone: The party with the portable unit can take calls but cannot make them. 2) The Intercom Mode permits the base and portable units to be used as a wireless intercom without interfering with normal telephone service. 3) in the Pager/Call Interceptor/Transfer mode, a person answering the regular telephone can transfer the call to the remote unit. The user in the house can "page" the remote, speak privately through the intercom to find out if the remote party will accept the call, and then transfer the call or hang up. (The outside caller is on "hold" and cannot hear the exchanges between the base and portable units.) The party in the house can stay on the line and make it a three-way conversation.

The base and portable units transmit on 49.860 MHz. To give the portable priority, a pulse oscillator in the base circuit is turned on when an incoming call is received or when the INTERCOM button is pressed. The oscillator supplies two 460-millisecond pulses each second, along with two 40-millisecond gaps. The base transmitter is on and its receiver is off when the 460-millisecond pulses are present. During the 40-millisecond gaps the base transmitter is off and its receiver is on.

An incoming call (or pushing the INTERCOM button) activates the base station. Its transmitter starts sending 460-millisecond bursts of 49-MHz RF, modulated by a 1000-Hz tone. That modulated signal is received by the portable unit and the user hears 1000-Hz "beeps." The person with the remote unit extends the collapsible antenna and presses the PUSH-TO-TALK button. A 49-MHz carrier, modulated by 7000-Hz, is transmitted by the remote and received by the base during the 40-millisecond periods that its receiver is active.

The 7000-Hz tone is fed to a 7000-Hz decoder. As long as the decoder is receiving the 7000-Hz tone, it shorts the squarewaves from the pulse generator and locks the base unit in the receive mode. At the same time, the 7000-Hz tone actuates a relay. One set of relay contacts connects the 600-ohm winding of an audio transformer across the telephone line. That "picks up" the phone. The relay is latched by a second set of contacts.

As long as the PUSH-TO-TALK button is pressed, the user at the remote unit can talk to the calling party through the base unit. The remote's carrier is modulated simultaneously by speech and the 7000-Hz tone. The speech is detected, amplified, and fed to the telephone line through the audio transformer. The remote returns to the receive mode when the PUSH-TO-TALK button is released. The base no longer receives the 7000-Hz tone so the outside caller (or the person using the intercom function) can talk to the remote. The signal from the telephone line is fed through the audio transformer and an amplifier, and used to modulate the base's 49-MHz carrier. The short 40-millisecond gaps in the transmission are hardly noticeable.

THIS *MODEL 3500 FREEDOM Phone* from Electra is small enough to fit in a shirt pocket.

At the end of the conversation, the person using the remote unit presses the LINE RELEASE button to "hang up" the phone. The remote unit's RF carrier is now modulated by a 4.5-kHz tone. That signal is received by the base during the 40-millisecond gap and applied to a 4.5-kHz tone decoder. The decoder output causes the relay to open and release the telephone line. The base is now standing by, ready for the next incoming call.

In the intercom mode of operation, the telephone is connected in series with the B+ supply across a winding of the line transformer. The carbon microphone-element varies its resistance as the user speaks. That modulates the current flowing through the transformer winding. The speech voltage induced in the other transformer windings is used to modulate the base unit's RF carrier and is received at the remote unit. From here on, the operation is the same as with an incoming call.

Circuit analysis

Schematic diagrams of the *MP-100* remote and *MP-101* base are shown in Figs. 1 and 2, respectively. Refer to those diagrams as we discuss the circuits and their operations in greater detail. Let's start with the remote shown in Fig. 1.

The receiver section is a standard single-conversion superhet receiver with an RF amplifier, a crystal-controlled oscillator/mixer, and a two-stage IF circuit. When the PUSH-TO-TALK button is in the receive (R) position, any signal from the base unit is detected, amplified, and fed to the speaker through the lower secondary on T7, the audio output and modulation transformer.

When the PUSH-TO-TALK button is held down in the transmit (T) position, the 8-ohm loudspeaker is used as a microphone feeding the base circuit of amplifier Q5. After futher amplification in the push-pull output stage, the speech signal appears in the upper secondary winding of the modulation transformer. At the same time, B+ voltage is applied directly to the transmit oscillator (Q12). The B+ for the RF final amplifier passes through the secondary of T7 so Q13's collector current is modulated by the audio signal. The modulated RF appears across tank coil L6 and is fed to the antenna through low-pass filter L1, L2, L3, C1, C2, and C3.

While the PUSH-TO-TALK button is in the transmit position, B+ is applied to the 7-kHz phase-shift oscillator (Q10) through diode D5. The 7-kHz tone is fed through a buffer to the primary of the driver transformer. After amplification, that 7-kHz signal modulates the RF output stage along with the speech. When the modulated signal reaches the base unit, the 7-kHz tone is decoded and used to latch the base in the receive mode.

When the conversation is over, the user releases the PUSH-TO-TALK button and presses the LINE RELEASE button on the portable phone. That applies operating voltage to the 4.5-kHz tone generator (Q9), buffer Q11, the transmit oscillator and final amplifier, and to the audio stages. The 4.5-kHz tone modulates the 49-MHz carrier and is used by the base to activate the line-release (hang-up) circuits.

Although the remote unit is in the receive mode, the receiver circuit is dis-

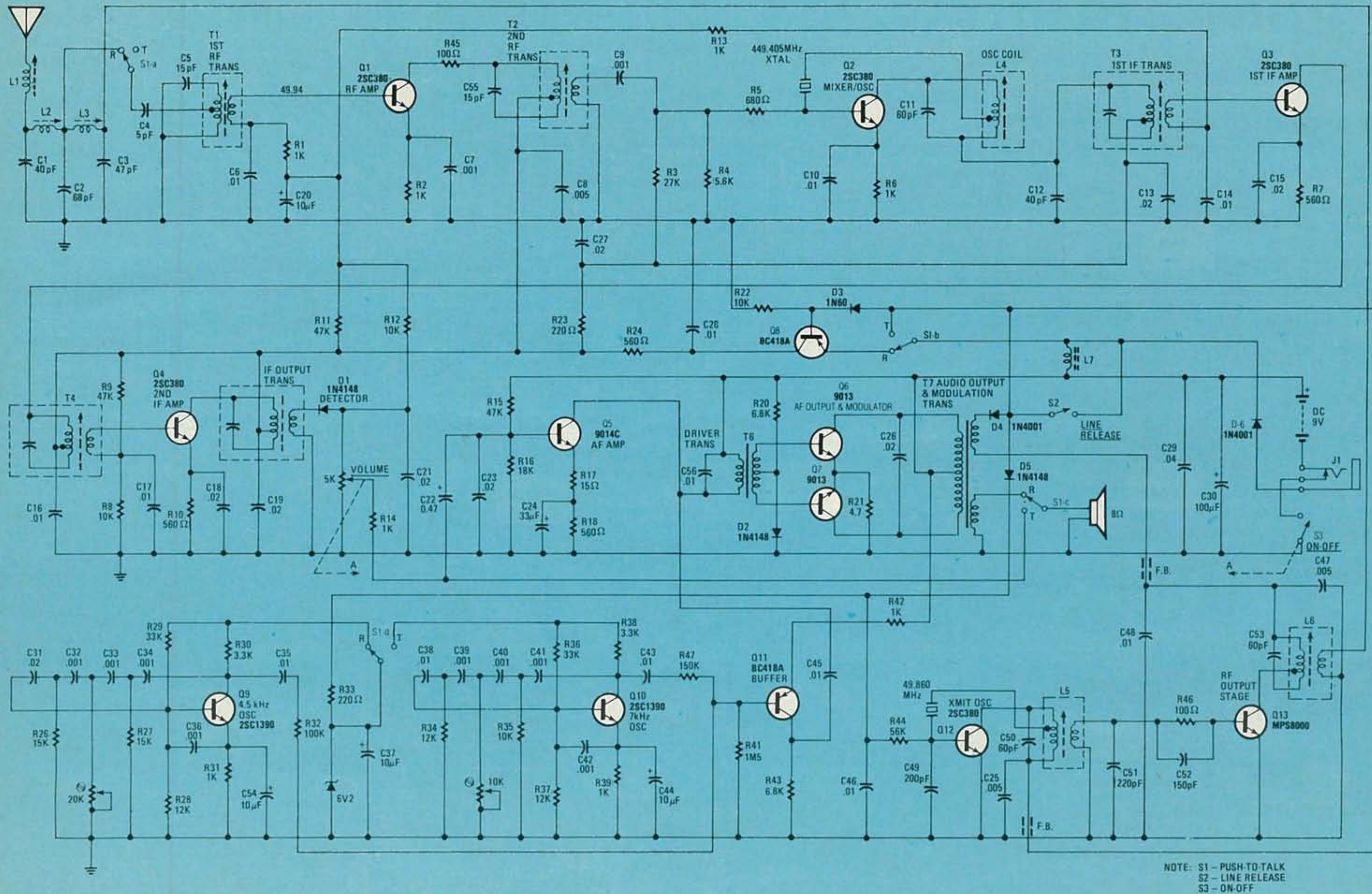


FIG. 1—THE RECEIVER SECTION of the *model MP-100* is a standard single-conversion superhet receiver with an RF amplifier, a crystal-controlled oscillator/mixer, and a two-stage IF circuit.

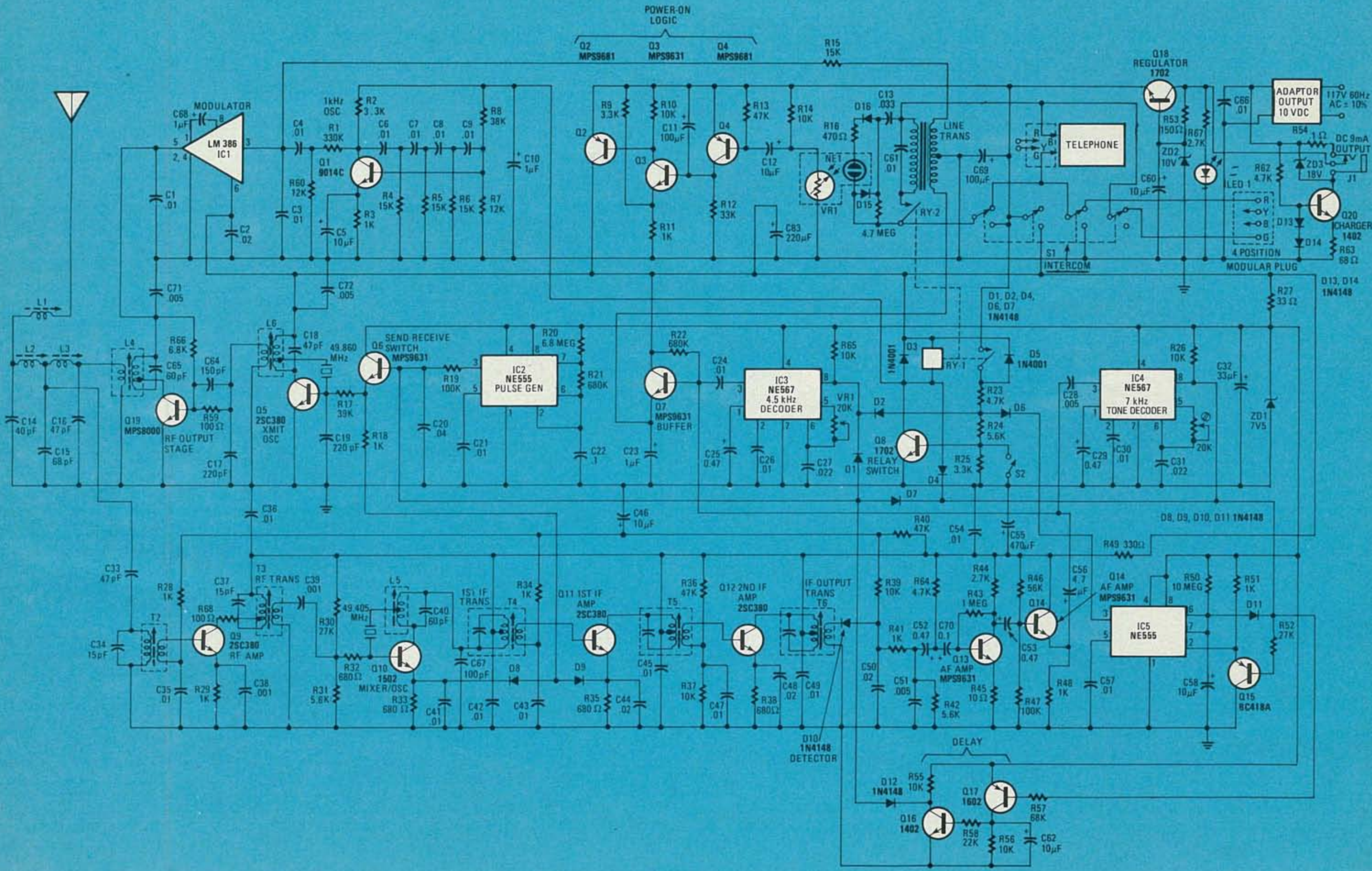


FIG. 2—SCHEMATIC DIAGRAM of the Muraphone *model MP-100* base unit. Power for the unit is supplied by a 10-volt DC adaptor. Transistor Q18 is a voltage regulator.

abled by closing the LINE RELEASE switch. Normally, the entire receiver front-end (Q1 through Q4) is supplied with B+ through the emitter-collector section of Q8. (Note that Q8 is called "Line Release Switch" in Fig. 1.) Diode D3 is back-biased so Q8's base current cannot flow through to Q12 and Q13 in the transmitter RF circuits.

As the LINE RELEASE switch closes, Q8's base and emitter are tied together through D3, a germanium diode. The diode turns on. The voltage drop across D3's junction is less than the base-emitter junction voltage of Q8, a silicon transistor, so Q8 turns-off. That breaks the B+ path to the receiver RF and IF circuits.

The base circuits

Refer to Fig. 2 as you follow the details of circuits in the base unit. Power for the base is supplied from a 10-volt DC adaptor through Q18, a voltage regulator. No voltage is applied to most of the sections until the station is activated by an incoming phone call.

When the phone rings, a 20- to 60-Hz AC voltage appears on the telephone line. In the U.S. it ranges between 40 and 150 volts RMS riding on 52.5 volts DC. This voltage is tapped off the R and G terminals of the 4-prong modular plug and applied across neon lamp NE1 through R16 and a voltage-doubler circuit consisting of C13, D15, and D16. Light from the neon lamp is directed to photocell VR1, causing the photocell's resistance to drop. The initial resistance change produces a pulse through Q4, turning it on along with Q3 and Q2. Transistor Q2 saturates and supplies power throughout the base circuit as long as the ringing continues.

Pulse generator IC2 delivers two 460-millisecond positive pulses per second. Thus, there are two 40-millisecond gaps in the output each second. The 460-millisecond pulses turn on Q6, the electronic send-receive switch. The 40-millisecond gaps turn it off because the output of IC2 is at zero volts. Thus, when Q6 is on it supplies the base current necessary to turn on Q5, the 49-MHz transmitter oscillator. The oscillator drives the final RF amplifier (Q19). Any audio appearing at pin 5 of the LM386 modulator IC modulates Q19's collector current. The modulated RF signal is fed to the antenna through a low-pass filter network.

When the ring signal turns on Q2, B+ voltage for the 1-kHz oscillator (Q1) flows through the relay coil. The current drawn by Q1 is low and, since there is no path to ground, the relay remains unenergized. Full supply voltage—minus the small DC drop across the relay coil—is applied to the Q1 circuit. Its output modulates RF amplifier Q19 and the 1-kHz tone is heard in the portable unit to alert the user to the in-

BASE AND REMOTE units of the Cobra *model CP-15S* cordless telephone from Dynascan.

coming call.

When the send-receive switch (Q6) is turned on by the ring signal, it also biases on diodes D8 and D9, located between the emitters of the mixer and first IF amplifier in the receiver circuit. Heavy currents flow through emitter resistors R33 and R35 and develop voltages that bias Q10 and Q11 to cutoff. That is how the receiver is turned off while the base unit is transmitting the 1-kHz "ring" signal to the portable.

During the 40-millisecond gap, electronic switch Q6 is turned off, the RF transmit circuit is disabled, and the receiver is turned on.

When the user at the remote nunit hears the 1-kHz beep, he answers by pressing the PUSH-TO-TALK switch. The remote then sends a 7-kHz tone to the base unit. That tone is received during one of the 40-millisecond periods that the receiver is turned on. The signal passes through the RF and IF circuits and the detector. The 7-kHz tone is recovered across R41 and R42 and processed by audio amplifiers Q13 and Q14.

The 7-kHz tone is fed from the emitter of Q14 to the inputs (pin 3) of the 7-kHz and 4.5-kHz tone decoders (IC4 and IC3) and to the base of buffer Q7. The outputs of IC3 and Q7 are not affected by the 7-kHz tone, but IC4's output pin (pin 8) is clamped to ground. Now, a DC path is completed through the relay, D4, and IC4 pin 8 to ground. That energizes the relay and closes its contacts. Contact RY2 connects the primary winding of the line transformer across the telephone line. That "captures" the line—in effect, picking up the receiver.

The ringing stops when the line is captured, so the power-on logic circuit (Q2, Q3, and Q4) is turned off and conversation can begin. Now that the bottom end of the relay coil is brought close to ground (via its connection through IC3), the voltage at this point is too low to keep Q1 oscillating. Therefore, the 1-kHz "ring" signal is cut off.

Finally, as relay contact RY1 closes, it supplies voltage through D5 to all the other circuitry in the base station, replacing Q2 as the current path. Contact RY1, in closing, also supplies a bias to Q8's base that turns the transistor on. Relay coil current now flows through Q8. So, as long as Q8 is conducting and

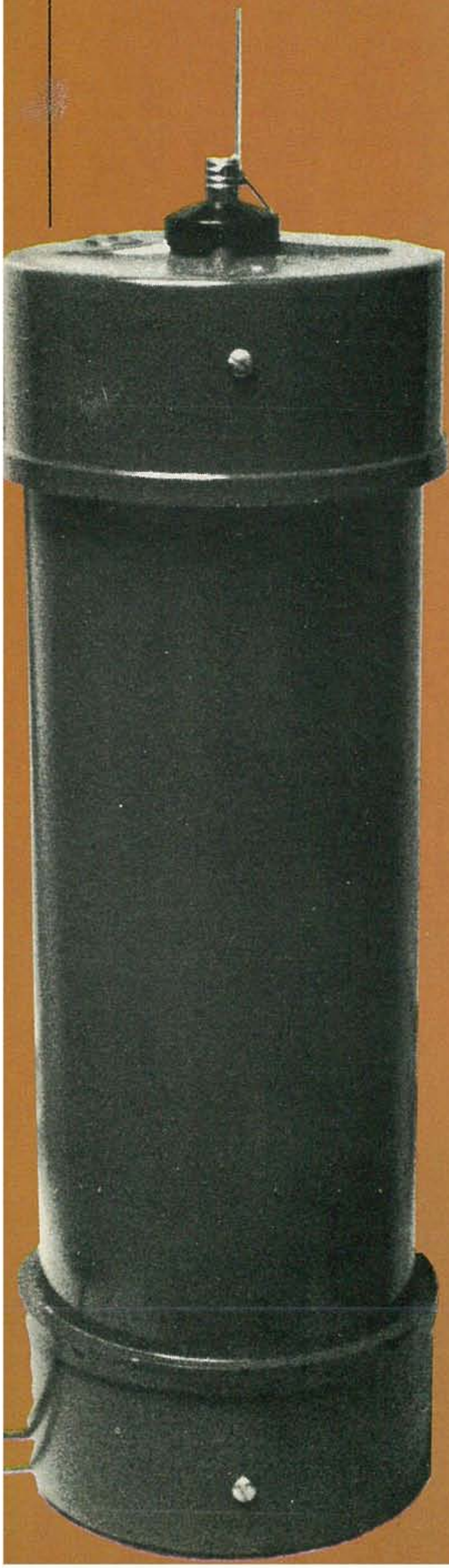
MURAPHONE *MODEL MP-100* **cordless extension telephone. This model is a receive-only unit.**

contact RY1 remains closed, the relay remains energized and the line remains captured.

During the time that the 7-kHz tone is being received at the base unit—any time that the remote's PUSH-TO-TALK button is pressed—the ground potential at pin 8 of IC4 is connected through D7 to the base of Q6. Transistor Q6's base is thereby shorted to ground and Q6 is kept turned off. Thus, the base transmitter is off and the receiver is turned on for as long as the remote unit is transmitting.

Speech is transmitted from the portable unit along with the 7-kHz tone and is detected and fed to the same points as the tone. Speech signals do not affect the decoders. Buffer Q7 is an emitter-follower with a high-frequency roll-off (the 1-μF capacitor and half the center-tapped winding of the line trans-

continued on page 72



NEGATIVE ION GENERATOR

A great amount of interest has been shown recently in negative-ion generators. Build one yourself and see how it benefits you.

RONALD E. PYLE

WITHIN THE LAST SEVERAL YEARS, negative-ion generators have found increasing popularity. Many benefits from exposure to negatively ionized oxygen have been claimed.* For example, some experimental evidence indicates that certain respiratory ailments can be alleviated; migraines, acute anxiety, and depression can be reduced or eliminated, and seriously burned patients can experience reduced pain and infection, and accelerated healing.

Physiologically, it has been found that in atmospheres containing an excess of *positive* ions, serotonin, a stress neuro-hormone that inhibits oxygen absorption in the body, is produced in the blood and carried throughout the circulatory system. An excess of serotonin can result in dizziness, inability to concentrate, fatigue, migraine, depression, and shortness of breath. Negative oxygen ions, on the other hand, cause the degradation of serotonin into a harmless by-product.

Because an oxygen molecule in air contains unpaired electrons it can readily accept an electron produced by natural or artificial means to become a relatively stable negative ion.

Negative oxygen ions can be produced efficiently and safely using the high-voltage corona-discharge method. High-voltage negative DC of approximately −6000 to −9000 volts is used to charge the tip of an emitting needle. That results in the production of a large quantity of electrons that are emitted at high velocities from the tip due to the large accelerating potential. The relatively high-energy electrons that are released react with the oxygen molecules in the air to produce the desire negative oxygen ions.

*Voisinet, Roger, Journal of Environmental Sciences, July/August 1978, pp. 28 - 29.

How it works

Figure 1 shows a simple, low-cost circuit based on the high-voltage corona-discharge method. The NE555 is used in the astable mode. It produces a continuous squarewave at a frequency of approximately 40 Hz and duty cycle near 10% at pin 3. This squarewave output is then coupled through R3 to a Darlington transistor pair (Q1, Q2) that is used to switch the primary of a standard 12-volt three-terminal automobile-ignition coil.

The high-voltage, AC output from the ignition coil is then half-wave rectified by connecting it to the cathode of a 45,000-volt high-voltage diode assembly using standard high-voltage ignition wire. (Note the polarity of the diode carefully.) The resulting negative DC is then filtered by high-voltage capacitors C4, C5, and C6. A common sewing needle is used as the electron-emission source, and its blunt end is soldered to the anode end of the high-voltage diode assembly (often referred to as a stick diode).

In Fig. 2, a simple, unregulated, power supply for the negative-ion generator is shown. The output of power transformer T1 is half-wave rectified by D2, current limited by R5, and filtered by capacitor C7. The power supply produces (under load) approximately 10 volts for the circuit.

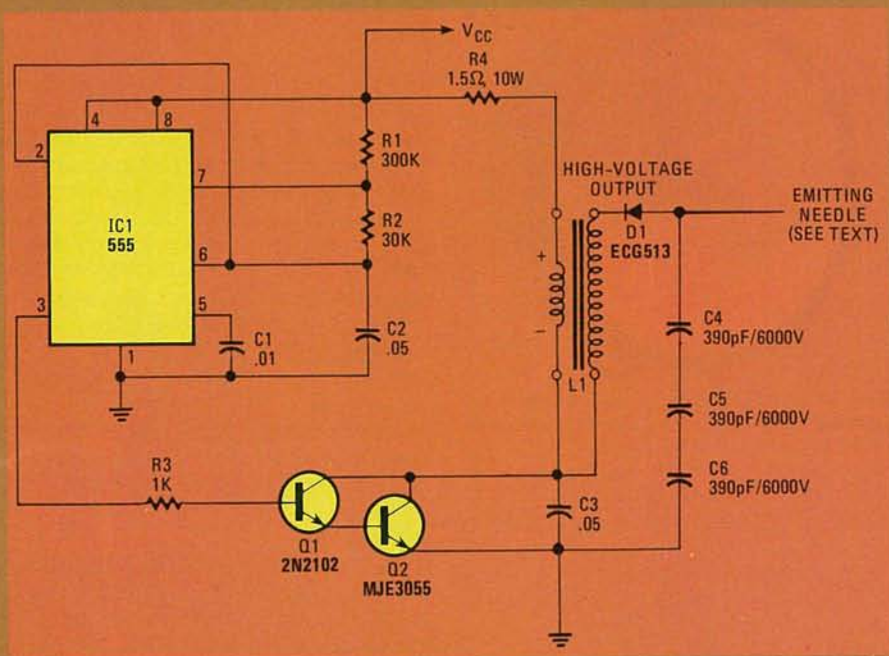


FIG. 1—SCHEMATIC DIAGRAM of the negative-ion generator. The NE555 is used in the astable mode.

PARTS LIST

Resistors ¼ watt, 5% unless otherwise indicated
R1—300,000 ohms
R2—30,000 ohms
R3—1000 ohms
R4—1.5 ohms, 10 watts
R5—5 ohms, 10 watts

Capacitors
C1—0.01 μF, 50 volts, ceramic disc
C2, C3—0.05 μF, 100 volts, ceramic disc
C4-C6—390 pF, 6000 volts, ceramic disc
C7—1000 μF, 35 volts, axial lead electrolytic

Semiconductors
D1—ECG513 45,000-volt diode array
D2—1N3880
Q1—2N2102 NPN transistor
Q2—MJE3055 NPN transistor
IC1—NE555 timer
L1—12-volt, three terminal, automotive ignition coil
T1—power transformer, 12.6 volts, 3 amps

Miscellaneous: PC board, perforated board, or IC breadboard; four-inch diameter PVC pipe with end-caps; high-voltage automobile ignition wire; hookup wire; heat sink, mica washer, and heat-sink compound; terminal strip; aluminum bracket material; line cord; ½-amp fuse; hardware, etc.

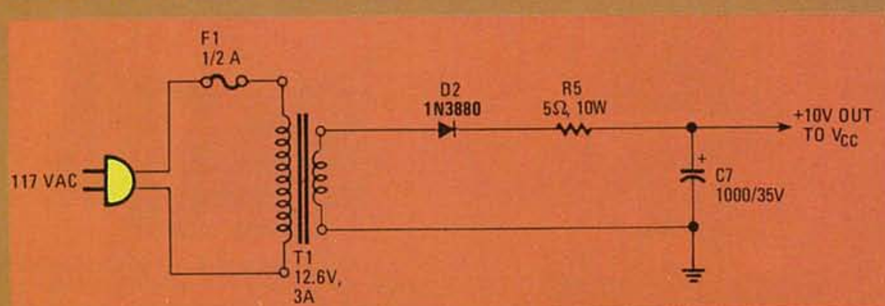


FIG. 2—THIS SIMPLE, UNREGULATED, POWER SUPPLY produces approximately 10 volts for the negative-ion generator.

Construction

The circuit in Fig. 1 can be built easily on a small (1¼ × 2¼ inches) piece of perforated board, printed-circuit board, or universal IC breadboard, as shown in Fig. 3. Transistor Q1 does not need to be heat-sinked as its load current (Q2's base current) requirements and therefore the transistor's power dissipation are not excessive. However, Q2 is mounted off the circuit board and heat-sinked for thermal overload protection as shown in Fig. 3. Because the MJE3055's (Q2) mounting tab is tied to the collector, care must be taken to isolate the mounting tab from ground. That is done by using a mica washer and heat-sink compound between the transistor's case and the heat-sink, and mounting the transistor using a nylon bolt.

The +10-volt power supply shown in Fig. 2 was built to allow for a compact installation. A right-angle aluminum bracket made from a 2½ × 3-inch piece of 3/32-inch aluminum sheet was epoxied to the top of the power transformer, T1, as shown in Fig. 4. A seven-lug terminal strip was then epoxied to the bottom of the aluminum

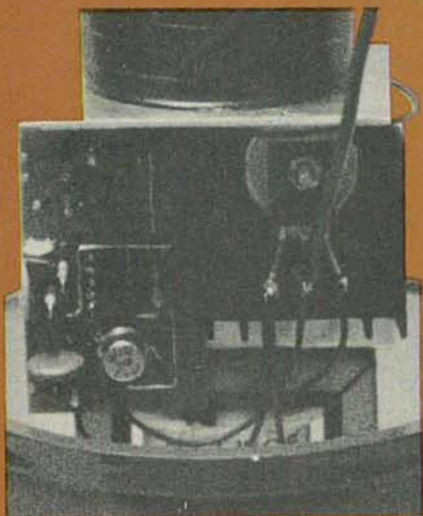


FIG. 3—THE ION-GENERATOR circuit is built on a small piece of circuit board. Transistor Q2 is mounted next to the board and should be heat-sinked as shown.

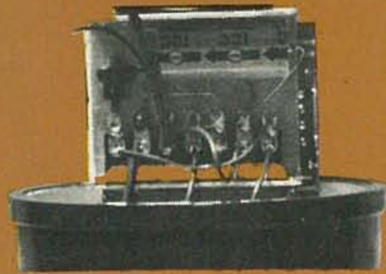


FIG. 5—ALL POWER-SUPPLY components, except T1, are mounted on a terminal strip that is epoxied to the bracket.

FIG. 6—INTERIOR VIEW of the top PVC cap. Rectifier D1 and capacitors C4, C5, and C6 are shown.

FIG. 4—A RIGHT-ANGLE BRACKET is epoxied to the top of transformer T1. The circuit board is mounted on the bracket using ¼-inch plastic stand-offs. The connections to the ignition coil, and the lead from the coil's high-voltage terminal, will be concealed by the PVC pipe in the completed project.

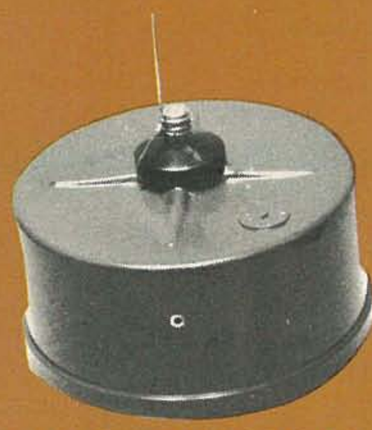


FIG. 7—A COMMON SEWING NEEDLE is used as the electron-emission source. The blunt end of the needle is soldered to the anode of the rectifier.

bracket for component mounting as shown in Fig. 5. The power-supply components—rectifier D2, power resistor R5, and filter capacitor C7—are then soldered to the terminal strip. The small circuilt board and Q2 (mounted on its heat sink) are mounted on the other side of the bracket. Epoxy Q2's heat sink directly to the bracket, and mount the circuit board, using ¼-inch plastic stand-offs and epoxy, as shown in Fig. 4.

Another piece of 3/32-inch aluminum sheet measuring approximately 2½ × 2½ inches, was epoxied at a right angle to the top of the power-supply bracket as shown in Fig. 4 to serve as a mounting base for the ignition-coil assembly. Once the epoxy has set, the ignition coil can be epoxied to the mounting base. All solder connections between the power supply, coil, and circuit board can be completed now.

The completed assembly is housed in a piece of standard 4-inch diameter PVC 3/32-inch wall pipe, approximately 13 inches long, with two standard 4-inch PVC end-caps. The power supply, coil, and circuit-board assembly is bolted to the bottom end-cap after a suitable side hole is drilled for the 120-volt AC line cord.

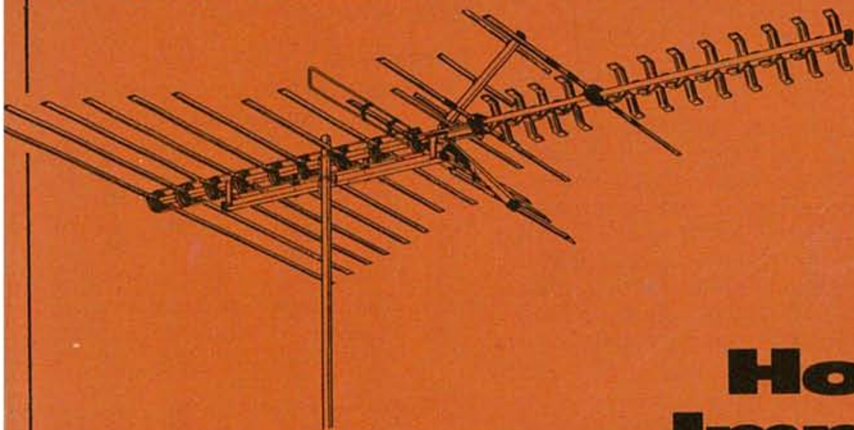
The high-voltage rectifier, D1, and high-voltage filter capacitors C4, C5, and C6, are then mounted in place with epoxy through a 9/16-inch hole drilled in the top PVC end-cap as shown in Figs. 6 and 7. One end of the series-connected high-voltage capacitors is soldered directly to the anode of the rectifier; the other end is connected to ground on the power supply, coil, and circuit-board assembly. The automobile high-voltage ignition wire lead from the coil's high-voltage output is soldered to the cathode of the rectifier. A two-inch long common steel sewing needle is used as the emission source. The needle's blunt end is soldered to the anode of the rectifier. Make certain that the diode polarity is as shown in Fig. 1. In addition, after assembling the completed unit and PVC housing, make certain that the high-voltage connections are not located near any potential discharge-points on the assembly.

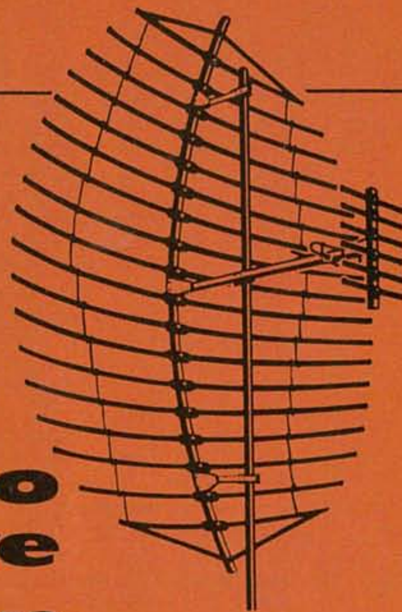
Summary

In the circuit shown, the high-voltage negative DC at the anode has been measured with a high-voltage probe at approximately −9000 volts, which is sufficient for generating negative oxygen ions. Although it is *not* lethal, the instrument is a high-voltage source and should be treated with respect and caution.

