

Radio- Electronics

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FOR SELF-IMPROVEMENT**

\$1.25 MAY 1980

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What happened at WARC-79
Build a \$125 triggered scope**

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Inside the Beta video recorder
Build a wide-range audio generator**



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CIRCLE 36 ON FREE INFORMATION CARD



The new Energaire ionized oxygen generator will make a handsome addition to any desk.

Miracle Fuzz

A new space-age invention and the same effect as lightning combine to create the world's first home oxygen regeneration system.

You need oxygen to live. You can live without food for 60 days, without water for seven days, but without oxygen, you won't make it past two minutes.

That small piece of fuzz located on top of the cylinder shown above emits negatively-charged electrons which attach themselves to molecules of oxygen, thus creating ionized oxygen.

You are already familiar with ionized oxygen if you've smelled the air after a thunderstorm. You feel great, revitalized, and alert. The lightning from the storm adds a small negatively-charged electron to each oxygen molecule in a process called ionization.

SCIENTISTS DISCOVER

Scientists discovered that air quality can actually affect your moods, your feelings and your sense of well being. Air that is positively charged caused people to be depressed, moody and tired. Negatively-charged air made people feel good. We have all experienced air that is positively charged in air-conditioned buildings or in a polluted environment.

Scientists looking for a way to turn positively charged air into negatively charged air developed the negative ion generator—a product that produces negatively charged particles that attach themselves to air molecules and thus create the same fresh feeling you get after a thunderstorm.

The new space-age product shown above is an ionized oxygen generator called the Energaire air purifier. The copper mesh fuzz on top of the unit is one of the secrets of the system.

Although it has no moving parts, you can actually feel a wind of ionized oxygen produced from the fuzz which spreads to fill an average-sized room in one minute.

CIGARETTE SMOKE TEST

To show the dramatic effect of ionized oxygen, you can take the Energaire, blow cigarette smoke into a clear bowl, and hold the bowl inverted over the system. The smoke will vanish. The charged oxygen particles appear to dissolve the smoke particles, precipitating them from the air.

In a room, the Energaire air purifier surrounds you with these oxygen ions and cleans and purifies the air so that even in a smoke-filled room, you will be breathing cleaner, country-fresh air all day long.

WALL TEST

Take our unit and place it next to a wall. Also

put a large piece of paper on the wall. Within a few days notice how black the paper gets. That black film is fine carbon particulate matter—the same pollutants you would normally breathe and that would pass through most air filters. By placing the unit in the center of a room or away from a wall, that same matter falls to the ground as dust.

A trip into the mountains exposes you to nature's freshly ionized oxygen. The Energaire produces this same effect. It will clean your room of odor-causing bacteria and stale, musty, or smoky air.

Ionized oxygen should not be confused with ozone. Ozone has a molecular formula of O_3 , whereas the molecular formula for ionized oxygen is O_2 with a negatively-charged ion.

DON'T BE CONFUSED

After we announced the Energaire last year, many companies came out with their own ion generators. We purchased a unit from each company and tested them at an independent laboratory. The results are shown below:

Name	*Ions	Price
Energaire	438,000	\$79.95
Omega 70Q	63,000	245.00
AirCare	72,000	149.95
Modulion	75,000	79.95

*Measurements indicate total number of ions per cubic centimeter per second at one meter. These figures may vary by plus or minus 10%.

Note: One unit not mentioned above produced no ions and actually produced ozone or several times the maximum ozone concentration allowed by federal government standards.

USED IN HOSPITALS

Many hospitals are now using ionized oxygen systems in their operating rooms and burn centers. Their units not only purify the air, but they also eliminate pollen and other irritants.

Working in a clean air environment, you think clearer, are more alert, and you function better. The Energaire is actually a miniature lightning machine. The minute you plug it in, energy is converted into ionized oxygen. This efficient system uses one watt of power or less than a penny per day to operate, so you leave it plugged in continuously.

We are so impressed with the pleasant effect of Energaire that we urge you to personally test it yourself in your home or office. Order one at no obligation. Put it by your desk, or in any room where you spend a great deal of time. See if it doesn't rid your room of odor-causing bacteria and stale, musty or smoky air. Try the smoke and paper tests mentioned in this advertisement.

SLEEP FASTER

At home, use the Energaire by your bed and see how country-fresh air allows you to sleep easier, deeper, and more relaxed.

You should notice the difference within one day—especially in a work environment. But use the Energaire for a full month. Then, if you do not feel totally convinced of the positive effects of ionized oxygen, return your unit for a prompt and courteous refund.

The Energaire is manufactured by the Ion Foundation, a leading ion research and development company.

Service should never be required, but if it is, there's a prompt service-by-mail center as close as your mailbox. JS&A is America's largest single source of space-age products—further assurance that your modest investment is well protected. The Energaire measures 9" high by 3" in diameter and weighs 24 ounces.

To order your Energaire ionized oxygen generator, send \$79.95 plus \$3.00 for postage and handling (Illinois residents, please add 5% sales tax) to the address shown below or credit card buyers may call our toll-free number below. We will send your Energaire ion generator complete with 90-day limited warranty on the electronics, a five-year warranty on the fuzz, and complete instructions.

Let space-age technology revitalize your life with the world's first home ionized oxygen generator. Order one at no obligation today.

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Ion Fountain™

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Breakthrough. The new Ion Fountain™ is in a class by itself. This negative ion generator gives you power to saturate your home or office with billions of refreshing ions. Without fans or any moving parts it puts out a pleasant breeze. A pure flow of ions pours from the top like water from a fountain, filling your room. The result? Your air feels like fresh ocean air—pure, crisp, and wonderfully charged.

The price? Only \$79.95. That's a price breakthrough because no other company can offer you a unit with higher ion output or better quality than the Ion Fountain™, even at triple our price.

HOW CAN WE DO IT?

Six years of experience helps. Plus a lot of ingenuity, aggressive research and a personal commitment to give our customers the best we can.

UTP Ion Research Center is a branch of our educational publishing company. And our commitment in publishing to give birth to new ideas and methods that enrich humanity is part of the Ion Research Center too. We're in business to serve you and your environmental needs.

WHAT ARE IONS?

Ions are electrically charged atoms in the air with either a positive or negative charge. The sun and cosmic rays as well as lightning and fast-moving water (like waterfalls, surf) generate trillions of negative ions every day. The more negatively ionized the air, the fresher and more alive it is. Air pollution, artificially controlled climates (with air conditioning and heating) and electronic equipment all produce excess positive ions, depriving the air of these small negative air ions and creating dead "stuffy" air.

WHAT'S THE SOLUTION?

Our rapid-growth technology, which sometimes takes its toll on the quality of our air, has also come up with the solution. Following Nature's model of the thunderstorm which uses a high electrical charge to purify, revitalize and stimulate the air, the UTP Air Energizer has been developed imitating this process. Both the thunderstorm and the Air Energizer fill the air with negative ions, restoring the natural electrical balance to the polluted, energy-depleted air. But the Ion Fountain can be used indoors in the home, office, workshop, laboratory, etc., keeping a fresh supply of ionized oxygen available night and day. This new breakthrough in fresh air control is not a cover-up

which masks or deodorizes. The unit actually removes the dust, smoke, bacteria and pollen particles from the air by attaching ions to them and causing them to sink to the earth where they can be vacuumed up rather than inhaled. At the same time ions electrically stimulate the energy-stripped air.

YOUR CHOICE OF TWO TOP-QUALITY UNITS!

There's only one unit that's better than the Ion Fountain. That's our own Executive System Four™. It sells for \$159. It has an even higher ion output. Plus! Our special Dial-An-Ion feature allows you to adjust the ion output anywhere from low to high. Not everyone knows that the need for ions varies. A large smoky room will require higher output than a small room. And some people want fewer ions while sleeping than while working. The new Executive System Four is our answer to this need for output flexibility.

FACTS YOU NEED TO KNOW The Ion Fountain™—System Five

<i>Ion density:</i>	430,000 ions per cm ³ /sec. at 1 meter. 1.55 million ions per cm ³ at 50 cms.
<i>Use:</i>	Large room or office—9000 cu. ft.
<i>Warranty:</i>	1 year
<i>Output voltage:</i>	15KV
<i>Ozone:</i>	Less than 2 parts per billion
<i>Dimensions:</i>	5 3/4" x 4 1/4" x 2 3/4"

Executive System Four™

<i>Ion density:</i>	Low to maximum of 540,000 ions per cm ³ at 1 meter. 1.6 x 10 ⁶ ions per cm ³ at 50 cms.
<i>Output voltage:</i>	15KV
<i>Ozone:</i>	Less than 2 parts per billion
<i>Dimensions:</i>	11" x 5" x 4"
<i>Use:</i>	Large room or office 10,000 cu. ft.
<i>Warranty:</i>	1 year

If the Executive System Four is better, why did we bring out the Ion Fountain? Not everybody is willing to pay \$159 for an air ionizing unit, no matter how good it is. Just like not everyone drives Rolls Royces. Most drive less expensive cars. The Executive System Four is for the person who wants the

absolute best quality and doesn't mind paying a little extra to get it. If you want highest ion output, flexibility, and a beautiful oak paneled case, buy the Executive System Four.

If you want something at half the price of the Executive System Four, but still better than any other units costing up to \$250, buy the Ion Fountain.

HOW TO GET ONE

To place your order now just send a check for \$79.95 plus \$3 shipping for the Ion Fountain. Or send \$159 plus \$4 shipping for the Executive System Four. Tell us your full street address as we cannot ship to Post Office boxes. (California residents add 6% sales tax.)

Our unit is dependable and trouble-free, but if by rare chance any problems occur our service-by-mail center sends off your unit within 24 hours of receipt or sends a replacement so you are not without fresh air and can enjoy your dust-free environment. And each Air Energizer is backed by a full one-year limited warranty.

HOW TO GET ONE FAST

Credit card holders can call our toll-free number below. Order a unit now and if you are not satisfied with its effects within 10 days simply return it for a full cash refund. Order your Air Energizer today.

UTP

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ELECTRONIC DEVICES FOR SELF-IMPROVEMENT

A look at how state-of-the-art electronics have combined with recent medical discoveries to help you master your mind and body's "involuntary" reactions. David R. Wheeler

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NEW USES FOR YOUR CAP METER

If your capacitance meter is collecting dust, then you're not using it to its fullest advantage. Here's a look at some of its many uses besides testing capacitors. Martin Bradley Weinstein

BUILD THIS 49

PROFESSIONAL DRUM SYNTHESIZER

Unique device provides many of the features only found in synthesizers costing several times more. Steve Wood

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TRIGGERED OSCILLOSCOPE

Part 2—Final construction details for a scope with a 2-MHz bandwidth and a zero baseline display for under \$125. Daniel Metzger and Dennis Perry

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VERSATILE ANALOG INTERFACE

When connected to your computer, this simple device along with the proper software can be used for a wide variety of interfacing applications, including joysticks. John R. Hanson

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WIDE-RANGE AUDIO GENERATOR

Great addition for your test bench produces sine and square waves over the audio band from 10Hz to 50kHz. Richard Schroeder

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R.E.A.L. SOUND LAB TESTS DENON CASSETTE DECK

Denon model DR-750 cassette deck rates excellent.

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DIAL-UP COMPUTER SOFTWARE

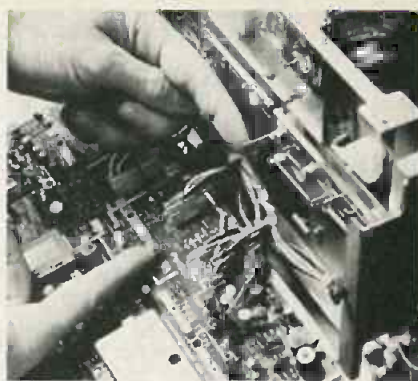
A look at the national software networks that your computer accesses via the telephone lines—what they offer and how to connect up. Jules H. Gilder

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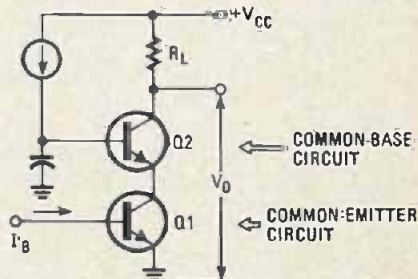
14	Advertising Index	22	Letters
104	Advertising Sales Offices	112	Market Center
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14	Computer Products	96	New Products
26	Editorial	90	Radio Products
135	Equipment Reports	98	Stereo Products
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ON THE COVER

This professional drum synthesizer consists of four individual modules that combine to provide features found only on synthesizers costing several times more. A unique pressure-sensitive transducer mounted inside the practice pad lets you literally pound out a tune. Get started building your own today, the story starts on page 49.



IT LOOKS COMPLICATED, and in fact, it is! It's the transport mechanism of a Beta-type videocassette recorder. But don't let looks scare you off. To find out how to troubleshoot and fix it, turn to page 65.



CASCODING CONFIGURATION of a common-emitter and common-base amplifier stages provide ultra-low distortion. To find out how this circuit works, turn to page 72.

Radio-Electronics, (ISSN 0033-7862) Published monthly by Gernsback Publications, Inc., 200 Park Avenue South, New York, NY 10003. Phone: 212-777-6400. Controlled Circulation Postage Paid at Concord, NH. One-year subscription rate: U.S.A. and U.S. possessions, \$13.00, Canada, \$16.00. Other countries, \$18.00. Single copies \$1.25. © 1980 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

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looking ahead

Fun and games: The latest electronics field to crack the billion-dollar sales mark probably will be the toy-and-game business. According to industry estimates, sales of those products at retail could total from \$800 million to \$1 billion in 1980—double the figure reached last year. There are an estimated 250 to 300 different electronic toys and games now on the market. One manufacturer, Coleco, says that factory sales last year totaled some \$425 million, with hand-held sports games leading the parade at about \$200 million. Football represented about half the sports game sales, followed by baseball, soccer, hockey, and basketball. Non-sports action games (shooting, space games, etc.) represented \$125 million; play and learning games at \$75 million, and miscellaneous toys at \$25 million.

Voice recognition and synthesis are promising new game-and-toy areas. A new game by Mattel has a microphone for each of two players and responds to vocal commands, distinguishing between their voices. Milton Bradley has introduced a new game which speaks half a phrase, challenging the participant to push the proper button to complete the phrase.

Microwave radiation: At what point can microwave radiation become hazardous to your health? That subject is preoccupying the Environmental Protection Administration, the Occupational Health and Safety Administration, the FCC, and many state and local bodies. It involves the telecommunications-electronics industry deeply, and will cut even deeper if it is determined that areas around powerful transmitters may be detrimental to wellbeing. The subject was brought into focus when it was found that the American Embassy in Moscow was being subjected to about 18 microwatts (μ W) of radiation per square centimeter, presumably from Soviet monitoring devices. (Interestingly enough, the Soviet Union has a set of standards which permits a maximum radiation level of only 1/20 of this value.) Although some Embassy employees complained of ill health, it's not known whether the radiation was responsible.

There are no official government standards for microwave radiation limits—the closest to a standard being the American National Standards Institute recommendation that levels be kept to 10,000 microwatts (10 milliwatts) or less. New York City has proposed a limit of fifty microwatts in populated areas—1/200 of ANSI's recommendation. Broadcasters say that this would result in a cutback so sharp that TV stations couldn't serve the metropolitan area.

Now, for the first time, the issue of microwave radiation is vitally affecting plans of broadcasters. The move of ten New York TV stations to the 110-story World Trade Center, scheduled for early 1980, has been postponed as the result of tests made with two UHF stations operating at full power from the 350-foot mast atop the Center's north tower. Radiation at the observation platform and on the top five floors of the south tower was measured at 200 microwatts and experts said it could rise as high as 360 μ W when all the stations are operating. Broadcasters and World Trade Center engineers are trying to devise shielding to prevent possible exposure of visitors and employees of the Center.

Among the proposals are a roof or some kind of screening atop the observation platform and metallized transparent Mylar wrapper on windows of the top five floors of the south tower.

JVC's videodisc: Japan Victor Corporation's VHD (Video High Density) videodisc system, now also endorsed by Matsushita Electric (see *Radio-Electronics*, April 1980), was demonstrated in production prototype form at a Tokyo press conference. The discs for the grooveless capacitance system measure 36 cm in diameter (about 10.2 inches), claimed to save about 25% in material cost as compared with a 12 inch disc. Each disc can play up to one hour per side, revolving at 900 rpm (twice the speed of the RCA disc and half the speed of the Philips/MCA disc.)

The disc, encased in a plastic cover, is fed into a slot in the player. The cover is then removed and play starts—a loading system similar to that employed by RCA. The stylus is a broad, diamond-tipped sled that rests on the disc and is positioned along the proper microscopic track by a pilot tone. The player can provide fast-forward and backward action, and accommodates dual audio tracks for stereo or two languages. An accessory provides random access, slow-motion and still frame. Another accessory converts the player into a PCM (Pulse Code Modulation) digital audio turntable.

JVC says the player could be ready for production next year and will be priced around \$500—timetable and price being similar to those established by RCA for its *SelectaVision* grooved capacitance system. RCA, meanwhile, invited some of its overseas licensees to a technical meeting on *SelectaVision* in Indianapolis. Two of the companies showing up hadn't been previously identified as licensees—Japan's Sony and Korea's Gold Star.

The presence of Sony in the group was seen as particularly significant. Sony is 50% owner of Japan's CBS/Sony Records. (The other owner is a recording licensee for *SelectaVision* videodiscs). Sony is also a licensee for the Philips/MCA optical disc system, which it plans to produce for the industrial-institutional-educational market. Other RCA videodisc licensees include such companies as Hitachi, General of Japan, Nippon Electric, Mitsubishi, Pioneer, Sharp, and Toshiba. Signing a license doesn't commit them to production. Pioneer plans to market a Philips/MCA-type player in the United States this year; it owns 50% of Universal Pioneer, which is manufacturing optical videodisc players. Sharp is also an optical disc system licensee.

TV industry returns: "Where was your TV made?" is no longer an answerable question, since television-set manufacture has become a truly international industry, with parts and subassemblies for all of them made all around the globe. But the answer to "Where was your 1980 TV assembled?" most likely is "In the U.S.A." Virtually every Japanese manufacturer selling sets here (except JVC, which is assembling in Canada) now has a plant in the United States—Sanyo in Arkansas; Forrest City, Arkansas; Sharp in Memphis, and Toshiba in Nashville, Tennessee; and Sony, Mitsubishi and Hitachi in Rancho San Bernardo (near San Diego), Irvine and Compton, California, respectively. Companies based in Taiwan and Korea are also starting assembly operations here, too. The major stimulus for those moves has been the quota on color TV imports from the Far East. But even when the quotas expire, the plants are expected to remain.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

The 90-minute miracle

Solderless saves time like you wouldn't believe. Our Proto-Board® solderless breadboards put everything you need to get your circuit up and running on an aluminum backplane that lets you work at frequencies from DC to half a Giga-Hertz. Three Proto-Board® models feature built-in regulated power supplies—and one of them's a build-it-yourself kit!

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CIRCLE 31 ON FREE INFORMATION CARD

Sony is not committed to one disc system

Sony demonstrated its optical video-disc system at the International Tape Association Conference in New York last October. The system is completely compatible with the new Philips-MCA mini-disc format and provides both 30-minute and one-hour-per-side modes. Sony and Philips have a cross-licensing agreement that allows each to use each other's patent rights for a wide range of products.

But Sony is not solely committed to the optical video system. It is also developing a player and discs for a capacitance system, and is committed to marketing Betamax video cassette players and recorders to the consumer and industrial markets.

Sony has not determined marketing plans for any video-disc format at the present time, but is conducting an extensive video-disc market survey, in view of the growing demand for "random access" playback capability.

Entertainment by satellite for workers far from home

Personnel in oil, mining, shipping and other industries in remote and isolated areas of the world will now receive news, entertainment programs and late movies via satellite. Companies with personnel in isolated areas have long had the problem of maintaining morale, and have found "canned" entertainment by film or videotape an important boost. Now with satellite programming, employees will be able to watch live news and newer entertainment. A beneficial side effect to the companies will be the complete elimination of shipping and handling problems.

Transmission will be via Western Union's Westar III communications satellite, and the programming will be handled by Video Communications, Inc., of Tulsa, OK. At the time the project was announced, it was expected that transmissions would start January 1, 1980, with 12 hours of programming—to be increased to 24 hours daily before the end of the year.

Video Communications now supplies major international oil industry companies with entertainment in film and videotape form. This service will be replaced with satellite transmission. Subscribers to the service will, of course, have to install a receiving earth station.

Hi-fi stereo TV sound due within four years

Television receivers fitted with stereo TV sound will be available to American viewers two to four years from today, according to *New York Times* writer Les Brown. Its impact on the market, some believe, may be as great as that of color television, when it was introduced some years ago.

High-fidelity sound would have an important effect on TV programming. It would greatly enhance the quality of orchestral broadcasts and improve all programs that include instrumental or vocal music. Hence we might expect to see that type of material get a larger share of prime time than it does at present. A recent study indicates that the public is ready for improved sound, even if it increases the price of a television receiver by \$150 to \$300.

The technology has been available for some time, and stereo TV is in actual use in Japan, where it is also used for bi-lingual programming. (Instead of stereo, one channel is in Japanese and the other in a foreign—non-Japanese—language.)

An all-industry committee (led by Thomas B. Keller, WGBH-TV, Boston) working under the Electronic Industries Association is now at work setting up standards for American multi-channel television. It is considering four systems: the one now in use in Japan, one proposed by Quasar, the U.S. division of Matsushita, one developed by Zenith and a proposal from Telesonic, a Chicago company. The findings will be submitted to the FCC, which is expected to act as soon as it receives the recommendations.

NOW—A TAPE-OF-THE-MONTH CLUB



BOOKS ON TAPE, INC., a California organization is introducing what it calls the "driver's library," at present about 250 books on cassettes, for an average monthly rental of \$9.00. The titles range from those of current best sellers like *The Empty Copper Sea* and *The Thorn Birds*, to classic authors like Mark Twain, Charles Dickens and Sir Arthur Conan Doyle, plus such moderns as James Thurber and Erma Bombeck.

The books are not abridged and come on a series of cassettes mailed in sets to the listener. Containers are addressed for easy return, and round-trip postage is paid.

More than 150 authors have had some of their books recorded by Books on Tape. Copies of the latest catalog may be obtained from Books on Tape, Inc., P.O. Box 7900, Newport Beach, CA 92660.

Institute of High Fidelity Now merged with EIA

Officials of the Institute of High Fidelity and of the Audio Division of the Consumer Electronics Group, Electronic Industries Association, have announced the successful conclusion of negotiations to merge the IHF into the EIA/CEG. The governing bodies and full membership of both organizations have ratified the merger.

The IHF will become an operating subdivision of the EIA's Consumer Electronics Group, Audio Division. It will, besides maintaining existing IHF programs, maximize services to the constantly growing high-fidelity segment of the industry.

Video players in 30 to 50% of U.S. homes in ten years?

Video disc players will be in 30 to 50% of the country's television homes within the next 10 years, Herbert S. Schlosser, RCA executive vice president, told the Caucus for Producers, Writers and Directors at a meeting in Los Angeles last October. He told the audience that RCA expected to introduce its *SelectaVision* videodisc system with about 300 titles, of which half would be feature films.

The video player, he pointed out, will make programs available to smaller groups. Since prime-time commercial television seeks the largest possible audience, material that would interest "only" five to ten million people would not appear on prime time, which means that many millions would not get to see certain programs that interest them. The video player will permit "narrowcasting," or programs designed to appeal to smaller and specialized audiences. "And it will be possible to make a profit while reaching only a fraction of the audience required for commercial success in conventional television," he said.

AM broadcast channel spacing to be narrowed to 9 kHz?

The FCC has recommended that 9-kHz channel spacing be adopted for the AM broadcast band (See *Radio-Electronics*, December 1979, page 14.) Before being put into effect, approval of the U.S. State Department and the other nations of the Western Hemisphere will be required. Mexico and Canada are not expected to agree.

The National Radio Broadcasters Association has filed comments objecting to the new move, pointing out that tests already made have shown up difficulties not foreseen, and have demonstrated that "theoretical projections and practical results quite often differ." The Association is pressing for extensive study and testing before taking definite steps to implement the proposed change.

continued on page 12

Three good reasons to buy your handheld DMM from Fluke.

Ask yourself what you're really looking for in a handheld DMM, and then take a good long look at ours.

CHOICES? The Fluke line of handheld DMM's now offers three clear performance choices. There's the 8022A Troubleshooter, a solid value for basic voltage/current/resistance measurements that offers 0.25% basic dc accuracy. The 8020A Analyst is the world's best-selling DMM and first to offer conductance for high-resistance measurements to 10,000 Megohms — now with accuracy improved to 0.1%. And the new 8024A Investigator, a powerful instrument also with 0.1% accuracy that boasts three unique capabilities: *logic level/continuity detection* with an audible "beeper" for

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CONVENIENCE? Pick one up and you'll know what *true* one-hand operation means — tough, lightweight, palm-size packages designed with in-line push buttons for quick range and function changes.

RELIABILITY? Count on it. A substantial number of components are used exclusively to insure reliability and to guard against overloads.

Calibration is traceable directly to the National Bureau of Standards.

LOW COST? Compare these U.S. prices: \$139 for the 8022A, \$179 for the 8020A and \$219 for the powerful 8024A.

Fluke standards of quality and customer service, of course, are uncompromising — for our line of handheld DMM's and all our products. For more facts call toll free **800-426-0361**; use the coupon below; or contact your Fluke stocking distributor, sales office or representative.



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**NRI training in TV
and Audio Servicing
keeps up with the
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Now you can learn to
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Learn at home at your convenience.

(diagonal) color TV. It's the only one that comes complete with built-in computer tuning that lets you program an entire evening's entertainment. As you build it, you introduce and correct electronic faults, study circuit operation, get practical bench experience that gives you extra confidence.

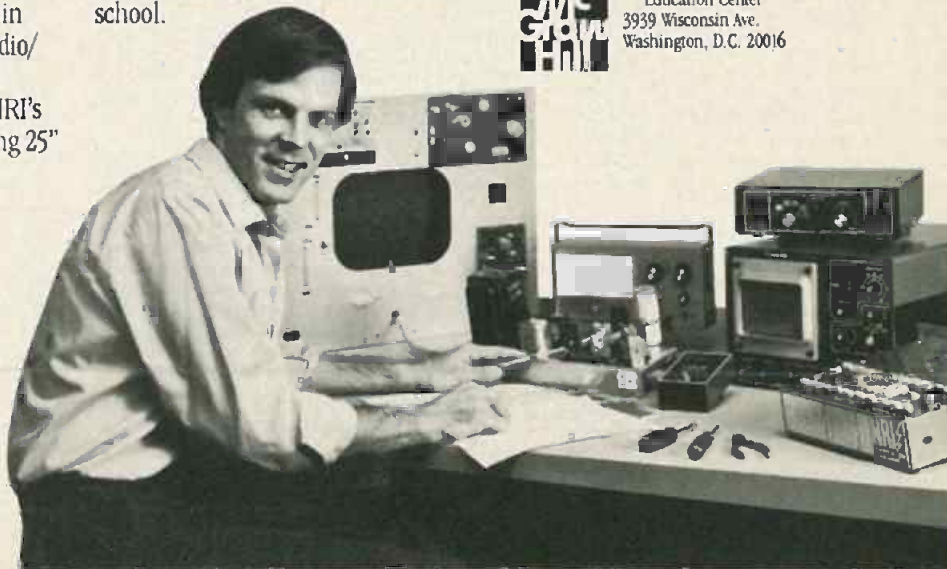
You also construct a solid-state stereo tuner and amplifier complete with speakers. You even assemble professional-grade test instruments so you know what makes them tick, too. Then you use them in your course, keep them for actual TV and audio servicing work.

NRI Includes the Instruments You Need

You start by building a transistorized volt-ohm meter which you use for basic training in electronic theory. Then you assemble a digital CMOS frequency counter for use with lessons in analog and digital circuitry, FM principles. You also get an integrated circuit TV pattern generator, and an advanced design solid-state 5" triggered-sweep oscilloscope. Use them for learning, then use them for earning.

NRI Training Works... Choice of the Pros

More than 60 years and a million students later, NRI is still first choice in home study schools. A national survey of successful TV repairmen shows that more than half have had home study training, and among them, it's NRI 3 to 1 over any other school.



(Summary of survey on request.)

That's because you can't beat the training and you can't beat the value! For hundreds of dollars less than competing schools, NRI gives you *both* color TV and audio...



Other NRI training includes Computer Technology, Complete Communications Electronics.

and now includes training in video cassette and disc systems. Send for our free catalog and see for yourself why NRI works for you.

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Washington, D.C. 20016

continued from page 6

Computer adjusts temperature for occupied or empty rooms

A new piece of equipment uses an intruder alarm and a door switch to reduce room temperature to a preset "empty room" value every time an occupant leaves. It then restores a higher temperature as soon as the room is again occupied.

The device was exhibited as a new product at the Second World Congress of Energy Engineers in Atlanta, GA. The manufacturer, Energy Management Systems of Austin, TX, states that production units will be available early in 1980. The device is intended for the hotel or motel market.

A sensitive, ultrasonic motion detector is combined with a remote door switch. Every time the door is opened the unit begins to monitor the room area for motion. If it discovers none, the room temperature control is set back to the "empty room" temperature until the door is again opened.

Since the temperature is set back only after detecting no motion, and since the equipment works only when the door is opened, the manufacturer believes the system is virtually fail-safe against accidentally setting back the temperature in an occupied room. (What happens if one occupant of a double-occupancy room leaves early in the morning, leaving the other asleep, is not entirely clear.)

Savings of 12 to 40% in heating costs are expected where the new device is used.

Superefficient generator to operate at -452°F

The rotor of a superconducting generator that will produce 18 megawatts of power has been put through its most severe qualifying test—spinning its 13-foot-long, 1.5-ton rotor 3,600 revolutions per minute, at 452 degrees below zero Fahrenheit (-269°C).

When completed, the new generator should produce as much electricity as a conventional machine twice its size and weight, say scientists of the General Electric Research and Development Center, Schenectady, NY, where the new generator is being developed.

At 452 degrees below zero, the windings of the stator magnets have practically no resistance; magnetic fields of fantastic strength can be produced.

The conductors used for the stator windings consist of thousands of filaments of a niobium-titanium alloy in a copper matrix. These are wound to form five racetrack windings, which are immersed in liquid helium at -452°F .

At that temperature, a critical problem was to prevent the windings from moving even a small part of a thousandth of an inch. A microscopic movement could gen-

erate enough heat through friction to reduce or destroy the superconductivity of the conductors. In the experimental generator, the windings are bonded into rock-solid modules with an epoxy-impregnation process. A unique aluminum support, designed by Dr. Trifon E. Laskaris, manager of the Center's Rotating Machinery unit, provides extra rigidity against the powerful magnetic and centrifugal forces to which the rotor is subjected.

The stator of the new superconducting generator is now under construction, and final tests of the completed generator are expected early in 1981.

SPACE PLATFORM FROM FIBERGLASS?



BEAMS OF HIGH-STRENGTH FIBERGLASS like the one above, being tested by chemist Pat Salisbury of Hughes Aircraft Co., may support platforms in the U.S. space programs. The material is fiberglass, impregnated with a polyester resin that starts out soft and sticky but becomes tough and rigid from the sun's radiation. The truss-like design is for greater rigidity. The weight is about half that of aluminum. Hughes is building a prototype seven-by-three-foot beam of this fishnet-like design for NASA's Marshall Space Flight Center at Huntsville, AL. If the idea proves practical, a series of beams could be joined to form a large platform in space, where the sun's ultraviolet rays begin hardening the material in a half hour and make it completely rigid within six hours.

CCD signal processor improves TV color

The first use of advanced charge-coupled device (CCD) technology in a mass-produced consumer product, a comb-filter signal processor that significantly improves the picture quality and sharpness of color TV sets, was described by RCA engineers

to the ninth annual Institute of Electrical and Electronics Engineers' (IEEE) Chicago Fall Conference on Consumer Electronics.

The CCD signal processor filters throughout the entire video-frequency range, thus making possible the enhancement of vertical detail in the picture. Furthermore, it is inherently stable because the CCD filter is not affected by the temperature and humidity conditions that are known to plague comb filters using more conventional technology.

The new RCA system incorporating the comb filter, through optimization of the horizontal and vertical aperture corrections, produces a clear and sharp picture free of the "dot crawl" and "cross color" that is associated with conventional color receivers.

Overall, the RCA engineers said, the new comb filter increases horizontal resolution to at least 330 TV lines compared with 260 lines in previous RCA sets.

Popular-priced metal tape announced by TDK

A new popular-priced metal audio cassette has been introduced by TDK Electronics Corp to meet the market demands created by the earlier MA-R.

TDK MA uses the same metal particle formulation as the top-of-the-line MA-R metal audio cassette. Like MA-R the coercivity and remanence of MA is 1050 oersteds and 3,000 gauss. Its magnetic energy is roughly four times that of the best high-bias tapes. The suggested list price for TDK MA is \$11.60.

Shopping mall takes lead in energy conservation

One of the largest enclosed shopping malls in North America, the Centre Mall of Oshawa, Ontario, Canada, has replaced the 80 lighting fixtures of its parking lot with 28 newly designed ones, with the double object of getting better light and saving 80 percent of the electricity formerly needed.

The older system used 320 mercury-vapor luminaires, mounted on 80 poles. With the new "double-reflector" system, each of the 28 poles carries a single thousand-watt metal halide lamp. The total consumption is 30.8 kW, as compared to 147.2 kW for the older system, making a saving of about \$9000 annually.

Besides saving energy, the new lights can be so equipped that they cut off on one or more sides, preventing "light pollution" in high-density residential areas. The smaller number of poles allows for additional parking space, and their more pleasing design improves the appearance of the parking lot.

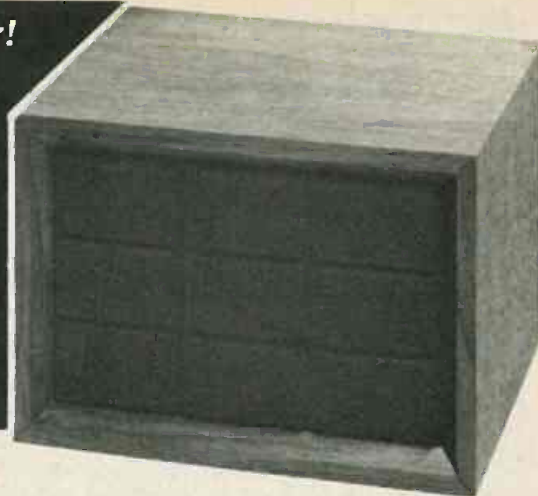
Not Just Another Limited Area Motion Detector!

guardex™

Protects Every Square Inch Of Your Building

Turns On Lights Automatically

Powerful Electronic Siren



The Guardex 8000 Alarm System is walnut grained and disguised to look like a small stereo speaker (6 3/4" x 9 3/4" x 8") and weighs less than 6 1/2 pounds.

Low Cost Computerized Burglar Alarm System Home - Office - Business

NO INSTALLATION

Just plug the Guardex 8000 alarm system in, make several simple control adjustments to suit your particular building and it works! There are no other wires to run. This totally self-contained burglar alarm can completely seal off every square inch of the surface of your building. It protects doors, windows, and what most alarms miss... your roof, walls and floors.

HOW CAN ONE SMALL COMPUTER PROTECT MY WHOLE BUILDING?

Guardex 8000 Alarm System works on the principle of audio discrimination. This, put simply, is the process of electronically separating normal everyday sounds, such as voices, telephones, etc. from break-in type noises such as breaking glass, prying metal, or forcing a door open. The Guardex 8000 protects one story homes and offices up to 2000 square feet and open commercial buildings up to 10,000 square feet. The Guardex 9300 with wireless remote sensor capability is available for multi-story homes and offices or single story with more than 2000 square feet. Call the factory for more detailed information.

TURNS ON LIGHTS AUTOMATICALLY

When the first break-in type sound is detected, the system will instantly turn on lights, radio, or other electronic equipment that you have plugged into the back of the alarm. These lights or other equipment will remain on for a period of five minutes, then automatically turn off.

POWERFUL ELECTRONIC SIREN

The Guardex 8000 alarm is equipped with a loud built-in siren. If during the five minute period the lights or other electronic equipment has been activated, a second break-in sound is detected, (it can be only a second or two after the first break-in sound) the built-in siren will start blasting for 90 seconds. At the end of approximately 90 seconds the siren will shut off and the alarm listens again. If another break-in sound is heard, the siren will come on for another 90 seconds. If no other break-in sound is detected, the siren will stay off and at the end of the five minute period the lights will shut off and the alarm instantly resets.



The rear control panel contains two standard AC plug receptacles for a table lamp, spot lights, radio, etc.; terminals for connecting optional outside siren and back-up battery (not included); entry delay time control and sensitivity control.

EXIT AND ENTRY DELAY

The Guardex 8000 alarm has a built-in exit delay allowing you approximately one minute to lock up and leave the building before the alarm is armed. When you enter your building you may find that just your normal entering sounds activate the siren. You may delay it from starting for up to 30 seconds by turning up the siren entry delay control.

BATTERY BACK-UP

Burglars rarely cut power. However, to give you total protection from a burglar and possible power failure, our alarm has provisions for a battery back-up. (Batteries not included). 12 volt lantern batteries are available at most hardware stores.

THE BURGLARY PROBLEM

The F.B.I. statistics show that at the present rate, one out of every four Americans are going to be burglarized. That is not a very pleasant fact, but it is true. You have a greater chance of being burglarized than being a victim of a fire or automobile accident. The time is now to help protect yourself and your valuables with a Guardex 8000 alarm system.

OUTSIDE SIREN

The Guardex 8000 alarm is equipped with a loud, built-in siren, but if you desire an additional siren to mount outside or in an area away from the main alarm, they are available with 50 feet of wire for \$24.95. (Connecting terminals are provided on the back of the alarm).

30 DAY NO RISK TRIAL

This is your opportunity to purchase an alarm system directly from the factory for only \$199.95. Try it in your home or business for thirty days without risking one cent. Put our Guardex 8000 alarm to your own test. See for yourself! It will protect every window and door from break-in. If you are not completely satisfied, return the alarm within 30 days for a complete refund. To order your Guardex 8000 alarm, CALL TOLL FREE to charge your credit card or send your check to Guardian Electronics, Inc. in the amount of \$199.95. If you want the optional outside siren, add \$24.94. (California residents add 6% sales tax.)

(If you require more information, call during California business hours, Monday - Friday)



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CIRCLE 68 ON FREE INFORMATION CARD

Teletext—To be or not to be

Once . . . each and every month, approximately two dozen people from the U.S. and foreign countries gather together for a meeting. It's official designation is Task Force A of the Teletext Subcommittee. This Subcommittee was organized by the Broadcast Television Systems Committee of the Electronic Industries Association. Its purpose is to gather and sift through the various proposals and make recommendations for instituting a teletext service within the United States. Eventually those recommendations will be forwarded to the FCC. I sit on that committee.

For those readers who may not already know, teletext is a system for transmitting information within the vertical retrace interval of a TV picture. Ultimately consumers will be able to attach decoders to their TV sets that will display the information. The exact nature of the information that will be transmitted is still undecided, but the possibilities are fascinating; they include everything from "electronic" mail and "electronic" newspapers and magazines to instant worldwide weather coverage. The service could even provide access to data bases and programs for "smart" (computer) terminals in the home.

If introduced, teletext will have a major impact on our lives as well as our economy. Never before have we had a means of transferring such huge amounts of raw data at lightning speed and providing that information to so many people. It can transform the TV set into much more than just a home entertainment device. It can become a vital adjunct to our everyday lives.

Teletext is more than simply a blackboard proposal. Task Force A is considering several systems that are already beyond the design stages and very much a reality. It is now up to Task Force A to gather the necessary information and make their recommendations. Certainly, each system must be carefully considered. But Task Force A must not drag its feet either—especially considering the snail's pace at which the FCC has instituted previous petitions dealing with the broadcast industry.

Nor should we as citizens let teletext slip by the wayside. If too much time is spent considering the proposals, and if too much politicking takes place, teletext will die. We mustn't let it! Let your opinions be known by writing to Charles D. Ferris, Chairman, Federal Communications Commission, 1919 M Street N.W., Washington, D.C. 20554.



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

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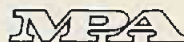
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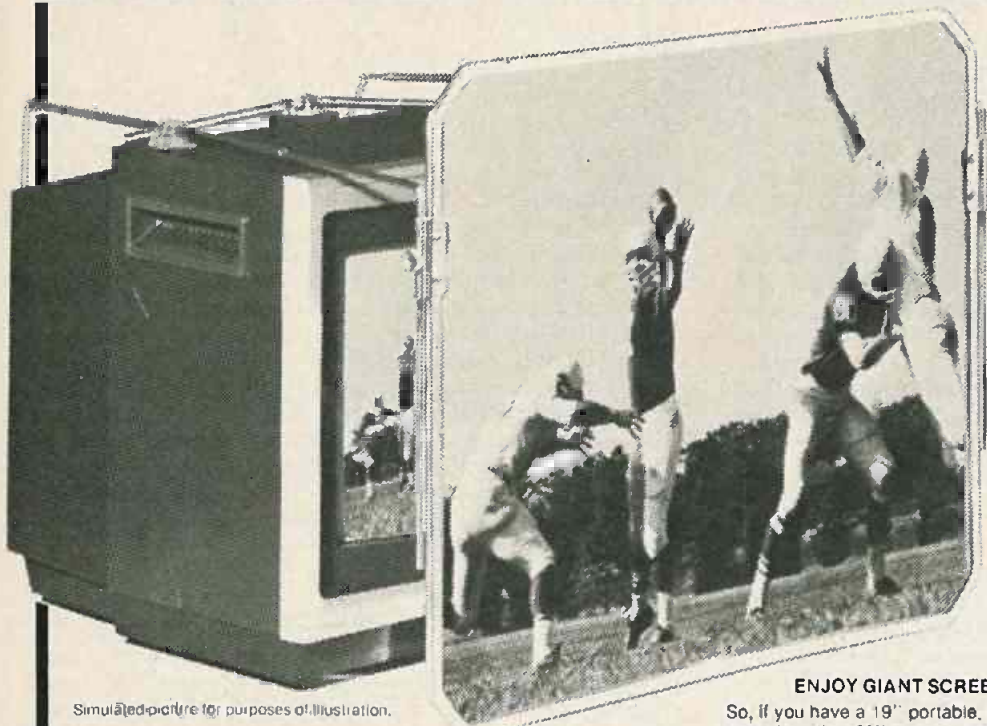
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The Incredible BEAMSCOPE ZOOM LENS



Simulated picture for purposes of illustration.

The Incredible Beamscope Zoom Lens represents a new application of technology to the field of T.V. Optics. One which we predict will tie the industry in knots, and force top management to re-examine their technical approach toward large-screen T.V. These are hard facts to face for an industry committed to charging more for what we believe is outmoded technology!

Today SONY, PANASONIC, G.E., ADVENT and SHARP, to mention only a few names, are marketing large-screen projection T.V. systems. These units are designed to offer dramatic theatre size screen presentation in your own living room. They are dramatic, and they are expensive! Expect to pay upwards of \$2,000 and more for a T.V. that must be viewed with separate movie-type screens, require precise placement of the lens with respect to the screen and can hardly be seen in daylight.

BEAMSCOPE SUPERIORITY

Beamscope provides a large-screen, theatre viewing system that can be used in any room, under any and all lighting conditions. Most important of all, it can be used with your present T.V. Depending on the size of the T.V. Beamscope will provide a superb picture, up to 475 sq. inch, with a diagonal measure of 30". The cost is not in the thousands, not even in the hundreds, but less than \$70! Football, basketball, hockey—bigger and better than you have ever seen them before. Every detail sharp and clear. The action easier to follow than it would be from the best seat in the house. Baseball, the races, your favorite program, Charlie's Angels, Chrissy and Janet of "Three's Company," come to life in your living room. And, what kind of quality can you expect for less than \$70, when SONY charges \$1,995 for its 40" video projection system. The answer is: Flawless! Beamscope not only gives you distortionless color and black and white but actually improves the color and sharpness of your present picture.

A PRODUCT OF COMPUTER SCIENCE

Due to the accuracy and precision required, Beamscope could not have been produced at a reasonable price without the aid of a computer. Simply stated, the Beamscope lens is constructed with thousands of spiral micro-grooves, so small they can't be seen. They are cut with computer accuracy into one side of a specially fabricated, exceptionally hard acrylic. When the Beamscope is placed in front of your T.V. these grooves literally explode the picture up to twice its normal size.

DISCOVERED BY ACCIDENT

Interestingly, we discovered the Beamscope Lens quite by accident, because it was intended for use by the visually impaired. It has been thoroughly tested and is today being used at the Optometric Center of the Southern California College of Optometry, and numerous other low vision clinics, Universities and Institutes throughout the U.S. Obviously then, the T.V. Zoom Lens is no gimmick, but a scientifically designed optometrically approved, University endorsed optical break-through, manufactured to the highest quality standards.

**MORE THAN DOUBLES
THE SIZE OF YOUR T.V.
SCREEN...COLOR OR
BLACK AND WHITE**

- Turn a 13" screen from 96 sq. inches to 352 sq. inches.
- Turn a 19" screen from 192 sq. inches to 475 sq. inches.
- Fits any screen from 10" to 25"
- Installs in minutes without tools.

JUST \$69⁹⁵

ENJOY GIANT SCREEN TV AT ENORMOUS SAVINGS!

So, if you have a 19" portable, the T.V. Zoom Lens will turn it into a super-console with a 30" screen and 475 sq. inch picture. That's two and a half times the normal 160 sq. inch size. Your 15" set will go from a 125 sq. inch picture to a 328 sq. inch picture.

Of course, if you've been thinking about a new set—wait! Try the T.V. Zoom Lens on your old set. One look will convince you of the hundreds and hundreds of dollars you can save by using the T.V. Zoom Lens to get a bigger, better picture with a small set selling for \$200 or \$300 less!

DON'T TAKE OUR WORD. SEE BEAMSCOPE FOR YOURSELF!

Beamscope must be seen to be believed! That's why we are willing to let you see for yourself on your own T.V. Order today, if you don't agree that it is everything we claim and more, return it to us for a refund of purchase price.

Better yet—check out the large theatre-size systems at your local department store. Once you compare them to Beamscope, you will understand our enthusiasm.

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Broadcasters agree on Westar

Look for much more television programming via satellite this Fall. Broadcast TV organizations, including independent programmers as well as the major networks, have made a commitment to use the Western Union Westar system. That means more news, sports, entertainment—and, yes—commercials will be available from the skies. But don't expect the full prime-time network line-up of programming to be beamed via satellite; for now, the networks only plan to use their newly acquired transponders as a back-up (in case of failures in the existing terrestrial web) and for special transmissions. In any case, barely three dozen of the nation's 800 TV stations have equipment to pick up a satellite signal yet.

Blairsat, a subsidiary of a leading broadcast advertising company, expects to start sending commercials to TV stations in about 31 cities this fall, and the company is presently analyzing how it can distribute syndicated game shows, reruns, and other TV programs to stations via the Westar transponder it will share with Hughes TV Network. Hughes, for its part, has completed an agreement with most professional baseball teams. Their viewers will see 500 "away" games this season beamed back to TV stations in the teams' home towns. Separately, Group W (Westinghouse Broadcasting) has a timetable for use of its transponder beginning in September when such syndicated shows as "John Davison" and "PM Magazine" go on the bird—with more likely to come.

The rest of the lineup aboard Westar birds will include programming from ABC, CBS, Bonneville Broadcasting, Spanish International Network, Video Communications Inc. and Satellite Communications Network. Cable News Network will use Westar to send news reports into its Atlanta headquarters (although CNN's 24-hour news service will travel via RCA Americom's Satcom 1 downstream to cable TV systems). Several other broadcasting groups will lease time aboard Westar transponders from Robert Wold Co., largely for use by their Washington or other news bureaus to feed stories back to the hometown stations. Meanwhile, ad agencies are expected to use the Blairsat service and others this fall for political commercials. The idea is that ad agencies can produce timely spots and, instead of using expensive air freight to deliver films or tapes (which can take a few days), the commercials can be beamed directly to TV stations for use that same day while a political issue is still in the news.

By corraling so many broadcasting clients (in addition to the Public Broadcasting Service), Western Union has set itself up in strong competition to RCA Americom's SMARTS for delivering programming via satellite directly to local TV stations. The first SMARTS tests (using Viacom programming and Post-Newsweek TV stations) finally got underway early this year. How impressed are local TV-station managers with satellite technology? Well, although such service is barely in its infancy, more than 80% of TV executives recently polled believe that satellites offer "great benefits" to commercial TV. That could mean we'll be seeing much more programming of all types transmitted via birds.

Much more programming from cable TV/satellite feeds

Every week seems to bring more program offerings intended for cable-TV customers via the cable/satellite hook-ups. Showtime Entertainment, one of the major pay-TV program providers, has announced it will earmark \$14 million this year to create

new shows—including concerts, musical performances, and comedy specials—in addition to the movies it buys from major studios. Home Box Office, the largest pay-TV company, similarly announced new programs and a commitment to use hundreds of new feature films during the coming year. Major League Baseball and UA-Columbia Satellite Services signed an agreement to continue their Thursday-night baseball Game of the Week next season under a multi-year contract which calls for about 40 regular season games to be transmitted annually, strictly for the cable/satellite viewers.

On the more esoteric side, "Pirate this Program," a free-form half-hour show which encourages viewers to videotape the telecast off the air, is now transmitted at 12:30 PM EST on Thursdays (right after Bob Cooper's "Coop's Satellite Magazine"). "Pirate this Program" is produced by the people who publish *Instant Replay* magazine, the periodical which is "printed" on videocassettes.

Crowded skies

A new version of "Space Wars" is about to be fought by lawyers representing companies who want the last remaining orbital-parking spaces available for domestic satellites over the United States. Hughes Communications, a new subsidiary of Hughes Aircraft, applied for the arc slots at 79° and 75° west longitude; then, a few weeks later, Southern Pacific Communications announced it wants those spots too, and told the FCC that it was unfair to hand out the last available C-Band slots without further examination. Hughes, a company which has long built satellites for Western Union and other companies, is expected to offer its satellite capacity for video as well as other services; each Hughes bird will have 24 transponders. The SP Communications satellites would largely supplement that company's terrestrial microwave network for voice and data communications. Details of the SPC satellite proposal will come out when the company submits its formal proposal to the FCC later this Spring.

Direct broadcast satellite activity

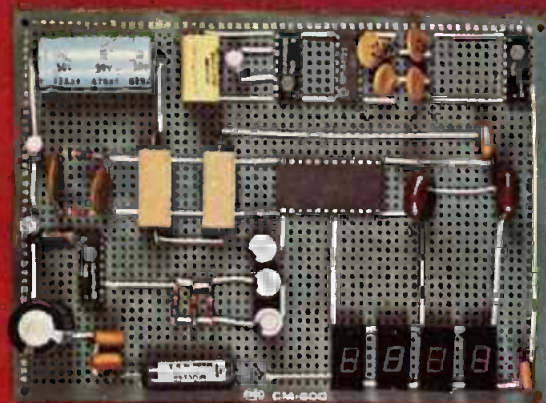
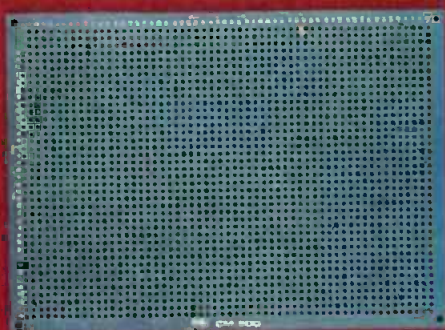
Comsat was due to submit its formal details for direct-to-home pay TV transmissions in the Ku-Band just as we went to press. But even before the complete proposal to the FCC turned up, there was considerable action about the plan to beam programs into one-meter, rooftop antennas. First, Comsat confirmed that it had negotiated a deal with Sears by which the giant retail chain would sell and install the home-reception equipment, expected to cost about \$300. That sort of nationwide distribution could speed the installation of the Comsat offering. Meanwhile, Comsat also hinted that it might make its package of programming (entertainment, sports, education, information, etc.) available to cable-TV systems so they could retransmit them to customers who didn't want to erect their own rooftop dishes.

Separately, the FCC has set up an internal task force to examine the feasibility of any direct-broadcasting in the 14/12 GHz range. Some observers believe that a heavy lobbying campaign (such as the one already begun by the TV broadcasting industry) could stymie the development of the Comsat plan. But others contend that Comsat's thorough preparatory work will help the project get into the sky close to the 1983 target date that Comsat has already announced.

continued on page 32



CM-600 Circuit Mount



CM-600 \$6.95*
RW-50 \$2.98*

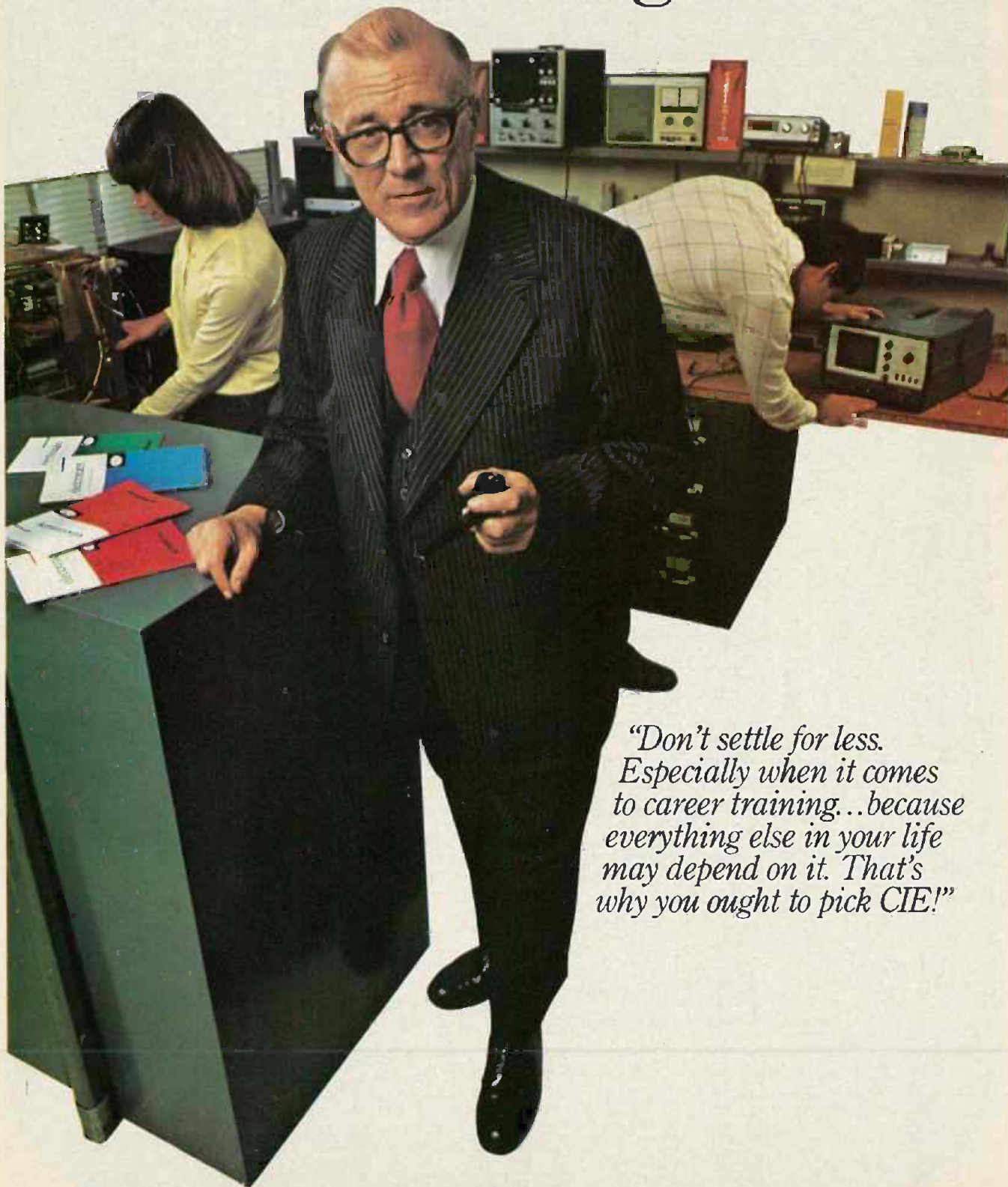
NEW CM-600 SOLDERLESS PROTOTYPE BOARD

CM-600 is a unique system for solderless construction of circuit prototypes, useful to both engineers and hobbyists. The CM-600 is a neoprene board 4½" (114mm) x 6" (152mm) with 2280 holes on .100" (2.54mm) centers. Standard components including DIP's are mounted by simply inserting leads into the holes in the long life neoprene material. Interconnections are easily made using 20 or 22 AWG (0,8 or 0,65mm) wire jumpers. Positive contact is assured by the elasticity of the hole, which compresses the leads together. To remove components or leads, simply pull out. This facilitates easy circuit changes making it ideal for breadboarding experimental circuits. CM-600 also features numbered rows and columns for easy reference. Accessory Kit RW-50 contains 50 pcs of AWG 20 (0,8mm) insulated jumper wires of assorted lengths from ½" (13mm) to 4" (100mm). Both ends are stripped and bent 90° for easy insertion. In stock directly from

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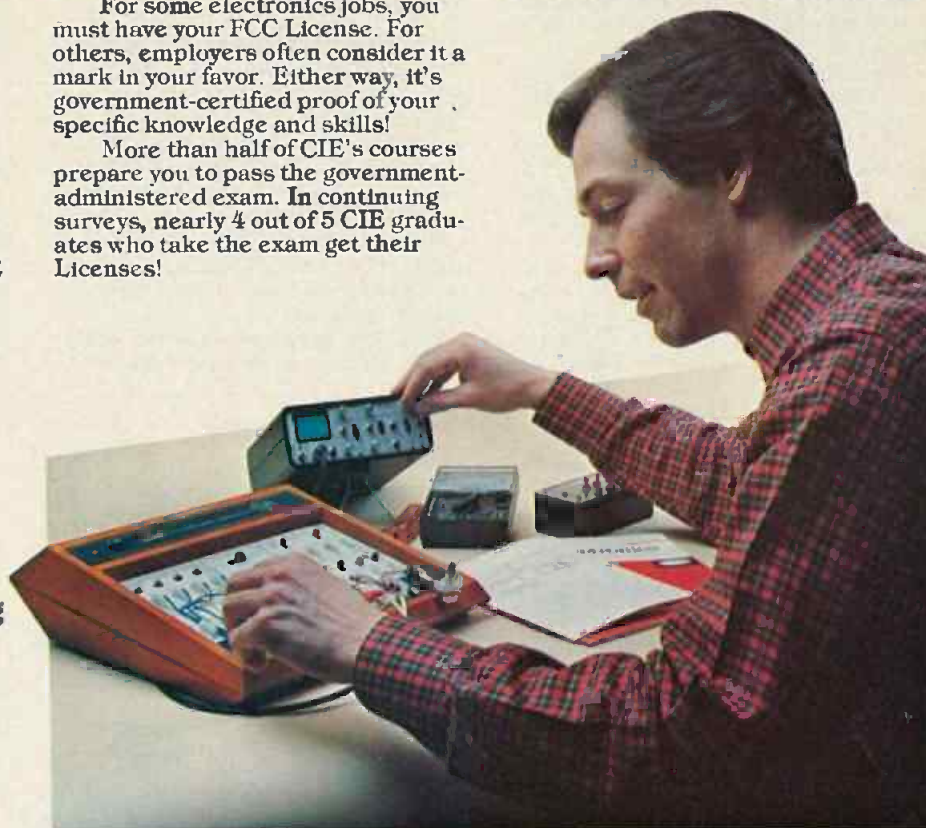
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THE IONOPHONE SPEAKER

In "Lights That Failed," (October 1979), the author laments the passing of the *ionophone* speaker. It was made in DuKane in the early 60's, and was called the Ionovac (in Europe, the Ionophone). Most assuredly, it is *not* dead.

Dr. Allen Hill, a laser physicist, has developed the Hill Type 1 Plasma Speaker. Hornless, it is driven by an integral vacuum tube amplifier. It operates from 700 Hz to at least 100 kHz. Two "conventional" drivers of very high quality (Audax) serve to fill in below 700 Hz.

The sound? With good program material, it *sounds real*, in a way that no other speaker can touch. The theory is fully justified.

Nor is Thermo-Plastic Recording really a failed invention, since it is simply a "frozen" version of the Eldophor projection system. And GE has embodied those principles in its light valve projection TV.

Matsushita is about to produce a set using a tube like the Philco "Apple." They both work on the same principle. Another layer of phosphor behind one of the stripes generates UV (or X-rays in the Apple) that

is picked up by a sensor and used to switch the color signals applied to the gun. No second beam is needed. Why hasn't it been used in large tubes? Probably because there are so many stripes per line that the required switching frequency is too high, or causes RFI problems.

Ultimately, however, there are no failed lights. Any really good idea has a way of turning up again.

WILLIAM SOMMERWERCK
Rosemont, PA

ETCHANT DISPOSAL WARNING

I was alarmed to read the letter from L. Scott Hofer about the disposal of ferric chloride etchant (January 1980 issue). One of the very first rules of chemistry is: *Never pour a base (or water) into a strong acid.*

Sodium carbonate is a fairly strong base; and when it is added "slowly" (Hofer's words) to a strong acid there is a violent reaction (the "foaming" Hofer describes). That reaction generates a lot of heat, as a result of ionization.