The "ion wind" generated by the rapidly moving ion flux from the emission source can be felt by carefully placing a finger near the emitting needle tip. For maximum effect, the negative-ion generator may be placed several feet from the user. **R-E**

"Looks to me like the audio stage is dead, indicating a shorted output transistor—but Pa thinks it's a split resistor."

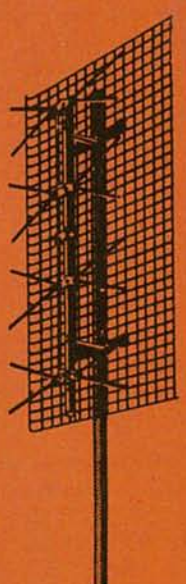




How to Improve UHF Reception

The results of this FCC study can help you improve your UHF-TV reception significantly.

DENNIS C. BROWN



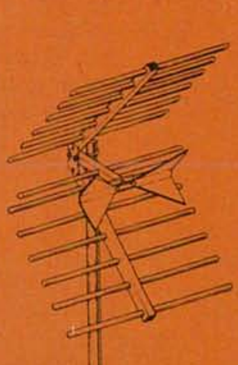
DID YOU EVER WISH YOU COULD TEST DOZENS OF TV-RECEPTION ACCESSORIES (LIKE ANTENNAS, preamps, lead-ins, splitters, connectors and baluns) before deciding which to buy to improve your reception? The Federal Communications Commission has done it for you. In this report, we will reveal which UHF-TV antenna-system components were found to be the best when tested for the FCC by the electronics labs of The Georgia Institute of Technology.

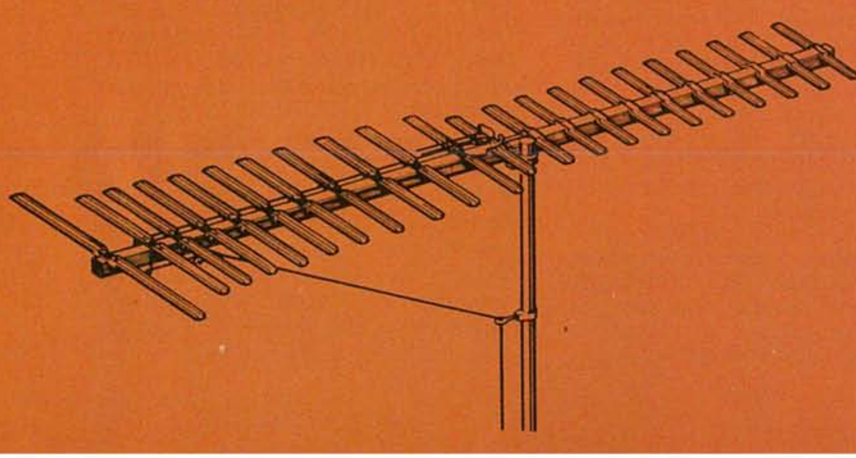
The FCC has recently proposed adding a large number of low-power UHF stations intended to serve only small-coverage areas. Those proposed stations, in addition to the rapidly increasing number of regular UHF and UHF-translator stations, may cause you to think about upgrading your UHF-TV receiving system. In addition to luck and a little black magic, good UHF-TV reception requires good antenna-system components to get the signal to your receiver.

The FCC has long been concerned about the difficulties many households have in receiving UHF. In a recent report to the Commission, the FCC staff explained that the most efficient and effective way to improve UHF reception is to improve the antenna and transmission-line system. Under contract to the FCC, Georgia Tech tested a large number of UHF antennas and accessories. Its tests results were released by the FCC in a 200-page report. The report, however, carefully omitted the names of the manufacturers of the equipment tested.

The author filed a Freedom-of-Information-Act Request with the FCC for the names of the manufacturers and the model numbers of the equipment tested. The FCC Office of Plans and Policy granted the request in full.

Three caveats are in order: First, although no doubt every effort was made to be thorough in the selection of components to test, some manufacturers' products may not have been tested. Omission of some product from the report should not be taken to indicate any conclusion about that product. Second, the Georgia Tech study does not take into account variations from unit to unit and from batch to batch in a maker's line for the more expensive products. Thus, the unit tested may have been a lemon, an exceptionally good piece, or an average sample. Third, because the public release was expected to be confidential in regard to the manufacturers' names, the report's conclusions should not be taken as either criticism or endorsement of a particular product or manufacturer by either Georgia Tech or the FCC.





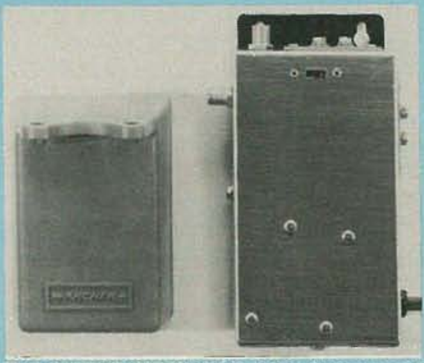
Before we look at the test results themselves, let's look at Georgia Tech's general conclusions:

1. UHF-only antennas provide better UHF performance than UHF-VHF combination antennas, providing, on the average, a 2-dB gain advantage.
2. Considering both overall performance and cost, the outdoor 4-bay bowtie antenna, at an approximate cost of $10, is considered the best antenna choice for UHF reception for most installations.
3. There are significant differences among preamps, with gains varying from −16 dB (an actual loss) to +35 dB, and with noise figures varying from 2.5 dB to 12 dB.
4. The benefit of a preamp is that it lowers the system noise figure, with a noise figure between 3 dB and 5 dB desirable.
5. A preamp mounted at the antenna will give better performance than one mounted indoors at the receiver. The improvement in performance is approximately equal to the loss suffered in the transmission line. A preamp gain of about 20 dB is desirable. A gain of 15 dB may be adequate, while more than 20 dB may be too much except in fringe areas.
6. New, dry, unshielded twin-lead exhibits the lowest insertion loss, while shielded twin-lead has the greatest loss.
7. Coaxial cables have the lowest VSWR (*V*oltage *S*tanding *W*ave *R*atio, a measurement of mismatch between connected components, with 1:1 indicating a perfect match) and shielded twin-lead shows the highest VSWR.
8. Unshielded twin-lead is susceptible to moisture and metal-proximity effects which cause significant degradation in performance. Shielded twin-lead and coax cables are immune to those conditions.
9. RG-6/U coax is the best choice for UHF-TV reception.
10. There is no clear correlation between the price of a splitter and its performance characteristics.
11. Insertion loss of splitters tested ranged from 0.1 dB to 5 dB, and insertion-loss differences among samples of the same model varied from 0.3 to 2.2 dB.
12. Splitter VSWR values ranged from 1.05:1 (very good) to 6.4:1 (not so good).
13. There does not appear to be much correlation between the price of a balun and its actual performance.
14. Insertion loss of the four models of baluns, from three manufacturers, ranged from 0.3 dB to 2.7 dB, with insertion loss difference among samples of the same model varying from 0.2 to 0.9 dB.
15. Balun VSWR values measured from 1.1:1 to 3.0:1, with VSWR differences among units of the same model ranging from 0.2 to 0.8.

The Georgia Tech study identified several efficient systems, ranging in cost from $47 to $260. The receiving system that the engineers considered to represent the optimum compromise between price and performance costs approximately $70 and consists of a UHF-only 4-bay bowtie outdoor antenna, a UHF-only preamp with a noise figure of 2 dB to 5 dB and a gain of 20 dB, and RG-6/U transmission line.

Antennas

Georgia Tech engineers looked at 55 configurations of commercially available antennas and tested ten models, both as-manufactured and after pruning break-away elements for best performance on the higher UHF channels. The Public Broadcasting Service had tested 29 antenna models and released data on those tests in 1978. Rather than re-testing those models, Georgia Tech used the PBS figures in its analysis. The results of the tests are summarized in Tables 1-3.



THE OUTPUT IMPEDANCE of this Archer *model 15-1134* from Radio Shack, a division of Tandy Corporation, is switch selectable (75 or 300 ohms).

As could be expected from an understanding of antenna theory, the Channel Master 6-foot parabolic dish antenna showed the highest gain and narrowest beamwidth, but an unexpectedly low front-to-back ratio, possibly because ribs, rather than screen wire are used for the reflector.

If you want a single antenna for both UHF and VHF reception, the Jerrold *model VU-933S* 33-element log-periodic VHF, yagi-with-corner reflector UHF, appears to be the best choice for UHF reception.

In general, among antennas you get pretty much what you pay for, with the higher-priced antennas generally giving better performance. Because not everyone will want to spend a lot of money or be able to accommodate some of the antennas (for example, I would dearly love to have the benefits of a six-foot dish but can't spare the space in my apartment), a close look at the tables should provide guidance to the best antenna type for your needs.

Preamplifiers

Georgia Tech tested twelve marketed models from ten manufacturers, plus a Blonder-Tongue prototype that is not commercially available. They were tested at the center frequencies of seven UHF channels. Those preamps intended for VHF, as well as UHF, reception were also tested at channels 4 and 9. All preamps were tested for gain, noise figure, 1-dB compression point level, and VSWR. The test results are summarized in Table 4.

The one reason for having a preamp in the receiving system is that it can improve the system's overall noise figure. The preamp noise figure sets the floor for the system's noise figure. To help, the preamp noise figure has to be lower than the TV tuner's noise figure. Although methods for testing receiver noise performance are presently the subject of engineering controversy, the FCC advises that typical noise figures for VHF tuners are 7 dB and for UHF tuners are 12 dB. Video-recorder tuner noise figures are a little higher because there is a signal-splitter ahead of the tuner. The gain in dB of a preamp should equal the sum of the tuner-noise figure plus losses suffered in transmission line, baluns, and splitter used. To overcome the degradation in signal quality caused by the transmission line, splitter, and baluns, the preamp should be mounted at the antenna, rather than at the receiver.

No one preamp tested showed all the characteristics that one might desire, but Georgia Tech concluded that the Winegard *model AC4490* was probably the best amplifier tested. Although thre isn't a one-to-one correlation between price and performance among preamps tested, it does appear that you generally get something more for more money. For example, the most expensive preamp tested, the Q-Bit *model Q-B0542*, showed the most gain, but it has little headroom and undistinguished distortion figures, making it useful only in fringe areas or where high-loss accessories or a poor tuner are used. The second most expensive unit tested, the Jerrold *model DSU-105*, had high gain and was above average in all other measurements. Carefully consider the measurements and your particular situation when you decide which preamp to buy.

Transmission lines

Among the seventeen types of transmission lines from five manufacturers tested were twin-lead, shielded twin-lead, and coaxial cables. Two factors are important: insertion loss and VSWR. Although space considerations

TABLE 1

Summary of UHF Performance Characteristics of UHF-Only Outdoor Antennas

Maker/Model	Type	Price ($)	Gain (in dB) Avg.	Max.	Min.	Avg. Beam Width (°)	Avg. F/B Ratio (dB)	Main/Side Ratio Avg. (in dB)	VSWR Max.	Min.	Re-marks
1. **Channel Master** 4228A	8-bay Bowtie w/screen	32.18	13.0	15.0	9.5	21.1	17.9	10.1	3.4	1.3	
2. **GC Electronics** 32-8978	4-bay Bowtie w/screen	10.55	9.1	16.0	1.0	54.8	15.4	15.4	3.0	1.1	a.
3. **Finco** 4BT	4-bay Bowtie w/screen	10.80	10.6	16.0	5.0	49.1	13.1	13.1	3.5	1.1	a.
4. **Winegard** KU420	4-bay Bowtie w/screen	9.44	11.8	13.1	9.0	49.3	14.5	14.5	2.0	1.0	a.
5. **Channel Master** 4193	1-bay Bowtie w/corner	9.65	8.0	12.0	4.0	59.9	12.6	12.6	3.0	1.1	
6. **Finco** CRB	1-bay Bowtie w/corner	8.35	7.3	12.0	4.0	55.2	12.7	12.7	2.6	1.1	
7. **RCA** 2BG17	Yagi w/corner reflector	19.95	7.6	14.0	1.3	47.0	11.6	10.5	3.0	1.1	
8. **Jerrold** CYD-1470	Yagi w/corner reflector	15.75	7.2	10.0	2.0	39.5	9.8	9.8	4.6	1.1	
9. **Radio Shack** U-75	Yagi w/corner reflector	12.94	7.7	12.0	2.0	44.9	9.9	9.9	2.0	1.1	
10. **Radio Shack** U-100	Yagi w/corner reflector	19.95	7.8	13.5	−6.8	37.8	11.0	9.5	3.0	1.1	
11. **Winegard** CH-9075	Yagi w/corner reflector	23.90	7.3	13.5	−3.0	38.5	8.1	7.3	3.2	1.1	
12. **Winegard** CH-9075	Yagi w/corner reflector	23.90	5.8	9.6	−7.8	40.3	12.7	12.7	2.5	1.4	b.
13. **Winegard** CH-9075	Yagi w/corner reflector	23.90	5.9	9.0	−4.1	39.2	10.2	10.1	2.3	1.2	c.
14. **Winegard** CH-9095	Yagi w/corner reflector	37.59	8.0	11.5	0.5	36.9	9.4	9.4	3.0	1.1	
15. **Winegard** CH-9095	Yagi w/corner reflector	37.59	7.1	14.6	−7.7	37.1	12.0	11.4	2.9	1.4	d.
16. **Winegard** CH-9095	Yagi w/corner reflector	37.59	6.9	13.7	−11.7	36.2	14.1	14.1	2.3	1.5	e.
17. **Kay Townes** AAU14G	Yagi	18.45	−3.0	10.5	−15.7	49.4	3.8	3.8	10.0	2.0	
18. **Antennacraft** Y-44	Log-Periodic	18.25	7.9	12.0	1.0	39.0	13.0	9.5	6.5	1.0	
19. **Blonder-Tongue** 0511	Log-Periodic	21.66	5.1	7.4	2.4	55.9	14.2	14.2	3.5	<1.7	
20. **Blonder-Tongue** 0512	Log-Periodic	39.99	6.3	11.6	1.7	43.8	13.0	12.0	4.5	1.6	f.
21. **Finco** P-5	5′ Parabolic w/Yagi Feed	54.80	10.1	13.9	−1.1	21.6	10.3	9.9	5.2	1.4	
22. **Channel Master** 4250	6′ Parabolic w/2-bay Bowtie Feed	68.42	15.0	17.9	11.7	16.1	11.0	11.0	3.2	1.4	

Remarks: a. Type concluded to be the best for most installations.
b. Same as antenna #11 with internal balun.
c. Same as antenna #12 pruned for better gain on higher channels.
d. Same as antenna #14 with internal balun.
e. Same as antenna #15 pruned for better gain on higher channels.
f. Same as antenna #19 with director elements.

keep us from presenting complete tables of insertion loss and VSWR measurements for each sample tested, some important points should be considered.

Although twin-lead has the lowest insertion loss, in most practical installations it is not the best choice. Twin-lead is highly susceptibile to performance degradation when it gets wet or when it is placed close to metal objects (such as an antenna mast). That weakness will often result in a significantly greater loss and a poorer impedance match (higher VSWR, which means greater loss and ghosts in the picture) than shown by coax under identical conditions. Shielded twin-lead is virtually immune to performance degradation due to moisture or proximity to metal, but it has a higher insertion loss. Shielded twin-lead also has high VSWR, compared to coaxial cables.

Not tested by the engineers at Georgia Tech, but important in urban areas, is susceptibility to noise pickup. While coax is relatively immune to spark-noise pickup, twin-lead picks up noise from auto ignitions and electric motors fairly readily.

All things considered, the additional cost of good coax in a UHF system (especially considering the cost of the receiver) is truly trivial and coax should be your choice for transmission line.

Splitters

The term "splitter" is used here to refer to a device that is used to separate VHF/UHF signals on one transmission line and feed only VHF signals to the receiver's VHF input and only UHF signals to its UHF input. Fourteen splitters were tested, all of which were packaged with UHF-VHF combination antennas. Because of the study's ultimate recommendation, we don't see much point in presenting complete figures on the splitter tests, but will offer some observations.

A splitter will cost you something in

TABLE 2

Summary of UHF Performance Characteristics of UHF/VHF Combination Outdoor Antennas

Maker/Model	Type	Price ($)	Gain (in dB) Avg.	Max.	Min.	Avg. Beam Width (°)	Avg. F/B Ratio (dB)	Main/Side Ratio Avg. (in dB)	VSWR Max.	Min.	Remarks
1. **Channel Master** 4749	VHF LP*/UHF Yagi w/corner	25.95	0.7	6.0	−5.0	37.4	10.2	9.4	4.1	1.4	
2. **Jerrold** VU-933S	VHF LP/VHF Yagi w/corner	41.37	9.0	10.9	−16.2	44.3	15.3	14.4	3.0	1.2	a.
3. **Jerrold** VU-933S	VHF LP/UHF Yagi w/corner	41.37	8.8	10.1	6.3	48.8	15.1	13.7	2.9	<1.2	b.
4. **Jerrold** VU-933S	VHF LP/UHF Yagi w/corner	47.16	7.0	14.0	−14.5	39.1	14.4	13.4	3.2	1.0	c.
5. **Jerrold** VU-937S	VHF LP/UHF Yagi w/corner	107.70	10.7	13.0	−6.3	30.7	13.5	9.1	3.0	1.4	
6. **Jerrold** VU-937S	VHF LP/UHF Yagi w/corner	107.70	9.6	12.6	3.8	33.8	12.3	8.5	4.1	1.4	d.
7. **Jerrold** VU-937S	VHF LP/UHF Yagi w/corner	113.49	10.1	13.5	3.0	29.1	12.5	10.1	3.0	1.0	e.
8. **Olson** AA-965	VHF LP/UHF Yagi w/corner	39.95	9.5	15.0	1.5	61.3	7.2	6.2	5.0	<1.9	
9. **Radio Shack** VU-110	VHF LP "V"/ UHF Yagi w/corner	34.97	6.1	10.5	0.0	31.3	7.1	5.8	5.0	<1.7	
10. **Radio Shack** VU-90	VHF LP "V"/ UHF Yagi w/corner	27.97	6.2	10.0	−0.9	36.5	7.2	4.6	5.3	1.5	
11. **Radio Shack** VU-160	VHF LP "V"/ UHF Yagi w/corner	54.97	7.2	12.0	2.5	34.9	8.5	5.0	2.4	1.6	
12. **Sears** 7931	VHF LP "V"/ UHF Yagi w/corner	34.95	4.3	8.0	−1.0	52.7	12.0	11.5	5.3	2.0	
13. **Winegard** CH-7080	VHF LP/UHF Yagi	34.34	6.7	10.0	4.0	44.2	14.1	12.9	3.1	1.0	
14. **Winegard** CH-7080	VHF LP/UHF Yagi	34.34	5.7	11.5	−9.5	40.7	16.5	15.4	2.7	1.5	f.
15. **Winegard** CH-7080	VHF LP/UHF Yagi	34.34	6.0	9.2	−1.7	44.5	15.2	14.0	2.6	1.2	g.
16. **Antennacraft** KTK-27	VHF LP/UHF LP	20.48	4.7	10.0	−1.0	50.9	13.5	13.0	3.5	<1.4	
17. **Lafayette** 18F01836W	VHF LP "V"/ UHF LP	21.95	1.6	4.5	−6.0	39.5	6.3	5.8	4.1	1.8	
18. **Blonder-Tongue** 0713	VHF LP "V"/ UHF LP	65.98	5.6	8.2	2.0	49.4	17.7	15.0	2.8	1.7	
19. **Blonder-Tongue** 0714	VHF LP "V"/ UHF LP	80.62	5.6	11.4	−5.0	40.4	14.6	11.8	4.3	1.9	h.

*LP: Log Periodic

Remarks:
- a. Believed to be the best VHF/UHF combination antenna tested.
- b. Same as antenna #2 pruned for better gain on higher channels.
- c. Same as antenna #2 with director elements added for UHF.
- d. Same as antenna #5 pruned for better gain on higher channels.
- e. Same as antenna #5 with director elements added for UHF.
- f. Same as antenna #13 with internal balun.
- g. Same as antenna #13 with internal balun and pruned for better gain on higher channels.
- h. Same as antenna #18 with director elements added for UHF.

insertion loss (from 0.1 dB to 5 dB in Georgia Tech's tests). A splitter will also introduce some impedance mismatch, with VSWR's ranging from 1.6:1 to 6.4:1. That mismatch can cause up to a 3.25-dB loss and cause ghosts in the picture.

Georgia Tech found no clear correlation between the cost and performance of the splitters tested. The most expensive (Winegard *model MSJ-5* at $8.95) had the lowest VSWR, but the highest average insertion loss. A medium priced unit (Radio Shack *model 6005* at $3.99) had the lowest average loss. Several samples of some of those units were tested, with variations between samples ranging from 0.3 dB and 1.5 dB.

Georgia Tech concluded that installing two transmission lines (one for VHF and one for UHF) to eliminate use of a splitter is a reasonable alternative. An additional 50 feet of RG-6/U cable will probably cost only a dollar or two more than a splitter, but will give better results. Two cables can usually be brought down from the antenna together, and installing them should not be much harder than installing a splitter.

Baluns

A balun (*BAL*anced-to-*UN*balanced) transformer is used for impedance matching between 300-ohm balanced line and 75-ohm unbalanced line. When using coax, you connect a balun between the antenna and the coax and, unless your receiver has a 75-ohm "F" connector on the back, you use another balun at the receiver to convert the 75-ohm impedance back to 300-ohms, balanced, for connection to the receiver screw terminals. In my experience, the balun used has a profound effect on the quality of UHF reception; an effect that is disproportionate to its slight cost and lack of complexity.

Georgia Tech tested several samples of four balun models. They found that there was little correlation between price and performance. Although the

TABLE 3

Summary of UHF Performance Characteristics of Indoor Antennas

Maker/Model	Type	Price ($)	Gain (in dB) Avg.	Max.	Min.	Avg. Beam Width (°)	Avg. F/B Ratio (dB)	Main/Side Ratio Avg. (in dB)	VSWR Max.	Min.	Remarks
1. **Radio Shack** 15-233	UHF Loop	0.99	0.1	3.0	−3.0	85.5	1.2	1.2	5.0	1.0	b.
2. **Radio Shack** 15-623	UHF 2-bay Bowtie w/screen	6.95	4.0	7.7	−4.0	51.1	9.9	9.9	5.3	<1.4	a.
3. **Radio Shack** 15-1810	VHF Rabbit Ears/UHF Concentric Loops	11.95	−2.2	3.0	−6.0	67.6	0.4	0.4	>10.0	1.2	
4. **Rembrant**	VHF Rabbit Ears/UHF Concentric Loops	22.45	−6.2	1.5	−12.5	75.1	3.4	3.3	3.0	1.1	
5. **Rembrant**	VHF Rabbit Ears/UHF Quadrature Loops	11.20	−2.3	4.0	−9.0	78.4	3.4	3.0	3.9	1.2	

Remarks: a. Considered by the Georgia Tech engineers to be the best indoor antenna tested, said to be "significantly superior to other indoor antennas evaluated."
b. Said by the study to "offer rather poor performance."

TABLE 4

Summary of UHF Performance Charactertistics of Preamplifiers

Maker/Model	Type	Impedance (Ω) Input/Output	Price ($)	Gain (in dB) Avg.	Max.	Min.	Noise Figure (Average)	1-dB Compression Point (Average)	VSWR Max.	Min.	Remarks
1. **Q-Bit** Q-B0542	UHF	75/75	182.00	33.9	35.0	31.7	4.6	−25.3	2.0	<1.1	a.
2. **Jerrold** DSU-105	UHF	75/75	125.10	27.3	30.8	24.0	9.4	−18.9	6.6	3.0	b.
3. **Finco** G-955-V	UHF	300/75	40.75	3.6	14.5	−15.9	10.2	−7.5	6.4	<1.9	c.
4. **Blonder-Tongue** 5018	UHF	300/300	42.44	13.7	16.0	10.6	4.8	−7.5	5.8	2.1	d.
5. **RCA** 10G203B	UHF	300/300	22.55	10.1	13.7	3.2	7.0	−9.3	5.8	<1.7	
6. **JFD** SP2382	VHF/UHF	300/300	35.74	10.7	17.6	1.0	10.9	−6.1	5.4	<1.2	e.
7. **Jerrold** 5283	VHF/UHF	300/300	93.23	14.7	19.3	9.5	6.5	−9.0	5.9	<1.7	f.
8. **Radio Shack** 15-1134	VHF/UHF	300/75	39.95	13.6	16.3	4.9	5.1	−17.4	4.5	<1.6	g.
9. **Radio Shack** 15-1134	VHF/UHF	300/300	39.95	14.2	18.1	7.5	5.2	−16.6	4.3	<1.6	g.
10. **Channel Master** 0064B	VHF/UHF	300/75	42.75	20.8	27.6	15.8	7.0	−12.0	5.0	1.4	
11. **Winegard** AC4990	UHF	300/75	52.76	16.4	20.0	11.1	4.6	−3.3	4.5	2.0	h.
12. **Colormax** CP35E	UHF	300/300	19.90	13.5	20.0	5.6	7.7	−7.0	6.3	1.5	
13. **Blonder-Tongue** Prototype	UHF	75/75	N/A	12.5	14.1	10.3	4.3	+2.9	3.2	1.2	

Remarks: a. The study concludes that the "usefulness of preamp #1 is limited to extreme fringe areas" or "situations where lossy components and/or an exceptionally poor tuner (high noise figure) are being used."
b. The study takes note of preamp #2's high noise figure and VSWR, in view of its price.
c. Preamp #3 is described by the study as, "may in fact be detrimental at frequencies above channel 54."
d. When used with other good components, preamp #4 "would represent a substantial improvement in system performance for a reasonable purchase price."
e. Preamp #6 is said by the study to be "of little benefit to system performance due to its extremely poor noise figure performance."
f. When used for *VHF* reception, the Georgia Tech engineers said that preamp #7 "could significantly improve the system noise figure."
g. Preamp #8 (same as preamp #9) "was considered to be one of the better preamplifiers (cost considered) that was tested on this program."
h. Preamp #11 is designed only to plug into Winegard outdoor antennas to form "active antennas." In the opinion of the enginers, preamp #11 "was probably the best preamplifier tested."

UHF DX'ing

The author lives in a high-rise apartment building that has a master antenna system and prohibits additional outside antennas. The Spanish International Network (SIN) recently established a "satellator" (*SATEL*lite trans*LATOR*) station on Channel 56 in Washington, DC. It carries, directly from the Westar satellite, the SIN programming of KMEX, Los Angeles, and KWEX, San Antonio. In contrast to full-power UHF stations that usually operate with an effective radiated power of from one to three million watts (they may use up to five megawatts under FCC rules), Channel 56 radiates only 1000 watts. Such low power is used because the station is intended to cover only a small neighborhood where the District's Spanish-speaking people are concentrated. The problem of trying to receive a one-kilowatt signal at a distance of over three miles is complicated by the fact that my apartment windows face away from the transmitter and I have to pick the signal off an adjacent building by reflection.

I tried a four-bay bowtie antenna, but it was unsatisfactory because of reflections from a number of tall buildings that lie in the antenna sidelobes. Not wanting to take up the whole room with a six-foot dish, I built a corner reflector, cut for Channel 56, from angle aluminum. Masonite, aluminum foil, brass rod, and a broomstick. I added a preamp and used a length of RG-59/U. When the Georgia Tech report came out, I immediately replaced the cable with RG-6/U. The RG-59/U must have come from an "off" batch. My eyes aren't calibrated in dB, but the improvement was greater than expected from predictions of the study.

The Georgia Tech study confirms my experience with baluns; there was a remarkable difference among baluns I tried, even among examples of the same model. One of the cheapest (I'd bought three of them at 99¢ each) was best for Channel 56.

Using the system described, during a period of good propagation, I have been able to log reception of 19 stations, including stations from Philadelphia, PA and Burlington, NJ. Total investment, including discarded components (RG-59/U and baluns) was under $70, modest for the benefit. **R-E**

UHF RECEPTION EQUIPMENT

For more information, circle the corresponding number on the Free Information card inside the back cover.

All Channel Products
(Rembrandt)
42-40 Bell Plaza
Bayside, NY 11361
CIRCLE NO. 79

Antennacraft
Highway 34 West
West Burlington, IA 52655
CIRCLE NO. 80

Blonder-Tongue Laboratories, Inc.
One Jake Brown Rd.
Old Bridge, NJ 08857
CIRCLE NO. 81

Channel Master
Ellenville, NY 12428
CIRCLE NO. 82

Colormax Electronic Corp.
180 Northfield Ave.
Edison, NJ 08817
CIRCLE NO. 83

The Finney Company
(Finco)
34 W. Interstate St.
Bedford, OH 44146
CIRCLE NO. 84

GC Electronics
400 S. Wyman St.
Rockford, IL 61101
CIRCLE NO. 85

Olson Electronics
Box 100
Mogadore, OH 44260
CIRCLE NO. 89

Q-BIT
311 Pacific Ave.
Palm Beach, FL 32905
CIRCLE NO. 90

Kay-Townes, Inc.
607 Turner Chapel Rd.
PO Box 593
Rome, GA 30161
CIRCLE NO. 86

Lafayette Radio Electronics
111 Jericho Turnpike
Syosset, NY 11791
CIRCLE NO. 87

Murata Corporation of America
(JFD)
1148G Franklin Rd. SE
Marietta, GA 30067
CIRCLE NO. 88

Radio Shack
1400 One Tandy Center
Ft. Worth, TX 76102
CIRCLE NO. 91

RCA Distributor and Special Products Div.
2000 Clements Bridge Rd.
Deptford, NJ 08096
CIRCLE NO. 92

Sears, Roebuck and Company
Sears Tower
Chicago, IL 60684
CIRCLE NO. 93

Taco Division-General Instrument Corporation
(Jerrold)
1 Taco St.
Sherburne, NY 13460
CIRCLE NO. 94

Winegard Company
3000 Kirkwood St.
Burlington, IA 52601
CIRCLE NO. 95

most expensive (Sony *model EAC-13W* at $4.90) showed the lowest average insertion loss, the second most expensive (Channel Master *model 7200* at $4.45) had the highest insertion loss and worst VSWR. A $2.89 unit (Channel Master *model 0035B*) had the best VSWR characteristics. My experience with respect to price and performance of baluns agrees with the Georgia Tech findings (see Sidebar). Insertion loss variation among samples of the same model ranged from 0.2 to 0.9 dB.

Connectors

Georgia Tech engineers observed that type of connectors used, and the nature of the connection itself, can have a significant effect on performance. In fact, their effect on picture quality sometimes seems to be magic. What appears to be a perfectly good connection may give a miserable picture, while a shaky connection that you wish you could trust to stay together gives a superb image on the screen.

Georgia Tech engineers noted that twin-lead plugs and sockets, spade lugs, and terminal strips all displayed such high VSWR levels that they could not be used in the test program. They speculate that similar effects may be observed in home installations. To avoid the problem of twin-lead connectors, the engineers finally resorted to soldering twin-lead to balun leads. That seems like a good practice for the home, if a bit inconvenient.

The engineers concluded that F-type connectors "accomplish good coaxial connections if the connectors are properly installed, and no problems should be encountered when frequent disconnections and connections are not required."

Conclusion

In a recent Louis Harris and Associates, Inc., survey, 27% of the households in communities where UHF reception should be possible reported receiving no UHF channels on their TV sets. Nearly six out of ten households interviewed felt that, in general, picture quality was better on VHF channels than on UHF channels. One in three households that received a UHF channel observed snow on the strongest UHF channel that they receive.

There is no need for you to be one of those who report such poor UHF reception. It's easy to improve your UHF reception to get better pictures on the channels you receive now, and to get stations you couldn't get at all before. Up to now, the biggest block to good UHF reception has been lack of information. This report should give you all the information that is necessary to receive UHF channels as well as you receive the VHF ones. **R-E**

Part 2 BEFORE WE CONTINUE with the construction of the modem, we'll make certain that everything is working properly so far. Have Part 1 handy as we proceed.

Checkout

As always, it is good practice to perform what tests you can before you install the IC's. Specifically you should check supply-pin voltages and grounds. Pin 4 of sockets 1, 2, and 3 should carry +12-volts; pin 11, −12-volts. Pins 5 and 3 on IC3; pins 5, 10, and 12 on IC1 and IC2; and pins 13 and 8 on IC4 should all be at ground potential. Finally, pin 16 of the socket for IC4 should read +5-volts.

If the voltages are correct, it is safe to install the LM348's (IC1-IC3) so that voltages at socket 4 may be checked.

Test each pin of socket 4, checking this time for any voltage that exceeds the 0- +5-volt range by more than one volt. If pin-1 or pin-5 voltages are negative, one of the Zeners is reversed. If the pin-11 voltage is far out of range, D3 or D4 is reversed. Do not install IC4 until all voltages at socket 4 are within range!