A far safer way would be to mix a large quantity of sodium carbonate solution in

cold water. Then slowly pour the relatively smaller volume of ferric chloride into the carbonate solution. The larger volume of carbonate solution will more quickly neutralize the acid and dissipate the heat as well.

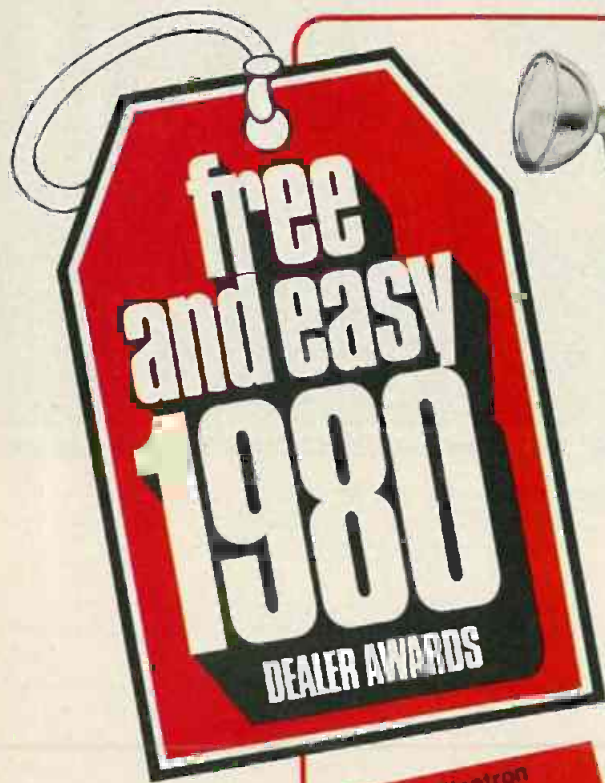
If he insists upon using his method, Mr. Hofer had better invest in a rubber apron, rubber gloves, and goggles! Sooner or later, he is going to have a small, but violent, "explosion" of chemicals spattering his clothes, face, and eyes.

ROBERT K. DEUNK
Cleveland, OH

AC OUTLET CHECKER

The "AC Outlet Checker" article (August; 1979) is interesting and provides a circuit that should give a lot of information. However, a much simpler checker for AC outlets can be made by connecting a neon lamp (through a resistor) between the hot terminal of a three-connector plug and the *grounding* terminal.

The neon lamp can be mounted in the base of the three-connector plug. If the lamp goes on, you know that (1) the hot



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wire is connected correctly (2) the outlet box is grounded, and (3) the grounding wire is connected correctly. Those are the principle safety factors.

To check that the common wire is connected, all you have to do is to plug an ordinary lamp into the socket.

Incidentally, on page 53 of the article the labeling of the "O," "X," and "K" lamps is confusing. And should "K" be a red lamp?

CARL HARTMAN,
Newport Beach, CA

The labelling of the lamps is indeed confusing. They should be labeled as follows: DS1=O, DS2=X, DS3=K.—Editor.

TANK GAME

I am writing in regard to the Tank Game project published in the November and December 1978 issues.

As shown in the article, the game does not operate properly. The tanks move forward and reverse but will not turn. This is due to a wiring mistake made in the schematic and PC board pictorial. The circuit should be changed to match that of the schematic shown in Fig. 1.

This will now allow the tanks to turn. In addition, the control switches will now operate differently: i.e., when the switches are pushed away from the player, the tank will move forward. When pulled towards the player, the tank moves in reverse.

I hope this will help anyone who built the game and has had problems.

RICHARD R. FALLSTICH
Allentown, PA

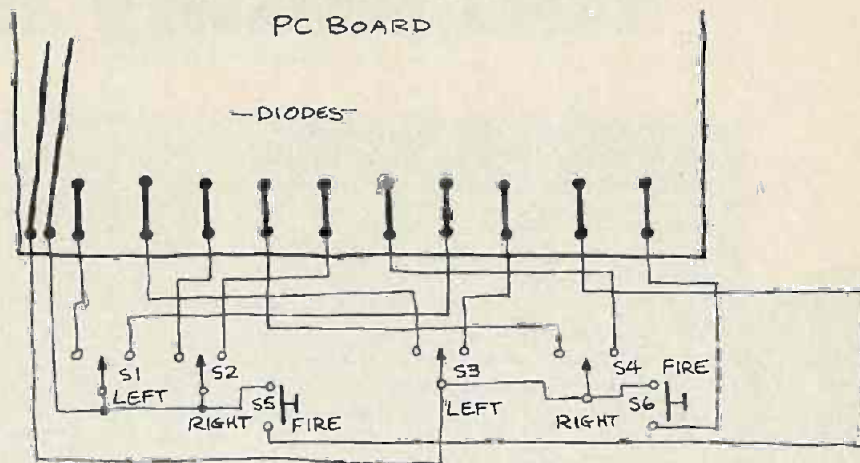
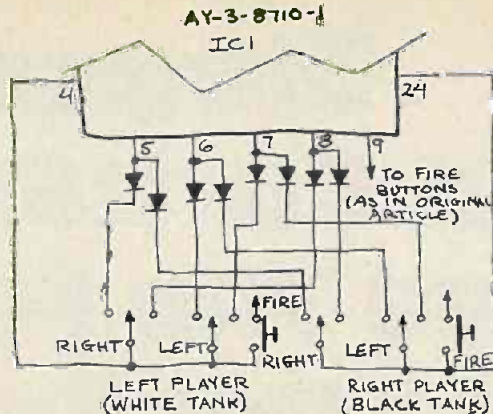


FIG. 1

continued on page 111

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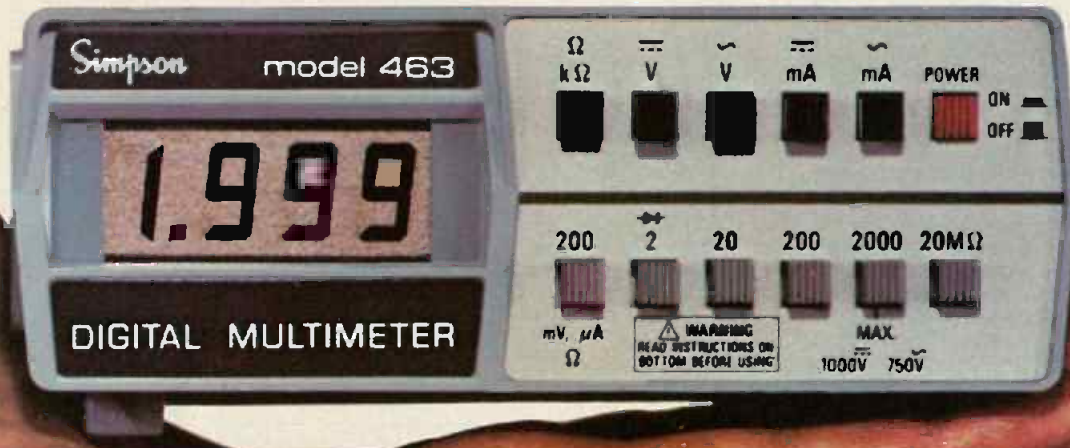
When you think of receiving tubes, think RCA! When you think of dealer awards, think RCA "Free and Easy 1980." Then get both from your local participating RCA tube distributor. Quality tubes and quality awards go hand in hand at RCA.

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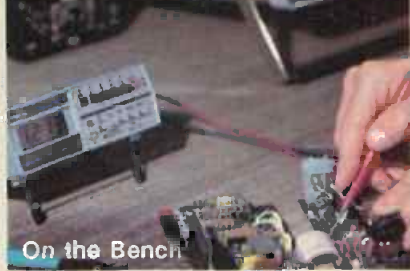


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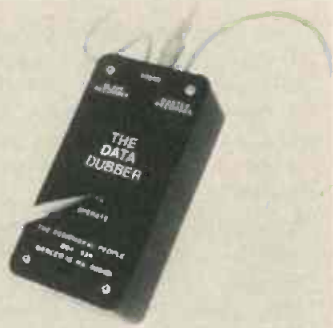
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Model 462
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CIRCLE 44 ON FREE INFORMATION CARD

Data Dubber For The TRS-80



CIRCLE 101 ON FREE INFORMATION CARD

ANYONE WHO OPERATES A RADIO SHACK TRS-80 microcomputer knows that loading in programs from cassette tapes is a touchy proposition—particularly with Level II BASIC. Tapes made directly from the microcomputer output are less touchy, but tapes from other

sources—borrowed or purchased—can be very difficult or impossible to load. Also, recorder-to-recorder copies, without special professional recording equipment or expensive duplicators, are usually a waste of time.

However, the *Data Dubber* (from The Peripheral People, Box 524, Marcer Island, Washington 98040. \$39.95 postage paid) solves those problems. You can duplicate and get perfect CLOAD's even from tapes with hum, distortion, or minor dropouts—and without any modification to the TRS-80. It can be used with both Level I and Level II BASIC.

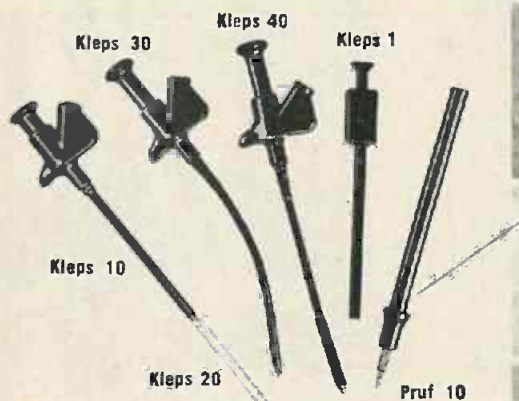
Ideally, the pulses from the TRS-80 to the cassette recorder during a CSAVE operation should be stored on the tape as perfect pulses—or at least as perfect sinewaves. That seldom happens because of the poor frequency response of standard audio recorders. Also, ideally, the TRS-80 would rather input pulses than sinewaves, and it especially dislikes the distorted sinewaves produced on playback of tapes made on other recorders. Head alignment, speed, and frequency response could be quite different from that of your recorder!

The *Data Dubber* is designed to take whatever data is on the tape, distorted or not, and

regenerate exact duplicates of the original pulses. Those idealized pulses are also available to feed a second cassette recorder for duplication. The *Data Dubber* does not care if the program is in BASIC or assembly language, since it simply idealizes the pulses. Unless there are data pulses actually missing from the recording—or pulses and pops that shouldn't be there at all!—the *Data Dubber* will usually load the tape the first time.

The first two stages of the *Data Dubber* essentially duplicate the high-pass filter and full-wave rectifier circuitry of the TRS-80 cassette input. The input pulses are then leveled in amplitude by a threshold detector, the output of which triggers a series of one-shot multivibrators. The time constant is set to duplicate the width of the pulses that the TRS-80 produces. Positive and negative pulses are summed together to make the bipolar pulses required by the tape recorder—a kind of sine-wave built out of squarewaves. There are two outputs, one preset to the optimum level for the TRS-80 input and the other preset just under the automatic volume-control threshold of the AUX input of the tape recorder.

continued on page 28



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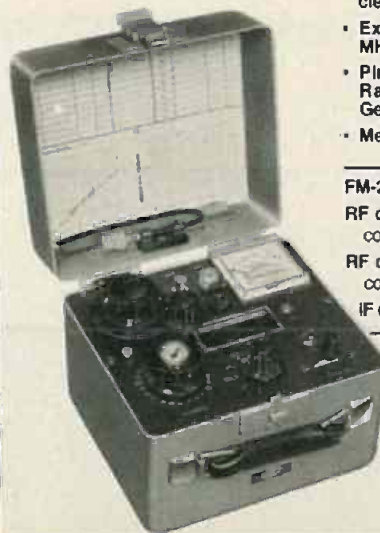
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	FLUKE 8024A		BECKMAN 3010			B & K 2815	
	WESTON 6100		FLUKE 8022A				
DC VOLTS	D	D	D	D	D	D	D
AC VOLTS	D	D	D	D	D	D	D
DC CURRENT	D	D	D	D	D	D	D
AC CURRENT	D	D	D	D	D	D	D
RESISTANCE	D	D	D	D	D	D	D
CONDUCTANCE		D		D		D	D
DIODE TEST	A	A		D		D	D
LOGIC LEVEL	A	A					
CAPACITANCE	A						
CONTINUITY	A	A		D			
TOTAL FUNCTIONS	9	9	7	6	7	6	6
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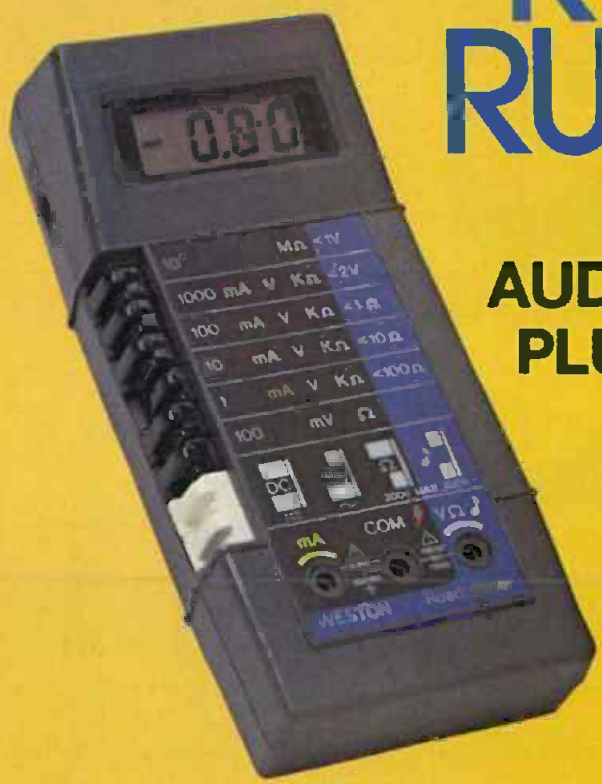
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CIRCLE 75 ON FREE INFORMATION CARD

The *Data Dubber* measures 5 × 2 × 1½ inches and has no controls. The only external connections are two cords ending in miniature phono plugs and a miniature phono jack. The cord labelled **MASTER RECORDER** connects to the earphone jack of the recorder that has the program. The cord from the *TRS-80* that normally goes to this earphone jack is instead plugged into the jack on the *Data Dubber* marked **TRS-80**. The cord labelled **SLAVE** is only used with a second recorder if you wish to make a copy of a tape; that cord plugs into the auxiliary input of the second recorder.

A red LED on the front panel of the *Data Dubber* is used as a level indicator. Simply set the master-recorder volume control so the LED lights brightly and steadily during the program lead-in pulses, and faintly flickers in brightness as the program is playing.

A clever battery-saver feature is incorporated into the *Data Dubber*. As long as there is no signal input, the *Dubber* draws only a fraction of a microampere of current from the 9-volt battery. However, as soon as a signal is input, an electronic switch turns the circuit on, and the battery supplies 7-10 milliamperes. When the input ceases, the circuit goes back into a virtually-off standby condition. That eliminates the need for an on-off switch.

In actual use tests, I found that the *Data Dubber* would load tapes that would not load elsewhere. I had one tape that only one recorder out of four different models would load, but it loaded fine with the *Data Dubber* and the standard *TRS-80* recorder. I made copies of that tape using the *Data Dubber* and the copies also loaded without any trouble. Some experimentation with level settings was necessary, as described in the instructions that come with the unit, since the LED apparently lights both above and below the ideal range.

While the *Data Dubber* will solve many tape problems for *TRS-80* owner, it cannot resurrect the dead. A program tape that has all the pulses recorded (even though they may be distorted) is loadable with the *Data Dubber*. However, if even one sync pulse is missing there is no way you will ever get the tape to load properly. If you have a tape that has never been "loadable" under any circumstances, don't think the *Data Dubber* will create any missing data. It won't. On the other hand, if one of your tapes loads after much fiddling with the volume control, the *Data Dubber* should clean it up sufficiently to permit a good load on the first try. R-E

Triplet Model 30 Grabber AC Clamp-on Meter

NAMING A PIECE OF TEST EQUIPMENT THE "Grabber" seems inappropriate to say the least. However, in this case the name is very appropriate: The *model 30 Grabber*, recently announced by the Triplet Corporation, actually does grab onto the reading and holds it indefinitely.

As you may have already surmised, the *Grabber* is a clamp-on type of device. However, the name can be more fully understood when you discover that, having once connected the *model 30* into the circuit to be tested, a slight push of a button on the right-hand side of the case will lock the pointer in that position as long as you desire. Triplet has called this feature *Memo-lock*, but it is easy to see why the meter is called the *Grabber*.

hy-gain. Super Stix.

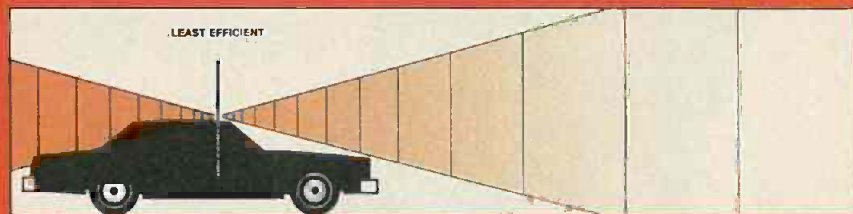
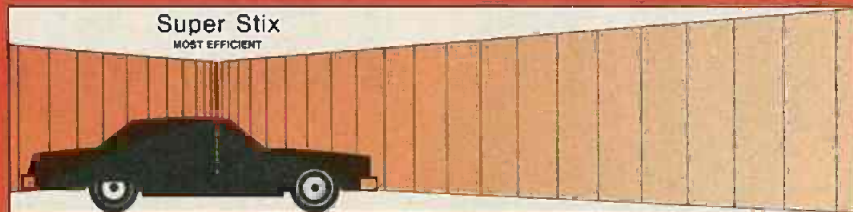
The best darn top-loaded CB antenna your money can buy!

- ☀ Just like the serious CBers, amateurs demand Hy-Gain, and 1,000,000 hams can't be wrong!
- ☀ Hand-crafted antennas, built with pride and precision by skilled craftsmen with 25 years experience.
- ☀ Every Super Stix antenna is inspected for 100% quality control, including SWR check.
- ☀ Because we use the finest materials available, we guarantee these Stix against failure. Any failure. That's how confident we are! We don't recommend it, but even bent a full 360°, it will not break.



Why Super Stix Perform Better

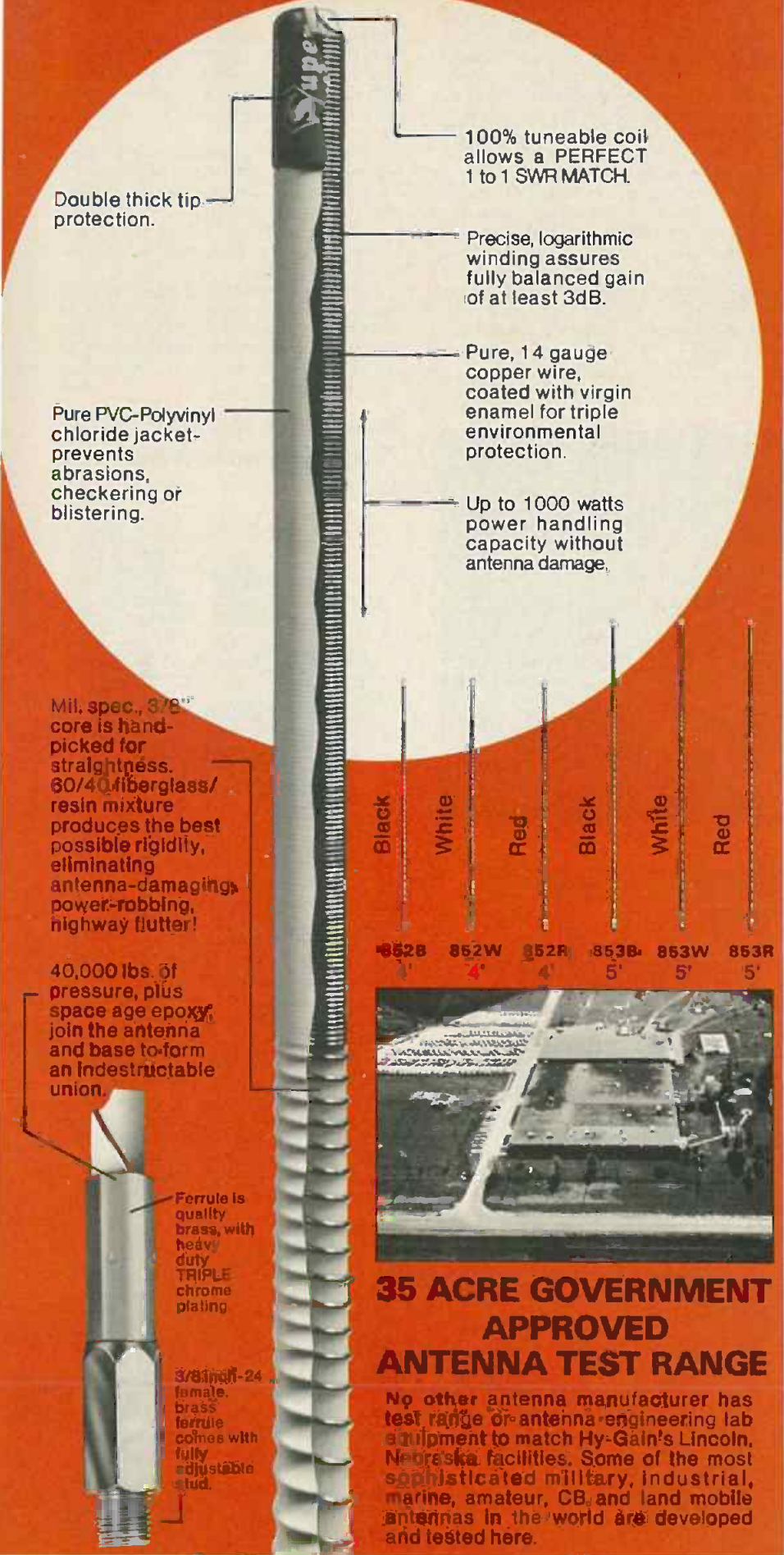
Super Stix are more than 5/8 wave electrically. This allows more than 80% of the signal to radiate from the most efficient portion of the antenna—the top.



TELEX hy-gain

TELEX COMMUNICATIONS, INC.

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Europe 22, rue de la Légion-d'Honneur, 93200 St. Denis, France.



Double thick tip protection.

100% tuneable coil allows a PERFECT 1 to 1 SWR MATCH.

Precise, logarithmic winding assures fully balanced gain of at least 3dB.

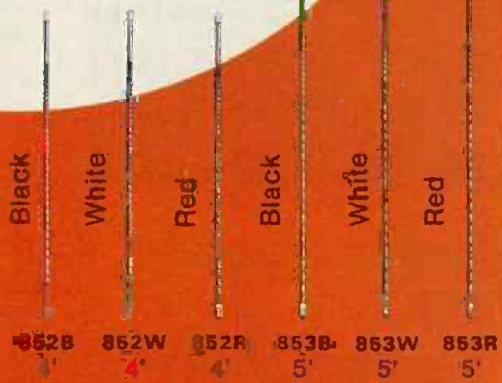
Pure, 14 gauge copper wire, coated with virgin enamel for triple environmental protection.

Up to 1000 watts power handling capacity without antenna damage.

Pure PVC-Polyvinyl chloride jacket-prevents abrasions, checkering or blistering.

Mil. spec., 3/8" core is hand-picked for straightness. 60/40 fiberglass/resin mixture produces the best possible rigidity, eliminating antenna-damaging, power-robbing, highway flutter!

40,000 lbs. of pressure, plus space age epoxy, join the antenna and base to form an indestructible union.



35 ACRE GOVERNMENT APPROVED ANTENNA TEST RANGE

No other antenna manufacturer has test range or antenna engineering lab equipment to match Hy-Gain's Lincoln, Nebraska facilities. Some of the most sophisticated military, industrial, marine, amateur, CB, and land mobile antennas in the world are developed and tested here.

Ferrule is quality brass, with heavy duty TRIPLE chrome plating

3/8 inch-24 female brass ferrule comes with fully adjustable stud.



CIRCLE 102 ON FREE INFORMATION CARD

If there is a need to measure the current in a conductor carrying AC to a large motor, for instance, all that has to be done is to find a convenient spot where the supply wires are available, open the *Grabber's* jaws (up to 1-inch) and slip them over the wire. Allow the jaws to close and, with the *model 30's* range switch set to the highest current position, reduce the range until a useful reading is obtained. If the *Grabber* happens to be in a position where it is difficult to see the reading, then press the button on the side, open the jaws, move the unit to where it can be seen; you'll find the last reading recorded while it was still on the conductor.

The clamp-on ammeter is a device with wide applications in industrial electronics. In the consumer electronics field, however, it is relatively unknown. Yet, it could serve even there if the technicians had access to such units. For instance, in a solid-state stereo amplifier, many facts can be determined if one learns to rely upon one measurement *not* normally made.

TABLE 1	
AC current:	0-6, 12, 30, 60, & 300 AC amperes
Accuracy:	±3% of full scale (calibrated at 77°F (25°C))
AC Voltage:	0-150, 300, & 600 AC volts
Accuracy:	(same as AC amps)
Sensitivity:	5,000 ohms/volt
Frequency Response:	±1% of full scale from 20 to 5,000 Hz.
Rectifier:	Average responding circuit calibrated to read RMS value of a pure sinewave.
Max. Input Voltage:	600V RMS.
Meter Movement:	Core magnet pivot-and-jewel type.
Overload Protection:	Diode type.
Weight:	Approx. 1 pound (0.45 kilograms) with test leads.
Size:	7 1/4 L x 2 1/4 W x 1 1/2-inches D (19 x 6.9 x 2.9 cm)
Accessories:	<i>model 32</i> ohmmeter adapter.
Max. Wire Size:	1-inch diameter.

That is the current that is being drawn from the AC line. A quick reading of that current, converted into power, will tell a great deal when compared to the published input power of the amplifier.

In addition to the current ranges (see Table 1), the *model 30* also has an accurate AC voltmeter scale. A set of test leads (supplied with the tester) is plugged into the end of the *Grabber* and you are ready to measure AC voltage in three ranges (150V, 300V, and 600V full-scale). Also supplied are two screw-on alligator clips, insulated for your protection and color-coded red and black. An optional adaptor (*model 32*) is available that allows the *Grabber* to measure resistances of up to 1,000 ohms.

The reading of the AC line voltage was found to be as accurate as one could require. When compared to the usual VOM used for such readings, the *Grabber* was easier to read if set to the 150V range, since that allows the line voltage to be read in the upper portion of the scale. (I have just checked the line voltage to my workbench and found it to be exactly 120 volts. That is the norm for this location. Very few standard VOM's will read that close.)

Another accessory available is the *model 101 Line Separator*. That unit allows the user to clamp the *Grabber* onto one leg of the line without slitting or separating the wires to do so. In addition, the *Line Splitter* increases the sensitivity of the *Grabber* by factors of 10 or 20. Thus, when using the *Line Splitter*, current measurements as low as 300 mA full-scale are possible.

The instruction manual is quite complete and, as with other Triplett instruments, the emphasis is upon safety; that element cannot be stressed too often or too much. There is a good applications section and a troubleshooting section that contains a schematic diagram and parts list for both the *model 30* and *model 32*.

The instrument is covered by a one-year limited warranty on defects and workmanship. There is a rather complete list of warranty service stations provided with the instrument and a bright-red tag which outlines the dangers associated with the measurement of electrical currents and voltages.

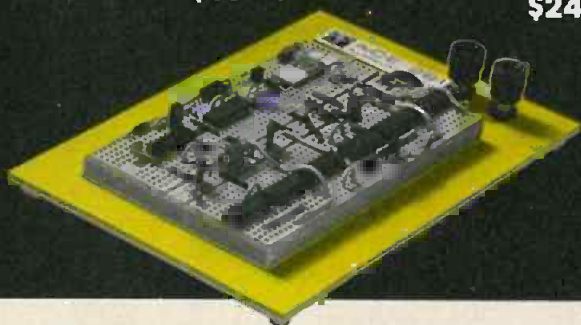
Any measurement that we tried with the *model 30 Grabber* verified that it met or exceeded the published claims made for the unit. It can be an important addition to your service bench or lab, whether you are a professional or a hobbyist. **R-E**

ACE 200-K with 728 solderless plug-in tie points, two 5-way binding posts. Capacity, up to eight 16-pin DIPs.

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ACE 201-K (shown here) with 1032 solderless plug-in tie points, two 5-way binding posts. Capacity, up to twelve 14-pin DIPs.

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Muraphone Remote Telephone Answering System



CIRCLE 103 ON FREE INFORMATION CARD

THE PRIMARY CONVENIENCE OF HAVING A REMOTE cordless telephone is in the answering. It makes sense to market a low-cost answer-only model that excludes a dialing option.

That is the philosophy behind the economical little *Muraphone*, a walkie-talkie size two-way telephone answering portable from the Mura Corporation (177 Cantiague Rock Road, Westbury, NY 11590.)

The *Muraphone* system consists of two main subsystems: the remote answering device (model *MP-100*) and the telephone interface base unit (model *MP-101*). An adaptor plugs into the AC line to operate the base unit. A small plug-in cord is provided with the system to recharge the nickel-cadmium batteries in the remote unit when the system is not in use.

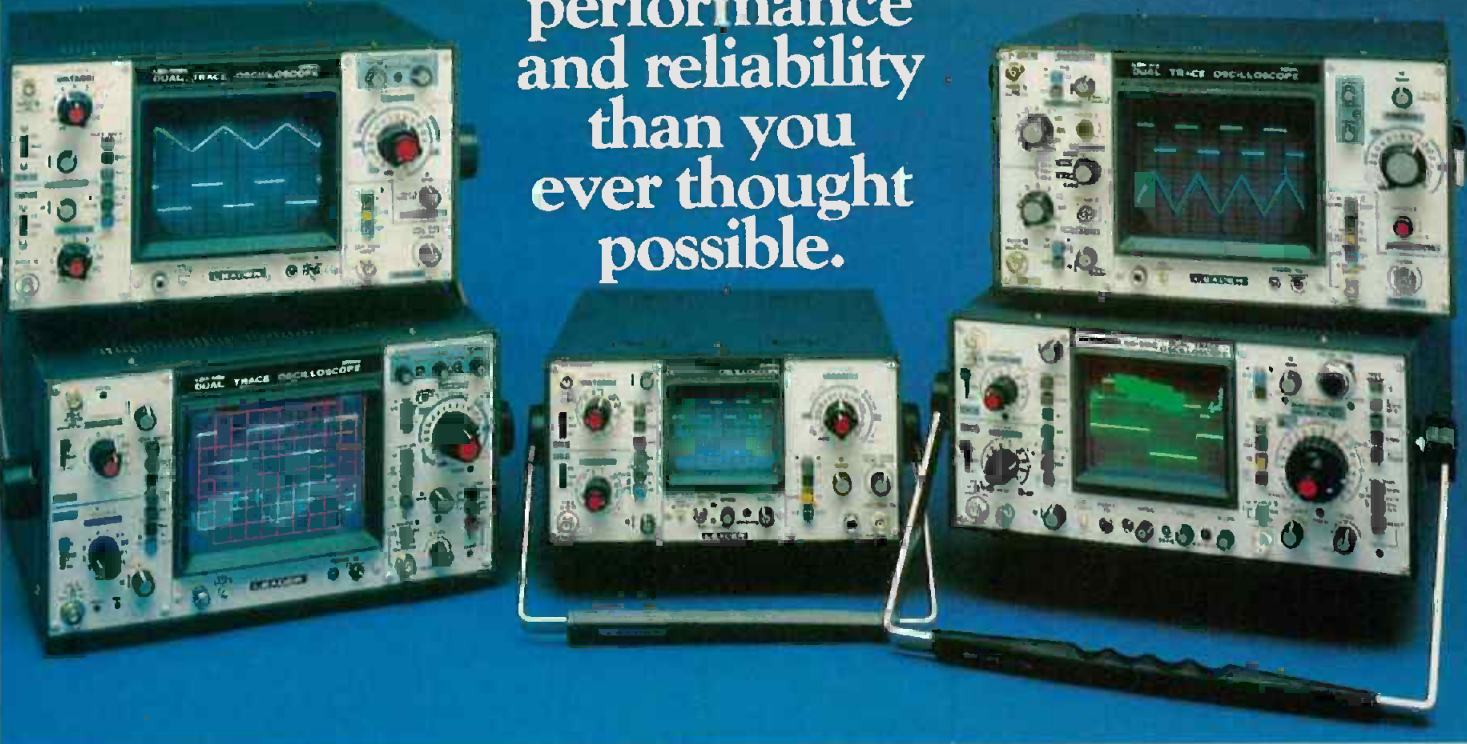
Installation

To hook up the remote answering system, all that is required is a telephone jack that uses a modular connector. If your telephone is equipped with the older style four-pin plug, an adaptor will have to be acquired to install the system. The need for a modular connector is nothing exclusive with Mura; all new telephone options come equipped with the modern plug. Fortunately, many electronic hobby and specialty stores offer several types of modular receptacles to extend the flexibility of your telephone.

Once the base unit has been connected to the telephone line, the first necessity will be to charge the hand-held's batteries. That is readi-

continued on page 40

10 to 30 MHz oscilloscopes with more performance and reliability than you ever thought possible.



It's easy to see why LEADER oscilloscopes are now specified more than ever. More performance and quality for less cost... with immediate deliveries from over 100 stocking distributors. They also come with the best two-year warranty in the industry... backed by efficient factory service depots on the East and West Coasts.

A full-range of reliable, medium bandwidth oscilloscopes.

LEADER's oscilloscope line includes 11 models, single and dual trace versions, for bench or field use. All models offer comprehensive triggering controls, TTL compatible Z-axis modulation, front panel trace alignment control and convenient, color-keyed front panel layout. Probes are furnished with every oscilloscope and options include probe pouches, carrying cases, front panel covers and rack mounting adapters.

30 MHz delayed sweep - \$1,530.

LBO-515B is a compact, precision oscilloscope at a moderate price. Using a PDA 4-inch CRT with parallax-free internal graticule, it features 5 mV sensitivity and delayed sweep for viewing and measuring complex waveforms. Also has 120 ns signal delay, trigger hold-off and x-y operation at full sensitivity.

30 MHz with signal delay - \$1,100.

LBO-520 combines a 11.7 ns rise time with 5 mV sensitivity and 120 ns signal

The surprising leader.

delay lines. Has single shot triggering, X10 sweep magnifier and bright, sharp PDA CRT. Triggers to 50 MHz.

20 MHz dual and single trace - \$835., \$610.

LBO-508A and LBO-507A give you versatility at low cost. Rise time is 17.5 ns with 1 MΩ (35 pFd) input impedance. Automatic or external triggering, X5 sweep magnifier, 10 mV/cm sensitivity and add/subtract modes.



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LBO-514 has both vertical and horizontal X5 magnifiers. Sensitivity is from 1 mV/cm to 10 V/cm. Sweep speeds from 0.2 s/cm to 0.1 μs/cm. Auto or normal triggering. Z-axis modulation. (Single trace version, LBO-513, \$495.)

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BW-2630 BATTERY TOOL

The new BW-2630 is a revolutionary battery powered wire-wrapping tool. The tool operates on 2 standard "C" size NiCad batteries (not included) and accepts either of two specially designed bits. Bit model BT-30 is for wrapping 30 AWG wire onto .025" square pins; BT-2628 wraps 26-28 AWG wire. Both produce the preferred "modified" wrap.

Designed for the serious amateur, BW-2630 even includes both positive indexing and anti-overwrapping mechanisms — features usually found only in industrial tools costing five times as much. Pistol grip design and rugged ABS construction assure performance and durability. In stock at local electronic retailers or directly from

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 Tel. (212) 994-6600 Telex 125091

*Minimum billings \$25.00, add shipping charge \$2.00
 New York State residents add applicable tax

SATELLITE TV NEWS continued from page 16

Canada gets the jump

Even as American policymakers and corporations make plans for direct-broadcast satellites, foreign efforts on similar ventures are moving along. In Canada, programs from the Canadian Broadcasting Corp.'s Pacific TV Network and Vancouver TV station CHAN are beamed, via Anik B, to cable TV systems and private homes in remote parts of the country. Homes authorized to get the service are being loaned a 1.8-meter earth terminal, free of charge. Meanwhile, a joint venture by several European electronics and aerospace companies may lead into a direct-broadcasting-satellite system for Western Europe—possibly as early as 1983. French and German organizations are spearheading the effort; but members of the British parliament are concerned about a Continental system that would also reach the United Kingdom, raising nationalistic viewing problems.

Audio going aloft too

National Public Radio, which began limited satellite feeds to its affiliates last Fall, expects to begin 24-hour service via its Westar I transponder this Spring. Plans call for the eventual use of 12 audio circuits for simultaneous feeds (with different programs going to different time zones). The high quality stereo transmission would include all formats of music in addition to NPR's first-rate public affairs programs. About 17 public radio stations presently have uplinks to feed entertainment and news programs into the network.

Mutual Broadcasting has begun to beam its radio programming to affiliates via Westar. Mutual's news, sportscasts, and special programming will travel via satellite. ABC, CBS, and the new RKO "Lifestyle" radio networks are committed to satellite transmission. Some of it is likely to begin this year and United Press International, the wire service that also provides hourly newscasts to radio stations, has moved ahead with its plans for satellite delivery too; it's likely to start within a matter of months. All those developments are in addition to the already existing half-dozen audio circuits that are aimed at cable TV systems using RCA Americom's Satcom birds.

Non-wave of the future

Digital transmission is almost certain to become the predominant format during the 1980's. That message has been repeated constantly in recent months at meetings as diverse as a conference of the Society of Motion Picture and TV Engineers and a computer/telecommunications seminar. Leaders from the satellite industry and other business groups see a rapid change-over to digital technology, not only for data and business communications, but also for video and other services. Most experts agree that satellites will spearhead the change. Indeed, Intelsat has already approved policies which will lead to complete international use of digital transmission by 1986.

"Flying saucers" ready for broadcasting uplinks

Small transportable satellite uplinks to help broadcasters cover sports and news events are being used for the first time this Spring. The equipment is supplied by Microwave Associates and is operated by Satelink of America, the new subsidiary of Robert Wold Co. Satelink leases use of the facilities to the TV networks and to other program producers.

The three packages can be deployed to different events and have been nicknamed "flying saucers" because the components can be collapsed and packed into 11 crates and shipped quickly by air-freight. One of the trade-offs in using the small 4.5-meter uplink dishes is that signals from them can be picked up only with downlink antennas of a diameter of at least 10 meters. Network headquarters and most TV broadcast stations are expected to install dishes that size—but, of course, that precludes many cable systems, and other users who are opting for antennas of 5 meters and smaller, from using the system.

GARY H. ARLEN

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- Seven functions: dc voltage, ac voltage, dc current, ac current, resistance, diode test, conductance (1/R)
- 3 1/2-digit resolution
- 0.1% basic dc accuracy
- LCD display
- Overload protection
- Free case
- Two year parts and labor warranty

- Nine functions: dc voltage, ac voltage, dc current, ac current, resistance, diode test, conductance (1/R), logic level and continuity detect, temperature (K-type thermocouple)
- Peak hold on voltage and current functions
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- 0.1% basic dc accuracy
- LCD display
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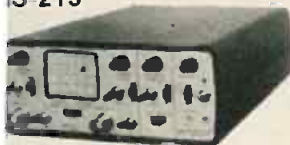
MS-15



Single Trace 15MHz
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\$299⁹⁵

MS-215

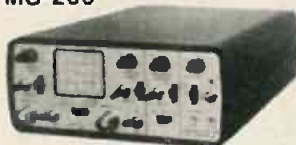


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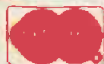
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	RANGE	ACCURACY
DC VOLTAGE	200mV, 2V, 20V, 200V, 1000V	.5%
AC VOLTAGE	200mV, 2V, 20V, 200V, 750V	1%
DC CURRENT	2mA, 20mA, 200mA, 2000mA, 10A	2%
AC CURRENT	2mA, 20mA, 200mA, 2000mA, 10A	3%
RESISTANCE	200Ω, 2kΩ, 20kΩ, 200kΩ, 20MΩ	.5%



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ly accomplished by interconnecting the base unit and the portable with the patch cord provided.

An initial charging time of 16 hours is recommended by the manufacturer. We advise prospective buyers to heed the manufacturer's advice. New nickel-cadmium batteries require an initial forming time to assure proper function after the initial charge.

While the manual plug-in battery charging scheme may not be as convenient as the built-in charge mechanism activated by setting competitive units in their base units, it is substantially less expensive.

In use

Once the batteries of the remote unit have been charged and the system is ready to use, operation is extremely simple. Merely switch on the hand-held remote and await an incoming call. You may wish to have the operator call you to test the system.

When your regular telephone rings, a piercing, pulsing call signal will wail from the remote speaker of the *Muraphone*. Its volume level is settable by the volume control.

To answer the *Muraphone*, merely press the talk button on the side of the remote—just as you would on a walkie-talkie.

There is no need to shout into the remote unit; level is factory-set for comfortable audio gain with normal telephone-voice level.

While you are using the *Muraphone* remote answering system, you will hear a consistent pulsing noise in the background. It is barely perceptible to the caller, but becomes very prom-

inent in the remote unit. The pulsing should not significantly degrade the intelligibility, but it is very noticeable.

To deactivate the *Muraphone*, or to hang up after the call has been completed, the user merely presses the LINE RELEASE button on either the remote or base unit.

A POWER indicator light shows the ready state of the base. During the recharge operation of the remote's nickel-cadmium batteries, the light is automatically switched off to show that the remote system cannot be used during that cycle.

It's a paging system, too

With the remote unit switched on and in the possession of someone whom you may wish to summon, the system becomes an effective paging system. The pager merely depresses the intercom button, and the alarm tone will then be heard from the speaker of the awaiting remote unit.

The person paged responds by pressing his talk switch and converses with the operator of the base unit in a normal manner.

While the *Muraphone* does not have the polish of more costly remote cordless telephones, it does work dependably. We found the maximum separation between the base and remote units that would still support reliable conversation to be in the neighborhood of 200 feet or so.

Specifications

The operating frequency of the *Muraphone* is the familiar 49.86 MHz, popular among license-free low power systems. Output is purposely kept below 100 milliwatts, and receiver sensitivity is nominally 3 microvolts.

An automatic disconnect circuit prevents the system from keeping a telephone "off the hook" accidentally. The circuit activates after 2 minutes have passed without any signal received from the remote.

The *MP-100* and *MP-101* provide the convenience of remote response to incoming calls while the user is away from the telephone. A prospective buyer would do well to look into the dollars-and-sense combination of the *Muraphone*. The *Muraphone* remote answering system sells for \$89.95. R-E

Transtronics Model 65 Continuity Tester

WITH ADVANCING TECHNOLOGY, NEW BASIC testers appear from time-to-time on the electronic scene. The \$19.95 model 65 *Electronic Workmate* from Transtronics is such a device. This unique penlight-size leadless continuity tester comes complete with 2 AAA 1.5 volt batteries and pocket clip. Unlike most continuity testers, the *Electronic Workmate* needs no additional wires or clip-leads, and has a 220K internal DC resistance.

It is useful in testing many different types of electronic components, or in checking wiring and repairing appliances. You simply hold one lead of the component under test with one hand, and the *Electronic Workmate* in the other hand. When the probe of the *Workmate* is touched to the other component lead, your body and fingers complete the circuit! If the component under test has continuity—even beyond 10 megohms—a red LED in the tip of the *Workmate* glows bright enough to be recognized. The brighter the glow, the lower the

continued on page 42

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Accurate performance you can rely on, time after time. That's what you expect from a quality DMM. But don't expect to pay as much for it any more. Because now Sabtronics brings you top quality DMMs with more features and better accuracy than other comparable units on the market today. And they cost surprisingly less!

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What you get is a precision crafted unit that features single-chip LSI logic, laser trimmed resistor network and a stable band-gap reference element for better long term accuracy. Basic DCV accuracy is 0.1%. The Model 2035A gives you 32 measurement ranges over 6 functions and the Model 2037A an additional two temperature ranges.

First in features. First in price.

Both models feature a "touch-and-hold" capability with the optional probe - a reading is retained for as long as you wish. Now you can make measurements in hard-to-reach places without taking your eyes off the probe tip or stopping to record data.

The two-terminal input for all measurement functions eliminates switching test leads when measuring voltage, resistance or current. The Model 2037A even has a built-in temperature measuring circuit with a -50°C to +150°C range and is supplied complete with the sensor probe. It is ideal for checking IC, resistor, transistor, heat sink and enclosure temperatures or for

monitoring environmental test temperatures.

Plus more features.

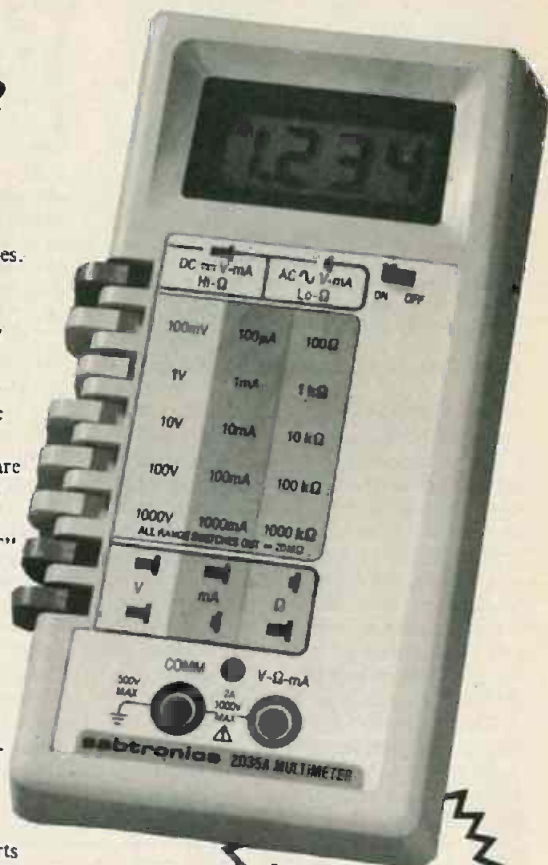
The Hi-and-Low power ohms capability allows you to make in-circuit resistance measurements and to check semiconductor PN junctions. In addition automatic polarity, automatic zero, automatic decimal point and overload protection are standard features. And you get up to 200 hours operation from a single 9V transistor battery. The automatic "LO BAT" indicator warns you of the last 20% of battery life. The large, crisp LCD readouts allow easy viewing indoors or outdoors in bright sunlight.

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Assembling either kit is simple with our easy-to-follow, step-by-step instructions. The built-in calibration references allow you to calibrate the unit any time, any place. We've even eliminated difficult point-to-point interconnect wiring. All parts mount on the PC board. The only wires you solder are the two battery clip leads.

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With all of these features and performance characteristics no other handheld DMM comes even close to matching the price/performance ratios of the Models 2035A and 2037A. Providing the best value for money in test equipment, Sabtronics has become one of the world's largest producers of DMMs. You can order with confidence. Use the convenient order form or call us with your Master Charge or Visa number for prompt delivery.



Model 2035A
\$74.95
 F.O.B. Factory

Making Performance Affordable



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 Telephone 813/623-2631

BRIEF SPECIFICATIONS:
 DC VOLTS: 100 μ V - 1000V, 5 ranges
 AC VOLTS: 100 μ V - 1000V, 5 ranges
 DC CURRENT: 0.1 μ A - 2A, 5 ranges
 AC CURRENT: 0.1 μ A - 2A, 5 ranges
 HI-OHMS: 0.1 Ω - 20M Ω , 6 ranges
 LO-OHMS: 0.1 Ω - 20M Ω , 6 ranges
 TEMPERATURE: -50°C - +150°C
 (-58°F - +302°F), 2 ranges
 (Model 2037A only)

Size: 3 1/2" W x 6 3/4" L x 1 5/8" H

WEIGHT: 11 oz. (excl. battery)
 OVERLOAD PROTECTION: 1000V DC or AC peak all voltage ranges, 250V DC or AC peak all Ohms ranges; 2A/250V fuse all current ranges.

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- _____ Model 2035A Handheld Multimeter kit(s) @ \$74.95 ea. \$
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- _____ Model AC-110 Battery Eliminator(s) @ \$7.95 ea. \$
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CIRCLE 104 ON FREE INFORMATION CARD

resistance of the item under test.

Because the tip is at a small negative polarity (.5 volt) compared to the case, you can test diodes, transistors and SCR's. Fuses, switches, relay coils and contacts, solenoid coils, transformers, motor windings, tube filaments, incandescent lights, meter movements, photocells, cables and cable harnesses, line cords, selenium rectifiers, resistors (up to 12 meg-ohms) and even capacitors (down to 50 picofarads!) can be checked for continuity, opens, or shorts. Traces on printed circuit boards can be checked for opens or solder bridges.

The *Electronic Workmate* is five inches long and 1/2 inch in diameter, with a 1/2-inch pin-point probe that can penetrate PC board masks or thin wire insulation. The silver metal flourentine finish, black tip, and slip-on plastic

protective probe cover, combine to give the *Workmate* a sleek modern appearance. The top of a mini-LED protrudes slightly from the black tip and it glows with sufficient brightness to be used in well-lighted surroundings.

The circuitry is permanently potted in the probe-end, making the unit virtually indestructible. It is guaranteed for two years! No circuit information is provided—or needed—but a detailed instruction sheet tells you specifically how to check fuses, low-leakage silicon diodes, silicon transistors (identifies NPN or PNP), non-electrolytic capacitors and long cables (including twisted-pairs), and lists 18 other types of continuity and direct current checks. The instructions also cover using the *Workmate* as a logic probe, but I found it almost useless for that purpose.

The maximum tip current when testing a component is only about 25 microamperes, so the *Workmate* can even be used to test sensitive meter movements or other very low-current devices. When testing meter movement, don't expect to see the meter needle move unless it's a 50 microampere, or more-sensitive, meter movement. The *Workmate* tests coil continuity, not deflection. In addition, AC voltages as low as 3 volts peak-to-peak are detectable.

When testing capacitors, the length of time the *Workmate* LED is lighted gives you a rough idea of the capacitance. With a .25 µf capacitor, the LED will take about 3 seconds to dim and go out. A small capacitor gives a quick flash. That feature allows you to check for the location of opens in long coaxial or paired cables, since there is sufficient capacitance between the wires (or the center conductor and shield) to flash the LED. The duration of the

flash is a rough indication of how far down the cable one conductor is open.

In actual use, I found the *Electronic Workmate* to be extremely handy and easy to use. My first real test for the *Workmate* was in tracing a wiring harness above and below the chassis of a stereo tape player. The wires ran all over the place, but end-to-end checking was easy with the *Workmate* using just a fingertip instead of a cliplead. (Of course, the power was off!) The trouble, incidentally, was traced to an open rectifier in the power supply—the *Workmate* indicated that there was no continuity in either direction.

About the only limitation of the *Workmate* for semiconductor testing is a result of its great sensitivity. High-leakage semiconductor devices (such as selenium rectifiers, or germanium transistors and diodes) light the LED *dimly* when reverse-biased. However, in the forward direction the LED glows *brightly*, as you would expect.

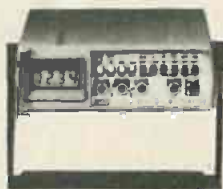
The *Electronic Workmate*, Model 65, complete with batteries and two-year warranty, sells for \$19.95, plus 60¢ postage and handling, from Trantronics, Dept. RE, 13101 NE Hwy 99, Suite C-3, Vancouver, WA, 98665. R-E



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- REL: This stands for relative reference in the dB mode or offset measurements in other functions.

- Conductance function - resistance to 10,000 MO
- AC measurements to 50 kHz and higher
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- Touch-Hold probe for tricky places (Y8008)
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Model 8024A:
The Investigator

- Nine functions: dc voltage, ac voltage, dc current, ac current, resistance, diode test, conductance (1/R), logic level and continuity detect, temperature (K-type thermocouple)

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- Selectable audible indicator for continuity or level detection
- 3 1/2-digit resolution
- 0.1% basic dc accuracy
- LCD display
- Overload protection



Model 8022A:
The Troubleshooter

- Six functions: dc voltage, ac voltage, dc current, ac current, resistance, diode test
- 3 1/2-digit resolution
- 0.25% basic dc accuracy
- LCD display
- Overload protection

8022A
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Model 8020A:
The Analyst

- Seven functions: dc voltage, ac voltage, dc current, ac current, resistance, diode test, conductance (1/R)
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Panasonic's 4" full-range speaker, the big sound of AM and FM will really sound big. There's also the Panasonic RF-2900. It has most of the features of the RF-4900, but it costs a lot less.

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The incredible, new, 50 channel Bearcat 300 Scanner with Service Search is another first in scanner innovation. Another triumph in synthesized spaceage technology. Another first from the leader in real excitement.

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Simply push the police service button, for example. You'll search and find only the frequencies allocated to police—and be able to monitor every local, active frequency. Then they are programmed into the normal scan operation via keyboard entry.

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ELECTRONIC DEVICES FOR SELF-IMPROVEMENT

State-of-the-art electronics combined with recent medical discoveries can help you master your mind and body's "involuntary" actions.

DAVID R. WHEELER

"EVERY DAY, IN EVERY WAY, I AM GETTING better and better."

Emile Coué had the idea that telling yourself you were improving was enough. That was in the 1920's and before the miracle of electronics made it possible to have total control over one's body and mind.

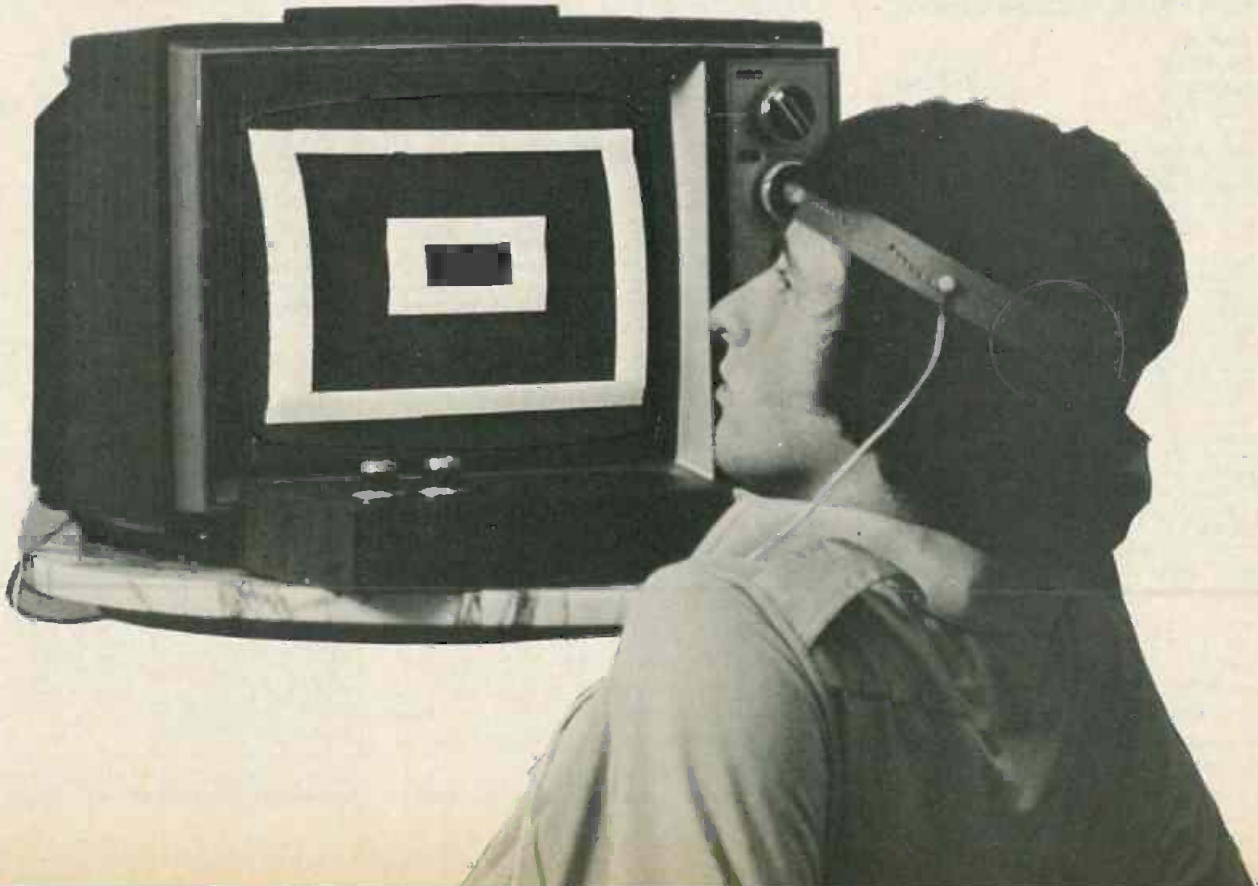
To change your behavior, your habits, and/or to improve yourself, two conditions—call them principles of behavioral technology—must be present and used.

They are something which can be observed and measured, and feedback of the observed "something" has to occur. To improve at bowling, golfing, pool, or handball, you have to know where the ball went after being hit. Improvement comes about as adjustments are made from feedback. Knowledge of the results is of critical importance if you are to learn.

Electric devices have been used since the beginning of this century as crude, and sometimes dangerous, apparatus for curing diseases. Electrical current

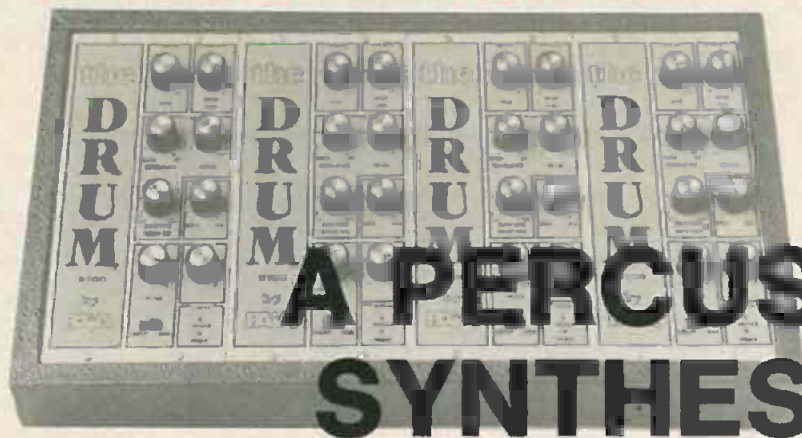
was sent through the human body to purge the system of "malevolent and evil spirits." Many of the mail-order catalogs at the time contained advertisements for the miracle "cure in electricity." Today, medical researchers are experimenting with low-voltage currents as a means of stimulating bone repair in patients with broken bones. That is not self-improvement, but medical treatment.

Behavior modification—the technology of altering and controlling thought and action—rests soundly on the prin-



BUILD THIS

the DRUM... .



A PERCUSSION SYNTHESIZER

For the musician and musician to be.

This unique 4-channel synthesizer adds more than just a beat to your music.

STEVE WOOD

PERCUSSION SYNTHESIS SEEMS TO BE growing more popular daily. The trouble is, it's expensive! Or it was. Building The Drum is a good way to get yourself fixed up with a great little percussion synthesizer that can do all the fascinating things that you're hearing on the radio and TV (and much more), without going into the red. The Drum is a four-channel synthesizer consisting of four type-5700 percussion modules.

The Drum has some goodies that don't seem to be available on most percussion synthesizers now on the market. Let's examine the functions of some of the control and interface features on The Drum, and I think you'll see what I mean.

One of the most unique features of The Drum is its sensor device. It's a small audio transducer that can be mounted just about anywhere you want to put it. That means that you don't have to add more "things to hit" to your existing drums. You can simply mount the sensor on one of the drums you are already using and have that drum serve a dual purpose. The Drum synthesizer has provisions for a "cancel" control, such as an ordinary on/off type foot-switch (like the kind used with special-effects for guitar). That way, you don't have to dislocate your arm trying to hit a new piece that's behind you because there was no more room in front or to the sides.

For those who would like something that looks and feels like an actual drum surface, we have found that mounting the sensor in a practice-pad gives good results. However, it has also been noted that the dynamic range (evidenced by differences in synthesizer output pitch and volume level, with respect to the degree of force exerted on the practice-pad or drumhead) is somewhat less when using a practice-pad than that afforded by, say, a tom-tom. The reason is that the tom-tom (and just about any other drum) has a much longer decay time than a practice-pad, and a natural amplification that far exceeds that of the practice-pad. This gives the "envelope follower" circuit in the synthesizer a stronger and longer lasting signal to work with. We'll get into that a little later.

Since there are as many different ways to mount the sensor as one can think of, there must be a control on the synthesizer to allow the drummer to make adjustments for the differences in source-signal amplitude that will be encountered when using various drums and/or practice-pads as the "trigger" source. That control is simply a 500K pot, across which the input signal is dropped. The wiper picks off the desired signal level and feeds it to the input amplifier. We call that control **SENSOR GAIN**, and it is labeled R1 on the schematic in Fig. 1. The power supply for The Drum is shown in Fig. 2.

turn page for diagrams

Other front-panel controls include: **ENVELOPE DECAY TIME**, **INITIAL PITCH**, **PITCH MODULATION UP/DOWN** (this one is unique; we'll see why shortly), **WAVEFORM SELECT/MIX**, **NOISE/OSCILLATOR MIX**, **NOISE FILTER** (auto sweep or manual), and **OUTPUT LEVEL**. There are two status-indicator LED's on the front panel, one of them to show when the power is on, and the other to show when a trigger has been sensed.