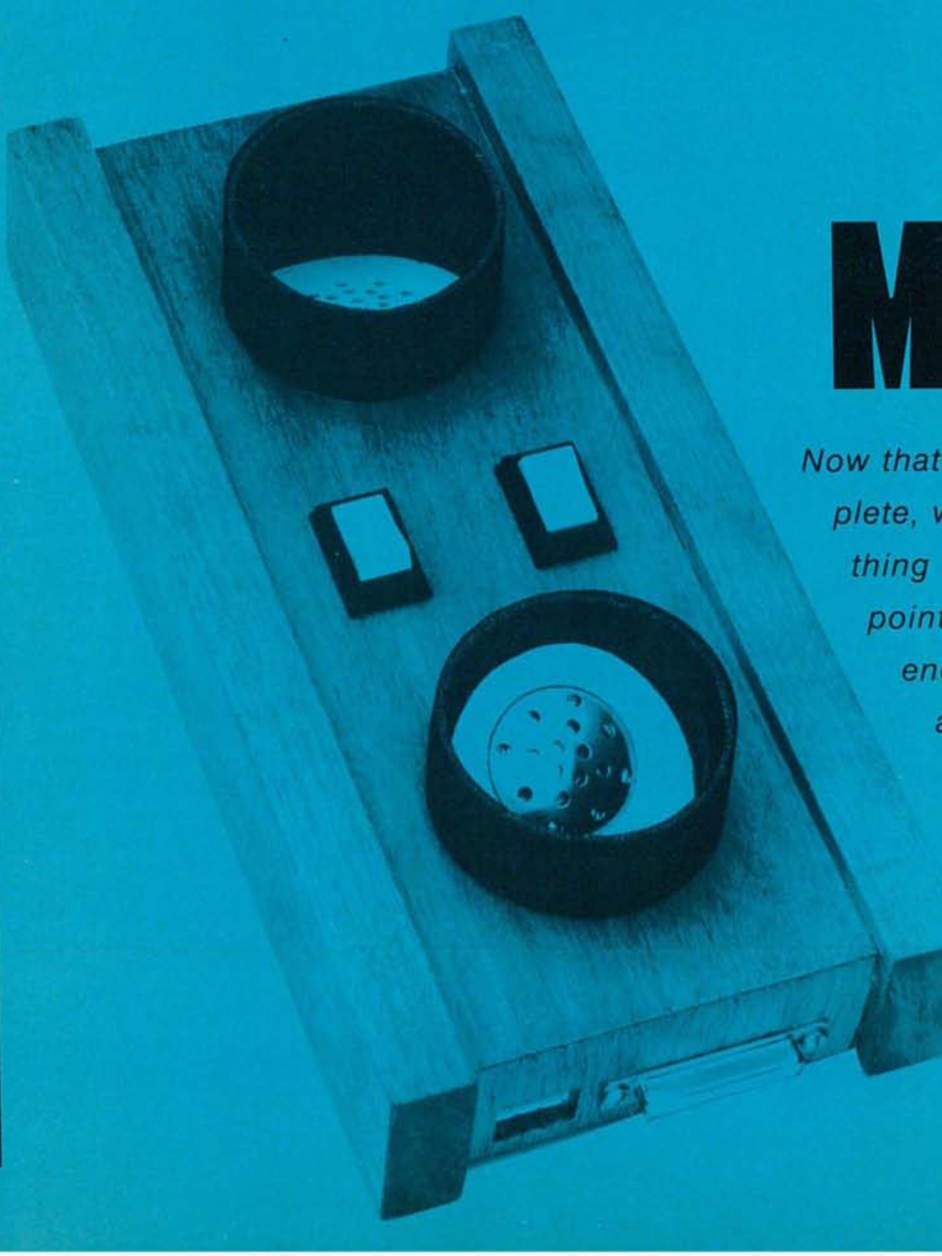
Other likely errors that are detectable at this point are incorrectly connected power supplies, incorrectly run jumpers, and misaligned sockets.

If the socket-4 voltages are acceptable, remove power, install IC4, and supply power again. You should hear a tone from the speaker. Changing S1's position should change the tone.

Now apply a logic-level voltage (high or low) to the TX DATA input. When you change that level you should also hear a change in the tone frequency in both switch positions. If you have jumpered the board for RS-232 operation, your logic levels at that point will be ±12-volts. Otherwise your logic-levels will be +5 volts and ground. You should be able to generate four different tones in all. That indicates that the TX DATA buffer, the modulator section of the MC14412, and the output buffer are working correctly.

To verify the operation of the demodulator section, connect a VOM or logic probe to pin-1 of IC3. The logic state of that pin should change as the speaker is moved closer to the microphone. When the speaker is far from the microphone, the logic level should be high. It should go low as the speaker is moved nearer to the microphone. That verifies that the input buffer, filters, and level detector are working.

Finally place the speaker near enough to the microphone so that its tone just causes the pin-1 logic to change state. Now monitor the state of the RX DATA line while you apply different logic-level signals to the TX DATA line. The RX DATA line should follow the TX DATA line in both switch positions. That verifies that the RX DATA buffer, limiter,



$60 MODEM

Now that the modem is nearly complete, we'll make sure that everything that's been done to this point is correct, show you an enclosure that's also the acoustic coupler, and begin to look at the software that makes the modem work.

ROBERT WARD

and MC14412 demodulator section are functioning.

The above test procedure is possible because the MC14412 has been connected to demodulate its own transmissions. If it is functioning correctly, set it up to demodulate external signals by adding a jumper at the TEST position on the board. In addition the wiring to switch S1-b must be reversed so that it switches as shown in the schematic.

Troubleshooting

If some test has indicated a problem, check your work carefully. Several likely sources of error have already been mentioned. If you can't spot an obvious cause, replace the microphone. Our experience has been that a faulty microphone is responsible for about 90% of the problems encountered. Do not tinker with the filters. Many of these modems have been built and to my knowledge the filters have not once been a source of trouble.

Many problems involve a failure in the demodulator section. Check to see if a strong signal is reaching the level detector, and whether or not the MC14412 is generating an output.

If you have a 20-volt peak-to-peak signal at the input of the level detector, then pin 5 of the MC14412 should be at ground potential. If it is, the MC14412 RX DATA output-level (pin 7) should be the same as the modulator's TX DATA input-level. (That assumes a close acoustic link from the speaker to the microphones.) Trouble here indicates a problem in the limiter, the switch, the test settings, or the MC14412. If you suspect the limiter, try replacing D1 and swapping IC3. Before you declare the MC14412 to be at fault, you should check the signals at each pin of the IC. Compare what you find with what you would expect, based on the schematic.

It's more likely that the signal is present at the input of the level detector, but that the level detector never switches. Check it and if necessary replace D2, D5, C2, and the LM348 (IC3) (try swapping it with another).

If there isn't a strong enough signal at the input of the level detector at either switch-setting, double check the microphone, the switch, and the input buffer. Again try to clear up the problem by swapping LM348's.

For any thorough debugging, you will need an oscilloscope. Use it to verify the waveforms shown in Fig. 1.

The enclosure and acoustic coupler

In this construction project, since the enclosure also forms the acoustic coupler, it is an integral part of the modem. Unfortunately most low-cost kits usually address this area with a simple "add a crystal microphone and an 8-ohm speaker." If you've ever tried to buy them, you should know that "muffs" (what you put the phone handset into) are not exactly a drug-store item.

Our solution is to make the muffs out of short lengths of 2¼-inch radiator hose and a tennis ball. Needless to say, those materials are inexpensive and readily available. It may sound crude, but with a little care the results are acceptable.

Using the template provided in Fig. 11, cut two ovals out of Masonite or other thin, rigid material to act as mounting baffles for the speaker and microphone. One of those is drilled to give a grill pattern, and the speaker is glued to its back. A hole is drilled in the other, large enough to mate with the microphone flange. Contact cement is a good adhesive to use.

Cut two 2-inch lengths of radiator hose. Use a hobby tool with a sanding drum to bevel the inside edge of one end of each until you are satisfied with the way the handset from your phone fits them.

Make the base from soft wood. A brace and bit or hole-saw may be used to drill the holes. Both tools will create problems if used on a close-grained hardwood. If your joints mate accurately enough, the enclosure can be glued together and finished like a piece of cabinetwork. As you will see from the procedure below, a hollow-ground planer blade and a table saw (perhaps a friend has one) will prove very handy.

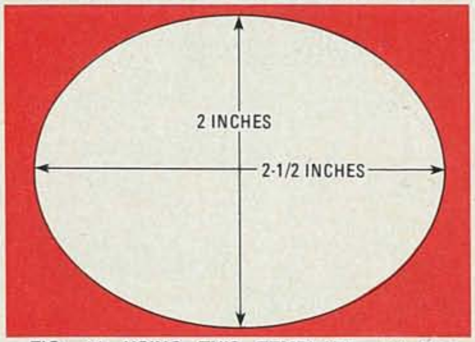


FIG. 11—USING THIS TEMPLATE, cut two Masonite ovals to act as mounting plates for the microphone and speaker.

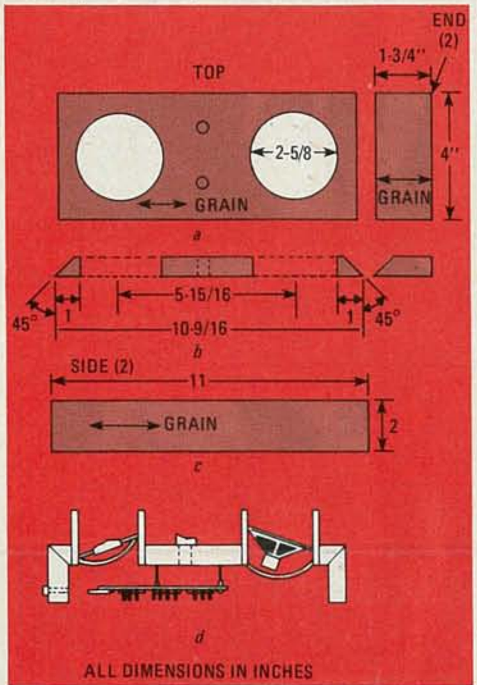


FIG. 12—ALL LUMBER NEEDED FOR THE ENCLOSURE can be cut from a single two-foot length of one-by-five-inch stock.

Begin by cutting all five pieces as shown in Fig. 12. A two-foot length of one-by-five-inch stock will provide enough material for everything. Cut the three pieces with mitered ends slightly wider than the four-inches indicated. Glue these three pieces first. I have found that miter joints may be clamped during gluing with wide masking tape or furnace tape. First, create a hinge at the joint by taping around the outside surface. The joint may now be opened and glue applied, and then taped or tied closed while it dries. Before committing yourself, try the hinge to be certain that the surfaces mate well when the joint is closed. By gluing the three pieces as a unit and leaving a little extra material, you have the option of resawing the edges (again with a planer blade) to insure that they will mate accurately with the side pieces. The side panels may be held in place with any type of weight or clamp while they are being glued.

You will want to make provision for whatever type of switches and connectors you intend to use. Most of them are not designed to be mounted in a panel ¾-inch thick. Thus you may need to back-rout (or merely drill from the back with your brace and bit) until the wood is thin enough to allow the mounting of your components. Alternatively, you can drill large holes and glue mounting plates on the surface.

Insert the muffs—the radiator hose—into the enclosure as shown in Fig. 12 and fasten them with carpet tacks, staples, or more contact cement. Leave about one inch (the end with the bevel) showing above the top surface of your enclosure.

Now cut three or four layers of cardboard into rings about two inches in diameter. Insert a telephone handset into the muffs and, working from the bottom, insert the cardboard spacers. Press in the masonite baffles and the pickup elements until the face of each baffle rides on the spacers. Mount the baffles by gluing around the back edge of the baffle with silicone sealant. Cut a tennis ball so that it will fit into the muff behind the speaker, drill a small hole in it to pass the speaker cable, and glue it in place. Remember to keep the speaker lead accessible from the rear so that it can be resoldered to the board.

Finally, drill mounting holes in each corner of the circuit board. Do this carefully; avoid both components and foil traces! Using plastic washers or other non-conductive standoffs, screw the board to the wood between the muffs. It should just fit. If not, it may be possible to turn it so that it overlaps the bottom of the muff containing the microphone (you may have to trim the bottom of the hose before you can do this.)

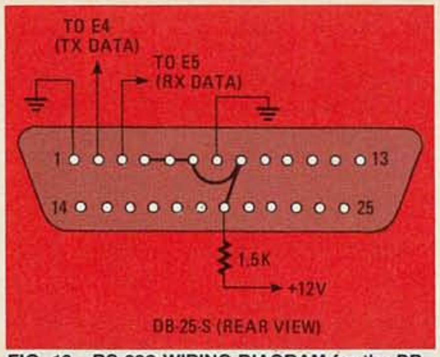


FIG. 13—RS-232 WIRING DIAGRAM for the DB-25-S connector. Tying pins 4, 5, 6, 8, and 20 together as shown eliminates the need for handshaking signals.

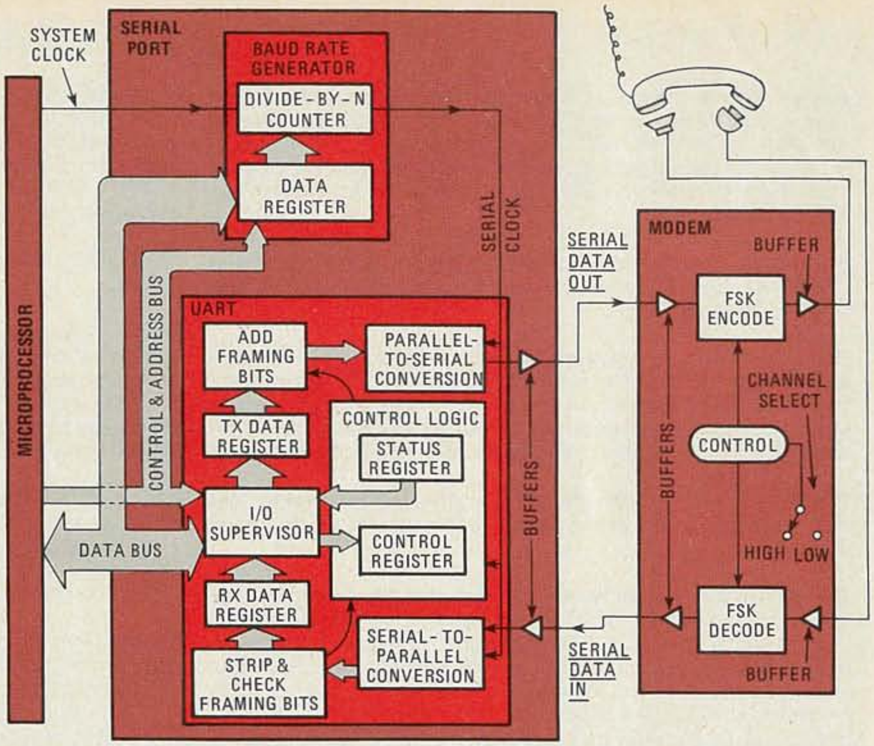


FIG. 15—BLOCK DIAGRAM of a complete serial-communications system. Some control functions have been deleted from the baud-rate generator for simplicity.

Wire the DB-25-S connector as shown in Fig. 13 for standard RS-232 communications. Tying pins 4, 5, 6, 8, and 20 to 12-volts through a 1.5K resistor eliminates the need for "handshaking" signals that are not really necessary in this application. Wire switch S2 and the power connections and you are finished.

Serial Communications

When parts of a computer "talk to" each other, as do the memory and microprocessor, it is usually over only a few inches of transmission line (in this case printed-circuit traces). Because of that, it is practical to enhance the processor's speed by making those communications a parallel process.

Several bits of data are transmitted simultaneously—in parallel—over separate transmission lines. That technique is not practical when two machines wish to talk to each other over long distances, because each bit of the simultaneous transmission would require a separate transmission line. If we were transmitting eight bits (a *byte*), we would require at least eight transmission lines. That is certainly not a practical approach for the hobbyist in San Francisco who wishes to send data to his friend in Philadelphia.

The solution is to send the same eight bits over *one* transmission line, sequentially. To make certain that the parties at both ends of the line can identify the beginning and end of a byte, certain extra *framing* bits (called "stop" and "start") are added. To detect transmission errors a *parity* bit is usually added (see Fig. 14).

The parity bit is used to make the total number of 1's transmitted for each byte either odd or even, depending on whether odd or even parity is used. If, when using even parity, a byte appears whose total number of transmitted 1's is odd, we know that an error has occurred.

Figure 14 shows the use of DC logic-levels—a "low" level for a space and a "high" level for a mark. In other words, serial communication can be—and often is—accomplished over a "hard" transmission line without a modem. Only when the data is to be transmitted over a link where DC signals may not be transmitted—the phone line for instance—is a modem necessary.

A block diagram of one end of a serial-communications link is shown in Fig. 15. There are three main components: a microprocessor, a serial-communications port, and a modem. The microprocessor controls the flow of data to and from the serial port.

The baud-rate generator—which may have functions besides those required by the serial port—provides a clock signal that controls the serial-to-parallel-conversion. The higher the output frequency of the baud-rate generator, the faster sequential bits will leave the serial port or be assumed to enter the port.

Most of the rest of the functions are provided by an IC referred to variously as a UART, USART, or ACIA. (*U*niversal *A*synchronous *R*eceiver/*T*ransmitter; *U*niversal *S*ynchronous/*A*synchronous *R*eceiver/*T*ransmitter; *A*synchronous *C*ommunications *I*nterface *A*daptor). That IC actually performs the serial–parallel conversion and formats or decodes the transmission according to conditions specified in a "control word" written by the processor during initialization.

The rest of the serial port consists of buffering that converts the internal logic levels (normally CMOS or TTL) to logic levels suitable for transmission by a hard-wired link to other machines (the ±12-volt levels specified in the RS-232 convention, for example).

The last stage of the communications link is the modem. Our modem complies with the Bell 103 standard for FSK (*F*requency *S*hift *K*eying) audio data-transmission which specifies two channels and conventions for transmitting binary data on each channel.

The standard is full-duplex; it allows simultaneous transmission in both directions over the same transmission line. (Half-duplex permits data to flow in only one direction at a time.) That is accomplished by assigning outgoing transmissions to one channel and incoming transmission to the other. The lower-frequency channel is usually reserved for transmissions from the station initiating the call and is referred to as the *originate* channel. The upper-frequency channel is the *answer* channel and is used for transmissions from the responding station.

Particular frequencies have been specified to represent the two binary states.

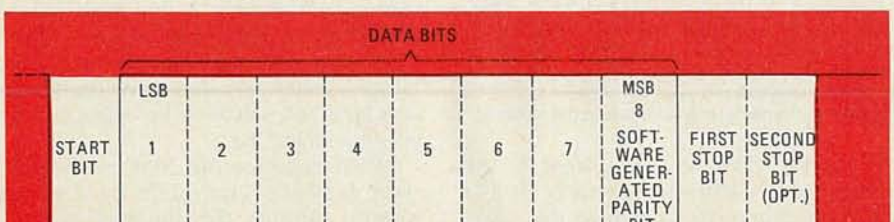


FIG. 14—DATA BITS are transmitted one-after-the-other in serial communications. Note that framing and parity bits are added.

GLOSSARY

Asynchronous—Serial communications formats that require new synchronizing information with each new character (start and stop bits) are referred to as asynchronous. Do not be misled. As in all other serial communication, the transmitter and receiver must become synchronized during the data transmission. See **synchronous.**

Baud rate—The rate at which data is transmitted, measured in bits-per-second. The most commonly used rates are: 100, 110, 150 and 300 baud.

Bell 103—Originally one model of modem manufactured by Western Electric (AT&T). The particular tones used in that modem have become a standard in the United States and are used in virtually all low-speed applications. European systems and high-speed modems use different tones and different conventions.

Break—A signal that one station in a serial link may use to "get the attention" of the other station. It consists of a continuous space.

Duplex—In a technical sense, a communications standard that allows simultaneous transmission of data in two directions over one transmission line is called full-duplex. Standards that allow only one station to transmit at any given time are half-duplex. Note that the Bell 103 standard is full-duplex. Even so, most commercial 103-type modems include a switch marked FULL/HALF DUPLEX. That switch has no bearing on the true duplex capability of the modem; instead, it selects the source of the character echo: FULL for remote echo, and HALF for local echo. See **echo.**

Echo—In virtually every system, what the user types on the keyboard is displayed to him on some type of device, usually either a printer or a CRT. That confirming display is called an echo. It may be created locally—by the terminal or modem—or it may be created by having the receiving station transmit back everything it receives. The former is a *local echo*, often inaccurately referred to as half-duplex mode; the latter is *remote echo*, or what is frequently called full-duplex operation. Remote echo has the advantage of giving an immediate and graphic verification that the data was received correctly.

Line-feed delay—A "NULL" or other non-printing character transmitted following a carriage return or line-feed (the former may be distinct in some systems and called a carriage-return delay). The purpose of those characters is to insure that a teletype has time to execute the earlier command characters before receiving any new printable characters.

Mark—The "standby" state in serial communications, a logic "one."

Parity—A quality of a binary number. Numbers having an even number of ones are said to have *even parity*, all other numbers have *odd parity*. A "parity bit" may be added to a binary number, for instance to a 7-bit ASCII character representation, and by selectively setting that added bit high or low, any desired parity may be generated.

Recognition character—A pre-arranged character used to initiate a serial-communications link. Many large time-sharing systems sense the calling station's baud rate from that character. Commonly used characters include "carriage return," "control-C" and "control-A."

RS-232C—A serial-communications standard in which 25 separate control, handshaking, data, and power connections are defined. Logic levels for data transmissions are nominally −12 volts for a logic one and +12 volts for a logic zero. Normally, only a few of the 25 lines are used. A 25-pin "D" connector is standard in this system.

Space—A logic "zero" in serial communications.

Stop bit—A mark (logic "one") that indicates the end of a character in asynchronous serial transmissions. The combination of that bit and the required start bit (a space) guarantees a change of state at least twice per character. Note that 110-baud transmissions frequently require two stop bits. At most other standard speeds, one stop bit will usually be acceptable.

Synchronous—Serial communications in which data is transmitted blocks (usually about 100 characters) with new synchronization information (framing characters) sent only once with each new block. See **asynchronous.**

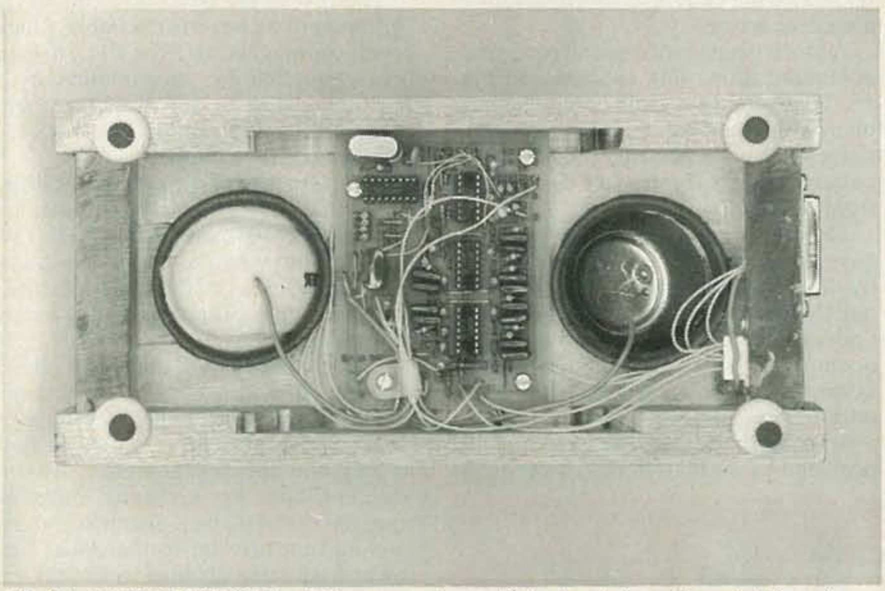


FIG. 16—EIGHT OF THE NINE two-letter commands used in the terminal emulator select the options.

TABLE 1

State	Channel	
	Originate	Answer
Ø (mark)	1070 Hz	2025 Hz
1 (space)	1270 Hz	2225 Hz

Table 1 summarizes the assignment of frequencies. The modem converts the incoming logic levels into the proper frequencies and vice-versa.

The modem is also equipped with buffers to translate an incoming transmission's signal levels to logic levels compatible with its own circuitry. It also includes filters that enhance the accuracy of the encoding and decoding sections and buffers that convert the output signals to levels compatible with the serial port.

Note that the only signal connections between the computer's serial port and the modem are SERIAL DATA IN and SERIAL DATA OUT.

When coupled with a suitable software package, the hardware can provide a wide range of capabilities, from a simple but useful terminal emulator (to be discussed next month) to a slave or master-slave station in a complex data network. The latter includes provisions for dumping large data blocks in both directions over the link and for passing control characters that allow the distant machine to control or be controlled by the local machine.

We'll continue our look at the software needed to control the modem next month. Among the things that we'll present is a terminal emulator to allow your comuter to communicate via the modem. R-E

Error-Correcting Hi-Fi Amplifier

Though older than negative feedback, feedforward is the latest in distortion reduction.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

AT THE 65TH CONVENTION of the audio Engineering Society, two engineers from the Sansui Company (1250 Valley Brook Ave., Lyndhurst, NJ 07071), presented a paper entitled "Design and Construction of a Feedforward Error-Correction Amplifier." Some time later, S. Takahashi and S. Tanaka, the two engineers involved, reduced that mathematically complex presentation to somewhat simpler form and, at the Consumer Electronic Show held in Chicago in June 1980, Sansui actually demonstrated a prototype of a "feedforward" amplifier.

In order to understand the concept of feedforward error-correction or distortion-elimination in an audio amplifier, it would be best to make a brief review of the principles behind the better-known negative-feedback techniques that were being used in audio amplifiers before the term "high fidelity" existed. Negative feedback is used in just about every hi-fi amplifier sold today to improve performance. Properly used, negative feedback can improve the signal-to-noise ratio of an amplifier; the damping factor of an amplifier (making it higher); the amplifier's input impedance, and (probably most important of all) it can reduce distortion.

Figure 1 shows how negative feedback, as applied to audio amplifiers, works. Input signal V_I is amplified by amplifier A. The amplifier also generates a certain amount of distortion, shown in Fig. 1 by the tall spike labelled (1). Negative feedback, applied through network B, returns some of that distorted signal, out-of-phase, back to the input of the amplifier where it is amplified again, partially cancelling the total distortion at the output. The out-of-phase fed-back distortion component is labelled (2) in Fig. 1, while the *net* distortion at the output is designated as (3).

In theory, distortion is reduced to a value determined by:

$$\frac{1}{1 + (A)(B)}$$

where "A" is the gain of the amplifier and "B" the feedback factor (expressed as a decimal fraction). What that means is that distortion would disappear completely *only* if the amount of feedback, $1 + (A)(B)$ were *inifinite*. For one thing, if infinite feedback were applied to an amplifier, it could no longer be called an amplifier because it would have no gain from input to output. Furthermore, for practical amplifier design, a stable application of even moderate amounts of negative feedback requires a phase-compensation circuit consisting of reactive elements such as capacitors. Those phase-compensating networks reduce the effective amount of feedback at higher frequencies. This means that at higher frequencies, distortion is reduced less by negative feedback. Typically, solid-state amplifiers using high levels of negative feedback tend to have higher levels of distortion at high frequencies than they do at low and mid-frequencies.

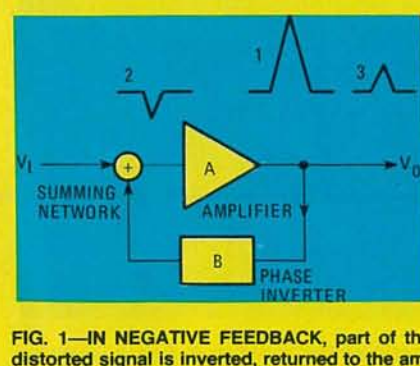


FIG. 1—IN NEGATIVE FEEDBACK, part of the distorted signal is inverted, returned to the amplifier input, and summed with V_I partly cancelling the total distortion.

It has also been shown in recent studies that, while high levels of negative feedback tend to reduce static forms of distortion—such as harmonic distortion—as predicted by the formulas, they can lead indirectly to the introduction of other, dynamic forms of distortion like TIM (*T*ransient *I*nter*M*odulation) distortion. Dynamic distortion may be more annoying audibly than static distortion; static distortion is more easily measured.

Another technique for reducing distortion in amplifiers, called feedforward, was postulated by H.S. Black in 1928. That's the same H.S. Black, incidentally, who developed the negative-feedback theory in 1937. The idea of feedforward is actually much older than the more widely known and generally used negative-feedback distortion-correction approach.

Using the feedforward concept in an actual amplifier could not be done, unfortunately, until audio engineers had solved a number of important practical problems. According to the two Sansui engineers who have now come up with a practical feedforward amplifier design, the technique offers the following important advantages:

1. Virtually complete cancellation of many kinds of distortion over a wide frequency range, and,
2. Stable operation with no danger of self-oscillation.

In order to design an amplifier using the feedforward technique, several problems had to be solved. Calculations for complete and correct cancellation of output distortion had never been developed. Earlier theoretical designs of feedforward amplifiers were based upon a bridge or one-pole compensation network, but actual amplifiers use a two-pole compensation network at higher frequencies. It was thought that application of feedforward to output stages would result in a loss of output power. Additionally, it was thought that feedforward could reduce distortion only over a very narrow range of frequencies and therefore that it would not be much better than negative feedback—and perhaps not even as effective.

A solution

Sansui claims to have solved the problems associated with feedforward amplifiers. Their new feedforward amplifier is a hybrid configuration of negative feedback and feedforward techniques and is the first practical use of feedforward theory in an actual working amplifier.

Figure 2 shows the operating principle of Sansui's new feedforward amplifier. Amplifier A is the driver stage (with two-pole compensation). Amplifier A0 is the power stage of the amplifier. Error-correction amplifier A1 provides the feedforward correction signal. (The use of an error-correction amplifier had not been considered previously.) In operation, an input signal passes through the driver stage, through the power-output stage, and to load R_L. The negative feedback loop, B, returns the distortion components of the signal (out-of-phase) to the input of the driver stage as it would in any conventional negative-feedback amplifier. At the output of the driver stage, the feedforward amplifier A1 picks up the audio and the out-of-phase distortion components. After amplification, they are fed through the combining network Z1. The purpose of that network is to insure correct amplitude and phase relationships between the error-correction amplifier and the output stage over a wide frequency-range.

Any distortion generated in the amplifier-output stage, A0, that has not been cancelled by negative feedback is introduced into the error-correction amplifier A1 with its phase *reversed*. When the two signals (the main signal and the error-correction signal) are combined in summing networks Z1 and Z2, the distortion components cancel out because the error-correction signal is out-of-phase with—but equal in amplitude to—the remaining distortion components at the output of the power stage A0.

In the actual circuit, Z1 is a capacitive network used to speed up the distortion component while Z2 is an inductor used to delay the output of the main amplifier (see Fig. 3). The design of the summing networks is critical because the phase and amplitude relationships of the distortion components must be uniform over a wide frequency range if proper distortion cancellation is to occur.

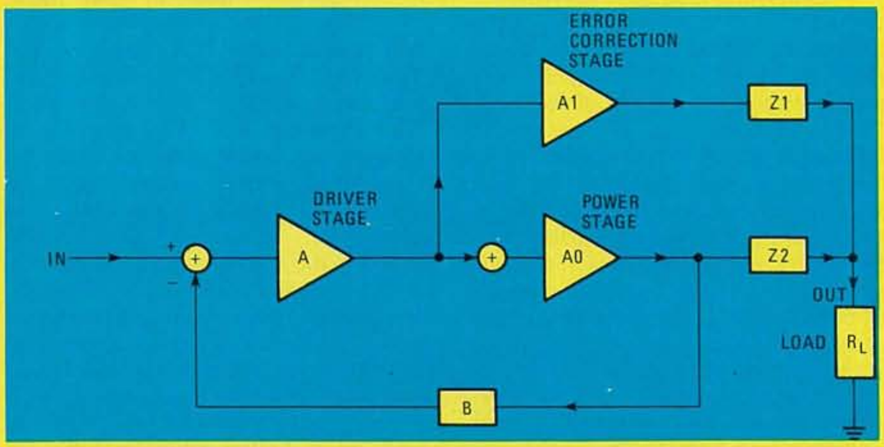


FIG. 2—SIMPLIFIED BLOCK DIAGRAM of Sansui's new amplifier shows that it is a hybrid design, combining feedforward and negative-feedback techniques.

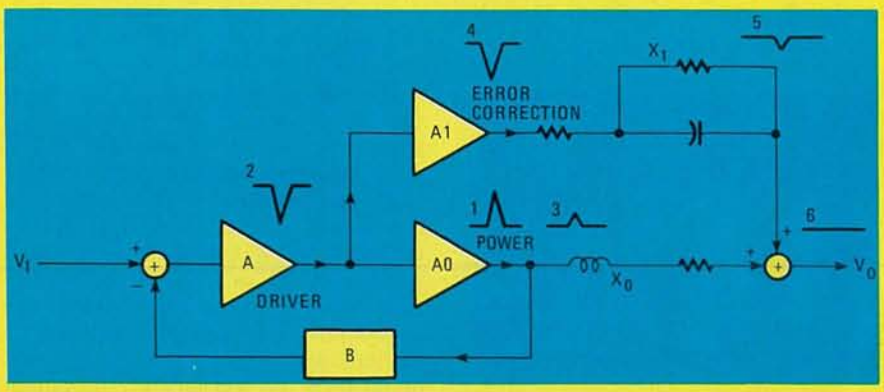


FIG. 3—THE DISTORTION COMPONENTS of the output of amplifiers A1 and A0 are equal in amplitude but opposite in phase. After conditioning by the phase-modification networks, X0 and X1, the outputs are summed, cancelling the distortion.

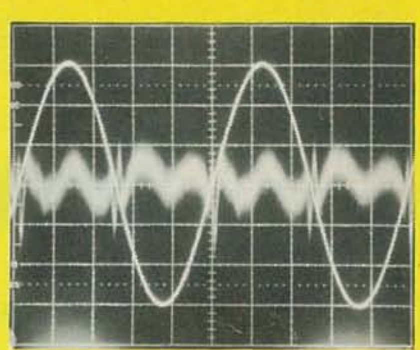


FIG. 4—A NEGATIVE-FEEDBACK AMPLIFIER'S output waveform with residual distortion shown as a secondary trace (at center). The amplifier is delivering 100 watts into an eight-ohm load at a frequency of 20 kHz.

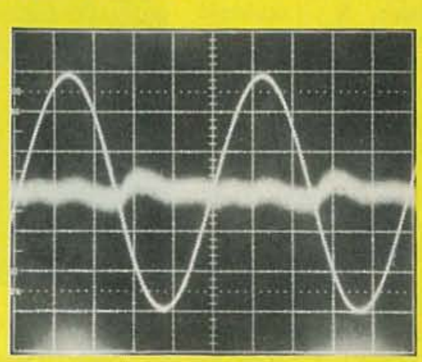


FIG. 5—THE OUTPUT (and residual distortion) of an amplifier using Sansui's feedforward design. The test conditions are the same as in Fig. 4.

A more graphic illustration of what takes place in the feedforward amplifier is shown in Fig. 3. As in Fig. 1, distortion (1) is generated by the power-output stage, A0. Reverse-phase distortion (2) reaches the input of A0 through the normal negative-feedback loop, B, and driver-stage A. Waveform (3) represents the reduced (but not quite eliminated) distortion appearing at the output of power-stage A0 after application of negative feedback.

In addition to the partial correcting effects of the negative-feedback system, error-correction amplifier A1 passes along the detected distortion, as represented by (4). This distortion component is time-aligned and attenuated by the resistance and capacitance elements identified as X1. Meanwhile, the phase and amplitude of the distortion (3) appearing at the output of A0 are adjusted (by the reactive and resistive elements identified as X0) so that the distortion signal is equal in amplitude but opposite in phase to the distortion component (5) appearing at the output of the error-correction amplifier A1 and its summing elements. Addition of the distortion components (3) and (5) results in their complete cancellation at the output point, V_O.

The mathematical impossibility of using ordinary negative feedback to eliminate distortion completely can be shown by the following relationships (refer to Fig. 1):

$$V_O/V_I = \frac{A}{1 + (A)(B)}$$

$$\text{When } A \gg 1, V_O/V_I = \frac{1}{B}.$$

Since the ratio of V_O/V_I can never be exactly equal to 1/B (but only nearly equal to it) distortion can never be zero.

By contrast, consider the situation that exists in the feedforward circuit represented by Fig. 3.

$$V_O/V_I = \frac{(A)(A1)(X1) + (A)(A0)(X0)}{1 + (A)(A0)(B)}$$

$$= \frac{\frac{(A1)(X1)}{X0} + A0}{\frac{1}{(A)(B)} + A0} \times \frac{X0}{B}$$

When $X0/X1 = (A)(B)$, $A1 = 0$, and $V_O/V_I = X0/B$.

The equations balance, and the distortion is "zero."

Distortion improvement in a practical amplifier

Figures 4, 5, 6, and 7 show several comparisons of amplifier distortion with and without the feedforward circuitry. In Fig. 4 we see a 20-kHz waveform when the amplifier under test is delivering 100 watts of power into an 8-ohm load. The residual distortion present in this output is superimposed on the oscilloscope photo and is represented by the horizontal secondary trace at the center of the screen. In Fig. 5 we see an oscilloscope photo taken under the same test conditions, but this time the test amplifier uses Sansui's feedforward technique. If you were to measure the total distortion, using a meter-type distortion analyzer, the distortion figure would not be that different at this test frequency, especially if a low-pass filter were placed between the output of the amplifiers and the input to the distortion analyzer. Yet when we compare the actual waveforms of the distortion components of the two amplifiers it is evident that the feedforward amplifier (Fig. 5) shows none of the switching distortion that was evident in Fig. 4 (the spikes that are seen in the waveform every time the output sinewave crosses the zero axis).

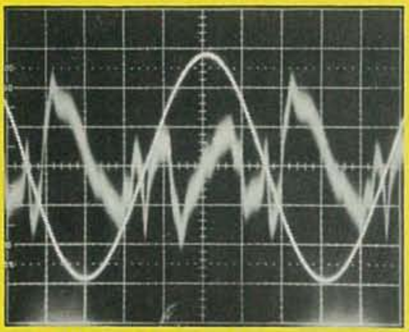


FIG. 6—NOTE THE SEVERE RESIDUAL DISTORTION of a negative-feedback amplifier that has been deliberately driven to very high distortion-levels.

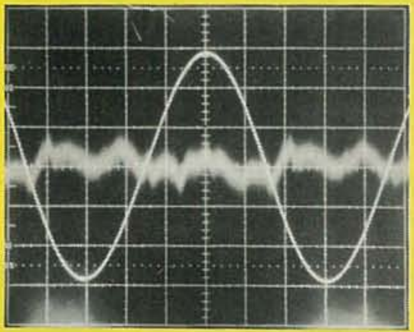


FIG. 7—OUTPUT of a feedforward amplifier when it is driven to the same level as the amplifier in Fig. 6. Note the difference in the residual distortion trace.

Figure 6 shows the same test condition and test signal as the earlier photos, but this time the amplifier has been deliberately driven to higher distortion levels. Figure 6 shows the output of a conventional amplifier with negative-feedback distortion-reduction circuits. Figure 7 shows the output waveform when Sansui's feedforward circuitry is used. Even when deliberately driven to higher levels, distortion has been almost completely cancelled by the feedforward approach.

According to Sansui's engineers, the feedforward technique should find widespread use in audio amplifiers, since feedforward circuitry, added to an amplifier using conventional negative feedback, can help eliminate some of the last vestiges of distortion that remain in most audio amplifiers. Among Sansui's innovations in the design of this new amplifier are:

1. A feedforward configuration based on two-pole compensation that is found in existing amplifiers.
2. An output summing-network designed for exact adjustment of phase and amplitude to achieve full distortion-cancellation.
3. An error-correction amplifier with good linearity to isolate the feedforward circuitry from external loading-factors.

All of that makes this an interesting new amplifier design that other audio equipment manufacturers may well want to investigate for possible use in their products. **R-E**

What's News

Programmable circuitry aids very large scale integration

A number of factors are now leading to a new generation of semiconductor technology, very large scale integration (VLSI), reports Texas Instruments. The most important one is probably the increasing number of active element groups—logic gates, memory bits, etc.—that can be put on a single chip.

Two factors oppose VLSI. As the complexity of the circuit increases, the time and cost of circuit design multiplies. And as the circuit becomes more sophisticated and complex, the number of applications for it decreases. At the limit of VLSI technology, a special unit would be needed for each application. The high design costs for such sophisticated processors would mean that only applications in which extremely large numbers of identical units could be used would be practical.

Those design costs can be reduced fantstically by a new approach: solid-state programming, says TI. In the new class of programmable components, the architecture of the unit remains essentially the same until the final stage of manufacture. Then the last mask or masks are so designed as to fit the unit to the functional specifications of a required application. That is expected to offer a cost improvement of 15 to 1 over the same system implemented in standard LSI circuitry, but now custom-designed throughout for a given application.

TI sees a situation where "logic-array masters" are produced and stockpiled. The final programming step—the customizing—would be added in the final two metallization steps, with design costs as low as a third that of the custom-designed product.

Where production volumes are very large, the custom logic designs may, of course, continue to hold their own.

Florida seeks improvement in highway speed radar

A special commission set up by the Florida legislature to evaluate its new police-radar law, and suggest modifications if desirable, has come up with a proposal—by one member of the commission—that the present law should be strengthened, even if it means guidelines more stringent than those that have been developed by the federal government.

Yet some witnesses testified that equipment which can measure up even to those standards is very difficult to find. Professor Lee S. Nichols of the Virginia Military Institute contends that although there are approximately 70,000 radar units in use: "There are no radar units on the road today that will meet the specifications of the federal study."

Operator training was found to be needed as much as equipment improvement. Ron Eagle of the National Traffic Safety Administration stated that the Administration intends to publish a mandatory training program, based on the results of a recent National Bureau of Standards study, that would include 24 hours of classroom instruction and 16 hours of on-the-road practical training. NRTSA also plans to compile a Qualified Products list, which would include only those radar units that meet the Federal specifications established by the NBS study.

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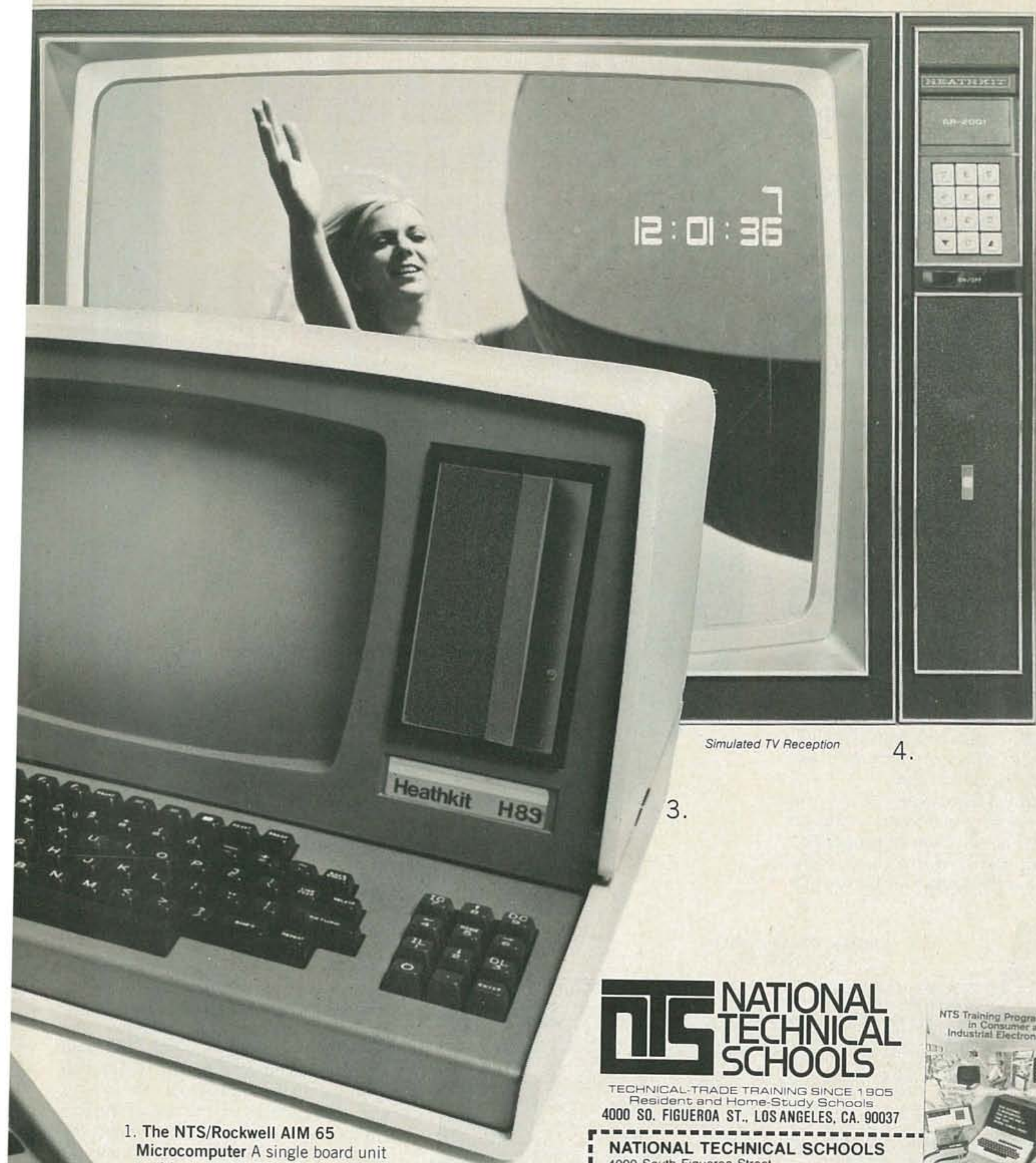

Simulated TV Reception

4.

3.

VERSATILE LIGHT SEQUENCER

Part 2

THIS MONTH WE'LL conclude our look at the Lumitron-4 light sequencer, test the unit, and finish up by giving you some ideas for a lighting display.

Figure 9 shows suggested case dimensions and provides a drilling-guide for holes for the switches, pots, and LED's.

The LED's, used to monitor output-channel activity, are press-fit into their mounting holes and their leads connected to a terminal strip. The 330-ohm current-limiting resistor for each LED is connected directly between the cathode lead and the appropriate location on S6 (refer to Fig. 4).

The last board to be mounted should be the one holding S6. It should be positioned so that switch S6-a is at the left when the switch assembly is viewed from the front of the cabinet. Use spacers at least 3/8-inch long when mounting the switch board in the cabinet.

The power supply (Fig. 10) uses a wall-plug transformer for safety and space-saving reasons. The full-wave bridge rectifier (BR1), filter capacitors, and voltage regulator are all wired to one terminal strip inside the control-unit cabinet. On the same terminal strip is the audio-input coupling capacitor. All audio-circuit connections should be made using shielded cable.

The wiring connections to S6, the panel-mounted components, and the card socket are best made using ribbon cable. For ease of wiring, it is recommended that the socket for the control-unit board not be mounted until all wiring to it has been completed. In the prototype, the card socket was mounted horizontally using 5/8-inch threaded spacers placed at a height of 5/8-inch from the enclosure bottom. This height was chosen to allow the use of another 5/8-inch threaded spacer to support the center of the circuit card. Figure 11 shows the completed control unit.

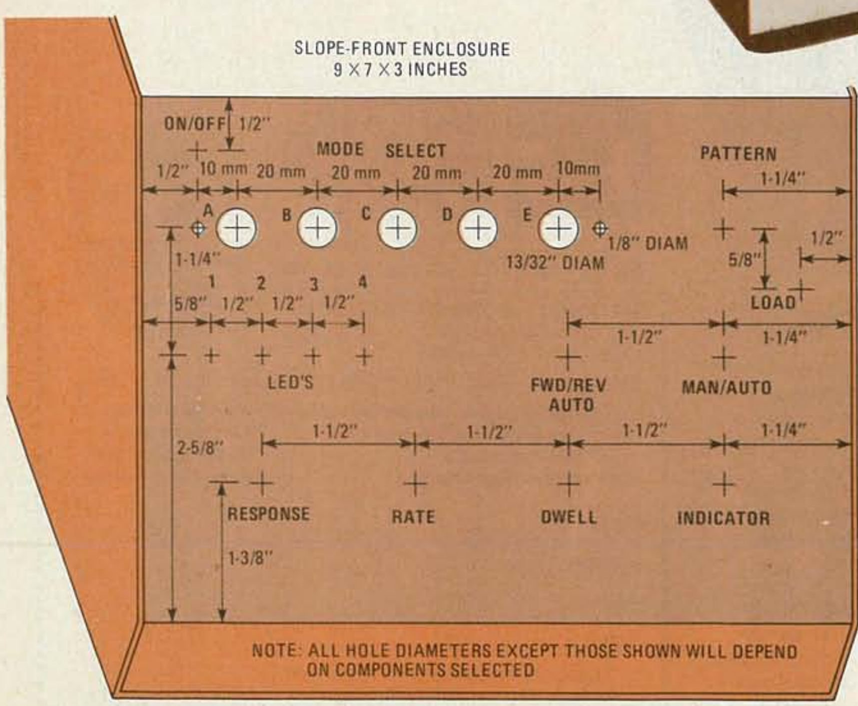

FIG. 9—USE THIS as a drilling guide for the control unit's front-panel components.

The schematic in Fig. 12 shows one of the four power-switching unit sections. A foil pattern for the complete unit is provided in Fig. 13, and a parts-placement diagram in Fig. 14.

The assembled power-switching unit is shown in Fig. 15.

(It is also possible to use solid-state zero-crossing relays in place of the triacs and triac-drivers. In that case, wire all the relays' "+" terminals together and connect them to the +5-volt control-signal lead from the control unit. Connect the "−" terminal of each relay

More on the Lumitron-4 four-channel light controller and instructions for building an eye-catching light display.

DAVID L. HOLMES

to the appropriate-channel signal-lead.)

As with any construction project, steps should be taken to insure that the Lumitron-4 is safe to operate when completed. Be sure that adequate heat sinking is provided for the triacs. Also be sure that the power source is adequate to power all four channels operating all lights simultaneously. For a 15-ampere, 117-volt circuit, a maximum wattage of 450 watts per channel should be allowed. The permissible wattage increases to 600 watts per channel for a 20-amp circuit. The rating of fuse F1 should be chosen in accordance with the total load.

Under certain conditions, you may wish to operate the light display at less than full intensity. Two circuits that will permit that are shown in Fig. 16. The one in Fig. 16-a changes the brightness of the entire display while the circuit in Fig. 16-b allows independent control of each channel.

Standard household-type dimmers may be used but be absolutely certain—especially in the first case—that they can safely handle the power.

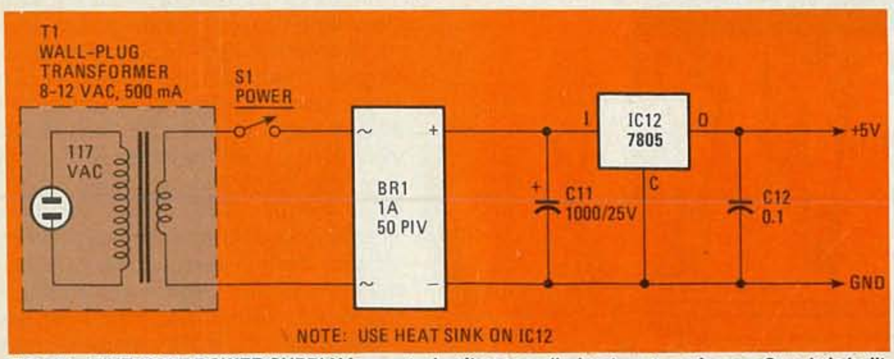

FIG. 10—FIVE-VOLT POWER SUPPLY for control unit uses wall-plug-type transformer. Supply is built on terminal strip using point-to-point wiring.

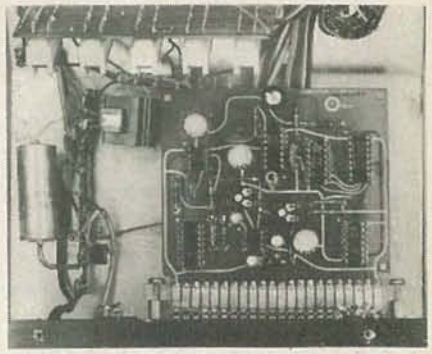

FIG. 11—COLOR-CODED RIBBON CABLE makes connections neater and easier and simplifies signal tracing.

Operation

The control unit may be operated and tested with the aid of the console LED's and does not require connection of the power-switching unit. Before turning on the control unit, rotate all variable controls to their full counterclockwise position, place the FORWARD/REVERSE switch in the FORWARD position, set the indicator switch to the MANUAL position, set the PATTERN-SELECT switch to pattern "D" and depress MODE-SELECT switch A. Turn the unit on and verify that all console LED's light steadily.

Next, depress MODE-SELECT control switch E and verify that one LED at a time is lit and that the LED's light sequentially in one direction. The rate of movement should vary as the RATE control is rotated clockwise. Moving the PATTERN-SELECT switch to a new position and depressing and releasing the LOAD button should cause a new light pattern to be displayed. The light patterns available include: one light, two adjacent lights, every other light, and three lights. Setting the MANUAL/AUTO switch to the AUTO position should cause the light pattern to change automatically, with the time between changes increasing as the DISPLAY control is rotated clockwise.

The modes controlled by MODE-SELECT switches B, C, and D require an audio signal of at least 50 millivolts for proper operation. With the RESPONSE control still in the full counterclockwise position, depressing switch C should not affect the light movement. Rotating the RESPONSE control clockwise should eventually cause the light pattern to move in sync with the audio signal. Depressing switch B should cause the intensity of all the LED's to change in sync with the audio signal. When switch D is depressed, the light pattern should move at a constant rate, but the intensity of the display should

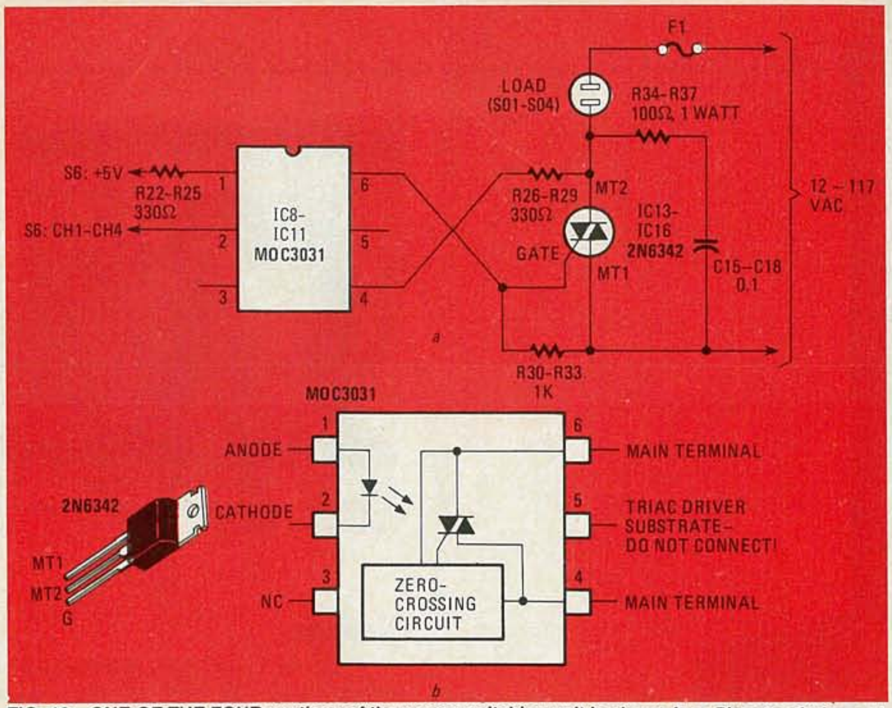

FIG. 12—ONE OF THE FOUR sections of the power-switching unit is shown in *a*. Pinouts of triac and optoisolated zero-crossing triac driver are shown in *b*.

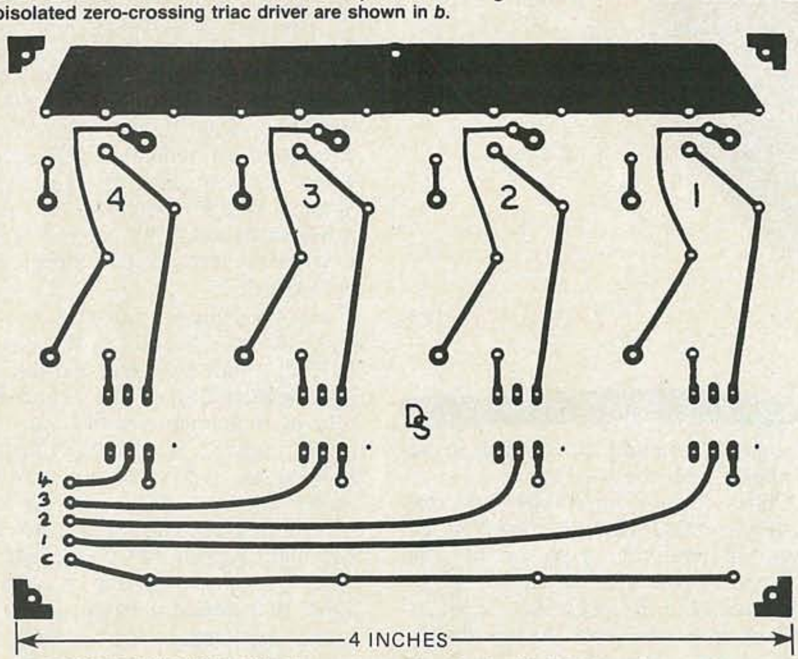

FIG. 13—POWER-SWITCHING UNIT is constructed on single-sided PC board.

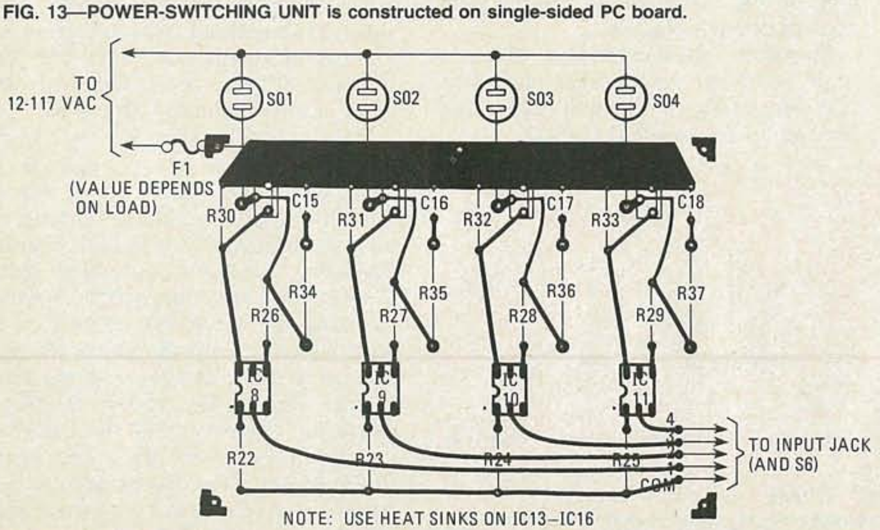

FIG. 14—SIX-PIN TRIAC DRIVERS are inserted into eight-pin IC sockets with pins 4 and 5 removed.

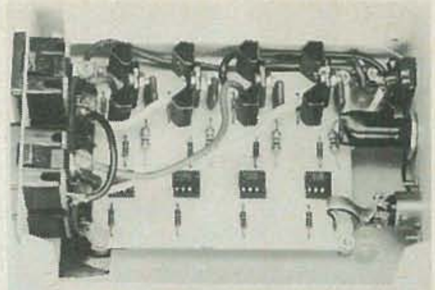

FIG. 15—IT IS IMPORTANT that triacs be heat-sinked, especially if heavy loads are to be driven.

fluctuate with the audio signal. For any mode where the light pattern is moving, positioning the FORWARD/REVERSE/AUTO switch in the AUTO position will cause the pattern to change directions periodically. The DWELL control determines the time interval between changes.

Releasing all MODE-SELECT switches will cause the light display to go off but it will reappear as soon as a mode is selected.

The lowest signal level that the audio section will respond to may be set by adjusting R12. This is useful for normally high-level signals that would otherwise limit the sensitivity control to a very small movement before saturation of the audio section occurred. Potentiometer R10 may be adjusted to obtain the desired balance between sound-sync chase, and intensity of fluctuation, for the same RESPONSE control setting.

After completing the functional check of the control unit, connect the power-switching unit to a light display consisting of at least one light per channel. The power-switching unit should be connected to a voltage source meeting the requirements of the lamps (i.e., 12 volts for 12-volt lamps, 117 volts for ordinary household lamps, etc.). Repeat all previous functional checks and verify that the light display connected to the power switching unit corresponds to the LED display of the console. One thing to keep in mind here is that the LED's may barely be visible when the light display is bright.

Lighting display

Now that you've completed the Lumitron-4 and verified that the unit is operating properly, you need to devise an appropriate light display. The lighting display used with the device requires four separate lighting circuits. The fastest way to create a four-channel display is to obtain four strings of Christmas tree lights and tape them together in a bundle. The strings should be placed, one on top of the other, so that the first bulb of three of the strings fits between the first and second bulbs of the fourth string. The idea is to have every fifth bulb in the composite string on the same circuit.

In creating your own unique display,

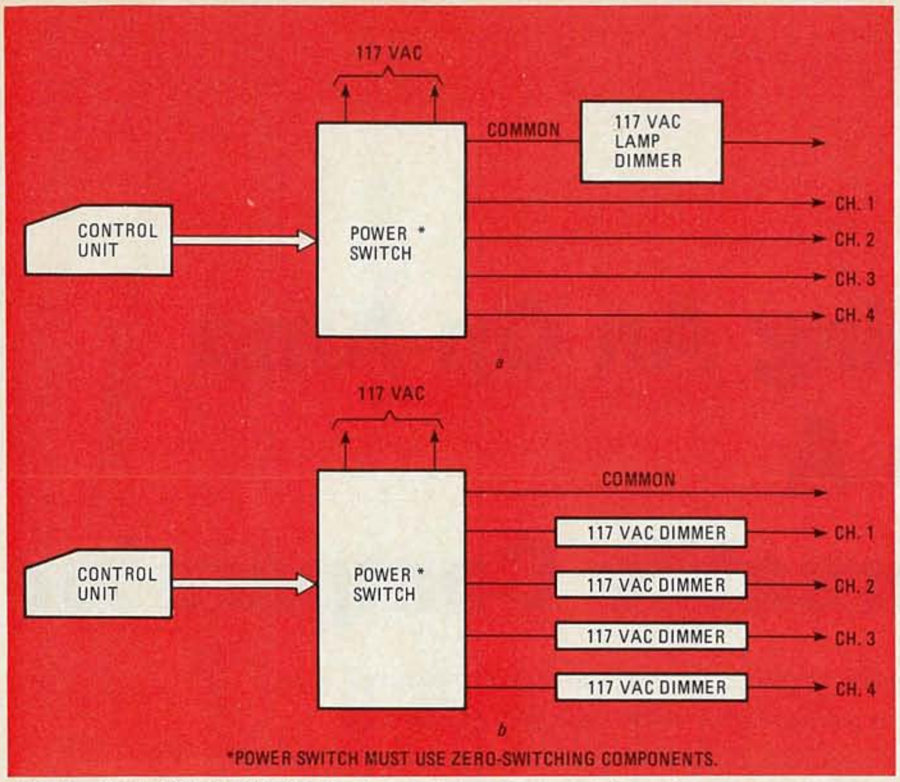

FIG. 16—OPTIONS FOR DIMMING Lumitron-4 display. All-channel dimmer is shown in *a*; individual-channel unit in *b*.

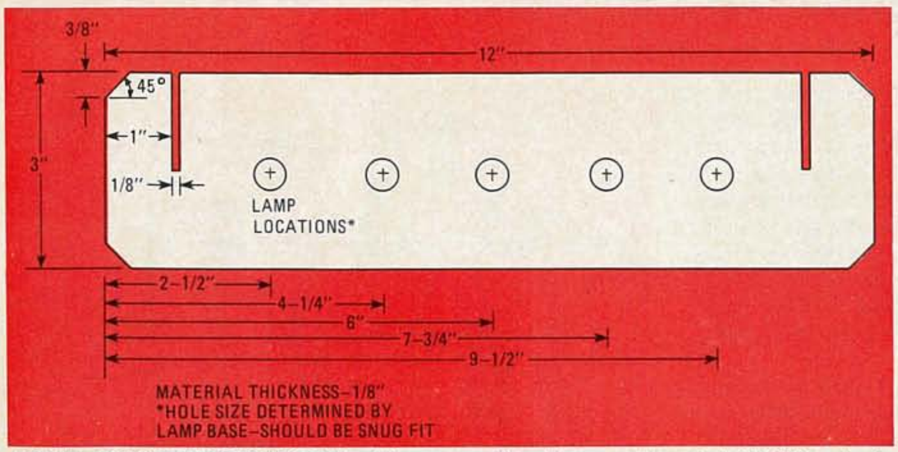

FIG. 17—FOUR OF THESE PIECES should be prepared to make square frame to hold infinity mirror's 12-volt lamps. Masonite is a good material to use.

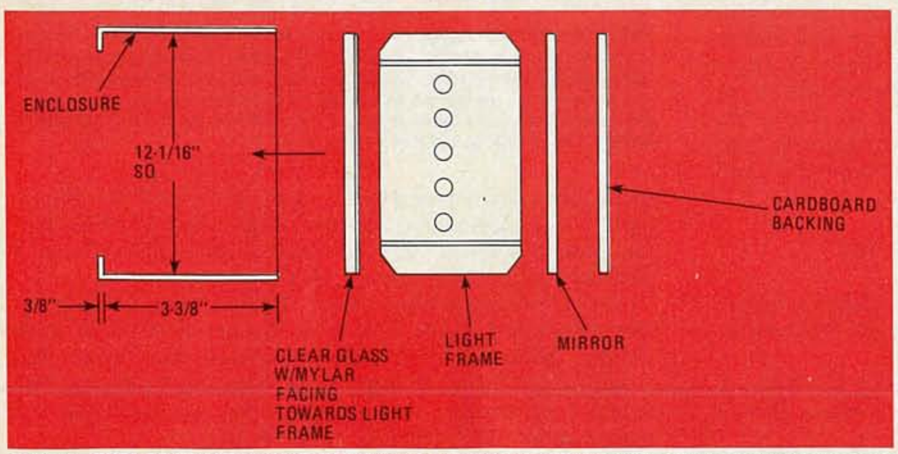

FIG. 18—EXPLODED VIEW of infinity mirror. A small notch will have to be cut or filed in the case to pass lines for lamps.

just remember to have every fifth bulb on the same circuit, and a common wire to all bulbs. Another very important point is that *the common wire must be able to carry enough current for all four circuits, operating all of the bulbs simultaneously, when required.*

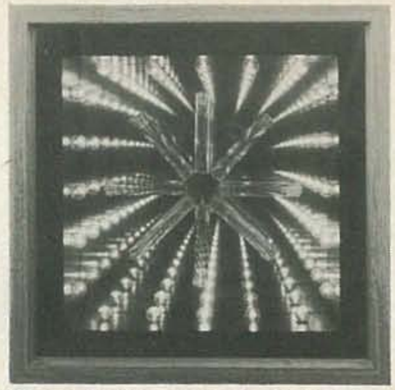

FIG. 19—INFINITY-MIRROR DISPLAY. Lamps may be clear or colored, according to taste.

A real eye-catching display that is rather easy to build involves the use of the "infinity-mirror" illusion that can be created with the aid of readily available Mylar sun-reflecting film. To construct the infinity-mirror you'll need a clear piece of glass (double-strength is recommended), a mirror the same size as the glass, a sheet of the Mylar reflecting-film, lights, and a frame to hold them, and a case. A convenient case size has inside dimensions of 12 1/16 × 12 1/16 inches, which allows the use of precut mirror squares and simplifies the construction of the display.

The Mylar film is applied to the glass and is trimmed flush, creating a "one-way" mirror that is placed in the display front with the Mylar film on the inside of the display. The light frame is inserted next, followed by the mirror square. It will be necessary to cut a notch in the case to allow passage of the light-display control leads around the mirror. Place a small piece of electrical tape on the edge of the mirror where it comes in contact with the control leads. Cut a piece of cardboard to fit over the back of the mirror and secure the entire assembly so that all pieces of the display fit snugly together within the case. Refer to Figs. 17 and 18 for construction details. Figure 19 shows the completed infinity mirror light display.

With the display activated, multiple reflections of the lights within the display will create an infinite-tunnel-of-lights illusion. The secret of this illusion is the Mylar film, because it partially transmits light to the outside of the display while reflecting a portion of it to the back mirror for re-reflection. Only the first row of lights seen in the display is real; the rest of the lights are reflections.

A lighting display comprised of multiple infinity mirrors is very effective and will add to your enjoyment of the Lumitron-4. **R-E**

Using An Op-Amp As A Versatile Comparator

This simple circuit uses any common op-amp to form a comparator with variable hysteresis between two trip-points—one fixed and one movable.

JERALD GRAEME, Burr-Brown Research Corporation

AN OPERATIONAL AMPLIFIER IS A CONVENIENT DEVICE FOR ANAlog comparator applications that require two different trip points. The operation of a comparator is such that the output is high when the voltage at the positive (+) input is more positive than the voltage at the negative (−) input, and the output is low when the input conditions are reversed. By biasing one of the input terminals, the trip point can be shifted. The addition of a positive-feedback network will introduce a precise variable hysteresis into this switching action.[1] Such feedback develops two comparator trip points centered about the initial trip point that is equal to the reference (bias) voltage.

In some control applications, one trip point must be maintained at the reference level, while the other trip point is adjusted to develop the hysteresis. That type of comparator action is achieved with the modified-feedback circuit that is shown in Fig. 1.

Signal diode D1 blocks positive feedback when the comparator output is low and permits positive feedback through resistor R2 when the output is high. Thus, when the comparator output is low, the trip point of the comparator is determined by the reference voltage E_R. When the comparator output is high, the trip point is shifted by the addition of positive feedback through resistor R2. This second trip point is shifted from the original trip point by:

$$\Delta V = R1 \times (V_Z - E_R) / (R1 + R2)$$

where V_Z, the Zener voltage, is greater than reference voltage E_R. Varying resistor R2 will adjust the hysteresis without disturbing the trip point at E_R.