We will explain the function of all those, as well as the half dozen interface jacks that are associated with The Drum module, in the design analysis.

How it works

The Drum transducer, which converts the mechanical action of striking the drumhead to the electrical input required by the synthesizer board, consists of a piezoelectric element encapsulated in a silicon compound. The silicon encapsulant supports and protects the element as well as serving as a coupling medium for the mechanical excitations. The voltage produced by the transducer is proportional to the magnitude of the mechanical force applied. (how heavily the drumhead is struck.)

The signal that is derived from the transducer is fed to input jack J1 (Fig. 1) and dropped across R1. The wiper of that pot picks off the signal at the desired level and feeds it to the non-inverting amplifier built around IC1-a; in turn, the amplifier

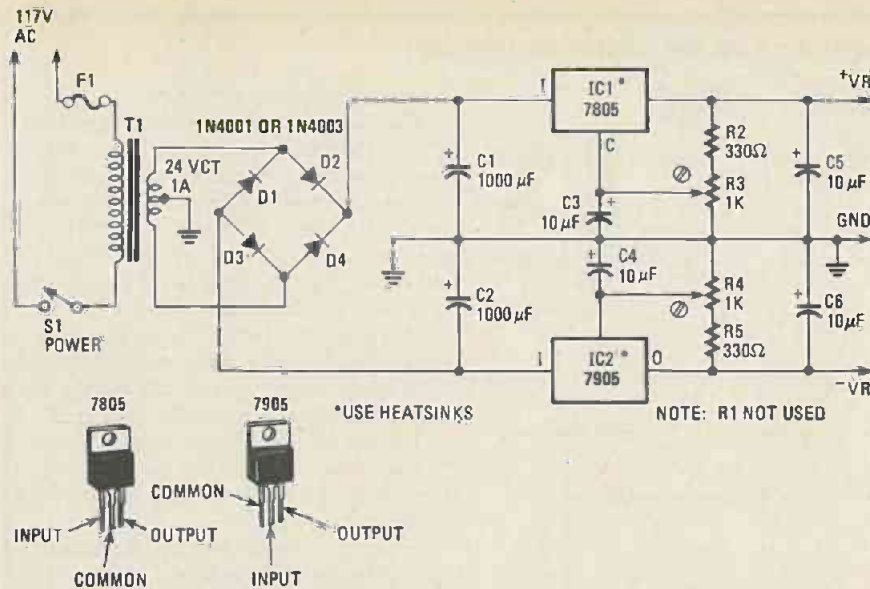


FIG. 2—THE POWER SUPPLY is hefty enough to supply the four modules that are used in the four-channel percussion synthesizer.

POWER SUPPLY PARTS LIST

- R1—not used
 R2, R5—330 ohms, ½ watt
 R3, R4—1000 ohms, trimmer pot
 C1, C2—1000 µF, 20 volts, electrolytic
 C3—C6—10 µF, 10 volts, electrolytic
 D1—D4—1N4001 or 1N4003
 IC1—LM340T-5 or 7805 positive voltage regulator, 5 volts
 IC2—LM320T-5 or 7905 negative voltage regulator, 5 volts
 T1—transformer, 24 volts, CT, 1 amp

Transistor Q3 serves as a second emitter-follower which tracks the voltage on C3 and provides the relatively heavy currents required to charge C4 quickly enough to produce a percussive attack waveform. Capacitor C4's discharge path is through resistor R10 and DECAY control R11. The attack and release (A/R) waveform that appears across C4 is buffered by the voltage-follower IC1-c. IC1-c's output provides the voltage that will control dynamics by means of the voltage-controlled amplifier and sweep the voltage-controlled oscillator and voltage-controlled filter.

Amplifier-stage IC1-d is configured as a sign-changer which allows the A/R control voltage to produce either upscale or downscale pitch shifts from the VCO. After it has been processed by the sign-changer, that control voltage is coupled by R25 and the INITIAL PITCH control R26 to the frequency-control input of the VCO, IC2.

The outputs of the 566 VCO are found at pins 3 (squarewave) and 4 (triangle). Because of the differences in the energy content of a squarewave and a triangle, the squarewave will sound louder. That accounts for the rather large difference between the values of the mixing resistors R28 and R29. The 500K pot R32 serves as a mix control by attenuating the unwanted waveform to the desired degree. Isolation-resistors R30 and R31 sum the mixed signal which is then coupled to the input of the next mixing stage by C9.

Resistor R43 couples the selected or mixed VCO signal to the VCO noise mixer circuit. The other input to this mixer circuit, R44, is fed from IC3-b. IC3-b's output is filtered white noise, generated by Q4—a transistor selected for its noise characteristics when operating in an avalanche condition.

The noise generated by Q4 is picked off at its base and capacitively coupled to the filter/amplifier IC3-b. Diodes D5, D6, D7, D8, and associated components, form the circuitry which sets the corner frequency of that filter. If S3 is switched to make connection with R33, then R34 (INITIAL FREQUENCY) serves as a manual filter frequency control. With S3 switched to sweep (the envelope follower output) the filter will be swept by the envelope-follower output and R34 serves as a sweep-range control.

PARTS LIST

Resistors ¼ watt, 10% unless otherwise specified

- R1, R24—500,000 ohms, potentiometer, linear taper
 R2, R3, R19, R20, R29, R39, R60, R_{SP} (only one needed)—100,000 ohms
 R4—680,000 ohms
 R5, R30, R31, R41, R44, R46, R47—470,000 ohms
 R6, R17—1500 ohms
 R7, R27—3.9 megohms
 R8, R9, R28, R61—1 megohm
 R10, R15, R33, R38, R50, R51—1000 ohms
 R11—250,000 ohms, potentiometer, audio taper
 R12, R18, R22, R23, R37, R40, R48, R56, R57, R58, R_S (only four needed) 10,000 ohms
 R13, R14, R53—150,000 ohms
 R16—2.2 megohms
 R21—50,000 ohms, trimmer potentiometer
 R25—3900 ohms
 R26, R34—100,000 ohms, potentiometer, reverse audio taper
 R32, R45—500,000 ohms, potentiometer, linear taper with SPST switch
 R35—3300 ohms
 R36—470 ohms
 R49, R59—220,000 ohms
 R52—15,000 ohms
 R54—5000 ohms, potentiometer, linear taper
 R55—33,000 ohms
 R62—100,000 ohms, potentiometer, audio taper (only one needed)

Capacitors

- C1, C7—15 pF, ceramic disc
 C2, C3, C9—0.1 µF, Mylar
 C4, C14—33 µF, 16 volts or higher, electrolytic
 C5, C6, C8, C13—.05 µF ceramic disc
 C10—1 µF, 10 volts, electrolytic
 C11, C12—.01 µF, polyester

Semiconductors

- D1, D2, D5—D8—1N914 or 1N4148
 D3, D9—TIL-209-B light-emitting diode
 Q1, Q6—2N5139 or PN5129
 Q2, Q3—2N3391 (GE)
 Q5—2N5129 or PN5129

Q4—2N2712 (GE, Sprague or other, selected for noise output. As supplied in the kit, the center lead has been clipped off.)

IC1, IC3—4136 quad op-amp (Exar, Raytheon, TI)

IC2—566 voltage-controlled oscillator (National, Signetics)

IC4—CA3080 (RCA or equal) operational transconductance amplifier

IC5—CD4001 CMOS quad NOR gate

S1, S2—SPST switch, on R32 and R45, respectively

S3—SPST slide switch

J1, J6, J7—open-circuit phone jack, ¼ inch
 J2, J3, J5—closed-circuit phone jack, ¼ inch

J4—stereo phone jack, ¼ inch

Miscellaneous: wire, knobs, hardware, circuit board, front and rear panels, drum transducer, etc.

The following are available from Paia Electronics, Inc., PO Box 14359, Oklahoma City, OK 73114:

- No. 5700 —Complete kit of all parts necessary for a single drum module, including drum transducer, circuit board, front panel, etc. \$59.95 plus \$3.00 postage and handling.
 No. 5700PC—Etched, drilled and labeled circuit board for single module. \$15.95 postage paid.
 No. 5700P—Complete kit for four-module drum set, including case, power supply, and four drum modules. \$269.75 plus \$10.00 postage and handling.
 No. 5700S—Piezoelectric transducer \$25.00
 No. 4771—Complete kit of parts for power supply \$29.95
 No. 4771PC—Etched and drilled circuit board for power supply, \$6.95
 Assembled units available. Write for prices.

JOHN S. SIMONTON, JR.

ELECTRONIC CIRCUITS FOR SIMULATING drum sounds have been around for a long time. In the past they have primarily been simple bridged or parallel T oscillators as shown in Fig. 1. In use, the gain of the amplifier is adjusted so that the circuit is held just below the point of oscillation. When a narrow pulse is applied to one of those oscillators, its normal stability is disturbed and it generates a damped sinusoidal waveform.

That type of circuit is frequently used in automatic percussion units because in that kind of application we are most concerned with the timing of the beats.

The reason that every drummer in the world is not rushing out to replace his bulky and cumbersome instruments with those small, inexpensive electronic equivalents is that devices of that type aren't capable of the dynamic control that a musician needs for personal expression in performance. Damped oscillators are good for simulating the sound of a fixed-pitch drum struck with more or less constant force, but little else.

But recently, many percussionists have begun to use electronics to supplement their traditional instruments, using devices that can capture the dynamics and style of their playing. And because the circuitry used in these electronic drums is close kin to that used in modern electronic music synthesizers, drum synthesizers can produce an unbelievably wide range of voices from natural to unearthly.

Figure 2 shows a block diagram of a typical drum synthesizer (The Drum, as it happens). Undoubtedly the most striking difference between that and a more conventional type of music synthesizer is that The Drum has no keyboard, this element's function of real time control being taken over by the drum transducer, a device that translates the force of the stick hitting the drumhead into an electrical signal that the rest of the synthesizer can use.

After being amplified, the output of the transducer is applied to a circuit that is called an envelope follower, but is in fact more a peak detector with a controllable release time. The envelope produced by this circuitry is used in a number of ways. In conjunction with the voltage-controlled amplifier it is used to change the constant amplitude output of an oscil-

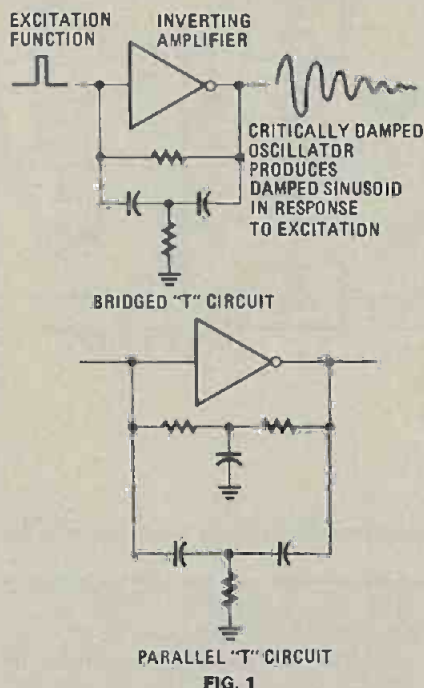


FIG. 1

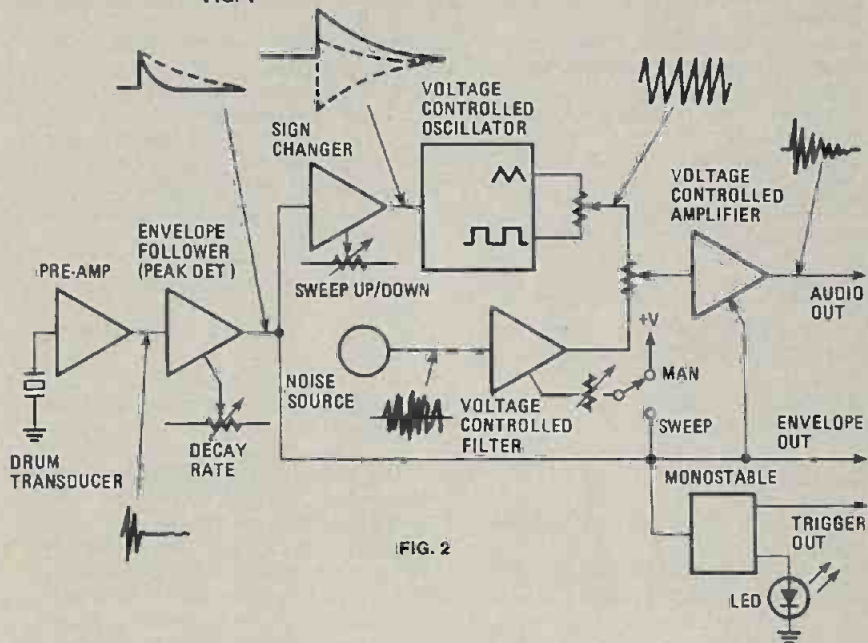


FIG. 2

lator into the classic percussive sound envelope. That approach is capable of producing longer decay times than are possible with either mechanical drums or damped oscillators. And since the peak output of the envelope follower is related to the output of the drum transducer, which is in turn a function of the striking

force, dynamics are preserved.

The control envelope is also applied to a sign changer where it can be either attenuated or inverted depending on the setting of a knob and the resulting new control voltage is used to change the frequency of the primary pitch source, a voltage-controlled oscillator. Because of that the pitch can be modulated either up or down to follow the envelope (like a pedal timpani only with much greater than natural range); or, at mid settings of the control, produce no pitch shift at all.

The use of a VCO as the pitch source also allows us a somewhat broader selection of the tone colors than is allowed by alternative expedients.

In addition to a pitched component, many drums—most notably snares—also have un-pitched components. In the synthesizer, un-pitched sounds are produced by the noise source. Since noise comes in different colors (white, pink, etc.), a voltage-controlled filter is provided to alter the noise spectrum as desired. The filter

is voltage controlled so that it too can track the envelope, another effect that can not be duplicated by mechanical drums.

The remaining circuitry (envelope and trigger out, etc.) is useful in combining more than one synthesizer card to produce a single voice.

Resistor R45 works in a manner similar to R32 in the waveform-mix circuit, attenuating either signal to the desired degree. Resistors R46 and R47 sum the mixed signal and feed it to the input of the buffer amplifier IC3-a and from that point the signal is applied to the signal input of the VCA, IC4.

Except when sinewave output is select-

ed, S2 will be closed, putting R51 in parallel with R52. That provides an attenuator at the input of IC4 which will keep the input signal level to the CA3080 transconductance amplifier within its linear operating region (input of 100 mv or less). Opening S2 removes the major portion of the attenuator and allows the VCO triangle output to overdrive the VCA's

input slightly, producing a sinewave.

The gain of IC4 is determined by the current that is flowing into pin 5 of the device. That current flow is manipulated by Q5 and Q6 which in turn are controlled by the envelope-follower's A/R output voltage.

We'll discuss construction and use next month.



TRIGGERED OSCILLOSCOPE

Part II—Construction details and calibration instructions for the low-cost scope that features a continuously displayed zero baseline.

DANIEL METZGER and DENNIS PERRY

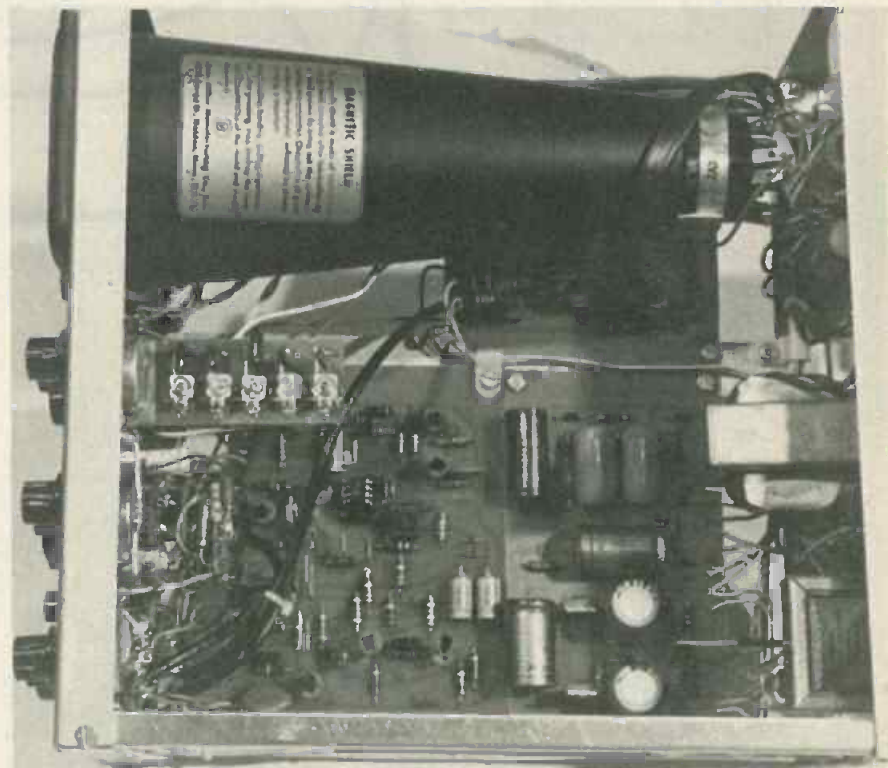
LAST MONTH WE DESCRIBED THE FEATURES of this inexpensive DC scope and went into detail on the operation of its various circuits. We continue this month by resuming our broken-off discussion with suggestions on selecting the CRT to meet your requirements.

Construction

Many types of CRT's have been used in this design, including 3BP1, 3EP1, 3ACP11, 3FP7, 3RP1, and 2AP1. Five-inch types can be used, but whatever is gained in screen size will be lost in sharpness of focus. The 3RP1A and 3WP1 are especially nice because they are flat-faced. The 3WP1 has about twice the deflection sensitivity of the others, and can be used to produce a scope with 5-mV sensitivity. The CRT must be shielded with MuMetal (nothing else will work) unless the power transformers can be located two feet from the CRT. Surplus houses that sell CRT's usually have fully formed shields.



DISPLAY of a 500-kHz squarewave at 0.4 μ V/div shows a fast risetime and clean squarewave response.



TOP VIEW of the scope. The amplifier board is beneath the CRT. The power-supply board is at the rear near the transformers mounted on the back panel. The sweep board is up front near the controls. The attenuator board, with its five trimmers, is on a bracket held by the vertical-sensitivity control. Astigmatism control is on rear panel near base of the CRT.

The vertical and horizontal output wires must run straight to the CRT and be kept away from each other and from other wiring and the chassis. The vertical and horizontal inputs should be kept short and separate from other wire bundles. The wires to and from the TRIGGER LEVEL switch carry fast squarewaves

and must be shielded to prevent coupling to other wires. The wires to the VERTICAL VARIABLE GAIN control should be kept reasonably short. Other wiring should be bundled and laced in the interests of neatness.

The input attenuator and sweep-timing resistors must be held to 1% if good

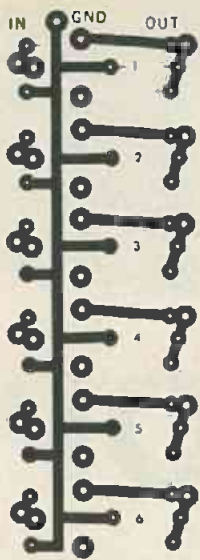


FIG. 6—FOIL PATTERN for the attenuator used in the vertical-sweep circuit.

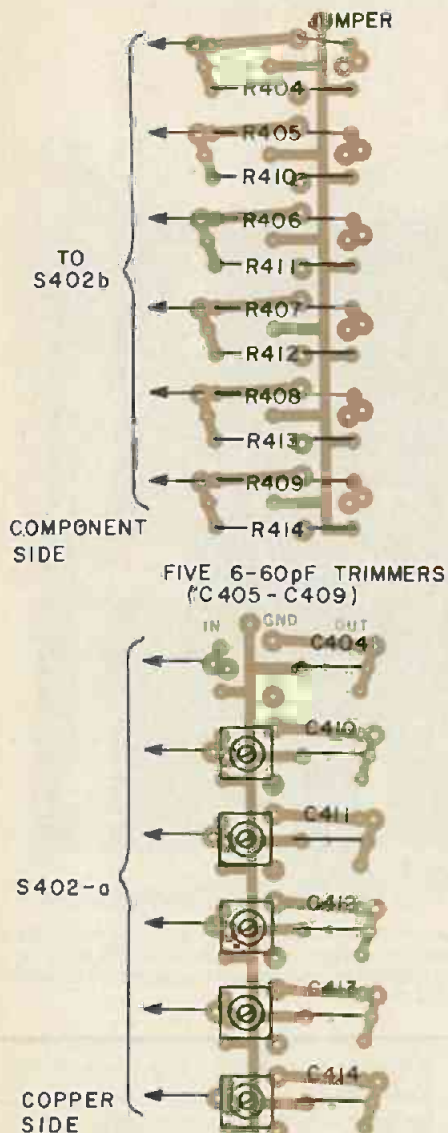


FIG. 7—COMPONENT PLACEMENT GUIDE for the vertical-input attenuator. The precision resistors are on one side and the frequency-compensating capacitors are on the other.

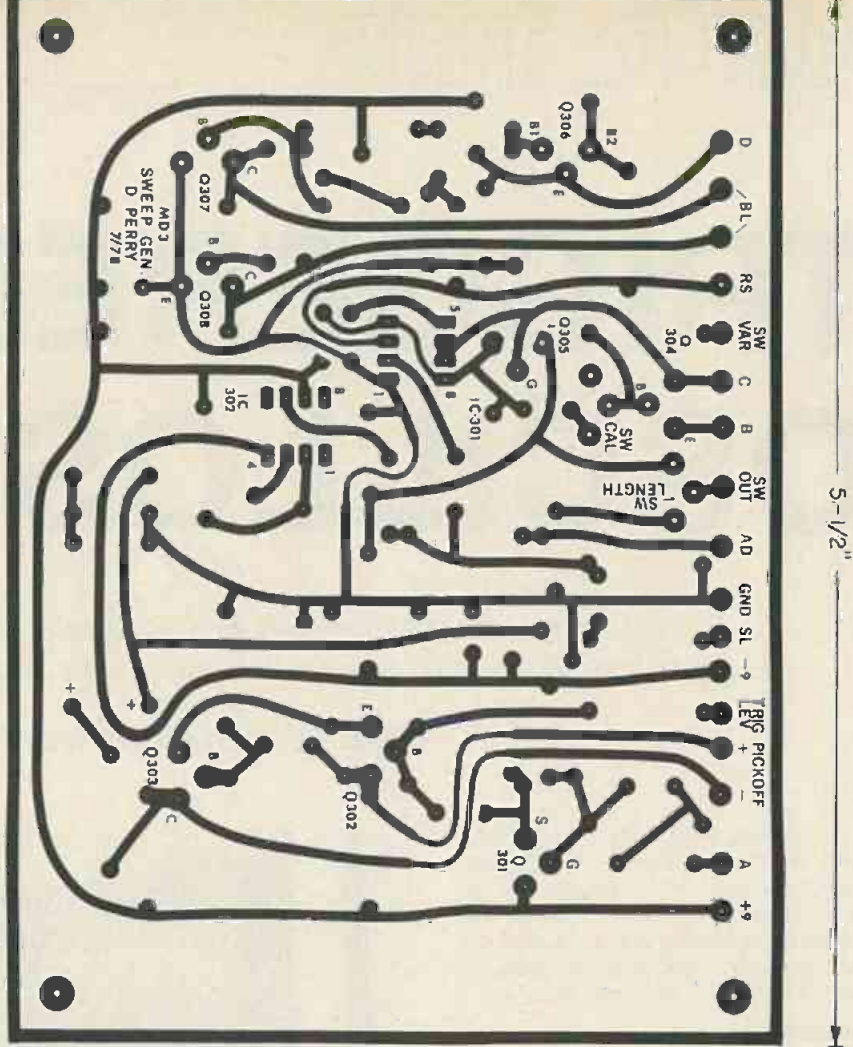


FIG. 8—THE SWEEP-GENERATOR PC-board foil pattern. The pads along the top edge are for connections to off-the-board components and leads to other circuit boards.

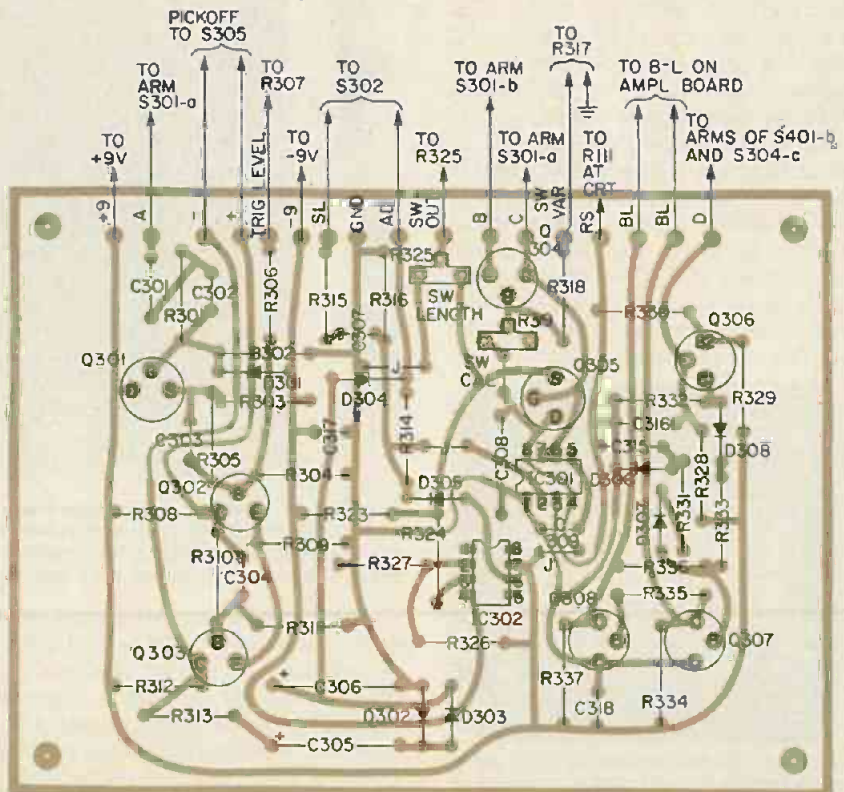


FIG. 9—HOW THE COMPONENTS ARE PLACED on the sweep-generator PC board. Note the positions of the three jumpers.

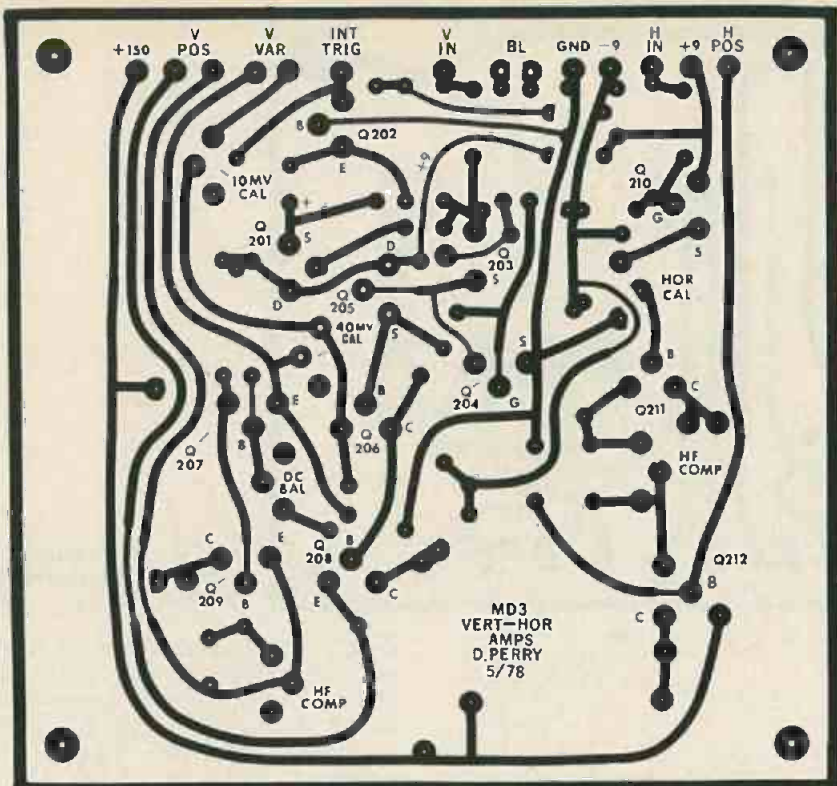
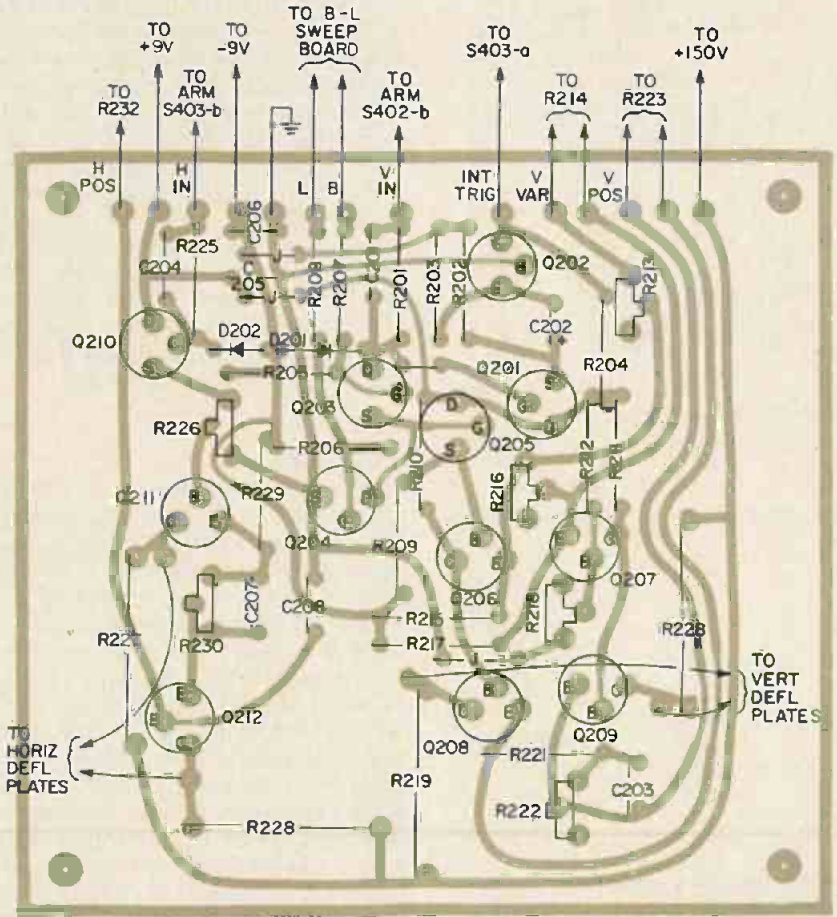


FIG. 10—PRINTED-CIRCUIT FOIL PATTERN for the board for the horizontal and vertical deflection circuits.