The circuit's other performance characteristics are similar to the common op-amp comparator circuit. The accuracy of both trip points is determined by the op-amp's input offset voltage, input bias current, and finite gain. Resistor R3 limits the current drain through the Zener diode, and resistor R4 provides a discharge path for the capacitance of diode D2.

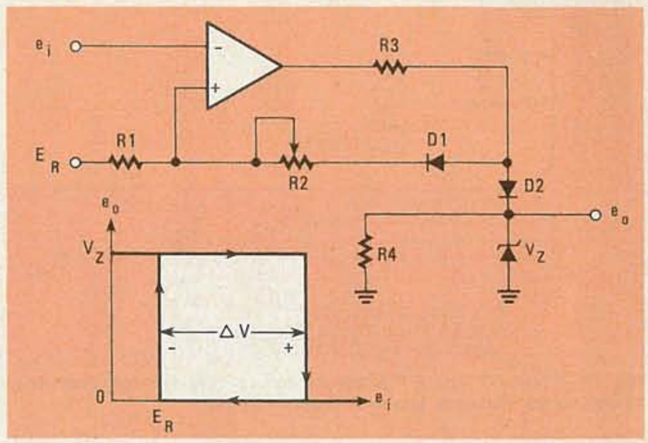

FIG. 1—CONTROLLING HYSTERESIS. Positive feedback circuit for analog op-amp comparator does not shift the initial reference trip point while introducing hysteresis in the second trip point. The voltage difference, ΔV, between the trip points can be adjusted by varying resistor R2. When the output voltage is taken from the Zener diode, as shown, it switches between zero and V_Z, the Zener voltage.

The output signal can be taken either directly from the op-amp output or from the Zener diode, as shown. With the latter hookup, the output signal voltage alternates between zero and Zener voltage V_Z, which might be desirable for interfacing with digital logic circuits. It should be noted, however, that this output cannot sink current in the 0-volt state.

Switching speed is determined by the op-amps slewing-rate limit for high-level input-drive signals. When the input drive is a low-level signal, the output rate of change is limited by the gain available to multiply the input signal's rate of change. Both the slew-rate limiting and the gain limiting of switching time are eased if phase compensation is removed from the op-amp. **R-E**

Reference:

1. Tobey, G., Graeme, J., and Huelsman, L. *Operational Amplifiers: Design and Applications,* McGraw-Hill (1971)

This is a reprint of a Burr-Brown application note entitled "Varying Comparator Hysteresis Without Shifting Initial Trip Point"

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hobby corner

Some answers from our readers and more questions from the mailbag.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

EVERY NOW AND THEN, IT'S NECESSARY to pause and catch up with your letters and cards. The mailbag has been unusually heavy lately and I don't want the stack to get any higher. So, we'll whittle it down a bit this month. But first I'd like to thank you for the interest that you have shown in Hobby Corner since it first appeared some four years ago. We have covered and uncovered a lot of ground in that time and your expressed interest has had many effects.

Your reactions have influenced the direction and content of this column. They still do so. I hope you will continue to let us know your thoughts, needs, and what you are doing. That way, Hobby Corner will be more likely to have topics that are of special interest to you.

You have always come through with solutions to the problems your fellow readers have encountered. This has been a perfect example of "someone has the answer to every question." Your help is appreciated by those who have the problems, and by the rest of us.

Another effect is a purely personal one. Your cards and letters have been the reason that this column is fun to write. When the fun goes out of something, it becomes just a task to do and get over with. For preventing that from happening: thanks.

On the subject of cards and letters, let me assure you that every one is read carefully and given full consideration. That is true whether the note is a question, an answer, a circuit to share, a complaint, a suggested topic, or anything else. Those of greatest general interest find their way into a future Hobby Corner.

So, keep the cards and letters coming and remember that those of you who enclose a self-addressed stamped envelope are most likely to get a direct reply.

Slave flash

Frank Eatherton asked for your help with a circuit for a wireless tripper for his photographic flash (**Radio-Electronics,** March 1981). Thanks to Mark Cipriano (Fulton, NY), Porter Holman (New York, NY), Harold Dahlquist (Mesa, AZ), and others, we can pass along the following information to all you photographers.

The whole job can be done with a very simple circuit and should cost you just two dollars, as compared with the 20 dollars or more that commercial units cost.

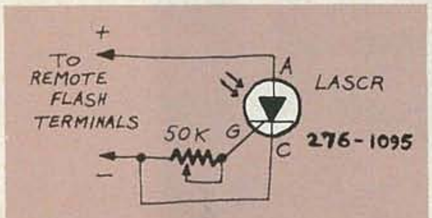

FIG. 1

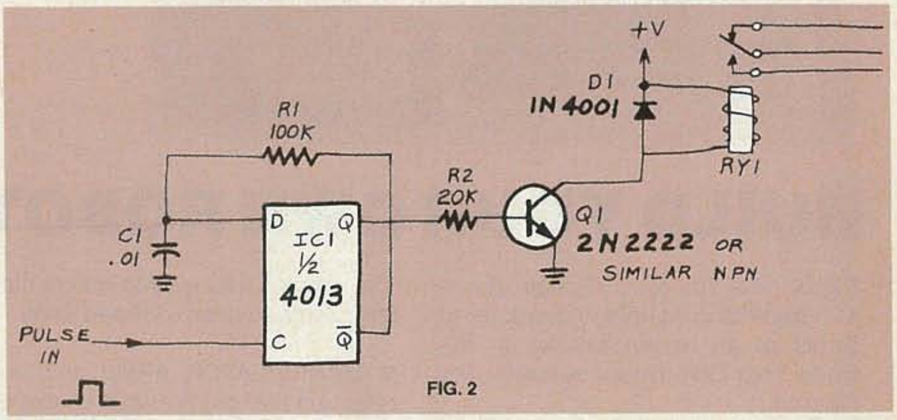

FIG. 2

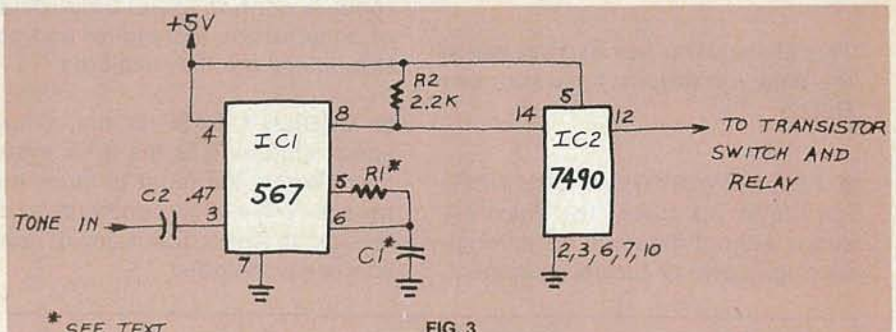

FIG. 3

The trigger circuit shown in Fig. 1 works by light. It is connected to the remote flash and, when the main flash fires, it detects the burst of light and fires the remote unit.

No batteries are required as operating voltage is taken from the flash. The 50K potentiometer lets you adjust the sensitivity of the device. It can be replaced by a fixed resistor if the adjustment feature is not needed. The LASCR (*L*ight-*A*ctivated *S*ilicon-*C*ontrolled *R*ectifier) can be a Radio Shack 276-1095 as indicated or any equivalent 200-volt unit.

Readers have suggested building the trigger in a small film can, or in an opaque plastic or metal tube. H.C. Gernhardt, Jr. (Princeton, WV) suggests that you insulate the leads and put the components in a piece of heat-shrink tubing. One reader embedded his trigger in casting resin. In any event, the LASCR window must be pointed out through a hole in the case. Tom Lillevig (Cedar Rapids, IA) points out that ambient light has less effect if the window is shielded by a short piece of tubing.

In operation, when light of sufficient intensity falls on the LASCR window, it effectively short circuits the flash terminals. That fires the flash or strobe.

There you are, Frank—no wires to trip over even if you have a dozen slave flash-units around the studio.

Alternate on/off

The request from E.M. Shanley for a circuit to alternately open and close a relay on sequential control pulses (**Radio-Electronics,** March 1981) brought forth a barrage of responses. Of special interest is the fact that so many different

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CIRCLE 11 ON FREE INFORMATION CARD

HOBBY CORNER

continued from page 62

solutions were offered. It certainly demonstrates that there is no one way to tackle any situation.

Joe Sobieski (Johnstown, PA) and R.C. Herron (Houston, TX) suggest the direct approach of using an alternate-pulse relay. They are available in almost any coil voltage from several relay manufacturers. If you can't get one from your distributor or mail-order house, Joe suggests trying Mountain West Co. in Phoenix, AZ (toll free phone number: 1-800-528-6169).

Many of you suggested using various types of flip-flops to provide alternate on/off voltages. The circuit shown in Fig. 2 is a good example of those. It was sent by Michael Vesti (Grass Valley, CA). In his circuit, the Q output alternates between high and low on successive pulses. That, in turn, operates the NPN transistor switch and the relay, which are chosen to match the applied voltage. Capacitor C1 and resistor R1 provide some debounce for a possibly noisy pulse.

Gary Bjorndahl (Grafton, WV) also uses the flip-flop approach, but with the first section of a 7490 counter filling the role. His circuit (Fig. 3) gets its pulse from an LM567 tone decoder that produces an output when the proper frequency is input. That frequency is determined by R1 and C1 using the formula: $F=1.1/R1C1$. Note that an off-frequency tone will not operate the relay. Does that give you any ideas for selectively operating several relays?

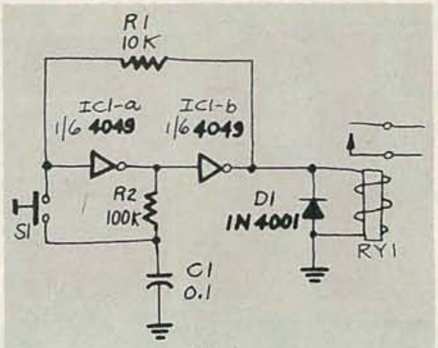


FIG. 4

The circuit in Fig. 4 is from R.W. Phillips (Raynham, MA). It requires a sensitive relay but is about as simple an approach as you will find.

Other suggestions for E.M. involved the use of SCR's and garden-variety relays. We'll take a look at those later.

Any ideas?

Berthil Berg (Almogordo, NM) is having difficulty in determining the speed of a revolving shaft (it turns at about 2000 rpm) accurately. Can any of you come up with a device that combines accuracy and simplicity? How about a circuit to detect a reflective strip on the shaft and feed that information into a frequency counter?

Nicholas Bodley (New York, NY) wants to know if you can draw two sawtooth waveforms that are 180 degrees out of phase.

Tom Grove (Silverdale, WA) would like to find a circuit that would let him check his camera-shutter speeds (from 1/5 to 1/1000 of a second).

Jim Pruitt (Lewiston, ID) needs to monitor the level of liquids in the various tanks in his camper. Instead of meters, why not LED's?

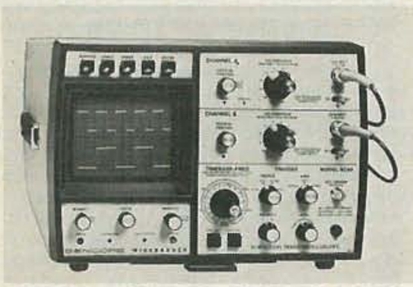
Don't forget the do-nothing/idiot box circuit "contest" is still running.

Well, those should keep you busy 'til next time! **R-E**

new products

More information on new products is available. Use the Free Information Card inside the back cover.

60-MHZ OSCILLOSCOPE, *model SC60,* the "widebander," has a 60-MHz bandwidth, usable to 100 MHz, and covers virtually all digital-logic families in use today. No peaking coils are used in the vertical amplifiers, providing true waveform reproduction through its entire bandwidth. Six-nanosecond risetime, and a post-deflection CRT, produce sharp, bright waveforms to 100 MHz. Human-engineered front-panel design, with large-sized control knobs and pushbuttons, eliminate unnecessary bumping of adjacent knobs or controls.



CIRCLE 151 ON FREE INFORMATION CARD

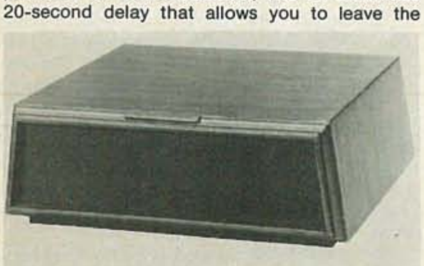
High sensitivity of 5 millivolts-per-centimeter on both channels enable the *model SC60* to be used in very low level circuits. Measurement capability is up to 1600 volts peak-to-peak, and there is protection to a full 200 volts. Delayed signal trace permits viewing the leading edge of waveforms on both channels. The user can add, subtract, or view the two input channels separately.

The *model SC60* features exclusive 5-MHz vector (X-Y) response (at 3° phase shift or less) with the push of a button. Special video-sync separators result in rock-solid sync on the most complex video waveforms. The *model SC60* "widebander" is priced at $1,695.00.—**Sencore,** 3200 Sencore Drive, Sioux Falls, SD 57107.

INTRUSION-ALARM SYSTEM, the *Archer Ultrasonic Intrusion Alarm System,* requires of the user only that it be plugged in and aimed at the area that is to be protected. A built-in "walk-test" lamp allows one to determine the protected area easily.

Any motion within that area triggers a loud, built-in alarm. It can be used with an external (optional) alarm siren or bell, and in any mode can be set to sound instantly or with a 15-second delay.

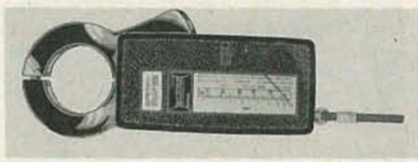
Other features include adjustable sensitivity, provision for remote control, and an automatic 20-second delay that allows you to leave the room without setting off the alarm. It comes in a simulated walnut-finish enclosure and is 2¾ × 9½ × 8¼ inches; it has U.L.-listed AC operation, plus provision for battery back-up. The *Archer Ultrasonic Intrusion Alarm System* is priced at $79.95.—**Radio Shack,** 1800 One Tandy Center, Fort Worth, TX 76102.



CIRCLE 152 ON FREE INFORMATION CARD

AMMETER, *model SPR-930* is a snap-around volt-ohm-ammeter that features ± 3% of full-scale accuracy over a full-frequency spectrum of 50 to 400 Hz. That feature eliminates any further calibration requirements anywhere in the world, and also eliminates costly recalibration charges.

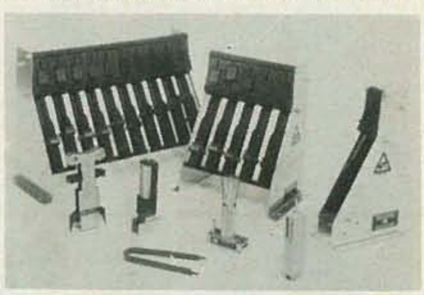
The model *SPR-930* is pocket size and has an impact-proof outer plastic housing. Components are mounted on an exclusive-design inside chassis to minimize damage from severe shock. There is a positive-acting detented range-switch and dial-drum mechanism, spring-loaded ball-pivot jaw action for smooth operation, and grip-fast texture housings. The rotary scale presents one range at a time, reducing reading error. The pointer lock freezes reading where lighting conditions or cramped quarters so require.



CIRCLE 153 ON FREE INFORMATION CARD

There are nine ranges: 10/30/100/300/900 amps AC continuous duty, 150/300/750 volts AC self-contained, and 25 ohms midscale. Current readings are instant and accurate without breaking the line. The model *SPR-930* is priced at $109.75.—**A. W. Sperry Instruments, Inc.,** 245 Marcus Blvd., Hauppauge, NY 11787.

INSERTION AND EXTRACTION TOOLS, a new *MDD*-series of DIP IC dispensers for MOS and CMOS, as well as standard devices, offer flexibility and convenience to a unique degree. Each channel easily accepts any standard IC shipping tube, and can accommodate any standard IC from 2-42 pins on .300, .400, or .600 centers. Adjustable guides position each IC individually for easy extraction, and simple gravity feed assures reliable deposit of the next IC into extraction position after the previous IC is removed. The tools are made of conductive carbon-filled thermoplastic with steel supports, assuring effective



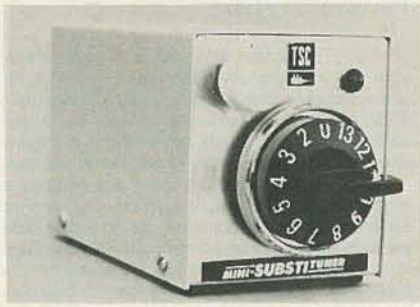
CIRCLE 154 ON FREE INFORMATION CARD

static dissipation (a grounding lug is included) and long-term, reliable performance. The *MDD*-series is available in 1, 5, and 10-channel versions.

The *model MDD-1* (1 channel) is priced at $21.85; the *model MDD-5* (5 channels) costs $83.43, and the *model MDD-10* (10 channels) is $160.45.

The *WK-7*, a new kit of DIP IC extractors to accommodate all IC's from 14-40 pins, consists of extractors EX-1 for 14-16 pin devices, and EX-2 for 24-40 pin chips, plus inserters MOS-1416, MOS-2428, and MOS-40 for 14-16, 24-28, and 36-40 pin IC's respectively. The *WK-7* is priced at $29.95.—**OK Machine and Tool Corporation,** 3455 Conner St., Bronx, NY 10475.

TELEVISION TUNER SUBSTITUTE, the *Mini-Substi-Tuner,* is a 300-ohm, VHF testing replacement tuner. It comes with the IF connector cable, plug, and is powered by two 9-volt batteries. There are 12 VHF channels, an on/off switch, AGC control, and an LED indicator. The *Mini-Substi-Tuner* will save the TV technician hours of trouble-shooting and repair time where there are tuner problems within the VHF circuit of a television set. The *Mini-Substi-Tuner* is priced at $24.95.—**Tuner Service Corporation,** 537 South Walnut St., Bloomington, IN 47401.



CIRCLE 155 ON FREE INFORMATION CARD

DIGITAL THERMOMETERS, *Series 1000,* indicate °F and °C and operate over a range of −20°F to 2000°F.

The series consists of three models, two of which operate from standard NiCr/NiAl thermocouples, and a third which uses diodes as its sensor. The *model 1003* measures temperature of .1° and 1° accuracy and has a °F/°C switch for direct readout in either scale. The *model 1001* has the feature of displaying differential temperature when the DX3 option allows the use of two probes to be connected to the instrument.

CIRCLE 156 ON FREE INFORMATION CARD

All series-1000 models are housed in a small, high-impact case and use an LCD readout that consumes only 800 μA. The series has battery life up to 500 hours.

Models 1001 and *1003* incorporate an automatic cold junction feature. The prices in the series run from $189.00 to $229.00, including a glass bead probe and batteries.—**Jenway Instruments, Inc.,** 10080 North Wolfe Road, Suite 372, Cupertino, CA 95014.

TEST INSTRUMENT, the Huntron *Compar-A-Trace, model HTR 1005B-1S,* is a unique CRT-based instrument for trouble-shooting solid-state components and circuits.

CIRCLE 157 ON FREE INFORMATION CARD

The unit features dual-channel switching, or single-channel operation, for comparison testing of analog or digital devices in, or out of, circuit. Visual displays appearing on the CRT screen indicate the condition of devices or circuits under comparison as they are tested *without* circuit power applied. A graticule faceplate supplies a reference standard for visual comparison of firing voltages for diodes, discrete components, or IC's. The *model HTR 1005B-1S* is priced at $965.00 —**Huntron Instruments, Inc.,** 15123 Highway 99 North, Lynnwood, WA 98036.

DESOLDERING SYSTEM, *model 4000,* "Hot Vac," contains a built-in vacuum pump, allowing it to be used at any location in a factory, repair center, or field location where normal AC electric power is available.

The solder is melted by the heated long-life tip, and the vacuum is turned on by the convenient switch located on the biomechanically designed handle. The solder that is removed is retained in the built-in solder reservoir, that may be emptied easily—even when the heater is hot.

CIRCLE 158 ON FREE INFORMATION CARD

Tip temperature ranges from approximately 500° F to 1000° F, allowing the *model 4000* to be used in a wide variety of applications. The temperature-sensing heater provides instantaneous temperature recovery, and transient spikes are fully suppressed, making it safe for desoldering MOS and other voltage-sensitive components.

The *model 4000* includes a built-in handle holder and a convenient handle for easy carrying. A variety of different-sized tips for various applications is also included.

The *model 4000* is priced at $399.00.—**Ungar,** 100 West Manville St., P.O. Box 6005, Compton, CA 90220. **R-E**

communications corner

The diode gives you all-electronic switching without a microprocessor! **HERB FRIEDMAN**, COMMUNICATIONS EDITOR

JUDGING BY THE HOOPLA, THE ONLY things worthwhile in life are microprocessor-controlled. Actually, if used properly, a microprocessor can create new applications or provide sophisticated features at a budget price. But as with all fads, people tend to get carried away with the fad itself, and today we find "computerized" kitchen ovens, sewing machines, and the like. In most of those applications, the user could get along without a home version of a "NASA space probe."

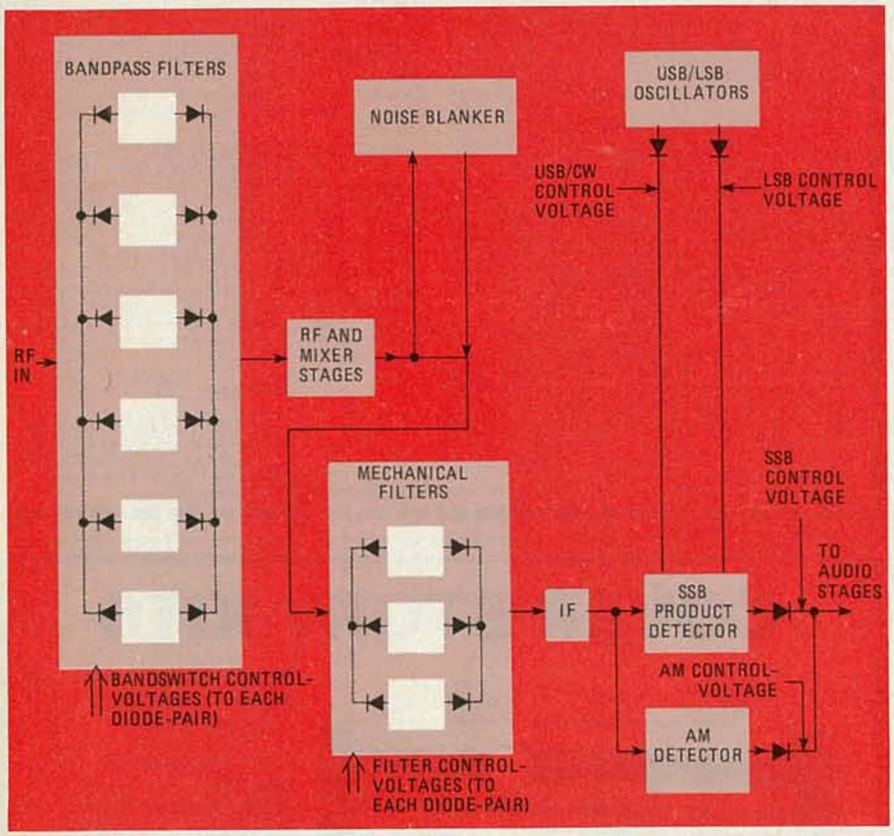


FIG. 1

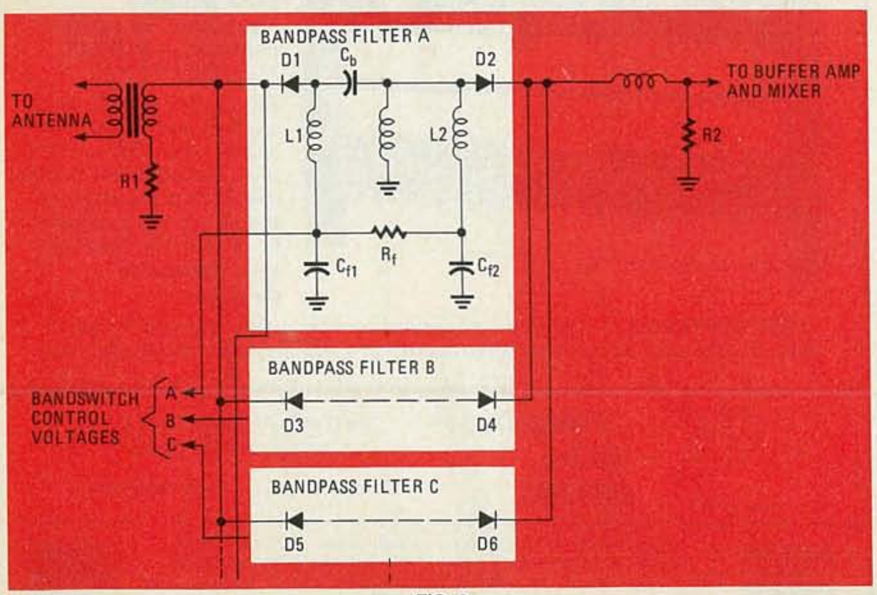


FIG. 2

Another aspect of electronic fads is that the excitement they create often obscures important developments for old or routine hardware. The ordinary diode switch is a perfect example of the problem. There is nothing really exciting about an ordinary diode. In fact, the diode is normally a rather dull subject—worth about a day in an average high school electronics course. Yet the diode plays an important part in modern communications equipment by providing a trouble-free substitute for bandswitches and RF-circuit selectors.

Most readers will remember the bandswitches of years past. Whether used in communications receivers, VHF monitors, or TV receivers, the bandswitch was used to switch between RF front-end circuits, including the first local oscillator. As the switch contacts aged or corroded they affected the RF circuits they switched.

Eventually, the user had to "ease" the bandswitch slightly beyond the detent to receive a TV station, or strike the bandswitch to settle the drift in a VHF communications receiver, or use up endless cans of contact cleaner—which usually did a better job of dissolving the plastic cabinet than cleaning the switch contacts.

Today, thanks to the diode, we no longer have to put up with the bandswitch. The diode performs noise- and drift-free electronic switching for us. Of course, it does take some sophisticated design work to use diode switching.

Figure 1, a simplified block diagram of part of the Kenwood *R-1000* receiver, shows how it's done. Other than the diode bridge used for the power supply, and the AM and AGC detectors, diodes are used throughout the receiver as switches.

Look first at the front end. Instead of the usual tuned input, the antenna signal feeds six bandpass filters. A DC signal from the main band-selector switch (which covers 0-29 MHz in 1-MHz increments) directs the DC control-voltage to the appropriate bandpass control diodes.

The desired mechanical filter is also selected by input and output control diodes that are controlled by a DC signal from the AM/USB/LSB selector switches. The diodes that turn on the SSB product detector and the output of the SSB/CW carrier oscillators are also controlled by DC from the AM/USB/LSB selectors. In short, not one single circuit that handles RF has a mechanical switching device. It's all done with diodes.

Whenever I try to explain the RF diode-switch in a class, someone always asks whether the DC control-circuit produces instability. The answer is "no" because the DC is fed into the ground end of the active circuit and is decoupled within its own RF loop. That is illustrated in Fig. 2, a simplified schematic of one *R-1000* bandpass filter.

The control-voltage from bandswitch-selector-position *A* is fed to the junction of C_{f1} and R_f. The positive voltage (or current) through L1 causes diode D1 to conduct (through R1) creating a path for the antenna signal from the RF transformer through D1 to the filter. Capacitor C_{f1} is used as a filter capacitor and establishes an AC ground (or common) at R_f/C_{f1}. The diode control-voltage also passes through decoupling resistor R_f to the junction of C_{f2}/L2, and on to diode D2, which also turns on, allowing the signal to flow out of the filter and on to the receiver. Decoupling resistor R_f and filter capacitor C_{f2}—which also places the junction at C_{f2}/L2 at AC ground—prevents any input signal to the filter from bypassing the filter to the output by flowing through the DC control voltage circuit.

Diodes D3 and D4 have received no control voltage from the bandswitch so they represent an open circuit to the RF transformer's secondary. When the bandswitch is moved to position *B*, control voltage is removed from D1 and D2 and applied to D3 and D4, thereby opening the path to the BAND *A* filter and closing the path to the BAND *B* (C, D, E, etc.) filter. (Each filter is actually used for several 1-MHz band segments.) Since all switching is done at "AC ground" potential there are no noise or drift problems associated with the bandswitching mechanism.

Don't the diodes rectify the AC signal? No, because once a diode conducts, it will pass an AC signal (or current) in either direction—AC is bi-directional—as long as the peak-signal value of the AC waveform is less than the applied DC voltage. The DC diode control-voltage can be several volts while the RF signal is in microvolts or even millivolts. As far as the AC signal is concerned, a conducting diode is just a low-value resistor.

So there you have it; the Kenwood *R-1000*. One of the most up-to-date SW receivers with frequency synthesis, bandpass tuning, and all-diode switching—and no microprocessor. I wonder how they accomplished that! R-E

stereo products

More information on stereo products is available.
Use the Free Information Card inside the back cover.

SPEAKER, *model SM-15*, is a wedge-shaped musical instrument speaker designed for club and concert applications where power and response are essential. The specifications for this system include a frequency response of 75 to 20,000 Hz, 8 to 16 ohms impedance, 200 watts power capacity, and a crossover point of 2.5 kHz.

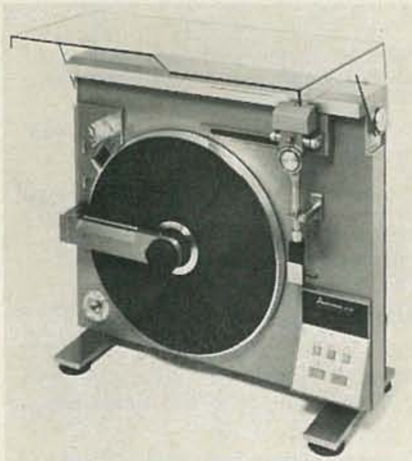
CIRCLE 131 ON FREE INFORMATION CARD

The *SM-15* also has a low-frequency driver with a 54-ounce magnet structure weight with 2-inch voice coil, and a large Dhorm high-frequency driver with a 30-ounce magnet structure weight with 1.5-inch voice coil. Price is $350.—**Heppner Sound**, Belvidere Rd., Round Lake, IL 60073

HEADSETS, *models HV-300, SP-800* and *SP-805*, are designed to incorporate a concept called Stereo Separation Control. That system alters the phase relationship of sound, separating one stereo channel from another, thus eliminating the "inside-the-head" effect and resulting in a concert-hall effect. All models feature a frequency response of 20 to 20,000 Hz, an impedance of 8 ohms, a stereo/monaural switch, and a 10-ft. lightweight cord. High velocity *model HV-300* (shown) has tapered Mylar transducers and individual volume controls. Isolation design *models SP-800* and *SP-805* have slide-type volume and tone controls. Prices: *model HV-300* is $49.95; model SP-800 is $39.95; *model SP-805* is $79.95. —**Mura Corp.,** 177 Cantiague Rock Rd., Westbury, NY 11590.

CIRCLE 132 ON FREE INFORMATION CARD

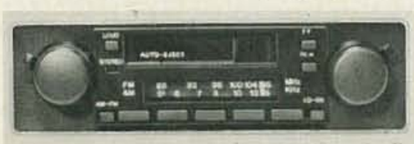
TURNTABLE, *model LT-5V*, manufactured by Mitsubishi Audio Systems. This fully automatic logic-controlled belt-driven turntable is unusual in that it mounts vertically. The platter is driven by a DC servomotor. Speed regulation is accomplished by a phase-locked loop. The aluminum diecast platter measures 12¾ inches in diameter. The statically-balanced linear-tracking tonearm is the straight-type measuring 8¾ inches. Manufacturer's specifications include a wow-and-flutter of 0.045% WRMS and a signal-to-noise ratio of 76 dB.



CIRCLE 133 ON FREE INFORMATION CARD

The *LT-5V* offers an array of automatic functions including tonearm lead-in and lead-out, speed and size change, reject and repeat, lead-in to any point on the record, lift/cue, left and right tonearm movement and cue prevention in the absence of a record. The turntable includes a stroboscopic speed indicator and muting circuitry, acoustic insulator feet to cushion vibration and a detachable dust cover that fits down over the top third of the unit. Suggested retail price is $450.—**Melco Sales, Inc.,** 3030 E. Victoria St., Compton, CA 90221.

AM/FM/MPX STEREO CASSETTE, *model 672*, is a compact unit featuring an FM input-noise canceller, FET front-end and pushbutton tuning. The stereo cassette has locking fast-forward/rewind and auto stop. Measuring 7 × 1⁹⁄₁₆ × 5½ inches, the short chassis and flat face fit easily into the dashboard of virtually any import or X-body car. Suggested retail price is $169.95.—**J.I.L.-America,** 737 W. Artesia Blvd., Compton, CA 90220.



CIRCLE 134 ON FREE INFORMATION CARD

INTEGRATED AMPLIFIER, *model A-60*, has overload margins on all its inputs, 36 dB above 2 millivolts on phono to allow use with high-output cartridges without overloading the first audio stage.

Line-level inputs, selected by push-button, include tuner, tape, and auxiliary, all with 100 millivolts into 100K ohms sensitivity for full output. Signal-shaping controls include treble and bass with 12 dB boost or cut at 15 kHz and 50 Hz respectively, and there is also a high-frequency filter with a 12 dB/octave slope that turns over at 7.5 kHz.

CIRCLE 135 ON FREE INFORMATION CARD

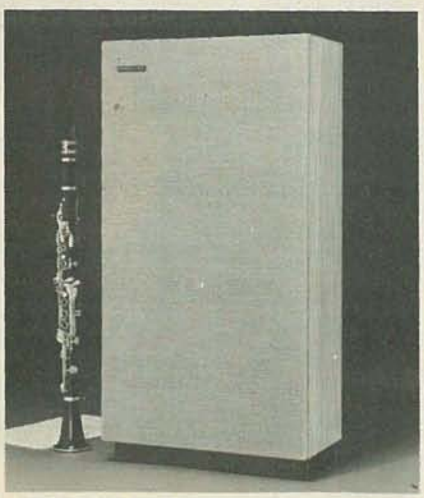
Line-level signal outputs are available at 100 millivolt level for tape and auxiliary at 5K ohm impedance. Headphones of 8–2K-ohm impedance may be driven from front-panel jack or from rear-panel speaker terminals.

The overall performance of the *model A-60* amplifier provides frequency linearity within ± 0.75 dB with both channels simultaneously driven from 20 Hz to 20 kHz at 35 watts continuous into 8 ohms at 0.2% total harmonic distortion. The damping factor is greater than 45 at mid-frequencies and an 8-ohm load. Delayed volt-current limiting with automatic reset protects against short-term overloads, while internal fuses protect against long-term overloads.

The *model A-60* is priced at $595.00.—**Arcam (USA), Inc.,** 652 Glenbrook Road, Stamford, CT 06906.

SPEAKERS, *model A150* and *model A60* are three-way and two-way systems. The three-way *model A150* uses a 10-inch acoustic suspension woofer, a 4½-inch midrange with ferrofluid, and a 1-inch soft dome tweeter with ferrofluid in a 30½ × 16½ × 8-inch cabinet finished in furniture-grade oak veneer. A 1½-inch black pedestal base is supplied for floor placement. Frequency response is 36-25,000 Hz ± 3 dB; crossover frequencies are 550 Hz and 4000 Hz; sensitivity is 90 dB (1 watt/1 meter) and the impedance is 8 ohms (nominal).

The two-way *model A60* uses a newly designed 8-inch acoustic suspension woofer and a ferro-fluid-cooled 1½-inch cone tweeter. Frequency response is 55-22,000 Hz ± 3 dB; crossover frequency is 3000 Hz, and the nominal impedance is 8 ohms. The compact size (18 × 11½ × 7½ inches) makes shelf or wall mounting convenient. It is suitable for use with amplifiers rated at 10-60 watts-per-channel.



CIRCLE 136 ON FREE INFORMATION CARD

The *model A150* is priced at $270.00; the *model A60* costs $100.00.—**Boston Acoustics,** 130 Condor St., East Boston, MA 02128. **R-E**

CORDLESS TELEPHONES

continued from page 35

former) to eliminate the 7-kHz tone. The speech is fed through the line transformer to the phone line.

Recall that the transmissions from base to remote units are not continuous, but are interrupted for two 40-millisecond periods each second. Those gaps do not significantly reduce speech intelligibility and they are necessary to allow the base to receive incoming transmissions from the remote.

When the conversations have been completed, the party at the remote unit presses the LINE RELEASE button. That activates the 4.5-kHz oscillator and the portable's transmitter circuits. This 4.5-kHz signal is received at the base unit during the 40-millisecond gaps and applied to the inputs of IC3, IC4, and Q7. The tone is decoded by IC3 and its pin 8 is clamped to ground. That forces the junction of R23 and R24 to ground through D2.

This action brings Q8's base to ground potential so the transistor turns off and releases the relay. Contact RY2 opens and releases the telephone line while contact RY1 opens to remove voltage from the base of Q8 and from the balance of the base unit's circuitry. The base unit is now on stand-by.

The base unit can also be returned to stand-by by pressing the LINE RELEASE switch (S2) on the base front panel. That action, too, takes Q8's base to ground potential so the transistor turns off and the relay opens.

The intercom

To use the *Muraphone* as an intercom for contacts between a party at the base station and a user at the remote unit, the INTERCOM button (S1) at the base must be kept pressed down. That disconnects the telephone line from the circuit. Operating voltage for the base-station circuits is obtained directly from the voltage regulator through S1. The power-on logic circuit (NE1, VR1, Q2, Q3, and Q4) is not used. The balance of the circuit operation is the same as when a call originates outside.

Note that one end of the telephone set connects to ground. The other end goes to B+ through the line transformer primary and relay contact RY2. Thus, excitation current for the carbon microphone cartridge flows when the relay is closed.

The battery for the portable unit is charged through a special circuit in the base station. Transistor Q20, D13, D14, and R63 form a constant-current charging circuit. The battery is charged by connecting the recharge jacks (J1) on the base and portable units through a recharging cable. **R-E**

new ideas

BOILER CONTROL

THE PURPOSE OF THIS CIRCUIT IS TO CONtrol the water temperature in a hot-water heating system. What it does is to lower the boiler temperature as the outside air temperature increases. For example, if the outside temperature is 0° (Fahrenheit), the boiler temperature would be 180°; if the outside temperature is 50°, the boiler temperature would be 140°, and so on. The result is a savings in fuel consumption.

The circuit is shown in Fig. 1. The op-amp—almost any common type will do—is used as a comparator. Thermister TH2 and R2 form a voltage divider that supplies a reference voltage to the op-amp's inverting input. Thermistor TH2 is placed outdoors, and the values of TH2 and R2 should be chosen so that when the outside temperature is 25°, the resistance of the thermistor and resistor are equal.

Resistor R1 and thermistor TH1 make up a voltage divider that supplies a voltage to the op-amp's non-inverting input. Thermistor TH1 is placed inside the boiler and the values of TH1 and R1 should be chosen so that when the boiler's temperature is 160°, their resistances are equal.

The output of the op-amp controls Q1, which is configured as a transistor switch. When the logic output of the op-amp is high, Q1 is turned on, energizing relay RY1. The relay's contacts should be wired so that the boiler's heat supply is turned on when the relay is *de-energized* and turned off when the relay is energized. An indicator, LED1, glows when the transistor conducts (Q1 is turned on), informing you that the boiler's heat supply is turned off (relay energized).

Circuit operation

As the outside temperature increases, the resistance of TH2 increases. The higher the resistance of TH2, the higher the voltage applied to the inverting input of the op-amp. But as the temperature of the boiler increases, and the resistance of TH1 goes up, the voltage applied to the non-inverting input of the op-amp decreases.

Perhaps the best way to see how that works is with an example. If the temperature in the boiler is 160° and the outside temperature is 25°, the voltages at the non-inverting and inverting inputs of the op-amp are equal. As the boiler heats up, the voltage at the non-inverting input becomes higher than the voltage at the inverting input. That, of course, causes the op-amp's logic output to go high, energizing the relay. When the relay is energized, the boiler's heat supply is turned-off.

As the boiler cools off, and the temperature drops below 160°, the logic output of the op-amp goes low, de-energizing the relay, and turning on the boiler's heat supply. The boiler's on/off point is determined by the voltage at the op-amp's inverting input, which in turn is determined by the outside temperature.—*Scott Busey*

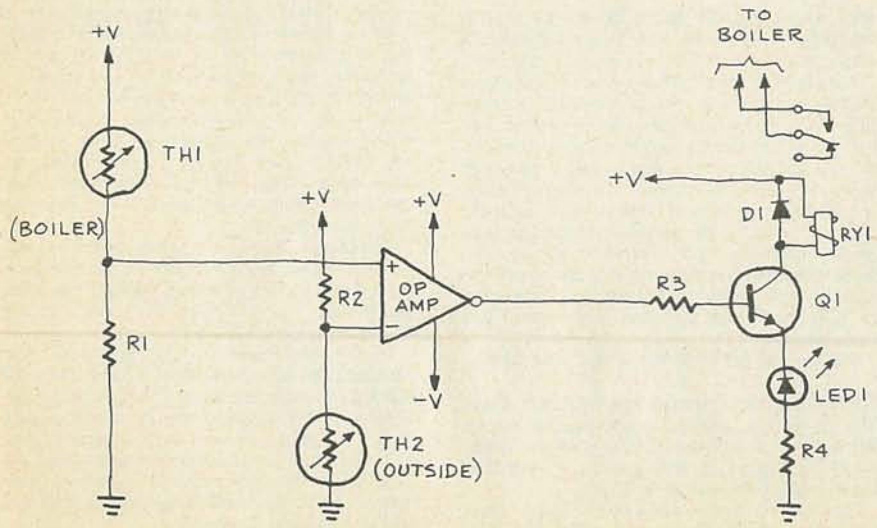
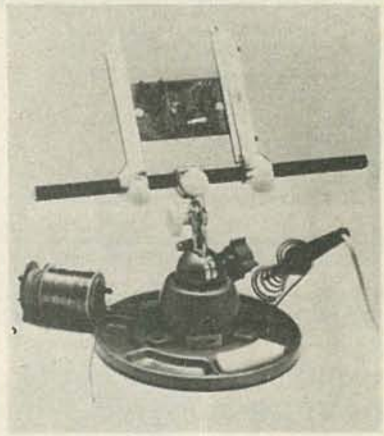


FIG. 1

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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books

More information on new books is available. Use the Free Information Card inside the back cover

GUIDEBOOK TO SMALL COMPUTERS, by William Barden, Jr. Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis, IN 46268. 127 pp. 5³⁄₈ × 8½ inch. Softcover. $4.95.

This book is for the person who may want to invest in a small computer for business or personal use. How does one choose among the many available? Here is a guidebook that will save such a person much time as well as guarding him or her from error on the basis of insufficient knowledge.

The opening chapter deals with basics common to all small computers, then gives a breakdown of types so the reader can form some sort of opinion as to which type of computer is best for his or her needs. Chapters 2 through 11 deal with 21 of the most popular computing systems presently available, from 14 manufacturers. Those are all reputable firms, so the system that seems to offer the best variety of what the buyer wants done is likely to be satisfactory.

Each system is described in terms of hardware and software. The hardware descriptions include the keyboard; display characteristics; CPU type; system bus; memory, cassette and floppy disk storage; line printers, etc. Software descriptions include BASIC interpreters for the system, assembly-language capabilities, disk operating systems, other languages, applications systems, etc. The book ends with a directory of small computer manufacturers.

CIRCLE 111 ON FREE INFORMATION CARD

Z80 INSTRUCTION HANDBOOK, by Nat Wadsworth. SCELBI Publications, P.O. Box 133 PP STN, Milford, CT 06460. 128 pp. 4¼ × 7¼ inch Softcover $4.95, + 75¢ postage.

This compact reference guide explains in simple terms the capabilities of the powerful Z80 instruction set. Industry standard mnemonics, machine codes (in octal and hexadecimal format), and usage for each Z80 instruction are implemented throughout. An appendix in the back of the book lists instructions alphabetically along with machine codes and timing data.

CIRCLE 112 ON FREE INFORMATION CARD

THE ILLUSTRATED DICTIONARY OF ELECTRONICS. TAB books, Blue Ridge Summit, PA 17214. 868 pp. 5³⁄₈ × 8¼ in. Softcover. $14.95.

Between "A" and "zymurgy" you will find over 24,000 concise and clearly-presented modern definitions of electronics/computer terms. The type is well chosen for easy reading, and the dictionary well laid out for easy access to whatever term you seek. The dictionary is supplemented by ten pages of color tables and data, which include the resistor color code, electronic symbols, wire gauge, temperature conversion, Ohm's law, conversion factors, electric/magnetic circuits, abbreviations, math symbols, math data, numerical data, and the Greek alphabet, both capitals and lower case.

CIRCLE 113 ON FREE INFORMATION CARD

THE BEGINNER'S HANDBOOK OF ELECTRONICS, by George H. Olsen (revised by Forrest M. Mims, III). Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 305 pp including index. 7 × 9½ in. Hardcover $17.95; softcover $6.95.

This book covers virtually every area of electronics in a simplified manner that will be of interest to students and beginners as well as hobbyists, experimenters, and technicians. The beginner can learn from it how to use resistors, capacitors, transistors, and the other basic building blocks of today's electronics, in everything from the simplest power amplifiers to the most sophisticated of telecommunications systems.

The broad range of subjects covered here includes the use of such components as integrated circuits and semiconductor devices in record players, radio receivers, airplane guidance systems, physical therapy machines, and many others. At the end of each chapter you will find questions to answer, which will show if you have grasped the material presented, and also a list of suggestions for further reading.

CIRCLE 114 ON FREE INFORMATION CARD

THE 8086 PRIMER, by Stephen P. Morse. Hayden Book Company, Inc., 50 Essex Street, Rochelle Park, NJ 07662. 205 pp including index. 6 × 9 inch. Softcover. $8.95.

This introduction to the architecture, system design, and programming of the 8086 microprocessor covers all its aspects. The author was the man responsible for the architecture of this first high-performance, 16-bit microprocessor, which was introduced in 1978.

There is a brief review of microprocessors in general, then a detailed description of the 8086. The 8086 is then considered as a circuit component and the reader is shown the fundamentals of designing an 8086-based computing system. The final chapters deal with 8086 assembly-language programming and 8086 high-level-language programming. There are many illustrations and examples, and appendices cover instruction set summary for the 8086, 8086 opcodes, and ASCII codes.

CIRCLE 115 ON FREE INFORMATION CARD

TRANSDUCER INTERFACING HANDBOOK, A Guide to Analog Signal Conditioning, Edited by Daniel H. Sheingold. Analog Devices, Inc., PO Box 796, Norwood, MA 02062. 231 pp. plus appendix, bibliography, device index, and general index. 5½ × 8½ in. Hardcover $14.50.

This book is about the interfacing of transducers to electrical analog circuitry in preparation for readout, further analog transmission or processing, or conversion to digital form. There is an increasing use of measurement and control in industry to improve efficiency and reduce costs, whether they are environmental, economic, or energy-related. The *transducer* is an essential link in that process, and the present volume deals with the electrical aspects of commonly used transducers that sense temperature, pressure, force, level, and flow.

The book's objective is to bridge the information gap about those matters for specialists on both sides of the interface. Nearly a hundred applications are described, and illustrated with diagrams, charts, and tables.

The 15 chapters cover: transducers as circuit elements, bridges, interference, amplifiers and signal translation, offsetting and linearizing, overall-design considerations, thermocouple applications, RTD applications, thermistor applications, IC temperature transducers, pressure-transducer interfacing, force-transducer interfacing, flowmeter interfacing, interfacing-level transducers, and an application miscellany.

CIRCLE 116 ON FREE INFORMATION CARD

service clinic

Here's more information about shutdown circuits and some related problems.

JACK DARR, SERVICE EDITOR

WE'VE TALKED ABOUT SHUTDOWN PROBlems before, but from the amount of mail I've gotten in only the last three weeks on the subject, maybe it's a good idea to do it again.

Let's go over the basics. Shutdown circuits are used in solid-state TV sets for two reasons: to protect viewers from X-rays, and to help avoid component damage if they're fast enough.

The most common shutdown circuit is called a high-voltage shutdown circuit, although it does not actually sample the high-voltage. Instead, it works from the regulated DC-voltage output of the power supply. The reason is because the high-voltage varies in direct proportion to the DC supply-voltage. If the DC supply-voltage goes up 25%, so does the high-voltage. If the voltage regulator fails in such a way that it doesn't hold the DC supply-voltage down, the high-voltage goes up, and the shutdown circuit triggers—or, at least, is supposed to.

That gives us a good starting point for our tests. Always read the regulated DC-output of the power supply first! If it's too high, and the set is shut down, there is a simple way to isolate the problem. Plug the set into a Variac. Monitor the regulated DC-voltage and bring the line voltage up slowly. Let's say that the DC-voltage should be +120 volts, a common figure. See if you can get the DC-voltage to that normal level and then check the set to see if it works. If it does, you have cleared all of the other circuits and the fault is in the voltage regulator.

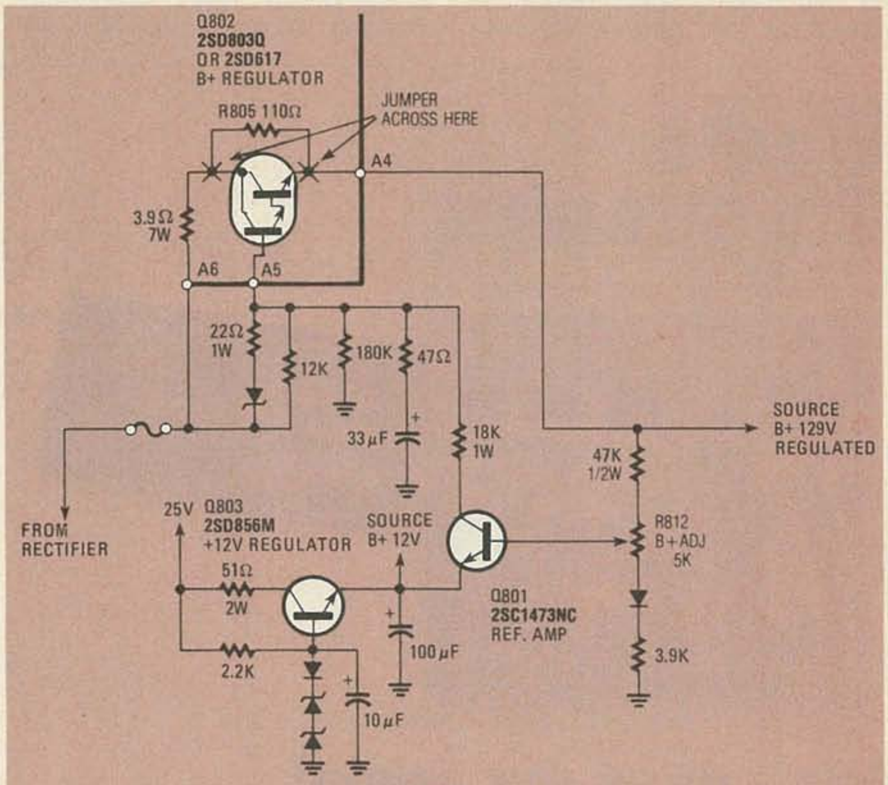


FIG. 1

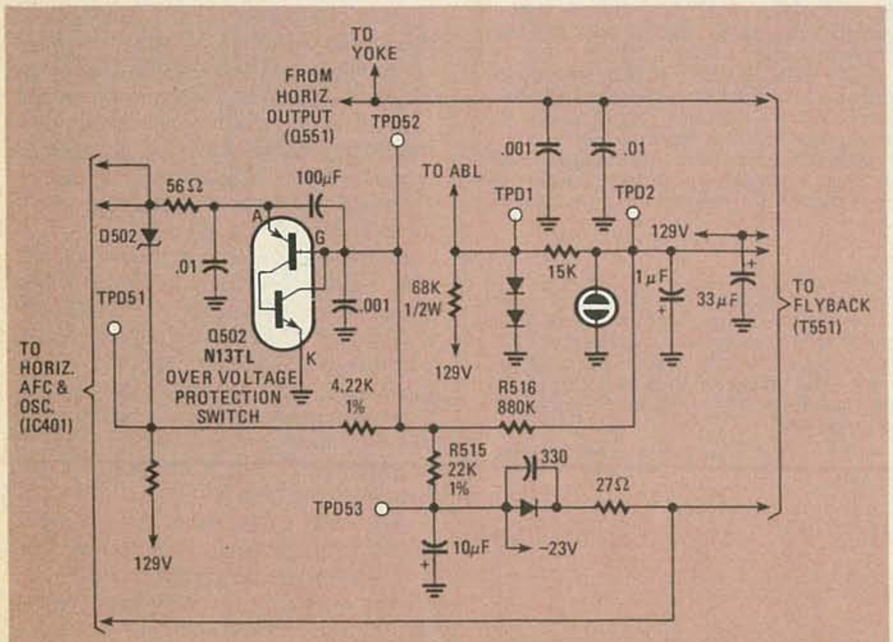


FIG. 2

Most shutdowns do just that—shut the set off entirely. There is no high-voltage and sometimes no sound. But some shutdown circuits do tricks. RCA's shutdowns throw the horizontal oscillator far off frequency so that the set can't be used (although there will still be a raster). Some Admirals use a "pulsing" circuit; the raster and sound will flash on once per second. If you see any kind of odd symptom, check the service data to see if it means that the shutdown circuit has been triggered.

A lot of shutdown circuits use an SCR. One common use for this type is to kill the drive to the horizontal-output stage. Some kill the DC-voltage supply; others short the drive signal to ground.

Either way, the horizontal-output stage has no drive, and should be cut off. If an SCR is used, check the DC voltage on it. Many have a DC voltage on the anode; if the SCR has fired, there will be no voltage at all here. Most of them do latch, and you must turn off the set, wait a few minutes, and then turn it on again. Some sets need a wait of a minute or two, to let a capacitor in the gate circuit discharge.

If turning the set back on lets it start up, work a short time, and then trip again; the problem is still there. Look for faulty transistors, shorted capacitors, and bad diodes on any of the flyback-device DC-voltage supplies. Some sets use a transistor for shutdown intead of the SCR. The result is still the same: the transistor is biased off until a fault occurs, then conducts and shorts something out to kill the high-voltage. Look for a leaky transistor in such circuits.

The service data should tell you how to check the shutdown circuits for normal operation. For example, with the *Quasar* TS-976 chassis, a Variac is used for testing. The voltage regulator is disabled by shunting a clip-lead across the shunt resistor (R805—see Fig. 1) on the pass transistor. The line voltage is then raised slowly while monitoring the high-voltage. Shutdown should occur just before the high-voltage reaches 31 kilovolts. The ABL (*A*utomatic *B*rightness *L*imiter) voltage should be monitored at the same time. (Motorola put a pair of handy test points for monitoring the ABL voltage on the back of the chassis. They are marked TPD1 and TPD2 (see Fig. 2) and the DC voltage across them should not be more than +37.5 volts.)

For the final check, the shunt should be taken off the regulator, and the line voltage raised to 130 volts AC. The shutdown should not trip if the regulator circuit is working as it should. For another test, the regulated DC-voltage output, +129 volts, should be monitored. If this is considerably off, the B+ regulator-adjust, R812, should be replaced. The original is factory-sealed and its setting can't be changed. If parts in the DC power supply or regulator have been replaced, and the B+ won't hold within limits, set the B+ to the correct value with the new regulator-adjust and then seal the control to prevent tampering. If the shutdown circuit itself is suspected, it can be defeated by jumpering a pair of test-points, TPD51/TPD52. The shutdown in the TS-976 is a Darlington transistor, Q502, and is labeled "Overvoltage Protection Switch."

There are quite a few other things that can cause shutdown, particularly in sets using SCR's. Stray arcing in the high-voltage section causes transients and shutdown. A friend ran into a couple of odd ones a while back. The complaint in both cases was: "It goes 'Pow,' then quits!" That didn't happen instantly, but several minutes after turn-on. Oddly enough, both were in the same chassis, an older Quasar. The cause in both cases was an arc from the ultor button of the tube to the shield.

In the first, no apparent cause was found. The owner said: "It only does this in the evenings." After some head scratching, my friend noticed there was an open-flame gas heater in the room. The cause of the arcing turned out to be moisture generated by it condensing on the glass of the bell, around the ultor. A thorough cleaning with alcohol and a good polishing cleared it up.

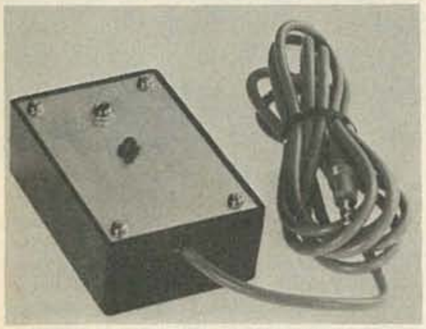
In the second, the glass around the ultor looked odd and a finger wiped along the glass came off very black! My friend asked the owner if he used a wood-burning heater; he did. Once again, a good cleaning with alcohol fixed the problem. The black was plain old *soot* that was deposited on the tube because of the high electrostatic potential on the chassis.

Any kind of transient may cause a shutdown: lightning, an arc in the set, or even turning an appliance on or off. If that happens, the shutdown circuit should be checked; it may be just a little "eager!" **R-E**

computer products

More information on computer products is available. Use the Free Information Card inside the back cover.

SIGNAL PROCESSOR, the *Compuloader,* is a signal processor that eliminates many of the problems associated with loading programs from cassette tape. It is self-powered and plugs directly into the miniature phone-plug output jack of the cassette recorder. The computer input line



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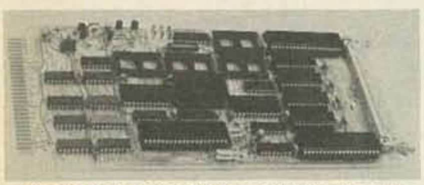
then plugs into it. To use, the recorder output level is turned up until LED glows to indicate that the signal level is high enough to be processed into the computer. The *Compuloader* sells for \$12.95. prepaid or \$14.95 if shipped C.O.D.—**Sound Concepts, Inc.,** P.O. Box 135, Brookline, MA 02146.

SINGLE-BOARD COMPUTER, the *ICB-85*, is designed as an instrument or remote-processing controller. It uses the 8085A processor with up to 16K bytes of ROM, 512 bytes of CMOS RAM, and has capability for expansion through the STD BUS. The CMOS RAM can be battery backed-up with three AA-size batteries to retain data for over two years. The board can accommodate five different PROM's: 2708, 2758, 2716, 2732, and



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2516. The type of PROM is configured via a jumper block specific to the PROM being used, and four sockets are provided on the *ICB-85* for the PROM's. Two 8255A's are used to give 48 parallel I/O lines. In addition, two serial I/O lines are available from the 8085A. Power requirement is +5V at 750 mA, plus power for the ROM's. The price for the *ICB-85* in 100-unit quantity is \$290; price for a single unit is \$390.—**Trebor Industries, Inc.,** Computer Products Group, P.O. Box 2276, Gaithersburg, MD 20760.

LEVEL II 16K COMPUTER, the *PMC-80*, is a software and hardware compatible equivalent of the Radio Shack *TRS-80 Model I*, Level II computer. It includes a cassette tape recorder, 16K RAM memory, Level II Microsoft BASIC interpreter in ROM, power supply, computer and keyboard all housed in one cabinet. The *PMC-80* will display on either a TV monitor or on a standard TV set

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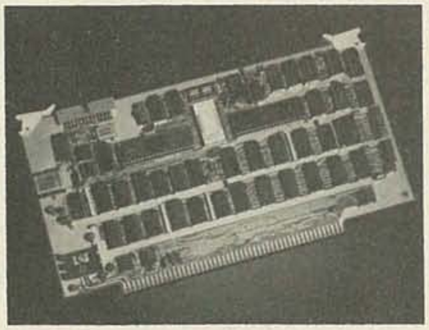
using a built-in VHF Channel-3 modulator. All software available for the *TRS-80* will operate in the *PMC-80* and Level II BASIC or system cassettes will load in this model without volume adjustment. Disk-based programs can also run on the *PMC-80* using the Radio Shack Expansion Interface with all peripherals for the *TRS-80* compatible with the *PMC-80* including speech recognition, printers, RS-232 adapters, etc. Price is \$595 with modulator.—**Personal Micro Computers, Inc.,** 474 Ellis St., Mountain View, CA 94043.

Z-80 CPU BOARD, the *2810*, is designed for use in S-100 systems. It features several user-selectable options enabled by easy-to-configure Berg jumpers. Those options include an RS-232C serial I/O port that can be used for a console interface. The number of bits per word, parity, number of stop bits, and baud rate are all software-selectable, while the serial port's address is jumper-selectable. Other options are I/O address mirroring, a power-on jump to any location in 64K, and M1 wait states.



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Regular features of the board include a jumper-enabled 2K ROM with monitor firmware. The monitor features an auto-baud select, allowing the serial port to match any baud rate from 2 to 56K baud set at the console. A switch allows the user to select a clock rate of 2 or 4 MHz. The *2810* also features separate crystal control of the CPU and baud rate IC's and LED's to indicate a Halt state, ROM Enabled, and Interrupt Enabled. Suggested retail price is $300.00.—**California Computer Systems,** 250 Caribbean Dr., Sunnyvale, CA 94086.

POCKET-SIZED COMPUTER, the *TRS-80 Pocket Computer*, features a large 24-character LCD display with English-language prompting and BASIC programming, and includes a 1.9K random access memory that retains information for the 300-hour life of its internal batteries. Pre-programmed tapes available for the *Pocket Computer* include real estate, civil engineering, personal finances, aviation, a math drill, and a games pack, and can be loaded with an optional cassette interface. The *TRS-80 Pocket Computer*

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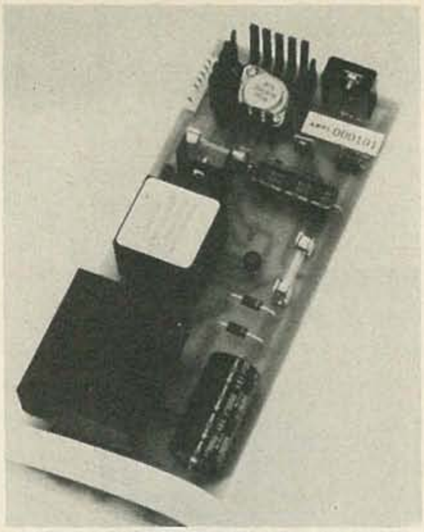
can also be used as a calculator—numbers may be edited, stored, reviewed, and placed in mathematical equations with up to 15 levels of parenthesis. The unit weighs six ounces and is less than seven inches long. Suggested retail price is $249.95 and the optional cassette interface is $49.00.—**Radio Shack,** 1800 One Tandy Ctr., Fort Worth, TX 76102.

POWER SUPPLY, the *AIM-Mate Power Supply*, is designed to power a complete AIM microcomputer system, such as the *AIM 65, Memory-Mate,*



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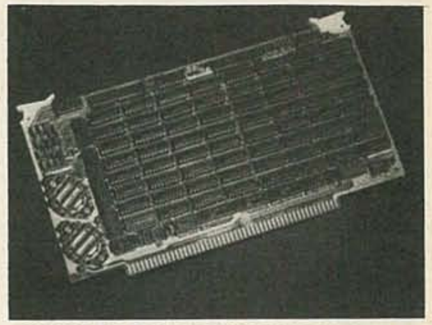
Video-Mate, and *Floppy-Mate*. The supply is 2¼ inches tall, slim enough to fit into many custom enclosures, as well as the *AIM-Mate* case. The 4 × 10 inch unit provides 5 volts at 3.5 amps, 12 volts at 200 milliamps, and 24 volts at .5 amp. For use with either 115 or 230 volts AC input, the supply includes short-circuit and overvoltage protection. The price of the *AIM-Mate Power Supply* (including shipping in U.S.A. only) is $79.00.—**Forethought Products,** 87070 Dukhobar Rd., Eugene, OR 97402.

STATIC MEMORY BOARD, *model 2032*, provides 32K of memory for S-100 systems and features a flexible bank-select scheme for memory expansion up to 512K.

The *model 2032* is selected when a byte indicating its bank is written to the bank port. Both the bank-port address and the bank(s) in which the board will reside, are jumper-selectable. The bank-select scheme is compatable with Alpha-Micro, Cromemco, and others.

The 32K of memory is divided in four 8K blocks, which are independently jumper-addressable to any 8K boundary in 64K. Each 8K block can be made independent of bank selection, while bank-dependent memory can be jumpered to come up active on power-on and reset. Further flexibility is provided by a jumper-selectable PHANTOM input, allowing byte-by-byte overlay of the *model 2032's* memory, and an MWRITE input that allows front-panel memory deposits. There are no DMA restrictions.



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Available with 200-, 300-, and 450-nanosecond RAM's, the *model 2032* can operate at 4 MHz without wait states. Jumper-selectable wait-state generation is provided however, insuring compatibility of the slower RAM's with even the fastest CPU's.