Vertical: 50mV P-P, 1kHz sinewave input; R214 at min resistance, S401 at DC
 Horizontal: 2V P-P, 1kHz sinewave to EXT HOR, S403 at 0.4V/DIV
 Sweep: 2V P-P, 1kHz sinewave at EXT TRIG; + SLOPE, AUTO, 0.4ms/DIV, DC GND



NOTE: CONNECTION TO HORIZONTAL DEFLECTION PLATE SHOULD BE MADE SO THAT BEAM SWEEPS FROM LEFT TO RIGHT; VERTICAL DEFLECTION PLATES SHOULD BE CONNECTED SO THAT POSITIVE INPUT TO VERTICAL AMPLIFIER PRODUCES UPWARD DEFLECTION OF BEAM.

FIG. 11—THE DEFLECTION-AMPLIFIER board has three jumpers and six trimmers for circuit calibration and adjustments. Leads to CRT deflection plates should be as short as practical to minimize stray capacitance.

Power Supply - 100 Board

TEST POINT	VOLTAGE		POSSIBLE CAUSE
	DC	AC P-P	
C103	-1100	40	D101 thru D106 D107-D113
D107A	-950	< 1	C105, T101, CRT
C107	+145	< 1	D114, C106
C108	-19	0.6	D115, D116
C110	+18	1	D118, D119
Q101E	-9.4	< 5m	D117, Q101
Q102E	+9.4	< 5m	D120, Q102

Trig & Vert Amp - 200 Board

Q201S	+1 to +2	=5m	
Q202C	+5	=2	
Q205G	0	50m	D201, Q205
Q205S	+1 to +2	45m	Q205
Q206E	Follows 0.6V below Q205S		
Q207E	+0.5 to +1.5	=0	R218
Q208C	=4	1.0	Q205, R215, R217
Q208C			
Q209C	75	50	Q208, Q209 R224

Horiz Amp - 200 Board

Q210S	+1 to +2	1.5	Q210, D202
Q211C			
Q212C	+75	60	Q211, Q212, R229

Sweep - 300 Board

Q301G	0	2	Q301, D301
Q301S	+1 to +2	1.8	Q301
Q302B	-1 to -3 Varied by R307		
Q302C	+1 to +9 SQR Q302, Q303		
Q303C	+1 to +9 SQR Q302, Q303		
C306	+8	0	D302, D303
Q304B	+7.3 to +8.5 Varied by R317		
R320-R322	+1.5 DC across R _T AT CAL		
IC301 pin 6	0 to +6 RAMP		Q304
Q305S	+1 to +7 RAMP		Q305
IC302 pin 6	+9 to -9 SQR		IC302, R327
IC301 pin 3	0 to +9 SQR		IC301
Q306E	0 to 7 RC Charge; Q306, R278		
Q306B1	+5 SPIKE Q306		
Q307C			
Q308C	0 to +9 SQR		Q307, Q308

A=anode B=base C=collector
 E=emitter G=gate S=source

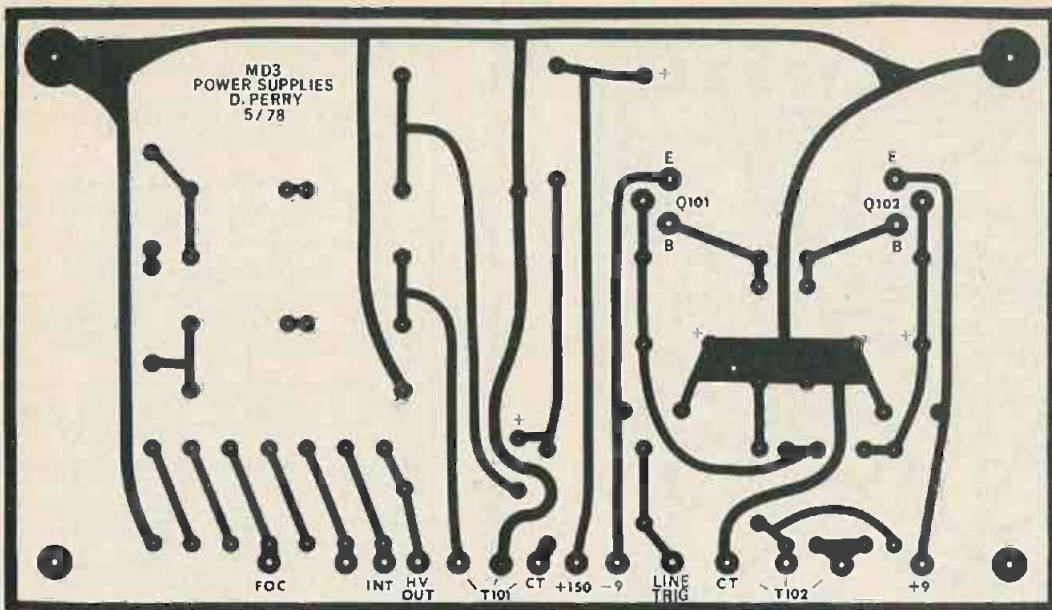


FIG. 12—THIS PRINTED-CIRCUIT PATTERN simplifies construction of the power supply.

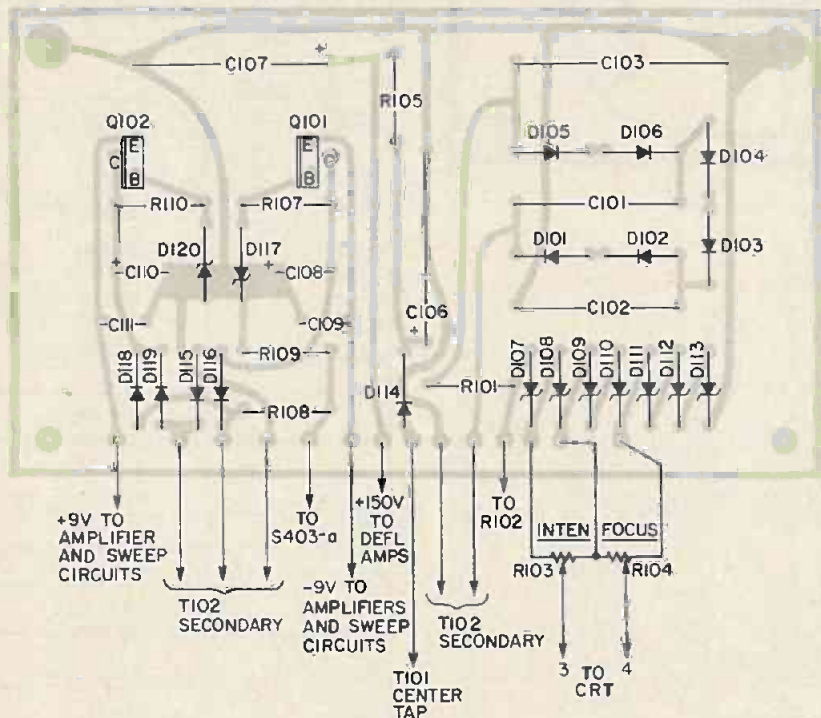
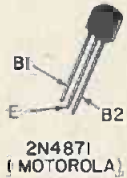
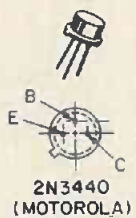
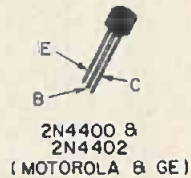
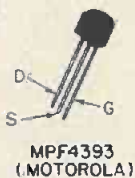


FIG. 13—POWER-SUPPLY COMPONENT LAYOUT is simple. Be careful; some of its voltages are dangerous.



PHYSICAL OUTLINES AND PINOUTS for the discrete devices used in the scope as active circuits. Be especially careful with the installation of the look-alike plastic devices.

calibration accuracy is expected. The timing capacitors must at least be in the same ratio, so if one is 7% high, strive to make them all 7% high. If a $\times 10$ probe is

to be used, the fixed frequency-compensating capacitors (CB) must be held to 5% tolerance.

The scope is constructed on four PC

boards. The foil patterns for the attenuator, sweep circuits, deflection amplifiers, and power-supply PC boards are in Figs. 6, 8, 10, and 12, respectively. The component layouts for those circuit boards are in Figs. 7, 9, 11, and 13.

Initial checkout

A spot can be focussed on the screen with only the power-supply board and CRT circuitry wired in. The 9-volt supplies will each need a temporary 470-ohm load if they are to be tested at this point. Now disconnect the primary of T101 to disable the high-voltage supplies while the sweep and low-level amplifiers are tested. The troubleshooting chart (Table I) shows the voltages to be expected at various test points. Once the Schmitt trigger, sweep generator, baseline generator, and low-level amps are determined to be functioning, the high voltage can be reconnected.

Calibration

Vertical: First display a 200-kHz squarewave and adjust high-frequency compensation control R222 for sharpest corners with no overshoot. With range S402 at 1 V/div and variable R214 at maximum resistance, inject a 2.12 volt RMS (6.0 volts P-P) 100-Hz sinewave, and adjust R216 for a six-division display. Now change the range to 4 V/div and, with variable R214 at minimum resistance ($\div 4$), adjust R213 for a six-division display. With the input grounded, adjust R218 so the trace remains stationary as R214 is rotated. The final step is to display a 1-kHz squarewave, and on each of the ranges from 0.1 to 10 V/div adjust the corresponding trimmer capacitor for the best squarewave with no rounding or overshoot.

Horizontal: With the horizontal atten-
continued on page 110

VERSATILE ANALOG INTERFACE FOR YOUR COMPUTER

Build this simple device to allow your computer to look at the outside world—without complex analog-to-digital conversion.

JOHN R. HANSON

INTERFACING AN ANALOG RESISTOR-CAPACITOR NETWORK TO A digital microprocessor has a wide variety of real-world applications. With this interface and the proper software, you can use the microprocessor to measure the time constant of a resistor-capacitor combination. This concept suggests numerous potential applications, including joysticks, a capacitance meter, proximity switches and more.

The circuits in Figs. 1, 2 and 3 use a minimum of components and a software timing loop to measure the value of the R-C network. A single IC allows you to build up to six of any of the circuits described here. Although this article describes 8080 and BASIC software, adapting the interface to any other type of microprocessor and software processor should be easy.

How it works

All circuits essentially consist of a resistor-capacitor network at the input of any one of the six non-inverting buffers in IC1. When the input of the buffer is low (at ground potential), the output is also low. As the voltage across the capacitor rises above approximately 3, the output changes to a logic high level. The resistor that charges the capacitor is connected to one bit of an 8-bit output port. The output of the buffer is connected to the corresponding bit on an 8-bit input port. Up to eight circuits could be implemented by one 8-bit input port.

Construction

The easiest way to build this circuit is on a small piece of perforated board. We recommend providing a socket for IC1. A small transistor socket works well to hold capacitor C_x (see Fig. 2). Component layout is not critical. The capacitor tester (Fig. 2) works best with a fairly stable +5 V_{cc} , but this is not at all critical in the other circuits.

Software

The real workhorse of all these circuits is a machine-language program called CVAL (see Listing 1). The first line of this CVAL routine has a variable called BIT#. Setting one of the eight bits in BIT# to a logic high with the rest set to a logic low level determines which bit of the I/O port to test. Since my sample circuits are connected to the least-significant bit, I set the LSB of BIT# to logic high level by setting BIT# equal to 01 (hexadecimal code). The routine then sets its counter (register-pair HL) to 0. The routine now outputs a logic high to the selected circuit and begins counting. When the buffer output finally goes high, the routine stops counting, outputs a logic low to the circuit, and returns to the calling program with a value in register-pair HL that is equal to the time constant of the resis-

LISTING 1.

```

ORG 04400H                                ;PROGRAM OUT OF THE
                                           ;WAY OF BASIC IN LOWER
                                           ;MEMORY
CVAL: MVI E, 01H*                          ;MOVE BIT# TO REG. E
      XRA A                                ;A = 0
      MOV H,A                              ;H = 0
      MOV L,A                              ;L = 0
      MOV A,E                              ;A = BIT# TO BE TESTED
      OUT 01H                              ;TURN ON SELECTED BIT
GO:   INX H                                ;START COUNT
      IN 01H**                             ;CHECK INPUT PORT
      ANA E                                ;MASK ALL BUT BIT#
      JZ GO                                ;JUMP IF BUFFER NOT ON
                                           ;YES
      XRA A                                ;A = 0
      OUT 01H**                            ;TURN BIT# OFF
      RET                                  ;RETURN TO CALLING
                                           ;PROGRAM

```

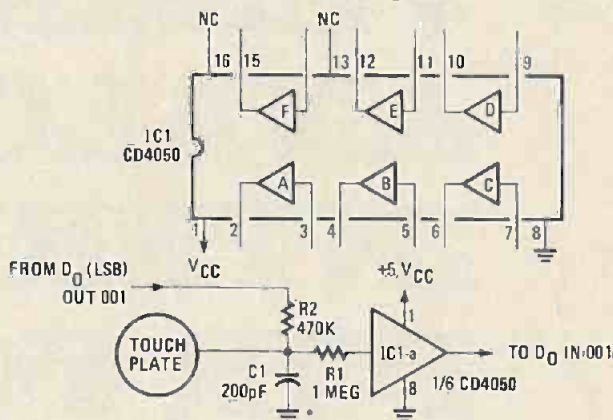
LISTING II

```

MAIN: LXI SP, 04800H      ;SET STACK POINTER
                          (ROUTINE STARTS HERE)
XRA A                    ;A = 0
OUT 01**                ;OUTPUT 0 TO ALL
                          CIRCUITS
OUT 0BH**                ;SWITCH OUTPUT = OFF
MOV D,A                  ;SWITCH STATE REGISTER
                          = OFF
ONYET: CALL TDM           ;SHORT TIME DELAY SO
                          CAPS DISCHARGE
CALL SWON                ;SWITCH BEING TOUCHED?
CPI 01                   ;SEE IF A = 1
JNZ ONYET                ;CHECK AGAIN IF NOT
                          TOUCHED YET
XRA D                    ;A = 1, EXCLUSIVE OR
                          WITH SWITCH STATE
MOV D,A                  ;D = NEW SWITCH STATE
OUT 0BH**                ;OUTPUT NEW SWITCH
                          STATE IN LSB PORT 013
OFFYET: CALL TDM         ;PAUSE FOR DISCHARGE
                          AGAIN
CALL SWON                ;SWITCH STILL ON?
CPI 01                   ;CHECK
JZ OFFYET                ;JUMP IF STILL ON
DBLCHK: LXI B, 04000H    ;B = 20H, C = 0
CALL DEC                 ;LONGER TIME DELAY TO
                          DEBOUNCE SWITCH
CALL SWON                ;SWITCH STILL ON?
CPI 1                    ;CHECK
JZ OFFYET                ;TRY AGAIN IF IT IS
TOUCH: MOV D,A           ;A = 0, SWITCH STATE =
                          OFF
ONLY: OUT 0BH**          ;TURN SWITCH OFF
JMP ONYET                ;CHECK FOR NEXT TOUCH
SWON: CALL CVAL          ;GET ACTUAL TIME
                          CONSTANT
MOV A,L                  ;GET LOW ORDER BYTE OF
                          CONSTANT
CPI 0BH***               ;COMPARE WITH MINIMUM
                          ON VALUE
JP ON                    ;IF IT IS GREATER SWITCH
                          IS ON
XRA A                    ;ELSE MAKE A = 0 TO
                          SHOW IT IS OFF
RET                      ;THEN RETURN
ON: MVI A, 01            ;MAKE A = 1 TO SHOW IT
                          IS ON
RET                      ;NOW RETURN
TDM: LXI B, 0100H       ;B = 01, C = 0
DEC: DCR C               ;DECREMENT C
JNZ DEC                  ;C = 0?
DCR B                    ;DECREMENT B
JNZ DEC                  ;JUMP IF BC = 0
RET                      ;TIME DELAY ALL DONE
    
```

Notes: My origin statement sets this program in the 18th K of memory (04400H). This gets it out of the way of my basic interpreter in the first 13K. Of course it may be relocated and run anywhere in memory.
 *—BIT #. This variable has one bit high to determine which bit of the I/O port is to be tested.
 **—Port numbers specific to my system. May be changed to fit whatever ports are free.
 ***—Minimum on value. If CVAL reads a value less than this SWON will return, indicating switch is off. This value determines the sensitivity of the touch switch.
 8080A mnemonics are used throughout. BASIC is Digital Group Maxi-BASIC Ver. 1.0.

ON). As shown, the program simulates a normally open momentary contact switch. Delete (or insert NOP's) lines TOUCH and ONLY, and the routine simulates a touch-on/touch-off switch. The routine operates by calling CVAL, and seeing if the result is greater than a byte called "minimum on value." The value I show for this is 0B (hexadecimal), which works for the value capacitor shown in Fig. 1 and a fairly positive contact of the touchplate. Lowering this value increases the



* SYSTEM SHOULD BE GROUNDED TO EARTH GROUND FOR TOUCH SWITCH APPLICATIONS

Fig. 1—TOUCH/PROXIMITY SWITCH can be used for touch-ON/touch-OFF control of a device or appliance or, with increased sensitivity, can be used in a proximity-operated intruder or burglar alarm.

sensitivity of the switch. If the switch tends to bounce at all, increase the value loaded in BC in line DBLCHK. I call a short time delay called TDM before each CVAL call to give the capacitor a little time to discharge; but if your application only calls CVAL occasionally, this is not necessary. If the touchplate is a fairly large piece of metal, the switch will trip just by coming near it (adjust the "minimum on value" for the best performance).

This type of proximity switch lends itself easily to security and burglar alarm applications. A single IC provides you with six inputs that could be sequentially polled by CVAL to indicate the status of all doors and windows. The metal plates would be easy to hide and difficult to defeat.

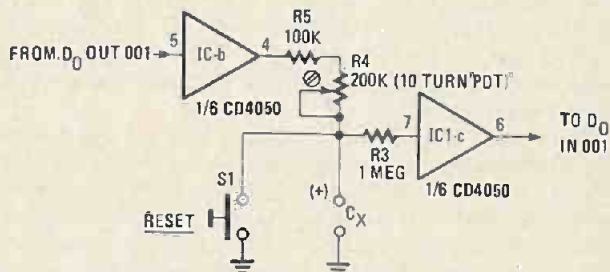


Fig. 2—A CAPACITANCE METER is formed when this interface is used with a microprocessor. The machine prints out capacitor values between 500 pF and 5 μF.

Capacitance meter

Figure 2 shows a circuit that, when driven by Listing III and CVAL, represents an extremely easy way to measure unknown

PARTS LIST

- Resistors 1/4 watt, 10% unless otherwise noted
- R1, R3, R6—1 megohm
- R2—470,000 ohms
- R4—200,000 ohms, 10-turn trimmer potentiometer
- R5—100,000 ohms
- R7—4700 ohms
- C1—200 pF, 10 volts, ceramic disc
- C2—.033 μF, 10 volts, polystyrene
- S1—normally open pushbutton switch
- IC1—CD4050 CMOS non-inverting hex buffer

capacitances. The circuit uses one buffer to charge the unknown capacitance through the calibration potentiometer. The RESET pushbutton insures that large-value capacitors are totally discharged before each test. To calibrate the unit, use one or more good-quality close-tolerance capacitors in the range of 0.005 μF to 0.01 μF , and repeatedly run Listing III, while adjusting R4 until the routine prints the correct value of the capacitors. Listing III could be written in any BASIC that permits calling a machine-language program (calls CVAL in line 60), and then

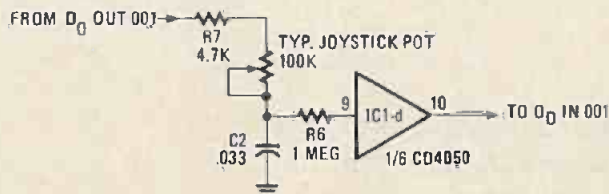


Fig. 3—THE POSITION OF A JOYSTICK CONTROL is printed out in numbers from 10 to 250. When the joystick is operated by a servo, the print-out can be a remote indicator.

LISTING III

```

10 OUT 1,0           ;remarks
                    ;OUTPUT 0 TO PORT 1
20 PRINT "INSERT UNKNOWN CAPACITOR"
30 PRINT "PUSH RESET FOR A SECOND"
40 PRINT "NOW HIT RETURN TO TEST, N-RETURN TO QUIT"
50 INPUT S$
55 IF S$ = "N" THEN GOTO 100
60 LET X = CALL (17408) ;CALL MACHINE LANGUAGE
                    ;CVAL
70 LET X = X*.0001   ;CONVERT TO MICROFARADS
80 PRINT "CAPACITOR EQUALS ";X;"  $\mu\text{F}$ "
90 PRINT " "        ;DO SOME CARRIAGE
                    ;RETURNS
91 PRINT " "
92 PRINT " "
95 GOTO 10          ;NEXT TEST
100 END

```

LISTING IV

```

10 OUT 1,0           ;remarks
                    ;CLEAR PORT 1
20 LET X = CALL(17408) ;CALL CVAL
30 PRINT X           ;SHOW VALUE OF JOYSTICK
                    ;POSITION
                    ;OR-(30 PRINT TAB (X/8);" *") ;USING THIS FOR LINE 30
                    ; SHOWS AN *
                    ;CORRESPONDING
                    ; TO JOYSTICK POSITION
40 GOTO 10
50 END

```

allows assigning the value returned in register pair HL to a variable (X). The values shown are good for capacitors in the range of approximately 500 pF to 5 μF . Vary the size of the charging resistor to measure other capacitance ranges.

Joystick interface

The circuit shown in Fig. 3, when polled by CVAL, provides a simple way of digitizing the position of a joystick potentiometer. The values shown will cause CVAL to return with a number in HL from about 10 to 250, representing the position of the joystick. Listing IV prints these values for unit checkout. Substituting the alternate line 30 (shown) moves an asterisk back and forth across the display screen according to the position of the joystick potentiometer. Two of these circuits are required to obtain both the X and Y values from the joystick.

These circuits only scratch the surface of the possible applications for this technique. A 4×4 array of touchplates with four 4-input CMOS NOR gates to monitor row status and software drivers sequentially testing the columns could form an inexpensive touchswitch hexadecimal keyboard. Many types of sensors (temperature, pressure, etc.) can be used directly with these circuits, thus allowing you to monitor analog-type signals with a minimum of hassle. A little experimentation will yield a large number of nifty applications, while doing minimum damage to your pocketbook. And your computer will thank you for letting it hear from something other than a keyboard. R-E

PIONEERS IN RADIO

Sir Jagadis Chundar Bose

FRED SHUNAMAN

JAGADIS CHUNDAR BOSE BEGAN HIS SCIENTIFIC career as a professor of physical science in Calcutta (where, as a native, he received two-thirds the pay of European professors with the same qualifications). Interested by Lodge's report on the work of Hertz (1894) he repeated all Hertz's experiments, working, as he said, "with none of those mechanical facilities at my disposal that every European and American scientist takes for granted."

He ran a meticulous series of tests on coherer materials, evaluating the sensitivity of practically all available metals. In these experiments, he discovered that the resistance of a coherer using potassium increased rather than decreased with the passage of an electric wave, thus questioning the validity of then-current coherer-action theories.

He invented an original coherer with spirals of fine wire, usually made of steel, laid in a slot cut in ebonite. The slot was

terminated at each end with brass plugs—one fixed and the other adjustable with a screw. The spiral bits made about a thousand well-defined contacts with each other, claimed Bose, and these contacts could be adjusted with the single screw.

In 1895 at a lecture in Calcutta, Bose transmitted the newly discovered electric waves 75 feet to an adjoining room, tripping a relay that fired a pistol and blew up a small mine.

Possibly Bose's most important work was his demonstration to European scientists that Hertzian waves actually existed in the real world, not merely in scientific papers. He constructed a compact demonstration apparatus using a turntable. This made it possible to perform most of the experiments for which Hertz had needed a long hall. The equipment could be packed in a case only 60 centimeters long and 30 centimeters high and wide (or about 2 feet by 1 foot). Using this equipment he lectured to the Royal Society in London in January of 1897, in

Paris on March 9, and in Germany and in other European countries later.

In working with coherers, Bose noted that they became less sensitive with continuous use, but regained sensitivity if not used for a while. Extending his studies to plants, he became convinced that the boundaries between animal and vegetable life and nonlife were not as rigid as commonly believed. Official science was outraged at this "metaphysical" and "nonscientific" approach, and the Royal Society refused to print his papers for many years. He was regarded as a mystic and was ostracized by the scientific community. To this day, his name rarely appears in any work on electronics. A similar—if not as complete—a suppression appears to have taken place with respect to his quite extensive efforts in the field of biology. Scribner's Encyclopedia states: "Today, when biophysics is a generally recognized discipline"—his theories might not appear so controversial. R-E

WARC-'79

The World Administrative Radio Conference recently adjourned. Many questions regarding frequency allocations were resolved—but many still remain.

STANLEY LEINWOLL*

ON DECEMBER 6, 1979, AFTER 74 GRUELLING days and nights of work, the World Administrative Radio Conference which was held in Geneva (WARC-79) completed its work. One hundred and forty two member countries of the International Telecommunications Union (ITU), which had convened the Conference, adopted and signed a new set of Radio Regulations that will come into force on January 1, 1982. In addition, WARC-79 adopted a large number of resolutions and recommendations relating to radio communications.

WARC-79 was the first general radio conference in 20 years. Its principal objectives were to review and revise, where necessary, many of the Radio Regulations that had been in force since 1960, including the vitally important Table of Frequency Allocations, which assigns frequency bands to all services using the electromagnetic spectrum for communications purposes. It is generally agreed that WARC-79 was the most important radio gathering ever organized by the ITU.

Telecommunications technology has developed at an astounding rate over the past generation, with the appearance of many new and revolutionary techniques, such as miniaturization and communications via satellite. When the last general Radio Conference was held in 1959, Sputnik I was barely one year old. Since then, however, more than 265,000 MHz of additional spectrum has been opened up for use by radio-communication services.

WARC-79 was held in the International Conference Center in Geneva. It was attended by more than 2,000 delegates and observers from 142 countries

*Stanley Leinwoll is Director of Engineering, U.S. for Radio Free Europe—Radio Liberty. He was a member of the United States Delegation to WARC-79.

and 30 international organization, including the International Amateur Radio Union (IARU), and various Broadcasting Unions from all over the world. More than 1,000 meetings of committees, working groups, and sub-working groups were held, and the conference generated thousands of pages of text, including a final document that was more than 1,100 pages long.

In spite of the vast expenditure of time, effort, energy, and money that went into WARC-79, many issues were left unresolved, being either deferred to the work of future conferences, or not clearly defined. Although many delegates expressed satisfaction over the outcome of the Conference, it appeared to some observers that there could be difficult days ahead, especially for amateur radio and shortwave broadcasting, as well as some space services.

As an indication of the potential difficulties that lie ahead, an unprecedented 83 reservations were taken at WARC-79, including five by the United States. A reservation is a statement that a country will not be bound by a decision made at a conference. In the area of shortwave broadcasting alone, 20 countries took reservations, expressing misgivings about the amount of insufficient additional spectrum allocated to this service. The United States was among those countries reserving the right to take whatever steps it deemed necessary to satisfy its shortwave broadcasting requirements.

Of particular concern was the failure of the Conference to allocate any additional spectrum space to shortwave broadcasting in the 6- and 7-MHz bands, even though an additional 850 kHz was added to the broadcasting services in the bands between 9- and 21-MHz. The Conference also recommended that a high-frequency broadcast-planning

WARC be convened several years hence, but many observers felt that planning the high-frequency bands would prove to be very difficult without additional space in the vitally important 6- and 7-MHz bands.

Although it will take years to fully assess the failures and accomplishments of WARC-79, here follow, in a nutshell, the results of the Conference that are of major interest to the readers of **Radio-Electronics**. There will be followed by an analysis of the results in terms of their possible future impact on radio-communications.

High-frequency broadcasting

The Conference allocated an additional 850 kHz to the existing bands between 9- and 21-MHz, including the creation of a new band at 13.6 MHz. (see Table I). The 26-MHz band was reduced by 70 kHz, and no changes were made in the 6- and 7-MHz bands. The net increase in spectrum allocated to HF broadcasting was 33%. (The United States had proposed a 46% increase, which the Soviet Union, which currently has extensive operations outside the bands allocated to shortwave broadcasting, was opposed to any expansion whatsoever.)

The Conference recommended that a HF-Broadcasting-Planning WARC be convened at the earliest possible date (probably 1983). This Conference will be in two sessions: the first will be technical, at which standards and procedures for planning will be determined. The second session, following the first by approximately 18 months, will be devoted to planning the efficient and equitable use of the bands allocated to broadcasting.

Actually, the expansion of the bands is tied to the planning conference, and to the successful completion of the



transfer and reaccommodation of fixed frequencies that are being displaced as a result of broadcast band expansion. WARC-79 set 1989 as the date when the expanded portions of the high-frequency spectrum would become available to the broadcasting service.

Twenty countries, including the United States, Canada, Great Britain, Federal Republic of Germany, Iran, People's Republic of China, Israel, Spain, Portugal, and Saudi Arabia, indicated concern over the success of the planning conference in light of inadequate expansion of the shortwave broadcasting bands, especially in the 6- and 7-MHz bands. They all took reservations dealing with high-frequency broadcasting.

The United States made a strong protocol statement at the conclusion of WARC-79 against jamming now being directed against some of its broadcasts, and reserved the right to take necessary and appropriate measures to protect its broadcasting interests as long as jamming continues.

Future impact on HF broadcasting

In addition to the concern expressed

by many countries that no planning procedure could succeed without sufficient additional spectrum space, a further complicating factor involves present levels of out-of-band broadcast operations. Because of the serious congestion in the shortwave broadcast bands a number of countries have moved their broadcasting services into bands now allocated to other services. The Russians, for example, currently schedule a great many transmitters out-of-band. In the region between 5900- and 5950- kHz, as a case in point, Russian broadcast transmitters operate on every 5 kHz channel.

As a consequence, it is feared by some experts that in the very near future additional countries, spurred by the inequity of the present situation, will authorize expanded out-of-band operation. The Final Acts of WARC-79 come into force on January 1, 1982, and it is possible that at that time, or even before, many countries will begin to expand the bands without waiting for the planning WARC, or for the reaccommodation procedure to be completed. That could develop into a potentially serious situation in terms of the success

of a planning conference, because countries that have already satisfied their broadcasting requirements are not likely to take a planning conference as seriously as they should. Under such circumstances, still other countries, observing what is happening, may get on the bandwagon to rush their shortwave broadcasting services out of band.