The *model 2032* comes completely assembled, burned-in, and tested for a suggested retail price of $700.00.—**California Computer Systems,** 250 Caribbean Drive, Sunnyvale, CA 94086. **R-E**

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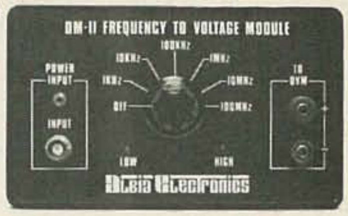

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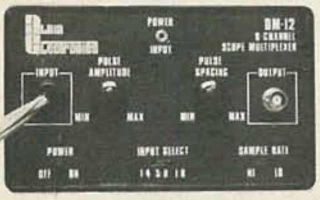

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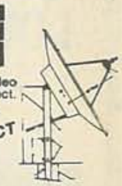

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CD4016BE	.32	CD4060BE	.89	CD4528BE	.72
CD4017BE	.54	CD4066BE	.48	CD4531BE	.84
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CD4019BE	.48	CD4069BE	.18	CD4539BE	.59
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CD4023BE	.19	CD4073BE	.24	CD4556BE	.58
CD4024BE	.44	CD4075BE	.24	CD4581BE	1.89
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CD4026BE	1.45	CD4078BE	.24	CD4584BE	.42
CD4027BE	.42	CD4081BE	.18	CD4585BE	.79
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LED212	T-1 3 mm Yellow	.14
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2N706	.29	2N3771	1.29	2N3706	.099	2N4410	.15	2N5772	.14	MPSA43	.16
2N1613	.29	2N3772	1.29	2N3710	.099	2N5087	.12	PN2222A	.089	MPSA56	.12
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2N1893	.29	2N6133	.56	2N3906	.069	2N5172	.12	PN2907A	.089	MPSA92	.14
2N2222A	.19	2N6489	1.25	2N3907	.099	2N5220	.14	PN3565	.12	MPSA93	.12
2N2369A	.22	2N6545	4.75	2N4123	.075	2N5221	.14	PN3567	.12	MPSA14	.12
2N2484	.24	2N3439	.78	2N4124	.075	2N5223	.14	PN4249	.12	MPS2925	.12
2N2905A	.39	2N6059	2.45	2N4125	.075	2N5226	.14	PN5138	.099	MPS2926	.12
2N2907A	.19	2N6055	1.45	2N4126	.075	2N5227	.14	MPSA05	.12	MPS3391	.12
2N3053	.29	2N6079	3.85	2N4401	.079	2N5401	.15	MPSA06	.12	MPS3392	.12
						2N5550	.12	MPSA13	.12	MPS3393	.12
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7401N	.22	74247N	1.24	74LS55N	.24
7402N	.24	74251N	.76	74LS73N	.32
7403N	.24	74259N	1.89	74LS74N	.32
7404N	.24	74273N	1.99	74LS75N	.35
7405N	.24	74276N	.98	74LS76N	.38
7406N	.36	74278N	2.38	74LS78N	.29
7407N	.36	74279N	.59	74LS83N	.69
7408N	.24	74283N	.98	74LS85N	.84
7409N	.24	74293N	.72	74LS86N	.38
7410N	.24	74298N	.84	74LS90N	.39
7412N	.36	74351N	2.20	74LS91N	.89
7413N	.39	74365AN	.58	74LS92N	.48
7414N	.39	74366N	.69	74LS93N	.39
7416N	.36	74367AN	.58	74LS95N	.48
7417N	.36	74368AN	.58	74LS96N	.58
7420N	.29	74390N	.96	74LS107N	.36
7422N	.36	74393N	1.29	74LS109N	.36
7423N	.36			74LS112N	.36
7425N	.32	74S00N	.36	74LS122N	.48
7426N	.39	74S02N	.38	74LS123N	.59
7427N	.32	74S03N	.38	74LS125N	.44
7428N	.42	74S04N	.44	74LS126N	.44
7430N	.22	74S05N	.48	74LS132N	.52
7432N	.39	74S08N	.48	74LS133N	.98
7433N	.39	74S09N	.59	74LS136N	.42
7437N	.36	74S10N	.48	74LS138N	.48
7438N	.36	74S11N	.48	74LS139N	.48
7440N	.22	74S15N	.48	74LS145N	1.09
7442N	.44	74S20N	.48	74LS147N	1.98
7445N	.84	74S30N	.36	74LS148N	1.36
7446N	.84	74S32N	.64	74LS151N	.42
7447AN	.65	74S37N	.89	74LS153N	.35
7450N	.22	74S38N	.89	74LS155N	.67
7451N	.29	74S40N	.39	74LS156N	.72
7453N	.29	74S51N	.48	74LS157N	.48
7454N	.29	74S74N	.58	74LS158N	.48
7472N	.36	74S85N	1.98	74LS160N	.69
7473N	.36	74S86N	.72	74LS161N	.58
7474N	.36	74S112N	.72	74LS162N	.72
7475N	.39	74S114N	1.29	74LS163N	.58
7476N	.38	74S124N	2.56	74LS164N	.58
7483AN	.48	74S132N	1.24	74LS165N	.89
7484AN	1.36	74S133N	.48	74LS166N	1.64
7485N	.66	74S134N	.54	74LS170N	1.59
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7490AN	.32	74S138N	.96	74LS174N	.39
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74100N	1.38	74S162N	3.70	74LS194N	.64
74104N	.64	74S163N	3.54	74LS196N	.88
74107AN	.44	74S168N	4.45	74LS197N	.88
74109N	.44	74S169N	4.45	74LS221N	.89
74110N	.45	74S174N	.96	74LS240N	.89
74111N	.58	74S175N	.96	74LS241N	.89
74116N	1.20	74S181N	3.95	74LS242N	.89
74120N	1.25	74S182N	1.69	74LS243N	.89
74121N	.48	74S189N	4.45	74LS244N	.89
74122N	.52	74S194N	1.68	74LS245N	1.65
74123N	.48	74S195N	1.68	74LS247N	.76
74125N	.48	74S201N	5.85	74LS248N	1.09
74126AN	.48	74S225N	4.95	74LS249N	.96
74128N	.64	74S240N	2.95	74LS251N	.54
74132N	.45	74S241N	2.95	74LS253N	.54
74136N	.52	74S244N	2.95	74LS257N	.56
74141N	.84	74S251N	1.19	74LS258N	.56
74142N	2.98	74S253N	1.95	74LS259N	1.29
74143N	3.44	74S257N	1.09	74LS260N	.89
74144N	3.44	74S258N	1.09	74LS266N	.36
74145N	.67	74S260N	.98	74LS273N	1.19
74147N	1.24	74S274N	15.85	74LS275N	3.95
74148N	.89	74S275N	15.85	74LS279N	.48
74150N	1.25	74S280N	1.98	74LS280N	1.98
74151N	.42	74S283N	2.95	74LS283N	.78
74153N	.36	74S299N	5.85	74LS290N	.72
74154N	1.29	74S373N	2.98	74LS293N	.38
74155N	.48	74S374N	2.98	74LS298N	.88
74157N	.48	74S381N	5.95	74LS299N	2.50
74159N	1.52	74S412N	2.98	74LS320N	2.75
74160N	.48	74S471N	6.45	74LS321N	3.95
74161AN	.64	74S472N	8.45	74LS322N	4.95
74162N	.64	74S474N	9.65	74LS323N	4.95
74163AN	.64	74S476N	5.95	74LS324N	2.50
74164N	.64			74LS348N	2.65
74165N	.64	74LS00N	.17	74LS352N	1.35
74166N	.68	74LS01N	.17	74LS353N	1.65
74170N	1.98	74LS02N	.22	74LS362N	9.95
74172N	4.95	74LS03N	.22	74LS365N	.52
74173N	.79	74LS04N	.22	74LS366N	.52
74174N	.58	74LS05N	.22	74LS367N	.52
74175N	.58	74LS08N	.17	74LS368N	.52
74176N	.76	74LS09N	.24	74LS373N	1.25
74178N	1.09	74LS10N	.19	74LS374N	1.25
74179N	1.09	74LS11N	.24	74LS375N	.64
74180N	.75	74LS12N	.24	74LS377N	1.25
74182N	.52	74LS13N	.25	74LS378N	.99
74184N	2.36	74LS14N	.39	74LS379N	1.09
74185N	2.36	74LS20N	.18	74LS390N	.98
74190N	.68	74LS21N	.18	74LS393N	.98
74191N	.68	74LS26N	.39	74LS395N	1.19
74192N	.68	74LS27N	.29	74LS447N	.37
74193N	.64	74LS30N	.18	74LS490N	1.89
74194N	.64	74LS32N	.29	74LS630N	85.00
74195N	.48	74LS37N	.29	74LS669N	.84
74196N	.78	74LS38N	.29	74LS670N	1.64
74197N	.72	74LS42N	.44		
74198N	1.39	74LS47N	.68		
74199N	1.39	74LS48N	.99		
74221N	.68	74LS51N	.21		

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SN7404N	.25
SN7405N	.29
SN7406N	.35
SN7407N	.35
SN7408N	.29
SN7409N	.29
SN7410N	.25
SN7411N	.29
SN7412N	.35
SN7413N	.40
SN7414N	.69
SN7416N	.29
SN7417N	.29
SN7420N	.25
SN7421N	.29
SN7422N	.45
SN7423N	.29
SN7425N	.29
SN7426N	.29
SN7427N	.29
SN7428N	.49
SN7430N	.25
SN7432N	.29
SN7437N	.25
SN7438N	.40
SN7439N	.25
SN7440N	.20
SN7441N	.89
SN7442N	.59
SN7443N	1.10
SN7444N	1.10
SN7445N	.89
SN7446N	.79
SN7447N	.69
SN7448N	.79
SN7450N	.20
SN7451N	.20
SN7453N	.20
SN7454N	.20
SN7459A	.25
SN7460N	.20
SN7470N	.29
SN7472N	.29
SN7473N	.35
SN7474N	.35
SN7475N	.49
SN7476N	.35
SN7479N	5.00
SN7480N	.50
SN7482N	.99
SN7483N	.69
SN7485N	.89
SN7486N	.35
SN7489N	1.75
SN7490N	.49
SN7491N	.59
SN7492N	.45
SN7493N	.45
SN7494N	.69
SN7495N	.69
SN7496N	.69
SN7497N	3.00
SN74100N	1.49
SN74107N	.35
SN74109N	.39
SN74116N	1.95
SN74121N	.39
SN74122N	.55
SN74123N	.59
SN74125N	.49
SN74126N	.49
SN74132N	.75
SN74136N	.75
SN74141N	.99
SN74142N	3.25
SN74143N	3.49
SN74144N	3.49
SN74145N	.79
SN74147N	1.95
SN74148N	1.29
SN74150N	1.25
SN74151N	.69
SN74152N	.69
SN74153N	.79
SN74154N	1.25
SN74155N	.79
SN74156N	.79
SN74157N	.69
SN74160N	.89
SN74161N	.89
SN74162N	.89
SN74163N	.89
SN74164N	.89
SN74165N	.89
SN74166N	1.25
SN74167N	2.79
SN74170N	1.95
SN74172N	4.95
SN74173N	1.39
SN74174N	.99
SN74175N	.89
SN74176N	.79
SN74177N	.79
SN74179N	1.49
SN74180N	.79
SN74181N	2.25
SN74182N	.79
SN74184N	2.49
SN74185N	2.49
SN74190N	1.25
SN74191N	1.25
SN74192N	.89
SN74193N	.89
SN74194N	.89
SN74195N	.69
SN74196N	.89
SN74197N	.89
SN74198N	1.49
SN74199N	1.49
SN74221N	1.25
SN74251N	.99
SN74276N	1.95
SN74279N	.79
SN74283N	1.49
SN74284N	3.95
SN74285N	3.95
SN74365N	.69
SN74366N	.69
SN74367N	.69
SN74368N	.69
SN74390N	1.49
SN74393N	1.49

74LS

Part	Price
74LS00	.29
74LS01	.29
74LS02	.29
74LS03	.29
74LS04	.35
74LS05	.35
74LS08	.29
74LS09	.35
74LS10	.29
74LS11	.75
74LS12	.35
74LS13	.59
74LS14	.99
74LS15	.35
74LS20	.29
74LS21	.35
74LS22	.35
74LS26	.35
74LS27	.35
74LS28	.35
74LS30	.29
74LS32	.35
74LS33	.59
74LS37	.45
74LS38	.45
74LS40	.35
74LS42	.89
74LS47	.89
74LS48	1.15
74LS49	1.15
74LS51	.29
74LS54	.29
74LS55	.29
74LS73	.45
74LS74	.45
74LS75	.59
74LS76	.45
74LS78	.45
74LS83	.89
74LS85	1.25
74LS86	.45
74LS90	.59
74LS92	.75
74LS93	.75
74LS95	.99
74LS96	1.15
74LS107	.45
74LS109	.45
74LS112	.45
74LS113	.45
74LS114	.49
74LS122	.89
74LS123	1.25
74LS125	.89
74LS126	.55
74LS132	.99
74LS133	.89
74LS136	.49
74LS138	.89
74LS139	.89
74LS151	.89
74LS153	.89
74LS154	1.75
74LS155	1.19
74LS156	1.19
74LS157	.89
74LS158	.99
74LS160	1.15
74LS161	1.15
74LS162	1.15
74LS163	1.15
74LS164	1.25
74LS165	1.25
74LS168	1.19
74LS169	1.19
74LS170	2.49
74LS173	1.39
74LS174	.99
74LS175	.99
74LS181	2.95
74LS190	1.25
74LS191	1.25
74LS192	1.15
74LS193	1.15
74LS194	1.15
74LS195	1.15
74LS197	1.19
74LS221	1.19
74LS240	1.95
74LS241	1.95
74LS242	1.95
74LS243	1.95
74LS244	1.95
74LS245	2.95
74LS247	1.19
74LS248	1.19
74LS249	1.19
74LS251	1.49
74LS253	.99
74LS257	.89
74LS258	.89
74LS260	.69
74LS266	.69
74LS273	1.95
74LS279	.75
74LS283	1.09
74LS290	.99
74LS293	.99
74LS298	1.25
74LS352	1.29
74LS353	1.29
74LS365	.75
74LS366	.75
74LS367	.75
74LS368	.75
74LS373	1.95
74LS374	1.95
74LS375	.89
74LS386	.69
74LS393	2.49
74LS399	2.49
74LS670	2.49
81LS95	1.95
81LS97	1.95

74S

Part	Price
74S00	.50
74S02	.50
74S03	.50
74S04	.55
74S05	.55
74S08	.50
74S09	.50
74S10	.50
74S11	.50
74S15	.50
74S20	.50
74S22	.50
74S30	.50
74S32	.55
74S38	.69
74S40	.50
74S51	.50
74S64	.50
74S65	.50
74S74	.79
74S86	.79
74S112	.79
74S113	.79
74S114	.79
74S124	2.49
74S133	.55
74S134	.69
74S135	1.19
74S136	1.75
74S138	1.35
74S139	1.35
74S140	1.15
74S151	1.35
74S153	1.35
74S157	1.35
74S158	1.35
74S160	1.95
74S174	1.59
74S175	1.59
74S188	4.95
74S194	1.95
74S195	1.95
74S196	3.95
74S240	2.95
74S241	2.95
74S242	3.15
74S243	3.25
74S244	3.25
74S251	1.45
74S253	1.45
74S257	1.35
74S258	1.35
74S260	.79
74S280	2.95
74S287	4.95
74S288	4.95
74S373	3.49
74S374	3.49
74S387	5.95
74S471	19.95
74S472	19.95
74S473	19.95
74S474	21.95
74S475	21.95
74S570	7.95
74S571	7.95
74S572	19.95
74S573	19.95
74S940	3.15
74S941	3.15

CA—LINEAR

Part	Price
CA3010H	1.07
CA3013H	2.15
CA3023H	3.25
CA3035H	2.48
CA3039H	1.35
CA3046N	1.30
CA3059N	3.25
CA3060N	3.25
CA3080H	1.25
CA3081N	2.00
CA3082N	2.00
CA3083N	1.60
CA3086N	.85
CA3089N	3.75
CA3096N	3.95
CA3130H	1.39
CA3140H	1.25
CA3160H	1.25
CA3401N	.59
CA3600N	3.50

CD—CMOS

Part	Price
CD4000	.39
CD4001	.39
CD4002	.39
CD4006	1.19
CD4007	.25
CD4009	.49
CD4010	.49
CD4011	.39
CD4012	.25
CD4013	.49
CD4014	1.39
CD4015	1.19
CD4016	.59
CD4017	1.19
CD4018	.99
CD4019	.49
CD4020	1.19
CD4021	1.39
CD4022	1.19
CD4023	.29
CD4024	.79
CD4025	.29
CD4026	2.95
CD4027	.69
CD4028	.89
CD4029	1.49
CD4030	.49
CD4034	3.49
CD4035	.99
CD4040	1.49
CD4041	1.49
CD4042	.99
CD4043	.89
CD4044	.89
CD4046	1.79
CD4047	2.50
CD4048	1.35
CD4049	.49
CD4050	.69
CD4051	1.19
CD4052	1.19
CD4053	1.19
CD4056	2.95
CD4059	9.95
CD4060	1.49
CD4066	.79
CD4068	.39
CD4069	.45
CD4070	.55
CD4071	.49
CD4072	.49
CD4073	.39
CD4075	.39
CD4076	1.39
CD4078	.55
CD4081	.39
CD4082	.39
CD4093	.99
CD 4098	2.49
CD4506	.75
CD4507	.99
CD4508	3.95
CD4510	1.39
CD4511	1.29
CD4512	1.49
CD4514	3.95
CD4515	2.95
CD4516	1.39
CD4518	1.79
CD4519	.89
CD4520	1.29
CD4526	1.79
CD4528	1.79
CD4529	1.95
CD4543	2.79
CD4562	11.95
CD4566	2.79
CD4583	2.49
CD4584	.75
CD4723	1.95
CD4724	1.95
MC14409	14.95
MC14410	14.95
MC14411	14.95
MC14412	11.95
MC14419	4.95
MC14433	13.95
MC14538	2.49
MC14541	1.95

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DIP JUMPERS

- Mate with Standard IC Sockets
- Fully Assembled and Tested
- Integral Molded-On Strain Relief
- Line-By-Line Probeability

Dip Jumpers are used for jumpering within a PC Board; interconnecting between PC Boards, backplanes and mother boards; and interfacing input/output signals.

Part Number	No. of contacts	Description	Wire Length	Price
924102-12	14	single end	12"	$1.51
924102-24	14	single end	24"	1.92
924102-36	14	single end	36"	2.33
924106-12	14	double end	12"	2.61
924106-24	14	double end	24"	3.02
924106-36	14	double end	36"	3.43
924112-12	16	single end	12"	1.67
924112-24	16	single end	24"	2.13
924112-36	16	single end	36"	2.58
924116-12	16	double end	12"	2.88
924116-24	16	double end	24"	3.34
924116-36	16	double end	36"	3.83
924122-12	24	single end	12"	2.60
924122-24	24	single end	24"	3.30
924122-36	24	single end	36"	4.00
924126-12	24	double end	12"	4.50
924126-24	24	double end	24"	5.20
924126-36	24	double end	36"	5.90
924132-12	40	single end	12"	4.35
924132-24	40	single end	24"	5.53
924132-36	40	single end	36"	6.71

DISCRETE LEDS

XC556R	.200" red	5/$1
XC556G	.200" green	4/$1
XC556Y	.200" yellow	4/$1
XC556C	.200" clear	4/$1
XC22R	.200" red	5/$1
XC22G	.200" green	4/$1
XC22Y	.200" yellow	4/$1
MV10B	.170" red	4/$1
MV50	.085" red	6/$1
XC209R	.125" red	5/$1
XC209G	.125" green	4/$1
XC209Y	.125" yellow	4/$1
XC526R	.185" red	5/$1
XC526G	.185" green	4/$1
XC526Y	.185" yellow	4/$1
XC526C	.185" clear	4/$1
XC111R	.190" red	5/$1
XC111G	.190" green	4/$1
XC111Y	.190" yellow	4/$1
XC111C	.190" clear	4/$1

XC556 RED LED, METAL MTG. HDW. 2-6" LEADS.
RL-2 . . $.39 ea. or 3/$1.00

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C.A. — Common Anode   C.C. — Common Cathode

Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95
MAN 2	5x7 D.M.—red	.300	4.95
MAN 3	C.C.—red	.125	.25
MAN 52	C.A.—green	.300	1.25
MAN 54	C.C.—green	.300	1.25
MAN 71	C.A.—red	.300	.75
MAN 72	C.A.—red	.300	.75
MAN 74	C.C.—red	.300	1.25
MAN 82	C.A.—yellow	.300	.49
MAN 84	C.C.—yellow	.300	.99
MAN 3620	C.A.—orange	.300	.49
MAN 3630	C.A.—orange ± 1	.300	.99
MAN 3640	C.C.—orange	.300	.99
MAN 4610	C.A.—orange	.400	.99
MAN 6610	C.A.—orange—DD	.560	.99
MAN 6630	C.A.—orange ± 1	.560	.99
MAN 6640	C.C.—orange—DD	.560	.99
MAN 6650	C.C.—orange ± 1	.560	.99
MAN 6660	C.A.—orange	.560	.99
MAN 6710	C.A.—red—DD	.560	.99
MAN 6750	C.C.—red ± 1	.560	.99
MAN 6780	C.C.—red	.560	.99
DLO304	C.C.—orange	.300	1.25
DLO307	C.A.—orange	.300	1.25
DLG500	C.C.—green	.500	1.25
DLG507	C.A.—green	.500	1.25
DL704	C.C.—red	.300	1.25
DL707	C.A.—red	.300	1.25
DL728	C.C.—red	.500	1.49
DL741	C.A.—red	.600	1.25
DL746	C.A.—red ± 1	.630	1.49
DL747	C.A.—red	.600	1.49
DL750	C.C.—red	.600	1.49
DLO847	C.A.—orange	.800	1.49
DLO850	C.C.—orange	.800	1.49
DL33B	C.C.—red	.110	.35
FND358	C.C. ± 1	.357	.99
FND359	C.C.	.357	.75
FND503	C.C. (FND500)	.500	.99
FND507	C.A. (FND510)	.500	.99
HDSP-3401	C.A.—red	.800	1.50
HDSP-3403	C.C.—red	.800	1.50
5082-7751	C.A., R.H.D.—red	.430	1.25
5082-7760	C.C., R.H.D.—red	.430	1.75
5082-7300	4x7 sgl. dig. RHD	.600	22.00
5082-7302	4x7 sgl. dig. LHD	.600	22.00
5082-7304	Overnge. char. (±1)	.600	19.95
4N28	Photo Xsistor Opto-Isol.		.99
LIT-1	Photo Xsistor Opto-Isol.		.69
MOC3010	Optically Isol. Triac Driver		1.25

SOCKETS — Test TEXTOOL Sockets — RECEPTACLES

ZERO INSERTION FORCE

Sockets:
* Nickel Boron Plating
* G.F. PSF Plastic Body
* For testing IC's

Part No.	Pins	Price
214-3339	14 pin	5.95
216-3340	16 pin	6.49
218-3341	18 pin	7.95
220-3342	20 pin	8.95
222-3343	22 pin	9.95
224-3344	24 pin	9.75
228-3345	28 pin	11.95
240-3346	40 pin	12.95

Receptacles:
* Nickel Boron Plating
* G.F. PSF Plastic Body
* Wire Wrap Contacts

Part No.	Pins	Price
214-3592	14 pin	9.75
216-3593	16 pin	9.95
218-3594	18 pin	10.95
220-3595	20 pin	11.95
222-3596	22 pin	12.95
224-3597	24 pin	12.75
228-3598	28 pin	13.95
240-3599	40 pin	15.95

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
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7206CEV/Kit*	Tone Generator Chip, XTL	9.95
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7207AEV/Kit*	Freq. Counter Chip, XTL	11.10
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74C163	1.69
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74C173	1.39
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LM309H	1.95
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LM340K-12	1.35
LM340K-15	1.35
LM340T-5	1.25
LM340T-12	1.25
LM340T-15	1.25
LM341P-5	.75
LM341P-12	.75
LM341P-15	.75
LM342P-5	.69
LM342P-12	.69
LM342P-15	.69
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LM350K	5.75
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.047mf	.21	.17	.13
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10/25V	.18	.15	.11
10/50V	.19	.16	.12
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22/50V	.24	.20	.18
47/25V	.25	.21	.19
47/50V	.29	.25	.23
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1.0/50V	.17	.15	.14
4.7/16V	.15	.13	.12
4.7/25V	.16	.14	.13
4.7/50V	.17	.15	.14
10/16V	.15	.13	.12
10/25V	.16	.14	.13
10/50V	.17	.15	.14
47/50V	.25	.21	.19
100/16V	.21	.17	.14
100/25V	.25	.23	.21
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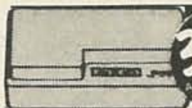

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PRICES

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The CT-90 is the most versatile, feature packed counter available for less than $300.00! Advanced design features include; three selectable gate times, nine digits, gate indicator and a unique display hold function which holds the displayed count after the input signal is removed! Also, a 10mHz TCXO time base is used which enables easy zero beat calibration checks against WWV. Optionally; an internal nicad battery pack, external time base input and Micro-power high stability crystal oven time base are available. The CT-90, performance you can count on!

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 10 MV to 150 MHz Less than 50 MV to 500 MHz
Resolution:	0.1 Hz (10 MHz range) 1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	9 digits 0.4" LED
Time base:	Standard-10.000 mHz, 1.0 ppm 20-40°C. Optional Micro-power oven-0.1 ppm 20-40°C
Power:	8-15 VAC @ 250 ma

7 DIGITS 525 MHz $99.95 WIRED

SPECIFICATIONS:

Range:	20 Hz to 525 MHz
Sensitivity:	Less than 50 MV to 150 MHz Less than 150 MV to 500 MHz
Resolution:	1.0 Hz (5 MHz range) 10.0 Hz (50 MHz range) 100.0 Hz (500 MHz range)
Display:	7 digits 0.4" LED
Time base:	1.0 ppm TCXO 20-40°C
Power:	12 VAC @ 250 ma

The CT-70 breaks the price barrier on lab quality frequency counters. Deluxe features such as; three frequency ranges - each with pre-amplification, dual selectable gate times, and gate activity indication make measurements a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1.0 ppm accuracy - that's .0001%! The CT-70 is the answer to all your measurement needs, in the field, lab or ham shack.

PRICES:

CT-70 wired, 1 year warranty	$99.95
CT-70 Kit, 90 day parts warranty	84.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC adapter/charger	12.95

7 DIGITS 500 MHz $79.95 WIRED

PRICES:

MINI-100 wired, 1 year warranty	$79.95
AC-Z Ac adapter for MINI-100	3.95
BP-Z Nicad pack and AC adapter/charger	12.95

Here's a handy, general purpose counter that provides most counter functions at an unbelievable price. The MINI-100 doesn't have the full frequency range or input impedance qualities found in higher price units, but for basic RF signal measurements, it can't be beat! Accurate measurements can be made from 1 MHz all the way up to 500 MHz with excellent sensitivity throughout the range, and the two gate times let you select the resolution desired. Add the nicad pack option and the MINI-100 makes an ideal addition to your tool box for "in-the-field" frequency checks and repairs.

SPECIFICATIONS:

Range:	1 MHz to 500 MHz
Sensitivity:	Less than 25 MV
Resolution:	100 Hz (slow gate) 1.0 KHz (fast gate)
Display:	7 digits, 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	5 VDC @ 200 ma

8 DIGITS 600 MHz $159.95 WIRED

NEW READ RECEIVER FREQUENCY

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double-duty!

PRICES:

CT-50 wired, 1 year warranty	$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95

DIGITAL MULTIMETER $99.95 WIRED

PRICES:

DM-700 wired, 1 year warranty	$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack +AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include; 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts:	100uV to 1 KV, 5 ranges
DC/AC current:	0.1uA to 2.0 Amps, 5 ranges
Resistance:	0.1 ohms to 20 Megohms, 6 ranges
Input impedance:	10 Megohms, DC/AC volts
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells

AUDIO SCALER

For high resolution audio measurements, multiplies UP in frequency.

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

$29.95 Kit $39.95 Wired

ACCESSORIES

Telescopic whip antenna - BNC plug	$ 7.95
High impedance probe, light loading	15.95
Low pass probe, for audio measurements	15.95
Direct probe, general purpose usage	12.95
Tilt bail, for CT 70, 90, MINI-100	3.95
Color burst calibration unit, calibrates counter against color TV signal	14.95

COUNTER PREAMP

For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer-included.

- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop

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WANGO/SIEMENS 282 Dual 5¼"	395.00
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6800 MICROMODULE™ PRICE LIST

MODEL NO.	DESCRIPTION	PRICE
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9609	Advanced Single Bd. Comp. (6809)	595.00
9601	16 Slot Mother Board	175.00
9602	Card Cage	75.00
9603	8 Slot Mother Board	100.00
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9610	Utility Proto Board	39.00
9611	Anth. Proc/Memory Module	495.00
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9629A	32K Static RAM 200ns	895.00
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- Standard parallel or RS232 C compatible
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Z80A-SIO/0	4.0 MHz	39.40
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2101-1	2.90	2.70	2.55
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2114L-450ns (4045)	5.50	5.25	4.75
4044 250 ns	8.95	7.50	6.90
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8	15	32	45
14	19	36	59
16	20	38	62
18	24	59	84
20	29	69	99
22	24	79	1.10
24	38	85	1.20
28	43	1.10	1.49
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FND503(500)	.500	Red	Comm. Cathode	.99
FND507(510)	.500	Red	Comm. Anode	.99
FND508	.500	Red	Comm. Anode (+1)	.99
FND530	.500	Red	Comm. Cathode	1.49
FND550	.500	Orange	Comm. Cathode	1.49
FND800(800)	.800	Red	Comm. Cathode	1.75
FND807(810)	.800	Red	Comm. Anode	1.75
HP5082-7340	600	Red	4 x 7 Hexadecimal	20.95
HP5082-7300	600	Red	4 x 7 Sgl. Digit RHD	18.95
HP5082-7731	300	Red	Comm. Anode	.75
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TIL309	270	Red	Numerical Display	9.95
TIL311	270	Red	4 x 7 Hexadecimal	10.95
MAN3A	320	Red	Array	5.95
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XAN3063	300	Red	Overflow CA Left DP	1.25
XAN3064	300	Red	Comm. Cathode Right DP	1.25
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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
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ICL 7107 3½ Digit A/D (LED)	14.95		
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ICL 8211 Voltage Reference	1.95		
LM 1830N Ground Fault IC	3/1.00		
LM 2900N Quad Amplifier	2/1.00		
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AY-5-3507 40MHz DVM	9.95		
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SPX33 Opto Coupler	3/1.00		
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TR 1402A UART	1.95		
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525-16	16 Hole Hard Micropolis	$29.95
● 40 & 77 TRACK DOUBLE DENSITY - SINGLE SIDED 5¼" W/HUB REINFORCEMENT RING		
577-01	Soft Sectored TRS 80, etc.	$32.25
577-10	10 Hole Hard NS Apple, etc.	32.25
577-16	16 Hole Hard Micropolis	32.25
● 40 TRACKS, DOUBLE SIDED, DOUBLE DENSITY 5¼		
550-01	Soft Sectored SA 450, MPI 52	$39.95
550-10	10 Hole Hard BASF, WANGCO	$39.95
550-16	16 Hole Hard Micro	$39.95
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FD800-01	Soft Single Density 3740	$33.50
FD800-32	32 Hard Single Density Shug	33.50
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FD850-01	Soft Double Sided Double Density 3740	49.80

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8703 8 bit TS	13.50
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8750 3½ Digit BCD	13.95
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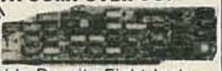

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- Controller 1.1 Revision Kit. 20% overall processing speed increase and supports standard printers. Reduced disk handling. Additional error checking. Improved manual. Vendor file expanded $145.00
- Pascal Revision Kit. Adds executive and chaining capabilities to Pascal environment $65.00
- Mountain Hardware Expansion chassis. 8 more slots for Apple. Hardware or software selectable. Includes power supply Avail. Soon $619.00
- Smart Term Apple 80 x 24 Video Card $349.00
- Symtex X-10
- Apple Silentype. With Apple Intelligent Interface Card $549.00
- NEW! California Computer Systems APPLE Clock. Only $124.95
- NEW! Z-80 Softcard for APPLE CPM 2.2 & M BASIC 5.0 $325.00
- SEC ECHO II Speech Synthesizer $249.95

NEW APPLE SOFTWARE

1. CYBERSTRIKE – Apple II version of Star Raiders from Atari on disk $34.95
2. RTH Stock Market Analysis – Hi-Res, Trend Lines, etc. $109.95
3. ASTEROIDS $29.95
4. "Both Barrels" – Hi-Res simulation of Western Gunfight and Skeet Shooting. Same author as Nasir $29.95
5. "Apple Tax Planner Package" $89.95
6. "New-DOS Tool Kit" $64.95
7. NEW! Apple Z-80 CP/M Software Call for Price

NEW Locksmith Ver 3.1 — Back up your valuable master diskettes! only $74.95. Prevent the loss of your expensive software.

MICROSOFT
16K ON A $175 PLUG-IN CARD.

Microsoft's new RAMCard simply plugs into your Apple II, and adds 16K bytes of dependable, buffered read/write storage. Until now, the only way to get this much memory was to have an Apple Language Card installed. VisiCalc, and other Apple software packages can take advantage of RAMCard. Even with the RAMCard in place, you can still access your ROM BASIC and monitor routines.

Z80 SOFTCARD $299.00

MOUNTAIN COMPUTER EXPANSION CHASSIS

By popular demand! Eight more slots for your Apple. Attractive sturdy enclosure, its own heavy duty power supply. Easy to use. Address cards in Expansion Chassis the same way as in your Apple. Only one additional command to specify in Apple or in Expansion Chassis.

$699.00

ATARI® 800 & 400
Personal Computer System

ATARI 800 $799.00
ATARI 400 $449.00

ATARI 800 Includes: Computer Console, BASIC Lang. Cartridge, BASIC Language Programming Manual, 800 Operator's Manual w/Notebook, 16K RAM Module, Power Supply, TV Switch Box.

Peripherals		**Education System Cassette Programs**		Spelling	35.00
Disc Drive	599.00	U.S. History	35.00	Basic Electricity	35.00
Printer	499.00	U.S. Government	35.00	Basic Algebra	35.00
Program Recorder	69.00	Supervisory Skills	35.00	**Basic Game and Program Cassettes**	
Software – ROM Cartridges		World History (Western)	35.00	Guide to BASIC Programming	18.00
Education System Master Cartridge	28.00	Basic Sociology	35.00	BASIC Game Programs	19.00
Atari BASIC	55.00	Counseling Procedures	35.00	**Add-On Memory**	
Assembler Debug	55.00	Principles of Accounting	35.00	8K RAM Memory Module	110.00
Basketball	42.00	Physics	35.00	16K RAM Memory Module	225.00
Life	42.00	Great Classics (English)	35.00	**Diskettes**	
Super Breakout™	42.00	Business Communications	35.00	Blank Diskettes	
Music Composer	55.00	Basic Psychology	35.00	Disk File Manager	5.00
Super Bug™	42.00	Effective Writing	35.00	**Accessory Controllers**	
Computer Chess	55.00	Auto Mechanics	35.00	Driving Controller Pair	18.00
Home Finance	55.00	Principles of Economics	35.00	Paddle Controller Pair	18.00
				Joystick Controller Pair	18.00

SINGLE BOARD COMPUTER SELECTION GUIDE

BOARD	PROCESSOR	ACP PRICE	ENCLOSURE	BOARD	PROCESSOR	ACP PRICE	ENCLOSURE
DIG. RSCH. BIG BOARD	Z-80 64K	649.00	N/A	SC-SBC100	Z80	239.00	N/A
SYM-1	6502	239.00	Add 39.95	AIM 65	6502	375.00	Add 49.95
Cromemco	Z80	409.00	N/A	Cosmac Vip	1802	199.00	Inc.

TEXAS INSTRUMENTS INCORPORATED
99/4 PERSONAL COMPUTER

Superior Color, Music, Sound & Graphics – & a Powerful Extended Basic – All Built-In.

Now! Special T.V. Adapter lets you use your existing T.V. set as a computer display.

$499.00
Console only.

MATTEL ELECTRONICS INTELLIVISION

ACP LOW PRICE
$259.95

GAME CARTRIDGES $26.95

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FOOTBALL	BASKETBALL	ROULETTE
AUTO RACE	MOTOCROSS	HORSE RACING
TENNIS	ADVENTURE	SUB BATTLE
GOLF	CHECKERS	ARMOR BATTLE
SOCCER	CHESS	SPACE BATTLE
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BOWLING	WORD FUN	

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CB RADIO

GET more CB channels and range! Frequency expanders, boosters, speech processors, interference filters, VOX, how-to books, plans. Catalog $2. **CB CITY,** Box 31500RE, Phoenix, AZ 85046

CABLE TV EQUIPMENT

100 brand new Philips cable TV converters/VCR programmers. $3560 (US funds). Prepaid to your door. Sample $48. **BIRNBOM,** 3655 Ridgewood, Suite 103, Montreal, Canada H3V 1B4 (phone 514-739-0614) USA Inquiries

FOR SALE

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

RF power transistors—tubes—special parts for "ham" linears. MRF454 $17.00, MRF455A $14.00, 8950 $9.00, 6LF6 $5.50, catalog and cross-reference help available. COD—Visa/MC. **WESTCOM** 1320 Grand, San Marcos, CA 92069. **(714) 744-0728**

FANON

BLAZING NEW TRAILS IN ELECTRONICS SINCE 1949

FANON/COURIER CORPORATION 990 South Fair Oaks Avenue, Pasadena, California 91105. TEL: (213) 799-9161 TELEX: 67-5448

RESISTORS ¼W, ½W 5% carbon films 3¢ ea. **No minimums.** 1% metal films. Send for details. Bulk pricing available. **JR INDUSTRIES,** 5834-C Swancreek, Toledo, OH 43614

HIGHLY PROFITABLE **ONE-MAN ELECTRONIC FACTORY**

Investment unnecessary, knowledge not required, sales handled by professionals. Ideal home business. Write today for facts! **Post card will do. Barta-RE-O, Box 248, Walnut Creek, CA 94597.**

RESTORE old radios or TV's to operating condition! Tired of searching for servicing information? Sams library of manufacturer's data for old radios dates to 1920. **Photofact** 1981 Index lists available service data for over 110,000 TV's. Auto Radios, CB's, and more. Send $2.50 plus 50¢ shipping to: **HOWARD W. SAMS CO.,** Dept X0108, 4300 W. 62nd St. Indianapolis, IN 46268.

ELECTRONIC telephone ringer replaces harsh bells with electronic tone at half ringer equivalency! FCC approved. $14.50. **CONSUMERS TELEPHONE,** 69-A Smith Street, Glen Head, NY 11545

MICROWAVE television! Complete systems and new publication available. Informative catalog on microwave and other television products $2.00 (refundable). ABEX, P.O. Box 26601-RM, San Francisco, CA 94126

SUBSCRIPTION TV. Complete 2300 MHz microwave antenna system. 18 inch dish, probe type unit. Six month warranty, $279.95. Detailed plans, $9.95, refundable towards antenna purchase. Program guide and parts also available. **DYNACOMP ELECTRONICS,** Dept. AMA, POB 4181, Scottsdale, AZ 85258 (602) 941-9395

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SPEAKER & ELECTRONICS CATALOG

1001 BARGAINS IN SPEAKERS

Tel.: 1 (816) 842 5092

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RECONDITIONED test equipment. $1.00 for catalog—**JAMES WALTER TEST EQUIPMENT,** 2697 Nickel, San Pablo, CA 94806

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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

MICROWAVE receiving systems. Kits or prebuilt. Microwave antenna plans, three different designs $5. Inquiries or Visa, Mastercard orders call (509) 448-8818. **BETA DESIGN GROUP,** POB 164, Airway Heights, WA 99001

1 BPI, 3000C, distortion analyzer and 1 leader LFM-39A wow and flutter meter. Excellent condition. **FINKLEA'S,** 223 S. McQueen St., Florence, SC 29501 (803) 662-2526

PICTURE tube rebuilding equipment— we sell and buy new and used equipment. Free training. **ATOL TELEVISION,** 6425 Irving Park, Chicago, IL 60634, Phone 312-545-6667

2150 megahertz downconverters $99.95 up, assembled. Details for SASE. **GW ELECTRONICS,** POB 688, Greenwood, IN 46142

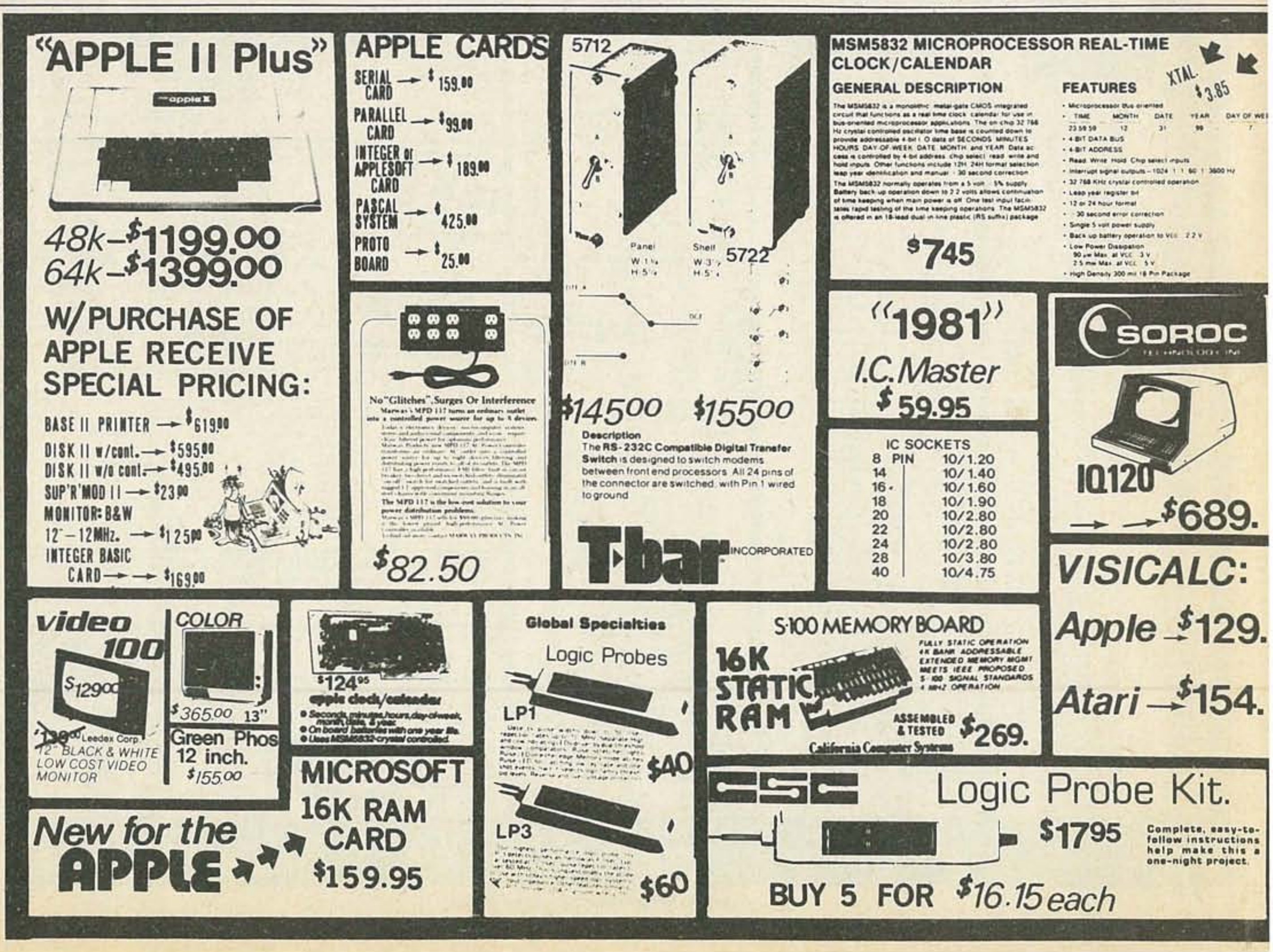
TELEPHONE or office bugged? Latest detection equipment finds out fast. Free literature. **CLIFTON,** Box 220-M, Miami, FL 33168

MICROWAVE receiver for MDS TV complete and ready to install. 24 db gain; $250. **ALEX,** (215) 568-4264

OSCILLOSCOPES, test equipment, new and reconditioned guaranteed. L.I. delivery available. **L.I. OSCILLOSCOPES,** (516) 277-4232

CABLE TV converters $39.95. Incredible 96 page catalog **free. ETCO,** Box 762, Plattsburgh, NY 12901

SAVE up to 50% on name brand test equipment. Free catalog and price list. **SALEN ELECTRONICS,** Box 82-F, Skokie, IL 60077



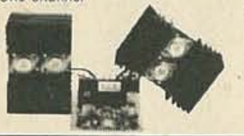
CIRCLE 40 ON FREE INFORMATION CARD

100W CLASS A POWER AMP KIT

Dynamic Bias Class "A" circuit design makes this unit unique in its class. Crystal clear, 100 watts power output will satisfy the most picky fans. A perfect combination with the TA-1020 low T.I.M. stereo pre-amp.

Specifications:

- Output power: 100W RMS into 8-ohm 125W RMS into 4-ohm
- Frequency response: 10Hz - 100 KHz
- T.H.D.: less than 0.008%
- S/N ratio: better than 80dB
- Input sensitivity: IV max.
- Power supply: ±40V @ 5 amp
- One channel



TA-1000 KIT $51.95
Power transformer $18.00 each

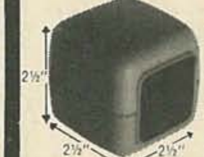
MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

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**

CUBO CLOCK CASES



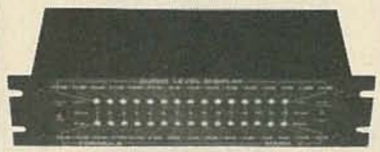
All brand new top quality plastic cases, originally designed for Cubo clocks. Case comes with top and bottom cover with a detachable front red filter for LED readouts. This can be used for many projects such as LED CLOCK, VU METER, LIGHT BOX, FREQ. COUNTER, ETC.

3 Attractive Colors (white, lime green or orange)

BUY 3 FOR ONLY $2.50

NEW! 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

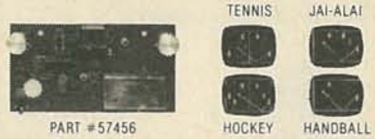
TV GAME BOARD

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



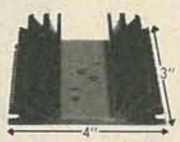
REGULATED VARIABLE D.C. POWER SUPPLY KIT

Uses UA723 I.C. and 2N3055 power transistor as regulator. Output voltages can be adjusted from 0~30V at an internal resistance of less than 0.005 ohm; ripple and noise less than 1 MV; with built on board LED and audible overload indicator. Kit comes with P.C. board; all electronic components, transformer; connectors; 2 panel meters for voltage and amp; a professional look metal cabinet and instructions.

Model TR-88A 0~15V D.C. 3 amp
Model TR-88B 0~30V D.C. 2 amp

$59.50 per kit NEW

MULTI-FINS HEAT SINK



Ideal for high power output. Holes predrilled for 1 to 3 transistor. Made of aluminum with ten radiating fins.

2 FOR $4.50

BATTERY POWERED FLUORESCENT LANTERN

MODEL 888 R

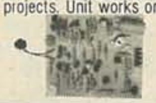
FEATURES

- Circuitry: designed for operation by high efficient, high power silicon transistor which enable illumination maintain in a standard level even the battery supply drops to a certain low voltage.
- 9" 6W cool/daylight miniature fluorescent tube.
- 8 x 1.5V UM-1 (size D) dry cell battery.
- Easy sliding door for changing batteries.
- Stainless reflector with wide angle increasing lumination of the lantern.

$10.50 EA

NEW! 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 latched you 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.

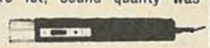


Model 968
$4.50 each

PROFESSIONAL FM WIRELESS MICROPHONE

TECT model WEM-16 is a factory assembled FM wireless microphone powered by an AA size battery. Transmits in the range of 88-108MHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case; mike is 6¼" long. With a standard FM radio, can be heard anywhere on a one-acre lot; sound quality was judged very good.

$16.50



SUB MINI SIZE FET CONDENSER MICROPHONE

Specification:

Sensitivity: − 65dB ± 3db
FEQ. Response: 50 Hz 8 KHz
Output Impedance: 1K ohm max.
Polar Pattern: Omni-directional
Power Supply: 1.5V 10V D.C.
Sound Pressure Level: Max. 120dB
EM4RP **$2.50** ea. or **2** for **$4.50**

30W + 30W STEREO HYBRID AMPLIFIER KIT

Kit includes 1 PC SANYO STK-043 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 60 watts (30 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100MHz and 10KHz.

$32.50 PER KIT

FOR 'BOX' BUILDERS

Pre-Drilled PC Board			**$17.50**
Tolriod Coils (Set of 4)			**$ 3.00**
Multi Turn Trim-Pots 10K ohm			**$ 2.50**
Trimmer Capacitor 6-35pF			**$ 0.60**
MC1358	**$ 2.50**	RC1458	**$ 1.00**
MC1350	**$ 2.00**	LM380	**$ 1.80**
MC1330	**$ 3.50**	LM340T-15	**$ 1.20**
		NE565	**$ 2.00**

We also have transformer, capacitors set, resistors set antenna transformer. Please call for price.

NEW MARK III 9 Steps 4 Colors LED VU

Stereo level indicator kit with arc-shape display panel!!! This Mark III LED level indicator is a new design PC board with an arc-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by rose). The power range is very large, from −30dB to +5dB. The Mark III indicator is applicable to 1 watt - 200 watts amplifier operating voltage is 3V - 9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

IN KIT FORM $18.50

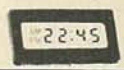
5W AUDIO AMP KIT

2 LM 380 with Volume Control
Power Suply 6 18V DC
ONLY $6.00 EACH

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) ON SALE
NIC2400 (24 hr) $16.99 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 EACH

2 WATT AUDIO AMP

Pre assembled units. All you need is to hook up the speaker and the volume control. Supply voltage from 9~15V D.C. measures only 2" x 3½", making it good for portable or discrete applications. Comes with hook up data.

BUY 2 FOR **$4.99**

SPECIAL 0.5" LED SALE 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

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 11.5 dB 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

CIRCLE 4 ON FREE INFORMATION CARD

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!

With Case Only $6.50 Per Kit

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 condenser 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

PRESS-A-LIGHT SELF GENERATED FLASHLIGHT

EXCLUSIVE!! **$3.95 ea**
Model F-179

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!

ELECTRONIC DUAL SPEAKER PROTECTOR

Cut 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.

"FISHER" 30 WATT STEREO AMP

MAIN AMP (15W x 2)
Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply ± 16V DC (not included). Power band with (KF 1% ± 3dB). Voltage gain 33dB. 20Hz - 20KHz.

Super Buy Only $18.50

SPACE WAR SOUND GENERATOR BOARD

Brand new preassembled module for a toy factory. The board gives out 6 different selectable space sound with LED light effect. Sounds include UFO take-off, space gun blast, wave, and space chime. 7 LED on the board will work with the sound. Requires 9V battery to operate. Speaker not included.

SPECIAL **$3.99** EACH SPEAKER **$1.25** EACH

ELECTRONIC PIEZO BEEP BUZZER

Unique surplus ⅞" Dia. piezo ceramic disc on circuit board gives a distinct high freq. buzz. Unit contains an I.C., 2 caps, 6 resistors and is already preassembled. Requires 9V battery to operate.

SPECIAL 2 FOR **$2.99**

2 BIT COUNTER, WARBLE PULSE ALARM BOARD

This new assembly easily converts to a counter, stop watch, warble and pulse alarm generator by adding a few components. We supply the data and typical applications. Requires 9V battery to operate.

SPECIAL 2 FOR **$1.99**

AUDIO OUTPUT dB METER

2¾"
2¾"

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

BATTERIES

PK/$10.00
2 PKS/$19.00

NICKEL CADMIUM BATTERY PACK 'D' SIZE

ILLUSTRATED LESS COVER

Output: 3.6 Volts @ 3.0 Amp/Hour. Consists of three each, 1.2 Volt "D" size Nickel Cadmium Cells stacked and plastic film encapsulated. Tabs are provided at each end for electrical connections. The individual cells can be cut apart if desired. Rated recharge rate is 30 mA, 14-18 hours. Size: 1¼" dia. x 7" long. New. Shpg. Wt. each pack, 1 lb.

9V RECHARGEABLE NI-CD BATTERY

Replace all 006P type 9V battery
Model: GC9

BRAND NEW $4.50 EACH

NI-CD BATTERY SALE

12V Pack 450 MZ/HR Size 3" x 1" x 2"
$8.00 PER PACK

4 AA Pack 450 MA/HR
$3.50 PER PACK

All above batteries are used but late date code and we guarantee to take back all bad ones for exchange.

GELCELL 6V 9AMP/HR SEALED LEAD ACID RECHARGEABLE BATTERY

5½"
4⅛"
2¾"

Sealed construction permits this battery to be operated in any position. Recharge rate 2.15 amp max. for 14-16 hours. All brand new. Limited quantities. Size of battery 4⅛" x 2¾" x 5½".

$16.50 each

ELECTRONIC PIN BALL MACHINE

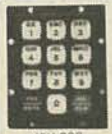
That sounds and plays like the real thing. All units are brand new but without the case Functions of the game include double flipper control, kicker control, 1-4 players, 3 speed ball control, tilt switch, automatic score, extra bonus cave and many more. All solid state with LED panel, no moving parts. Requires 9V battery to operate, speaker not included.

A perfect gift for yourself or friends.
SPECIAL **$8.99** EACH
SPEAKER **$1.25** EACH

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**

TOUCH TONE TYPE SLIM TELEPHONE KEY PAD



KEY 330

Weather proof plastic one piece keytops. Key numbers from 1-0. All switches momentary. Open one side not connected one side common. **$3.50 EACH**

SOUND ACTIVATED SWITCH

All parts completed on a PC Board SCR will turn on relay, buzzer or trigger other circuit for 2 - 10 sec. (adjustable). Ideal for use as door alarm, sound controlled toys and many other projects. Supply voltage 4.5V 9V D.C.

$1.75 ea. **2 for $3.00**

REGULATED DUAL VOLTAGE SUPPLY KIT

±4 30V DC 800 MA adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator I.C.

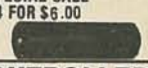
Kit includes all electronic parts, filter capacitors, I.C., heat sinks and P.C. board.

$12.50 PER KIT

AA SIZE NI-CD

SPECIAL SALE 4 FOR $6.00

RECHARGEABLE BATTERIES
LIMITED QUANTITY AVAILABLE



CRYSTAL CONTROLLED WIRELESS MICROPHONE SYSTEM

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ADDITIONAL MIRCOPHONE (TRANSMITTER) AVAILABLE AT $28.00 EACH

Transmitter: FET mic for flat 30~18 KHz response extra controlled 49 MHz 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).

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MURA WMS-49

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.

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BIPOLAR LED RED/GREEN

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2 FOR $2.20

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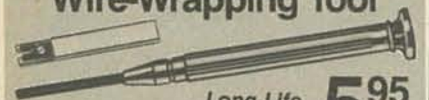

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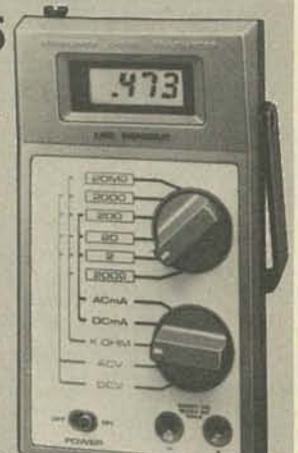

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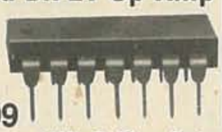
Quad BiFET Op-Amp



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7430	.19	7490	.49	74164	.89
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7442	.49	7493	.49	74175	.89
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78L05	.69	79L05	.79
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T = TO-220 K = TO-3 L = TO-92

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T = TO-220 V = 8 PIN K = TO-3

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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

GOLD

	1-24	25up	50up	100up
A8WG	$.55	$.54	$.53	$.52
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

Wire Wrap — TIN

	1-24	25up	50up	100up
A8WT-TI	$.41	$.40	$.39	$.38
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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1.8432	HC33	CO1A	9.50	5.00	HC18	CY7A	6.00	18.00	HC18	CY18A	4.75
2.00	HC33	CY2A	8.25	5.068	HC18	CY5B	6.00	18.432	HC18	CY19B	4.75
2.4576	HC33	CY2B	8.25	5.7143	HC18	CO5C	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	23.004	HC18	CY23B	5.25
4.00	HC18	CY3A	6.00	8.00	HC18	CY8G	6.00	27.00	HC18	CY27A	5.15
4.434	HC18	CY4C	6.00	10.00	HC18	CY12A	4.75	32.00	HC18	CY32A	5.15
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- PC Board
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Vref(Max.) - Vref(Min.)/13

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74LS26N	.39
74LS27N	.29
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74LS37N	.36
74LS40N	.34
74LS42N	.45
74LS73N	.38
74LS74N	.54
74LS86N	.45
74LS90N	.44
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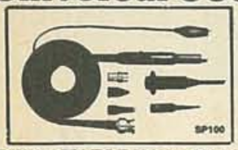

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MC958L	2.46	MC1445UDS	1.77	MC3470P	12.64	MC14490VP	4.24
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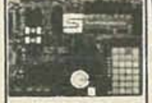

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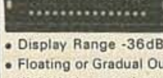

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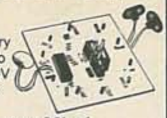

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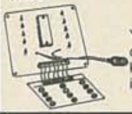

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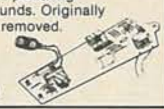

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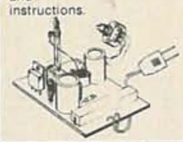

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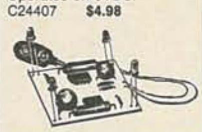

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3242	10.00	4015	1.15	4072	.35	74C02	.39	74LS14	1.25	74LS151	.79	74LS273	1.75
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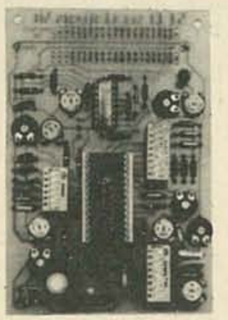

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4017	— .70	4050	— .45	74C02	— .27	74C173	— 1.30
4018	— .60	4051	— .80	74C04	— .40	74C174	— 1.30
4019	— .45	4052	— 1.10	74C08	— .30	74C175	— 1.20
4020	— .70	4053	— 1.10	74C10	— .27	74C192	— 1.30
4021	— .90	4066	— .70	74C14	— 1.20	74C901	— .50
4022	— 1.00	4068	— .25	74C20	— .27	74C926	— 8.95
4023	— .25	4069	— .25	74C32	— .45		
4024	— .55	4071	— .35	74C73	— .75		
4025	— .25	4072	— .35				
		4076	— .80				
		4077	— .35				

TRANSISTOR SPECIALS

2N1307 PNP GE TO-5	$ .40
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2N6233 NPN SWITCHING POWER	$1.95
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2N4908 PNP Si TO-3	$1.00
2N5086 PNP Si TO-92	4/$1.00
2N3137 NPN Si RF	$ .55
2N3919 NPN Si TO-3 RF	$1.50
2N1420 NPN Si TO-5	3/$1.00
2N3767 NPN Si TO-66	$ .70
2N2222 NPN Si TO-18	5/$1.00
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2N3904 NPN Si TO-92	6/$1.00
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7401	— .17	7473	— .35	74163	— .85
7402	— .17	7474	— .42	74164	— .85
7403	— .17	7475	— .49	74165	— .85
7404	— .24	7476	— .45	74166	— 1.05
7405	— .24	7480	— .45	74170	— 1.60
7406	— .33	7483	— .60	74173	— 1.30
7407	— .35	7485	— .75	74174	— .85
7408	— .27	7486	— .42	74175	— .75
7409	— .24	7489	— 1.60	74176	— .75
7410	— .17	7490	— .50	74177	— .75
7411	— .22	7491	— .55	74180	— .75
7412	— .22	7492	— .50	74181	— 1.90
7413	— .42	7493	— .50	74190	— 1.20
7414	— .90	7494	— .60	74191	— 1.20
7416	— .33	7495	— .60	74192	— .79
7417	— .37	7496	— .60	74193	— .79
7420	— .17	74107	— .35	74194	— .85
7425	— .35	74121	— .35	74195	— .65
7426	— .33	74122	— .39	74196	— .85
7427	— .35	74123	— .42	74197	— .87
7430	— .17	74125	— .45	74279	— .95
7432	— .27	74126	— .45	74325	— 2.25
7437	— .27	74145	— .75	74365	— .80
7438	— .27	74148	— 1.50	74367	— .80
7440	— .17	74150	— 1.10	74368	— .65
7441	— .85	74151	— .65	74390	— 1.50
7442	— .50	74153	— .55	75325	— 1.50
7445	— .70	75154	— 1.10	75491	— 1.05
7446	— .70	74155	— .75	75492	— 1.05
7447	— .75	74157	— .65	8T98	— 1.10
7448	— .75	74160	— .85	9312	— .60
7450	— .17	74161	— .80	9601	— .75
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74S03	.30	74S89	1.90	74S174	1.40
74S04	.40	74S112	.85	74S175	1.40
74S05	.45	74S133	1.40	74S194	1.10
74S08	.40	74S135	1.50	74S257	1.50
74S10	.30	74S138	1.25	74S258	1.40
74S11	.35	74S139	1.10	74S260	1.50
74S15	.40	74S140	1.00	74S280	1.50
74S20	.40	74S153	1.10	74S373	2.25
74S30	.40	74S151	1.25		
74S32	.40	74S157	1.25		

SCR's

	1.5A	6A	35A	110A
100	.45	.60	1.40	
200	.70	.80	1.90	9.00
400	1.20	1.40	2.60	12.00
600		1.80	3.60	15.00

TRIAC's

PRV	1A	10A	25A
100	.45	.80	1.55
200	.84	1.30	2.10
400	1.30	1.90	3.10
600	2.00	2.75	4.30

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74LS03	— .22	74LS96	— .90	74LS196	— 1.00
74LS04	— .27	74LS107	— .47	74LS197	— .90
74LS05	— .27	74LS109	— .45	74LS240	— 1.60
74LS08	— .27	74LS112	— .45	74LS241	— 1.60
74LS09	— .27	74LS113	— .45	74LS242	— 1.60
74LS10	— .25	74LS114	— .55	74LS243	— 1.60
74LS11	— .35	74LS123	— .75	74LS244	— 1.60
74LS12	— .35	74LS125	— .90	74LS245	— 2.25
74LS13	— .60	74LS126	— .90	74LS247	— .75
74LS14	— .80	74LS132	— .60	74LS248	— 1.10
74LS15	— .35	74LS136	— .80	74LS251	— 1.29
74LS20	— .30	74LS138	— .75	74LS253	— 1.00
74LS21	— .25	74LS139	— .70	74LS257	— .90
74LS22	— .25	74LS151	— 1.19	74LS258	— .90
74LS26	— .35	74LS153	— 1.19	74LS259	— 1.50
74LS27	— .45	74LS155	— 1.19	74LS266	— .70
74LS28	— .45	74LS156	— 1.19	74LS273	— 1.25
74LS30	— .30	74LS157	— .85	74LS279	— .70
74LS32	— .40	74LS160	— 1.00	74LS283	— .80
74LS37	— .35	74LS161	— 1.00	74LS290	— .80
74LS38	— .35	74LS162	— 1.00	74LS293	— .80
74LS40	— .40	74LS163	— 1.00	74LS365	— .80
74LS42	— .55	74LS164	— 1.00	74LS366	— .80
74LS47	— .75	74LS168	— 1.25	74LS367	— .80
74LS51	— .25	74LS169	— 1.75	74LS368	— .80
74LS54	— .25	74LS170	— 1.70	74LS373	— 1.50
74LS73	— .60	74LS173	— .90	74LS375	— .95
74LS74	— .85	74LS174	— 1.00	74LS377	— 1.50
74LS75	— .75	74LS175	— 1.00	74LS386	— .50
74LS76	— .45	74LS181	— 2.50	74LS393	— 1.50
74LS83	— .95	74LS190	— 1.25	74LS670	— 2.50
74LS85	— 1.10	74LS191	— 1.15	81LS97	— 1.10
74LS86	— .45	74LS192	— .90	81LS98	— 1.10

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1UF 20V	5/$1.00	30UF 6V	5/$1.00
2.2UF 20V	5/$1.00	33UF 20V	$ .60
3.3UF 20V	4/$1.00	47UF 20V	$ .85
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PRV	1A	3A	12A	50A	125A	240A
100	.06	.14	.35	.90	4.25	6.00
200	.07	.20	.40	1.30	5.25	9.00
400	.09	.25	.65	1.50	6.50	12.00
600	.11	.30	.80	2.00	8.50	15.00
800	.15	.35	1.00	2.50	10.50	18.00
1000	.20	.45	1.25	3.00	12.50	26.00

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741CV — .30	LM361 — 1.75	711CH — .40
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LM318 — 1.20		

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79HGKC-5V at 5A	$6.95	340T-5, 6, 8, 9, 12, 15 18 or 24V	$ .85
723	$ .50	320M5	$ .75
320T 5, 12, or 15V	$ .90	LAS1412 + 12V 3A	$3.95

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DB 25S female ... $4.25
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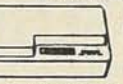

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ADVERTISING INDEX

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1. SENSITIVITY: Superb amplifier circuitry with performance that can't be matched at twice the price. Average sensitivity of better than 15 mV from 10 Hz to 500 MHz on every model and better than 30 mV from 500 MHz to 1.1 GHz on the Series 8010A and 8013.

2. RESOLUTION: 0.1 Hz to 12 MHz, 1 Hz to 50 MHz, 10 Hz over 50 MHz.

3. ALL METAL CASES: Not only are the heavy gauge aluminum cases rugged and attractive, they provide the RF shielding and minimize RFI so necessary in many user environments.

4. EXTERNAL CLOCK INPUT/OUTPUT: Standard on the 8010/8013 series and optional on the 7010 series is a buffered 10 MHz clock time base input/output port on the rear panel. Numerous uses include phase comparison of counter time base with WWVB (U.S. National Bureau of Standards). Standardize calibration of all counters at a facility with a common 10 MHz external clock signal, calibrate scopes and other test equipment with the output from precision time base in counter, etc., etc.

5. ACCURACY: A choice of precision to ultra precision time base oscillators. Our ± 1 PPM TCXO (temperature compensated xtal oscillator) and ± 0.1 PPM TCXO are sealed units tested over 20-40°C. They contain voltage regulation circuitry for immunity to power variations in main instrument power supply, a 10 turn (50 PPM) calibration adjustment for easy, accurate setability and a heavily buffered output prevents circuit loads from affecting oscillator. Available in the 8010 and 8013 series is our new ultra precision micro power proportional oven oscillator. With ± .05 PPM typical stability over 10-45°C, this new time base incorporates all of the advantages of our TCXO's and virtually none of the disadvantages of the traditional ovenized oscillator: Requires less than 4 minutes warm-up time, small physical size and has a peak current drain of less than 100 ma.

6. RAPID DISPLAY UPDATE: Internal housekeeping functions require only .2 seconds between any gate or sample time period. At a 1 second gate time the counter will display a new count every 1.2 seconds, on a 10 second gate time a new count is displayed every 10.2 seconds. (10.2 seconds is the maximum time required between display updates for any resolution on any model listed).

7. PORTABILITY: All models are delivered with a 115 VAC adapter, a 12 VDC cord with plug and may be equipped with an optional ni-cad rechargeable battery pack installed within its case. The optional Ni-Cad pack may be recharged with 12 VDC or the AC adapter provided.

8. COMPACT SIZES: State-of-the-Art circuitry and external AC adapters allowed design of compact easy to use and transport instruments.
Series 8010/8013: 3" H x 7-1/2" W x 6-1/2" D
Series 7010: 1-3/4" H x 4-1/4" W x 5-1/4" D

9. MADE IN U.S.A.: All models are designed and manufactured at our modern 13,000 square foot facility at Ft. Lauderdale, Florida.

10. CERTIFIED CALIBRATION: All models meet FCC specs for frequency measurement and provided with each model is a certificate of NBS traceable calibration.

11. LIFE TIME GUARANTEE: Using the latest State-of-the-Art LSI circuitry, parts count is kept to a minimum and internal case temperature is only a few degrees above ambient resulting in long component life and reliable operation. (No custom IC's are used.) To demonstrate our confidence in these designs, all parts (excluding batteries) and service labor are 100% guaranteed for life to the original purchaser. (Transportation expense not covered).

12. PRICE: Whether you choose a series 7010 600 MHz counter or a series 8013 1.3 GHz instrument it will compete at twice its price for comparable quality and performance.

MODEL 8010A/8013 1.1 GHz/1.3 GHz

MODEL 7010A 600 MHz

DEL	RANGE (From 10 Hz)	10 MHz TIME BASE			AVG. SENSITIVITY		GATE TIMES	RESOLUTION			EXT. CLOCK INPUT/OUTPUT	SENSITIVITY CONTROL	NI-CAD BATTERY PACK
		STABILITY	AGING	DESIGN	10 Hz to 500 MHz	500 MHz to 1.1 GHz		12 MHz	60 MHz	Max. Freq.			
010A	600 MHz	± 1 PPM	<1 PPM/YR	TCXO*	15 mV	N/A	(3) 1, 1, 10 sec.	.1 Hz	1 Hz	10 Hz (600 MHz)	YES OPTIONAL	NO	YES OPTIONAL
10.1A		± 0.1 PPM											
010A	1.1 GHz	± 1 PPM	<1 PPM/YR	TCXO*	15 mV	30 mV	(4) .01, .1, 1, 10 sec.	.1 Hz	1 Hz	10 Hz (1.1 GHz)	YES STANDARD	YES	YES OPTIONAL
10.1A		± 0.1 PPM											
10.05A		± .05 PPM		OCXO**									
013.1	1.3 GHz	± 0.1 PPM	<1 PPM/YR	TCXO*	15 mV	30 mV	(4) .01, .1, 1, 10 sec.	.1 Hz	1 Hz	10 Hz (1.3 GHz)	YES STANDARD	YES	YES OPTIONAL
013.05		± .05 PPM		OCXO**									

TCXO = Temperature Compensated Xtal Oscillator **OCXO = Proportional Oven Controlled Xtal Oscillator

RIES 7010A

010A	600 MHz Counter - 1 PPM TCXO	$199.95
010.1A	600 MHz Counter - 0.1 PPM TCXO	$249.95
TIONS:		
-H	Handle/Tilt Bail (not shown)	$2.95
i-Cad-701	Ni-Cad Battery Pack & Charging Circuitry Installed Inside Unit	$19.95
C-70	External Clock Input/Output	$35.00
C-70	Carry Case - Padded Black Vinyl	$9.95

SERIES 8010A/8013

#8010A	1.1 GHz Counter - 1 PPM TCXO	$399.00
#8010.1A	1.1 GHz Counter - 0.1 PPM TCXO	$450.00
#8010.05A	1.3 GHz Counter - .05 PPM Oven	$499.00
#8013.1	1.3 GHz Counter - 0.1 PPM TCXO	$550.00
#8013.05	1.3 GHz Counter - .05 PPM Oven	$599.00

OPTIONS

#Ni-Cad-801	Ni-Cad Battery Pack & Charging Circuitry Installed Inside Unit	$49.95
#CC-80	Carry Case - Padded Black Vinyl	$ 9.95

ACCESSORIES

#TA-100	Telescope antenna with right angle BNC	$ 9.95
#P-100	Probe, 50 Ohm, 1X	$13.95
#P-101	Probe, Lo-Pass Audio Usage	$16.95
#P-102	Probe, Hi-Z General Purpose	$16.95
#LFM-1110	Low Frequency Multiplier X 10, X 100, X1000 For High Resolution of Audio Freq.	$119.95

Optoelectronics inc
5821 N.E. 14th Avenue, Fort Lauderdale, Florida 33334

1-800-327-5912
FROM FLORIDA (305) 771-2051/2

ERMS: Orders to U.S. and Canada, add 5% for shipping, handling and insurance to a maximum of $10.00. All other orders add 15%.
.O.D. collection fee $2.00. Florida orders add 4% state tax. Personal checks must clear before goods are shipped.

CIRCLE 54 ON FREE INFORMATION CARD

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

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—John A. Blum, Box 446, Zelienolple, 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

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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.

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

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