The United States is dedicated to the success of the planning WARC, and will be watching this situation with particular concern.

Amateur radio

The Amateur Service has been allocated additional bands at 10.100-10.150 kHz on a secondary basis, 18,068-18,163 kHz on an exclusive basis, including amateur satellite, and at 24,890-24,990 kHz, also including amateur satellite on an exclusive basis. The availability of the latter two bands to the amateur service requires the satisfactory transfer of assignments to other bands of services already operating in those bands.

The amateur service in the 7100-7300 kHz band was almost dealt a crippling blow at WARC-79, when the Conference voted in late November to allocate that band to shortwave broadcasting on a worldwide basis. However, after some frantic behind-the-scenes deliberations, it was agreed to restore the band to the amateur service in the western hemisphere, with a footnote stating that the use of that band by the amateurs would not impose constraints on the broadcasting service using the same band in other parts of the world.

Future impact on amateur radio

It appears that the "constraints" footnote will enable some European, African, and Asian broadcasters to take liberties

continued on page 109

TABLE I

Summary of WARC-79 Shortwave Broadcast Band Expansion

Band (MHz)	Current Allocation	New Allocation	Net Change
6	5950-6200 kHz	5950-6200 kHz	0
7	7100-7300* kHz	7100-7300* kHz	0
9	9500-9775 kHz	9500-9900 kHz	+125 kHz
11	11700-11975 kHz	11650-12050 kHz	+125 kHz
13	Not Allocated	13600-13800 kHz	+200 kHz
15	15100-15450 kHz	15100-15600 kHz	+150 kHz
17	17700-17900 kHz	17550-17900 kHz	+150 kHz
21	21450-21750 kHz	21450-21850 kHz	+100 kHz
26	25600-26100 kHz	25670-26100 kHz	-70 kHz

Total

+780 kHz

*Allocated to the Amateur Service in western hemisphere, and to broadcasting elsewhere.



PUT YOUR

Digital capacitance meters do a lot more today than just measure capacitor values!

MARTIN BRADLEY WEINSTEIN

CAPACITANCE METERS HAVE BEEN around for decades. Surprised? The hullabaloo in the last year or so over the new wave of digital capacitance meters makes them seem like the newest instrumentation available, but capacitance has needed measuring for lots of reasons for a long, long time.

Believe it or not, measuring the value of capacitors *isn't* the most useful function a capacitance meter can be put to.

History

In the past, many schemes have been used to measure capacitance. Capacitance has been determined by calculations of the surface area (A), of metal plates, the dielectric constant (K) of an insulator, the distance (d) between plates, and the number (n) of plates. The formula, $C = \frac{KA}{d}(n-1)$ (0.224), is used to determine capacitance in picofarads for area in square inches and distance in inches.

Time and frequency measurements have been used to determine capacitance when the capacitor is placed into an oscillator or delay circuit. Another, simply implemented scheme involves passing a signal of known frequency and amplitude through the capacitor under test. Signal losses are determined through the formula for capacitive reactance, $X_c = \frac{1}{2\pi fC}$ and knowledge of the

design of the attenuator path. And, of course, precision bridges are an excellent way to measure a wide range of capacitance values with high accuracy.

Today's digital capacitance meters use analog-to-digital conversion techniques. The basic task is to measure the time that it takes to charge a capacitor to a known voltage through a known resistance.

Why measure capacitance?

For most applications, the exact value of a capacitor doesn't matter. You've heard that valid piece of advice many times by now, no doubt. So why not just take what the capacitor is labelled with to be its actual value and forget it?

Many times you can, but not always. For AC coupling, for DC blocking and bypass applications, for power supply filters, for deglitchers—no problem. But for notch filters, bandpass filters, band-reject filters, phase-shift oscillators, single-sideband quadrature filters, oscillators, neutralizing, tuning, and many other applications, precision becomes more of a necessity than a virtue.

In many applications, while the precise capacitance value doesn't make a great deal of difference, it's important to *match* capacitances.

How tolerant should you be?

Capacitor tolerance, usually expressed as a *percentage* value, is usually specified either by design rules-of-thumb or the specific criteria of a given application.

A .001 μ F ceramic, for example, might well be offered by a manufacturer with a $-20\%/+80\%$ tolerance—meaning that its actual value could be any-

where between .0008 and .0018 μ F and still meet its specifications.

The circuit you need it for, on the other hand, may require .001 μ F $\pm 1\%$. Buying a 1% cap can be both expensive and frustrating. It's much easier to survey the capacitors you have on hand. First, set yourself some limits:

$$\text{Limits} = \frac{(\text{Target value}) \times (1 \pm \frac{\text{percentage}}{100})}{100}$$

Similarly, you can determine within what tolerance of its nominal value any given capacitor is by calculating:

$$\% \text{ Tolerance} = \frac{(\text{Measured} - \text{Nominal value}) \times 100}{\text{Nominal value}}$$

Measuring temperature

Of course! Capacitors are available with stated temperature coefficients, stated as parts-per-million-per-degree-Centigrade. Normally, not even the newest digital capacitance meters could take care of measuring the small capacitance change produced by small changes in temperature; there is, however, a range of temperature coefficients between 500 and 1000 that permit some of today's more accurate instruments to measure temperature changes of just a few degrees accurately and repeatedly.

Note that to work effectively, the capacitor would have to be used as a transducer in conjunction with a cable no more than a few feet in length, calibrated at a known temperature (or a few), and the instrument itself (which may or may not be temperature-tolerant in terms of its own accuracy) thermally

CAP METER TO USE

isolated or separated from the capacitor/transducer.

The cable length, of course, contributes some capacitance to the measured total.

Capacitances that are not capacitors

We are very used to thinking of capacitance solely in terms of its manifestation in capacitors. But capacitance is an electrical characteristic arising out of physical laws, while a capacitor is simply a component.

Theoretically, all conductive surfaces not electrically connected to each other exhibit capacitance between each other. In practical terms, many things have capacitance:

Cables; adjacent printed-circuit traces, on either side of the printed circuit board; switches; relays, including reed relays; microphones; quartz crystals; semiconductor junctions; neon lamps; antenna-ground systems; adjacent windings of a coil (even though electrically connected at DC, there is a substantial potential difference between windings at RF); connectors; liquid crystal displays, and more.

While capacitance is not the primary, most sought-after, characteristic of these components, the fact that they have capacitance which we have a newfound capability to measure is of substantial value to us.

Measuring cable capacitance

The fact that an open pair of conductors in a cable exhibits capacitance leads to an invaluable collection of cable-troubleshooting techniques.

First, the capacitance for a number of standard cables, such as coax, twin-lead, and ribbon cable, is an integral part of their specifications. That value is expressed in various ways, such as in

terms of capacitance-per-meter, capacitance-per-foot, capacitance-per-mile or some other convenient capacitance-per-unit-length expression.

But even without access to the published data, that information can easily be determined for any cable, using your capacitance meter, with this relationship:

$$\text{Capacitance per-unit-length} = \frac{\text{Measured capacitance}}{\text{Number of units of length}}$$

As you will see in a moment, determining that value for each cable you commonly use can be a tremendous aid.

Determining cable length

Imagine having a huge spool of wire—

TABLE 1

DIGITAL CAPACITANCE METERS—A REPRESENTATIVE SAMPLING

Manufacturer	Model	Range	Best Accuracy	Price
B&K-Precision Dynascan Corp. 6460 W. Cortland St Chicago, ILL 60635	820	0.1 pF-1 farad	0.5%	\$140
	830	0.1 pF-199,900 μ F	0.2%	\$199
CIRCLE 92 ON FREE INFORMATION CARD				
Continental Specialties Corp. 70 Fulton Terrace New Haven, CT 06509	300†	1.0 pF-199,900 μ F	0.1%	\$250
CIRCLE 93 ON FREE INFORMATION CARD				
Data Precision Corp. Electronics Ave. Danvers, MA 01923	938	0.1 pF-1,999 μ F	0.1%	\$149
CIRCLE 94 ON FREE INFORMATION CARD				
Optoelectronics, Inc. 5821 N.E. 14th Avenue Fort Lauderdale, FL 33334	CM1000A	0.1 pF-10,000 μ F	1%	\$200 (Assm.) \$150 (Kit)
CIRCLE 95 ON FREE INFORMATION CARD				
Sencore 3200 Sencore Drive Sioux Falls, SD 57107	CA55	1.0 pF-200,000 μ F	1.0%	\$495
CIRCLE 96 ON FREE INFORMATION CARD				
IET Labs, Inc. 761 Old Country Rd. Westbury, NY 11590	CM-500 ²	1.0 pF-200,000 μ F	0.1%	\$299
CIRCLE 97 ON FREE INFORMATION CARD				

say telephone cable, on a spool big enough to be a college dormitory's prize coffee-table—and not knowing how much is there.

Imagine stringing intercom cable through a building and not knowing which of two cable ends goes all the way across the building, and which to the next room.

Ah, but you do know, given the capacitance-per-unit-length of the cable and your trusty capacitance meter.

Once again, the calculation is easy enough for the simplest of four-banger calculators:

$$\text{Cable length} = \frac{\text{Measured capacitance}}{\text{Capacitance-per-unit-length}}$$

Since the capacitance per-unit-length for most cables is relatively small, and the range of capacitance measurable with most capacitance meters extends quite high, the problem of very long cable lengths may be solved accurately by using that method.

Inspecting for cable flaws

The third arrangement of our basic relationship is especially useful.

A cable of known length and capacitance-per-unit-length can be inspected for open, shorted, or physically distorted conductors with a capacitance meter. Simply, the actual measured value of capacitance is compared to the value determined by:

$$\text{Capacitance} = (\text{Cable length}) \times (\text{Capacitance per-unit-length})$$

Here's how to interpret the results. A capacitance reading lower than the calculated value indicates either an open (or broken) conductor or severe stretching. Generally, a reading only a *little* lower than the calculated value shows stretching; a reading a few percent or more lower usually indicates a break.

The distance to a cable break can also be determined by calculating for cable length.

A capacitance measurement reading higher than the calculated value indicates a short—even a short of significantly high impedance—or insulation failure somewhere within the cable, or severe crimping. Unauthorized taps into a cable would also result in a higher-than-calculated reading.



DETERMINING VALUES of ordinary capacitors is only one of the many uses of these versatile meters, such as the model 830 shown above from B&K—Precision, Dynascan Corp.

Printed circuits

Under the banner of "good technique," we've been told how to design our printed-circuit board layouts to reduce a number of problems, most of which boils down to unintentional capacitive coupling: They include ringing, spurious oscillation, propagation delays, phase shifting, frequency shifting, unwanted pick-up of signals, cross-talk, noise, loading factors, and more.

Obviously, if the design-frequency criteria are known, a circuit's tolerance for additional, incidental, or stray capacitance can be calculated. And an actual PC board can be inspected with a capacitance meter even before parts are mounted to see whether or not the specs are met.

Other components

We have mentioned a number of "other" components that have capacitance. Capacitance measurements can be performed on those components for either of two broadly defined reasons.

First, capacitance measurements are a jim-dandy way of determining a component's suitability for application at a given frequency, using capacitive reactance as the key. For example, while you might use a reed relay at DC, would you use it at HF? VHF? UHF? Sure, it depends on how you're using it and what the circuit and the signal are; but you can save yourself a lot of trial and error—and error and error—with a little preliminary measurement and calculation up front.



DIGITAL CAPACITANCE METERS come in a variety of sizes. This one, the Data Precision 938, fits in your pocket.

Second, since capacitance varies with geometry, as we've seen at the beginning of this discussion, capacitance measurements can be used, either directly or indirectly, to determine whether or not a given component falls inside or outside of tolerance for given specifications, such as arcing point voltage (determined by spacing between electrodes), capacitive loading (encountered in TTL, CMOS and other IC technology) and more. Membrane switches and liquid-crystal displays are two excellent examples of components that can be "inspected" with a good capacitance meter.

Checking insulators

Remember our basic capacitance

formula? For a simple capacitor of two plates, it reduces to $C = 0.224 \frac{KA}{d}$

Want to determine the dielectric constant of a given insulator? Build it into your own capacitor. The dielectric constant of air is either 1 or close enough to be considered 1. So two plates of known geometry (or, as we'll see in a moment, undetermined geometry) and separation will have different capacitance values with materials other than air between them. As a result, the ratio of those values to the value with air between yields the dielectric constants for these materials.

Want to try for yourself? Start with a piece of window glass and two pieces of coated PC stock. You should get a K for window glass of about 8.

By the way, in applying the formula with unequally sized plates, it's best to use the smaller area in your calculations; also, where the plates are not precisely opposite each other, use the overlapping area.

Capacitive transducers

General Motors recently announced developments in transducer technology for monitoring critical carburetor adjustments, and for determining the fuel level within a tank.

The transducers in both of those cases were capacitors.

Obviously, since capacitors don't require (in fact, forbid) contact between their terminals, they are a natural choice in selecting transducers that will provide consistently accurate performance over extended use and they'll exhibit little or no wear.

You can make your own capacitive transducers, and check their performance characteristics and actual capacitance values with your meter.

For rotational (or angular displacement) measurements, try coupling to the shaft of an old tuning or trimming variable capacitor.

For linear motion, parallel plates or concentric tubes do quite well. For example, you could use a piece of PC board (say 12 × 12 inches) glued to the underside of a drawer as one plate of a capacitive transducer, and a second piece of PC board, foil side down, at the bottom of the drawer's cavity as the other. An RF signal coupled between them could hold in a relay (through a transistor). Sliding the drawer open would reduce the coupling, thus allowing the relay to drop out and sounding an alarm.

In fact, a cheap capacitor microphone will demonstrate changes in capacitance with air pressure, providing an easy and quick-responding barometric transducer.

The more you play the game, the more you'll learn. R-E

TROUBLESHOOTING BETA TRANSPORT MECHANISMS

*How to locate and solve
cassette loading/unloading problems in Beta-format
video cassette recorders.*

FOREST BELT

WHEN THE MECHANICAL AND ELECTRONIC functions combine as they do in video cassette recorders, a technician can find himself somewhat confused. Where do you begin to diagnose?

Your best bet probably is to depend on my *Easi-Way Servicing* technique. It offers a logical, step-by-step approach to diagnosing a defective component. The method adapts well to mechanical troubleshooting, even though it originated as an electronics diagnostic procedure.

Let's use that troubleshooting technique to deal with a few common symptoms. Complex though the threading/unthreading operation may seem, it really consists of only a few specific stages. Not many symptoms can actually appear in the operation.

To observe loading/unloading symptoms most conveniently, take the top cover off the recorder. Then, remove the plastic cover from the cassette-lift assembly (omit the cassette) and press the lift assembly down into its ready-to-load position until it latches.

To initiate loading when there's no cassette in the lift compartment, just depress the cassette-in switch. That switch is accessible at the front center of the lift assembly (See Fig. 1), when the assembly is latched down. Now you can see for yourself how the problem you are troubleshooting affects the threading or unthreading mechanism.

Will not load

The symptoms can be separated into two parts. The rare one is when the cassette-lift mechanism pops back up as soon as you push it down. In other words, it won't latch and loading cannot proceed.

A little reasoning and inspection tells

you that the cause must be mechanical. The EJECT button slide might be jammed, leaving the trip post for the cassette lift unable to move back for latching. The latching levers are on the right side on the lift assembly; the EJECT button slide is on the left. A linkage bar reaches across underneath.

However, when the EJECT button slide is stuck, it usually leaves the main AC motor on. That's something you would notice right away. (The AC motor and head drum do not rotate during loading, but they do run during the unloading and eject cycle.)

It's far more likely that the lift-latching mechanism has become bent or that some obstruction is holding the latching post out of position. Reach in with a thin probe (a soldering aid works) and try manipulating the latch.

The more common "won't-load" symptom, however, is simply that the tape fails

to thread after the cassette has been inserted and the lift latched down.

Again, push down the cassette-lift assembly without the cassette inserted. Press the cassette-in sensing switch. If nothing happens, that could actually end your mechanical analysis. You then proceed with an electronic tracing procedure until you find some logic signal (voltage), or lack of it, that is inhibiting operation. Once the flaw is located, you may have to return to mechanical observation or testing to find the actual trouble . . . and even then perhaps revert to electronic troubleshooting. Let's troubleshoot one case with that symptom, to give you some notion of the procedures involved.

Press down the lift and push the cassette-in switch. You expect the threading motor to turn on and drive the ring counterclockwise, but nothing at all happens. You can't even hear the threading motor try to run. It's time to investigate the

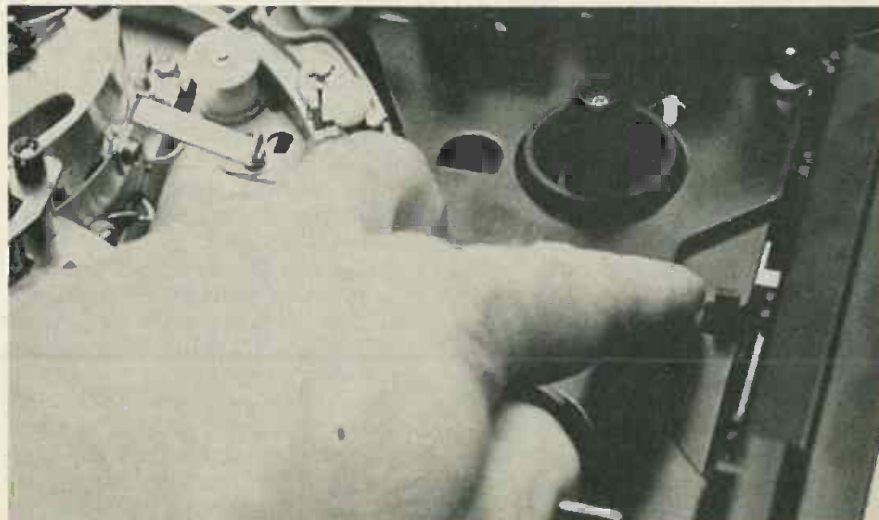


FIG. 1—THE CASSETTE-IN SWITCH is located at the front center of the lift assembly. Depress it manually to initiate the automatic loading process.

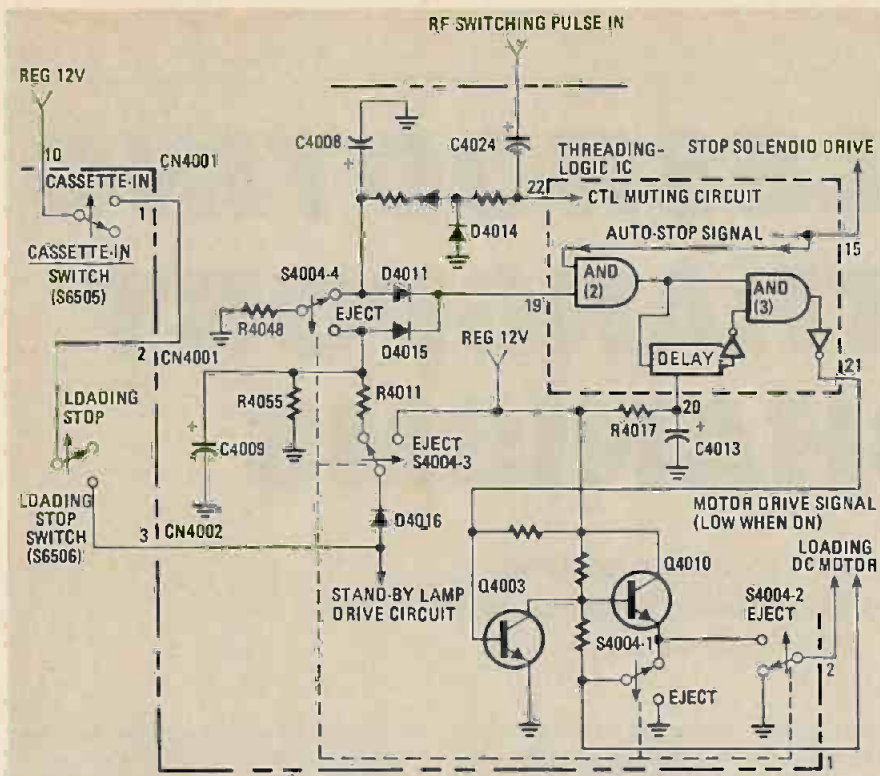


FIG. 2—BASIC THREADING CIRCUIT contains many safety interlocks that prevent damage to the machine during the tape loading process. A microswitch detects when the cassette is in place.

electronic functions of the recorder.
 Note—occasionally that test results in the normal operation of the mechanism. Yet, with the machine reassembled, it will not load. If that happens, check the plunger on the cassette-in switch. It may not be closing the switch—usually the fault of looseness inside the compartment or a misadjusted lift assembly.

For further testing the front panel must come off—and the bottom pan that hides two front-panel screws. **Be careful when you handle the uncovered chassis; some AC voltages may become exposed.**

For tracing a problem, a logic probe or a voltmeter can be used. **BUT REMEMBER:** you're tracing logic signals, not merely voltages. On a voltmeter some signals are normally high and some are normally zero or low.

Probably, you will find it simpler to start your check with the cassette-in switch. Referring to Fig. 2, you should find a logic high at both sides of the switch, with your finger holding the switch down. That is true also for both sides of switch S6506. It should remain closed until the threading-ring cam opens it at the end of loading.

Diode D4016 conducts a logic high, as do R4011 and D4015. Verify both! You should then find a logic high at pin 19, the threading-logic input for the IC.

At this point you must consider additional factors: Check pin 20 of the IC. Suppose you find it at a logic high. You recall that this would inhibit gate AND-3 and keep IC pin 21 at a logic high, which, in turn, keeps the threading motor off.

However, remember that you are making tests that may have consumed some time. If your tests took longer than 10 seconds or so, that has allowed time for the delayed-inhibit signal (at pin 20) to build up a logic high. And that's *normal*, under such circumstances.

To check the later stages of threading-logic properly, you must give the system a "fresh" start. Press the EJECT button and let the cassette-lift rise. Then push it back down and again press the cassette-in switch. Now measure IC pin 20 again. It should show a logic low for several seconds. If you wait, you'll find that it rises again to a logic high.

Recycle the cassette-lift assembly again, and check the logic state on IC pin 21 or at the base of Q4003 (both are the same, electronically). The logic state there should be low at the outset. If it is not, check the auto-stop line (IC pin 15). The IC will not deliver a logic low to pin 21 unless the auto-stop line shows a logic high. And don't forget to recycle the cassette-lift assembly, using the EJECT button if it takes you longer than ten seconds to find each test point.

With a logic low at IC pin 21 touch the logic or voltmeter probe to the junction of R4025 and R4026 (or the collector of Q4003 or base of Q4010). This junction should show a logic high.

One machine we tested loaded intermittently. The above junction measured at a logic high, but at times it would jump to a logic low. A poor solder joint between R4025 and the printed-circuit board was the cause. A faulty Q4003 could cause the same symptom.

Even if a logic high shows at the base and emitter of Q4010, a fault in the EJECT switch or its board connections might keep the voltage from the DC motor. For example, one such machine came from its shipping carton with the motor interconnect plug not positioned firmly on its pins on the PC board.

Another thought when servicing this particular symptom: Remember that a linkage or a solenoid must release the brakes on the cassette-reel turntables. Otherwise the brakes hold the tape in the cassette. When the time-delay runs out, the IC logic stops the voltage from reaching the threading motor. Yet, when you try to trace the fault with the cassette out of its holder—as just described—the threading proceeds properly. That's because there's no tape to hold the threading mechanism back. It can be frustrating to try to trace if you forget that particular odd characteristic.

A defect in the gear drive between the threading motor and the threading ring can stop movement, and will bring the electronic-delay into effect after ten seconds. So will something jamming the threading ring. In both cases, you must track the trouble electronically unless you find that the delay mechanism itself is the cause; then you seek a mechanical explanation.

Finally, don't forget that the IC itself can become defective. However, explore all other possibilities before replacing it.

Does not unload

Here's another symptom that is not uncommon. It can create a feeling of real difficulty. However, it's not all that tough to get into the mechanism to unwind the tape (very carefully) so you can test the mechanism and electronic functions. But don't do that before you have tried troubleshooting the electronics.

Troubleshooting in that case goes much the same as for threading. Drop the end panel for access to the EJECT switch. On the front of the machine, press the EJECT button down and see that it latches. Observe the mechanics to make sure the Eject slide moves properly.

Press the STOP button to unlatch the Eject slide. Raise the end panel almost into position and press the EJECT button again. Make sure the tab projecting from the Eject slide contacts the Eject switch properly (see Fig. 3).

Again drop the end panel. Latch the EJECT button down. With your finger, push the Eject switch backward to its Eject position. If the unthreading mechanism does not work now, you must trace the logic through the system again. Hold the EJECT switch back as you trace. Check the auto-stop line first; if it goes low from any cause, unthreading cannot proceed.

Remember also that *unthreading* requires a proper signal from the pulse generator that forms part of the video-head drum. Check the diodes first. Do they

Mechanical Easi-Way Servicing

To use my *Easi-Way Servicing* technique most effectively when electronics and mechanical functions combine, remember this dictum:

Analyze the mechanical functions first, then analyze the electronic functions that cause them or control them.

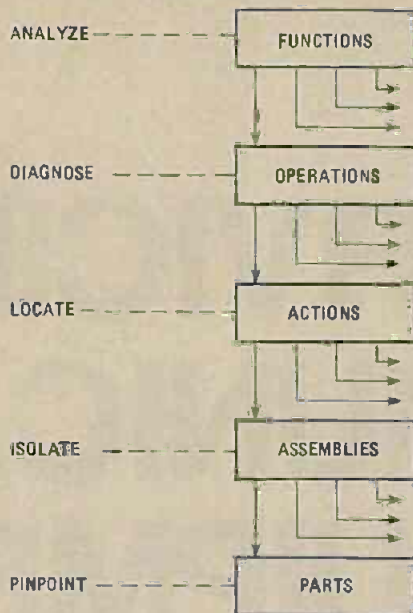
Keep to that rule at every level of the *Easi-Way Servicing* chart.

For example, first you "analyze the mechanical functions." Having decided which function is inoperative, you can then look for the particular electronic function that causes (or inhibits) the mechanical function.

Next, you "diagnose which mechanical operation" has ceased working within the function. Or, if you already know that the trouble is electronic, you diagnose the electronic section that is preventing operation.

Occasionally, in chasing an electronic fault, you'll find yourself back at a mechanical diagnosis. For example: You work your way down the chart, step by step, eventually finding a tape-slack detector switch holding the auto-stop line low, thus inhibiting operation. Yet, when you examine the tape, it's tight. If the switch is OK electronically, you'll probably find that it or its actuator is misadjusted mechanically.

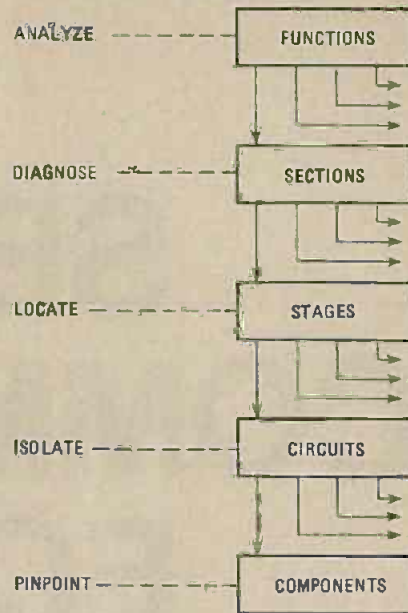
EASY-WAY™ SERVICING* (MECHANICAL)



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Obviously, the better you know the recorder you're working on, the easier you can spot potential causes of inhibit signals—whether they are actually protecting something or merely getting in

EASY-WAY™ SERVICING* (ELECTRONIC)



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the way of operation. If the machine is unfamiliar to you, this *Easi-Way* brand of reasoning helps immensely to narrow down the field of search.

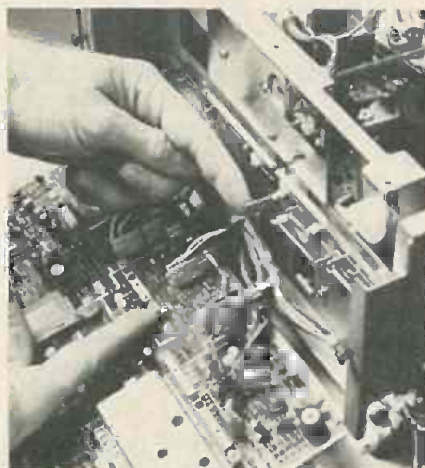


FIG. 3—MAKE SURE that the tab projecting from the Eject slide contacts the Eject switch properly.

deliver a DC voltage (a logic high) to D4011 (see Fig. 2)? If not, use your scope to trace back and find where the pulse disappears. If a logic high is present, make sure that D4011 passes it along to IC pin 19.

If you have to get the cassette out but the Eject mechanism does not work, take off the main cover (and the bottom pan). Remove the four screws that hold the cassette-lift cover. The two screws on the right side are hard to reach when the cassette lift is not raised, but a short, stubby or right-angle Phillips screwdriver will get at it.

First, pull the tape-tension arm toward the cassette and lift the tape clear. The

rest of the tape easily comes off from around the video-head drum. Don't let your fingers touch the drum nor any more of the tape than is unavoidable. And then try to touch only the tape edges. Again, move the tension arm and disengage the tape from around the lead guide post on the threading ring.



FIG. 4—WITH THE CASSETTE CLEAR, a small-tipped object such as a pencil may be used to unlatch the tape cover.

Work the cassette upward at the rear first, being especially careful near the left-rear corner where the cover opener is located. Raise the cassette upward, don't forget to make sure that the tape has not caught on something.

Once the cassette is clear, poke a pencil or a small-tipped object into the left-rear corner to unlatch the tape cover (Fig. 4). Only then should you wind the tape back into the cassette by hand. Do not leave

the cover closed because you will crimp the tape and perhaps break it.

Now you can proceed with the mechanical and electronic diagnosis.

Other symptoms

The threading motor could keep turning even after loading appears complete. A little thought and study of the schematic suggests various possibilities: threading-stop switch misadjusted and not opening, or defective. Of course, any malfunction that inverts the logic from the IC onward could leave voltage applied to the DC motor.

If, for example, transistor Q4003 should open, the logic would remain high on the base of Q4010 and the motor would continue to receive operating voltage. An open R4024 or 4026 would have the same result, as would a collector-emitter short in transistor Q4010. Similarly, an IC defect that prevents pin 21 from going high can keep the threading motor turning.

Far more troublesome are symptoms in which loading or unloading proceeds only partially. Generally, that kind of problem will prove to be mechanical. And yet, an intermittent microswitch can introduce symptoms that show up only at certain points of strain on the mechanism. You can usually identify those by applying a bit of pressure somewhere in the vicinity of the threading ring, but finding the faulty switch may take a bit of electronic investigation.

R-E

SERVICING COMMUNICATIONS EQUIPMENT

Can your service shop use some additional income? Consider getting into the installation and repair of commercial two-way radios.

GREG GRAMBOR

HAVE YOU EVER NOTICED HOW LONG IT takes between service calls on today's solid-state TV sets? It's going to get a lot longer, too, when varactor tuners catch on. Many TV service shops are beginning to look elsewhere for sources of income, and this article will examine one of those alternatives—the two-way radio business.

Almost anyone with some training and experience in TV servicing can qualify as a communications technician with just a little extra study and familiarization with two-way radios. First, you need that all-important First or Second Class Radiotelephone Operator's license. However, if you know electronics well enough to troubleshoot a 21-inch color TV chassis, you should have no problem getting the license. Just a few evenings spent with a book like *The Radiotelephone Operator's Q&A Manual* (published by Rider Books) or with the appropriate *Ameco Study Guide*, and you'll be able to take the FCC tests with confidence and, most likely, with success. Without a solid background in basic theory, it may take a bit more effort, but it's certainly not beyond anyone's reach.

Familiarization with the type of units you'll be servicing might take a little more effort. There are some home-study courses available in two-way radio repair, but if you're in a hurry, you might try

some other methods. One way to gain some preliminary, hands-on experience would be to invest in some old used units with schematics and service manuals. Then, take them apart section by section and rebuild them the way many schools teach TV service techniques. At the same time, brush up on transmitter basics with a good text like *The Radio Amateur's Handbook*, published by the American Radio Relay League, or *The Radio Handbook*, published by the Radio Society of Great Britain. Both books are considered standard industry texts.

If you own a larger shop and can use another employee, you could hire an experienced licensed technician and start building profits as you learn from him. This means you'll immediately have to purchase some test equipment, the kind normally not found in an average TV repair shop. You'll have to do this eventually, but if you hire an experienced communications technician you'll just do it sooner.

A primary test instrument is an FCC-type-accepted frequency meter. Every licensed land-mobile radio transmitter must have its frequency checked and certified once yearly by a licensed technician (this could be you)! So even if your customer's radios need no other service for an entire year (highly unlikely), the radios will generate at least one service call each per year. For a better look at

some of the other test equipment you'll need let's visit an actual two-way radio repair shop, Electronic Specialty Services (Palisades Park, NJ).

This business began as a TV repair service but is presently a successful communications shop. Although owner-operator Joseph Mannino says he is phasing-out the home-entertainment side of the business to concentrate on communications, he contends that there is no reason why anyone cannot maintain both types of customers if desired.

When we asked him what test equipment would be needed to start taking in two-way radios, in addition to the usual instruments found in a TV repair shop, he mentioned first a good-quality, FCC-type-accepted frequency meter. You also need a type-accepted deviation meter, a type-accepted wattmeter that can be used to read both forward and reflected power, a good-quality dummy load that is able to dissipate at least 100 watts, a 50-MHz (or better) oscilloscope (if you don't already own one) and a high-quality signal generator with a calibrated attenuator. Helpful, although not essential, would be a good RF probe, a digital voltmeter (DVM) and a set of high-grade alignment tools (less-costly alignment tools tend to crack coil cores in communications equipment). If you want to work on pocket paging devices (which can be lucrative) you need a sequential synthesized audio generator



AN ALTERNATIVE

with at least dual-tone capability.

All this equipment represents a considerable investment, and you should be careful not to go in underfinanced. If you prefer, you can start slowly, buying equipment unit-by-unit over a long period of time. There is also a brisk trade in used, reconditioned units that are perfectly adequate. You don't need a small fortune to get started.

Add a few other basics such as VHF and UHF antennas on your roof for conducting air checks, plus hardware like coax connectors, cable and mobile-type interconnection plugs, and you're ready.

Before you take the plunge, here are a few additional points to consider: Your customers will be relying on you to maintain their *business* communications. The two-way radio system will be one of their most important business machines. They'll expect prompt service, sometimes at odd hours. Their incomes will depend on it; and in the case of public safety radios (police, fire and ambulance), *lives* will depend on it. This may be a bit more demanding than repairing home-entertainment equipment, but it will be considerably more rewarding.

Building up the business

About the only way to effectively get started is to go out and drum up business. If you're presently running a TV service shop, this could mean taking time from it

to call on likely prospects.

What are your best prospects? Those businesses that use mobile units are, of course, your obvious targets. These would include sales organizations, trucking firms, service companies such as appliance repair shops, and construction companies. If you're near any developing areas, watch for stories of new neighborhoods starting up volunteer fire companies or ambulance squads. It's possible that you can get in with your bid and pick up a nice, steady account.

Many busy executives and professionals in all sorts of fields would appreciate the concept of mobile communications both for themselves and for their key employees. Invest in a little local advertising and spread the 'word of mouth' about your new venture . . . you may be surprised at the results.

The best way to assure an income base is by combining sales and service contracts. Selling the equipment plus having your customer sign a service contract with you lets you earn the profit on the merchandise you sell, plus what you earn on repairs and maintenance for at least the length of the contract. This is a more efficient way of doing business than just waiting for service calls.

Another way to spur equipment sales is to install a community repeater in your area. A repeater is usually set up at the highest point in your neighborhood that

you can lease or otherwise gain access to. As its name implies, the device picks up weak signals from mobile radios and inexpensive base stations, and amplifies them for a wider range. Repeaters operate automatically and usually require little maintenance. A properly operated repeater in a good location can cover up to about 75 miles. The FCC says you cannot operate a community repeater for profit, but you can bill your customers for its use, enough to cover operating expenses and your salary. The main object of the repeater is that it becomes the basis for mobile-equipment sales.

What kinds of technical work will all this get you into? Except for the fact that you'll be working with transmitters and receivers instead of just receivers, troubleshooting techniques won't be much different. If you can trace a signal through a circuit, take voltage readings, interpret waveforms and solder components, that's half the battle won. You'll be installing mobile and base radios, repairing them, and maintaining them with yearly, required-by-law frequency and modulation certifications, which must be performed by someone with a First or Second Class FCC Radio-telephone Operator's license. You'll also assure yourself of a steadier income than can be provided by the home-entertainment service field in these times of more reliable solid-state equipment.

R-E

DIAL-UP SOFTWARE NETWORKS

*Does your personal computer want to talk to others?
Has it developed a thirst for information and programs?
If so, look into inexpensive software networks that you can access via telephone.*

JULES H. GILDER

IMAGINE READING ABOUT NEWSMAKING events two minutes after a reporter halfway around the world files his story! How about getting an hourly news summary, or domestic and international news whenever you want it? Would you like to make and confirm travel arrangements from the comfort of your own home? Wouldn't it be nice to know what the weather was like in the city you are going to, just before you leave?

Would you like tips on buying, selling and financing a home? If you were selling your home you might want to list it on a nationwide basis. Or if you were thinking of moving to another city, it would be nice to get an idea of what kinds of houses were available there, and what the prices were like.

These are just a few of the hundreds of services offered by America's latest utilities. Instead of supplying you with gas, electricity or telephones, *these utilities supply you with information.* The information is available instantly and is only a phone call and a few keystrokes away.

For years, science fiction writers have portrayed the home of the future as being tied into huge central data banks. More recently, home computer makers have been telling us how useful their computers are, but have shown us few home-oriented applications. Well, the future has arrived, our home computers now have access to all kinds of data! All the equipment that you need is your own computer, an *acoustic coupler* or *modem* to allow your computer to use the telephone and, of course, the telephone itself.

What is an information utility?

While the term "information utility" tells us what such a service supplies, it

really doesn't shed much light on how it does it. Information utilities are computer systems, often using large mainframe computers or several minicomputers, that are accessed by an outside terminal or computer through the regular telephone system. These computers are set up to handle many users simultaneously and usually have available a wide variety of databases and other useful programs.

To make use of these programs and databases, you must subscribe to the computer service and be issued a user identification number and password.

There are two information utilities, each about a year old, that have been designed to serve the home/hobby computer market. The more popular of the two is called The Source. The other one is MicroNET. While on the surface the two seem to be in direct competition, a close look at the services offered by each shows that The Source offers much more than MicroNET and, in the long run, is cheaper too.

Both first require you to submit an application form indicating which of your credit cards (Master Charge or Visa) you want your charges billed to (both accept only "plastic" money). Upon acceptance, you will receive your ID number and password.

Looking at the initial outlays, it would appear that MicroNET is significantly cheaper. Its registration fee is only \$9 (actually, only \$4, since you get a \$5 rebate) compared to the \$100 required for The Source. In addition to the initial registration fee, however, it is also necessary to pay for the time that you use on these remote computers. You pay a fee for each hour (or part thereof) that you are connected to the utility's computer. For MicroNET, this

fee is \$5 per hour, any time of the day or night, while for The Source the fee varies depending on the hour. From 6 PM to 7 AM local time, and all day on weekends and holidays, the hourly charge is only \$2.75 an hour, significantly less than MicroNET. The picture changes considerably, however, if you wish to use The Source during business hours, when the cost runs \$15 an hour.

And don't let the initial registration fees fool you. While MicroNET has a low out of pocket investment to start with, that initial saving is quickly eaten up by the hourly connection charges. When you're using these remote networks, time flies by without your even noticing it!

How they work and what they offer

You sign on to either system in essentially the same way. After you enter your ID number, the system requests you give your password. Since you wish to keep this secret to prevent unauthorized access to your file, the password is typed in "blind"; that is, it is not displayed on the screen as you enter it via the keyboard.

Having done this, you are ready to take full advantage of the system's capabilities.

Both networks offer a lot. They give mainframe computing power to your home microcomputer. Each permits you to write programs in languages that may not be available on your home computer. For example, they both offer Extended BASIC, FORTRAN and Assembly Language programming capabilities. In addition, MicroNET has APL, PASCAL and SNOBOL, while The Source has COBOL and RPG II. Both offer text editors and word pro-



cessors, as well as a variety of game programs for entertainment.

From the remote computing standpoint, both services offer comparable capabilities. But when we leave this area and look at the *other* services provided by these information utilities, we begin to see the difference between them.

With The Source you have instant access to the United Press International wire service. Through it you can have your choice of a daily news summary, domestic news, international news, an hourly news summary, Washington Hotline, special features, sports news, financial news, weather and a host of other features.

In addition to UPI, The Source also gives you access to two *New York Times* databases. One is the *New York Times* News Summary, whose categories include front page headlines, national news, business news, metropolitan New York news, advertising news, editorials and obituaries. The second is the *New York Times* Consumer Data Base which contains abstracts from the *New York Times* and *over sixty other* major publications. The abstracts are grouped into categories to make searching easier.

If you are more interested in business than in current affairs, information utilities offer a comprehensive set of business and financial programs and information. Included are programs for accounts payable and receivable, gen-

eral ledger, payroll and data base management. Both also provide trading statistics and information on stocks, bonds and options.

Electronic mail is here

While the U.S. Postal Service and several major communications companies are still talking about electronic mail, The Source already has it. When you first connect to The Source, the system will check to see if anyone has left you a message or mail. If so, the words MAIL CALL will appear on your computer's screen as soon as you've finished signing on. To "pick up" your mail, all you have to do is type the word MAIL, followed by the word READ. The system will then display the sender's account number, the time at which the letter was posted and the subject of the letter. After you read the letter, you may file it, forward it to someone else, or delete it (throw it away).

As with ordinary mail, The Source's electronic mail allows you to request a "return receipt" so that you are certain that your letter has been received.

The system also allows for the writing and sending of form letters and for multiple-address mail (for which there is a charge of 15¢ for the second and each subsequent address). Multiple address-mail can be sent from a previously stored mailing list.

While MicroNET doesn't have a specific electronic mail system, it does

allow the user to post a message on a bulletin board that can be read only by the person for whom it is intended. As with any bulletin board, physical or electronic, the person for whom a message is intended must look at the board first before he knows that there is a message for him.

CB comes to computers

With Citizens band radio as popular as it is, it's not surprising that one of the networks, MicroNET, should offer a computerized version of CB radio. If you use this feature, you are asked to enter your "handle" (name) and the channel you want to tune to. After indicating your choice (e.g. Channel 19), you are told how many people are listening to the same channel and how many are actually taking part in the conversation. You may then choose to be part of the active group, or just to sit on the sidelines and "listen" (read from your CRT display). As is the case with real CB transmissions, if two people try to speak at the same time, there is no assurance that either message will get through ungarbled.

While MicroNET has chosen the CB approach to allow any user to speak with any other user or group of users on "public airwaves," The Source has decided that "private lines" are more desirable and as such has implemented

continued on page 108

MORE on

A look at the driver stages of the new super Class A amplifiers that achieve high output while maintaining a near-zero level of distortion.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

IN THE MARCH ISSUE, WE EXAMINED THE design of the new Super Class-A amplifier output stage developed by JVC. The Super-A design is intended to provide nearly the full efficiency of a Class-B amplifier circuit with no notch-distortion or switching distortion.

In discussing power amplifiers, it is usual to emphasize the design of the output stage since it is that stage that actually delivers power to the speakers. However, there are a number of amplifier characteristics that are determined by earlier stages, such as the driver or voltage-amplifier stages. Those characteristics include frequency response, gain, thermal drift, slew-rate, etc. The driver stage may also have a great bearing on the distortion characteristics of the entire amplifier.

Driver-stage distortion

In developing a driver circuit for their new Super Class-A amplifier, JVC's engineers examined first the three types of distortion that can be found in a common-emitter amplifier circuit. Figure 1 shows the input/output characteristics of a common-emitter amplifier circuit that is driven with constant current. Those characteristics are commonly

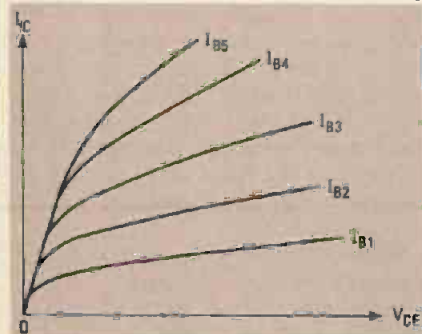


FIG. 1—INPUT/OUTPUT CHARACTERISTICS for a common-emitter stage. Collector current versus collector-to-emitter voltage is shown for a number of fixed values of base current.

called the V_{CE} - I_C characteristics. Note that in this diagram each curve rises to the right. That means the even with a constant input-signal current, the collector-current (I_C) increases as the collector-to-emitter voltage (V_{CE}) increases. It follows that the gain of the stage varies as V_{CE} varies. That variation of gain normally amounts to around 10% in the pre-driver stage, since variations of V_{CE} roughly coincide with those of the power supply voltage. JVC calls that type of distortion the V_{CE} distortion is illustrated (in exaggerated form) in Fig. 2.

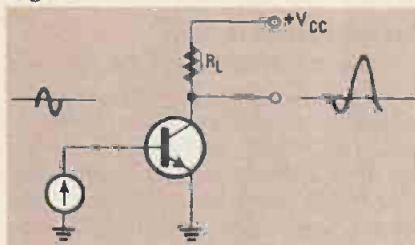


FIG. 2—SINGLE-STAGE COMMON-EMITTER amplifier. Variations in collector current as the collector-to-emitter voltage changes causes distortion.

A second form of distortion that occurs in common-emitter amplifier circuits arises because of the capacitance between the collector and base of the common-emitter transistor stage. Commonly called C_{ob} , that capacitance varies with the collector-to-base voltage (V_{CB}) in such a manner that it increases as V_{CB} decreases. In the common-emitter amplifier circuit, the C_{ob} variation of capacitance results in distortion, the nature of which is illustrated in exaggerated form in Fig. 3. In the course of the development of the Super-A Class circuit, JVC called that type of distortion ΔC_{ob} distortion.

The third and final form of distortion associated with a common-emitter circuit is known as ΔV_{BE} distortion. The input/output characteristics of a com-

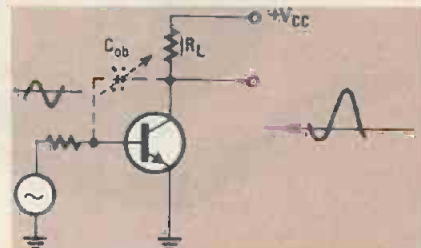


FIG. 3—JUNCTION CAPACITANCE within the transistor also causes distortion. That capacitance, called C_{ob} , varies in accordance with the collector-to-base voltage.

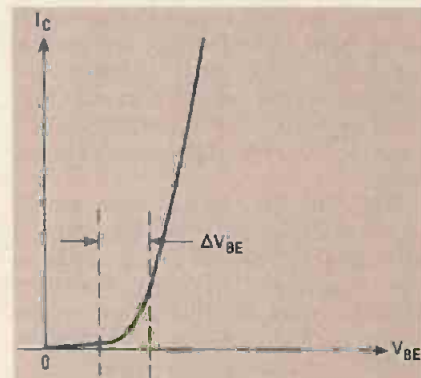


FIG. 4—INPUT VOLTAGE versus output current for a common-emitter stage. Operation in the nonlinear portion of curve causes distortion of the output signal.

mon-emitter circuit is shown in Fig. 4. Note the relationship between input voltage and output current. It is logarithmic. Therefore, if input and output are compared in terms of voltage, a high level of distortion is present. Figure 5 shows the general nature of that distortion, again in exaggerated form for the sake of clarity.

Several approaches are possible for reducing the ΔV_{BE} distortion. The use of constant-current drive or the connection of a current feedback resistor to the emitter might be one possible approach. Another approach might be to attempt to cancel the ΔV_{CE} distortion and the ΔV_{BE} distortion with each other by

SUPER CLASS A Amplifiers

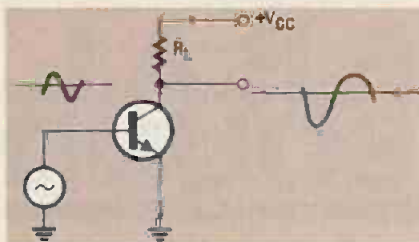


FIG. 5—DISTORTED OUTPUT WAVEFORM is caused by nonlinear operation of common-emitter transistor stage.

choosing an appropriate driving impedance, since those distortions are essentially mirror-images of each other.

Figure 6 shows a typical input/output characteristic of a common-base amplifier circuit. It shows the collector current (I_C) vs. the collector-to-base voltage (V_{CB}) for a number of fixed values of emitter current (I_E). In this circuit, variations of I_C caused by variations of V_{CB} are almost non-existent. It should be noted, of course, that current gain of the circuit is 0 dB (gain equals 1.0). However, the very fact that gain is not influenced by variations of V_{CB} is made use of in the familiar cascode amplifier circuit.

Cascode amplifier circuits are often

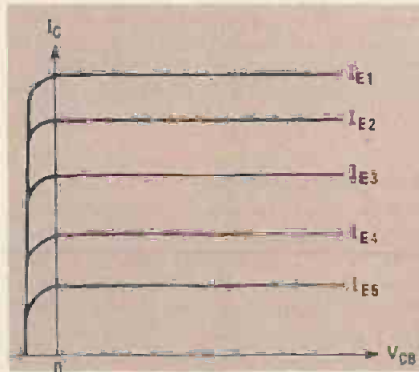


FIG. 6—INPUT/OUTPUT CHARACTERISTICS for a common-base amplifier stage. Collector current versus collector-to-base voltage is shown for a number of fixed values of emitter current.

used in high-frequency applications such as RF amplifiers because of their excellent frequency response resulting from the absence of the effects of capacitor C_{ob} . So, in that sense, there is nothing particularly new or different about them. However, when analyzed from the viewpoint of distortion and considered for their application in audio equipment, they have proven to be superior as a low-distortion amplifier circuit. The basic circuit of a cascode amplifier is illustrated in Fig. 7.

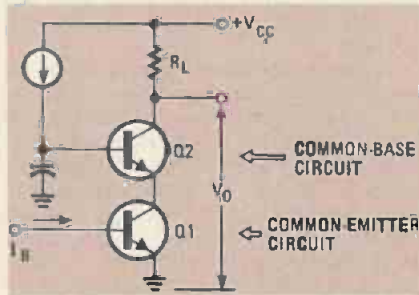


FIG. 7—SUPER CLASS-A DRIVER STAGE consists of cascoded common-emitter and common-base amplifier stages. Combination drastically reduces distortion.

That type of amplifier circuit provides excellent linearity through a combination of the common-emitter and common-base circuits, since the forms of distortion created by each of those circuits are effectively cancelled by each other. In the cascode circuit, input-signal current I_B is first amplified β times through the common-emitter transistor Q1 which has a large current gain. The signal is then applied to the emitter of the common-base transistor Q2, where it is amplified a times. Therefore, the output voltage across R_L is equal to:

$$V_O = \alpha \beta R_L I_B$$

Note that the input signal is considered to be in the form of a current (I_B) and not in the form of a voltage. In actual applications, a signal-source im-

pedance on the order of kilohms will suffice. That combination suppresses ΔV_{BE} distortion. Then, since an almost constant voltage is present at the emitter of the common-base circuit Q2, the V_{CE} of Q1 takes on a constant value regardless of the presence of the input signal. Therefore there is no variation of gain and C_{ob} due to the variation of V_{CE} or V_{CB} . The variation of gain due to any variation of I_C is negligible. Furthermore, the gain of Q2 can be considered to be 1.0 because of the characteristics of a common base circuit. As a result, nonlinear components disappear almost completely from the output-voltage V_O . Thus, the driver stage of JVC's Super-A circuit takes complete advantage of the properties of cascode operation and, according to JVC, reduces the distortion figure in the voltage and driver stages of an amplifier by one complete order of magnitude compared with conventional amplifiers.

Needless to say, there are many forms of distortion other than those that have been compensated for both in the driver and power stages of JVC's new Super-A Class amplifier products. Nevertheless, both in the driver and power stages, the most common drawbacks of semiconductors have been compensated for through the use of these new circuit approaches. As a result, the distortion (or, more properly, the harmonic distortion) of the Super-A circuit is far lower than the practical lower limit at which ordinary harmonic distortion meters function. The distortion level, in fact, lies far lower than the noise level of the amplifier. Typically, the harmonic distortion level of JVC's new A-X9 integrated amplifier measured by means of a spectrum analyzer for a test signal at 1 kHz and an output of 105 watts (the amplifier is rated at 100 watts from 20 Hz to 20 kHz, 8-ohm loads) was an infinitesimal 0.0005%, according to JVC. R-E

Denon Model DR-750 Stereo Cassette Deck



CIRCLE 106 ON FREE INFORMATION CARD

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

DENON IS THE TRADE NAME USED BY NIPPON Columbia Company, Ltd., of Japan, many of whose products are distributed in the United States by American Audiopoint, Inc., a division of the Discwasher Group (1407 N. Providence Rd., Columbia, MO 65201). Denon's *model DR-750* is a top-of-the-line two-headed stereo cassette deck. While most of us have been conditioned to think that a high price for a cassette deck is synonymous with three-headed operation (and conversely, that two-headed decks should cost less) our lab and listening tests on the *model DR-750* completely disprove that idea. Aside from the deck's inability to monitor recordings as they are made, the *model DR-750* is one of the best-performing cassette decks we have ever evaluated.

The unit can be operated either horizontally or vertically (as shown in Fig. 1). The cassette compartment at the upper left accepts direct insertion of the cassette tape, which makes for extremely accurate positioning of the shell. A transparent plastic door can then be swung down while the tape is in motion for protection against dust or dirt. The digit-tape counter, RESET pushbutton, MEMORY switch and POWER on/off switch are all positioned along the top edge of the machine.

Transport controls are all soft-touch, logic-control types and include PAUSE/MUTE, RECORD, play, stop, rewind and fast-forward pushbuttons. The PAUSE/MUTE pushbutton is rather novel. With the deck in the record mode and this button depressed, a blank space is recorded on the tape. Releasing the pushbutton then brings the tape transport into the pause mode, while subsequently depressing and holding the button again results in muted recording. To reactivate the recording, you just hit the play pushbutton after having brought the unit into the pause mode.

The twin meters serve as either VU or peak-reading record-level indicators. Meter response time in the peak mode is a mere 10 ms,

while in the VU mode response time is around 300 ms. The bottom section of the front panel contains a playback level control, a bias adjustment control (continuously variable to encompass all types of currently available tapes), a tape-selector switch (it determines equalization), and line record-level and microphone record-level controls.

Along the very bottom of the panel are a headphone jack, a timer set switch (to be used with an external clock timer, if that is desired), a VU-peak selector switch for the meters, a multiplex filter switch (to eliminate subcarrier output components from tuners when recording stereo FM programs), the Dolby on/off pushbutton switch, and left and right microphone input jacks. The real panel of the *model DR-750* contains the line-input and line-output jacks.

Depressing the RECORD pushbutton on the *model DR-750* places the machine in a standby state, which is shown by a tiny red indicator light just above the RECORD button. Unlike the situation with most other tape recorders, where it is necessary to depress record and play simultaneously to begin recording, once the RECORD button is depressed, you then simply press the play pushbutton to start the transport. This approach has the advantage of not requiring the machine to be placed in the pause mode (with the heads usually up against the tape) while you set up the proper record levels, or are waiting for the appropriate moment to initiate recording. As with most logic-controlled transport systems, it is possible (and perfectly safe) to go from any transport mode to any other without having to go through the stop mode.

While it is possible (and even advisable) to fine-tune the bias on this machine to optimize it for virtually any type of tape, recommended settings for the variable-bias control are provided for some 50 popular brands and styles of tape; these are listed in the owner's manual.

MANUFACTURER'S PUBLISHED SPECIFICATIONS.

Speed Deviation: $\pm 0.5\%$. **Fast Wind Time:** 70 seconds (for C-60 cassette). **Bias Frequency:** 100 kHz. **Signal-to-Noise Ratio (Dolby on, cobalt tape):** 65 dB. **Frequency Response:** cobalt or ferric oxide LH tape, 35 Hz to 18 kHz, ± 3 dB. **Wow and Flutter:** 0.04% WRMS, 0.1% unweighted. **Channel Separation:** better than 35 dB. **Crosstalk:** better than 65 dB (1 kHz). **Input Sensitivity:** line, -20 dB; microphone, -70 dB. **Output Level:** line, 1.0 volt; microphones, 1 mW into 8 ohms. **Power Requirements:** 120/200/220/230/240 VAC, 50 to 60 Hz, 38 watts. **Dimensions:** 16.33 W \times 11.93 H \times 8.9 inches D. **Weight:** 27.5 lbs. **Suggested Retail Price:** \$1400.

RADIO-ELECTRONICS AUDIO LAB

R.E.A.L. SOUND

RATES

DENON DR-750
CASSETTE DECK

EXCELLENT

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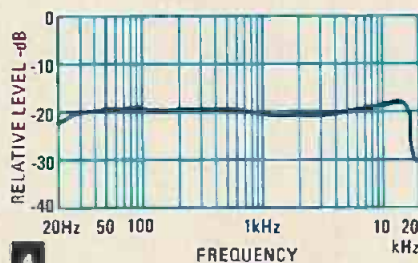
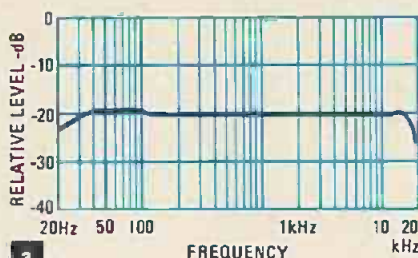
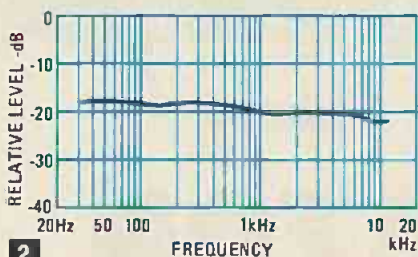
Optimizing beyond these nominal settings is rather tedious, since it involves making short recordings of tones, playing them back and comparing levels of the mid-frequency and high-frequency test tones recorded. The process must be repeated (tweaking the bias control for more or less bias, depending upon the results observed on the meters) until the mid- and high-frequency recorded tones are reproduced at the same levels. Here, of course, is where a three-headed machine would offer a distinct advantage, since you could monitor the results of the adjustments as they were being made. Our tests were made using the nominal settings recommended for the tape samples we used.

Lab measurements

Using the TDK prerecorded test tape AC-337, we first checked the playback response only. This test tape requires a playback equalization of 120 μ s and 3180 μ s (the standard value for ferric-oxide tapes). The recorded tones extend only from 40 Hz to 12.5 kHz, hence the limited curve shown in Fig. 2, which was flat within ± 2.0 dB over that range.

Using TDK's test tape AC-342 (a constant 3-kHz tone recorded at -10 -dB level from a reference of 250 pWb-per-mm), we were able

to measure speed accuracy by "counting" the playback frequency on our digital frequency counter. Speed deviation was well within the specified limits, measuring fast by less than 0.3%. The same tape was used to measure playback-only, wow-and-flutter, which proved to be an amazingly low 0.04% WRMS or 0.07% unweighted.



Interestingly enough, the record/play wow-and-flutter measurements made when we recorded our own 3-kHz tone and played it back on the Denon deck itself turned out to be exactly the same as the figures obtained from the prerecorded test tape, indicating that the double process (record/play) did not introduce additional wow-and-flutter components.

Table 1 summarizes our other test results. Denon type DX-3 C60 tape was used as the low-noise ferric-oxide sample, and TDK-type SA tape was used for the high-bias (cobalt-ferric) tape tests. Frequency response for the record/play function, using the Denon tape, extended from 20 Hz to 18.5 kHz, as shown in Fig. 3 (for the -3-dB rolloff points). Overall record/play response of the TDK-SA sample tape turned out to be somewhat better, extending to below 20 Hz and out to 19.5 kHz, as in Fig. 4.

In analyzing the headroom (the level above 0 dB for 3% distortion) shown in Table 1 for both types of tape, you should keep in mind that on the model DR-750, the 0 dB marking on the level meters corresponds to a magnetization level of 200 pWb-per-mm. Many tape-deck manufacturers arbitrarily calibrate their meters so that 0 dB actually represents a lower recording level (e.g., 165 pWb-per-mm); the result is that such decks tend to show a higher headroom figure that is really decep-

TABLE 1
RADIO-ELECTRONICS PRODUCT TEST REPORT
Manufacturer: Denon (American Audloport) Model: DR-750
CASSETTE TAPE DECK MEASUREMENTS

	R-E Measurements	R-E Evaluation
FREQUENCY RESPONSE MEASUREMENTS		
Frequency response, standard tape (Hz-kHz ± dB)	20-18.5, 3.0	Excellent
Frequency response, CrO ₂ Tape (Hz-kHz ± dB)	20-19.5, 3.0	Superb
Frequency response, other (see text) (Hz-kHz ± dB)	N/A	N/A
DISTORTION MEASUREMENTS (RECORD/PLAY)		
Harmonic distortion at 0 VU (1 kHz) (%)	1.5/2.5	Very good
Level for 3% THD (dB)	+4.0/+1.0	Very good
SIGNAL-TO-NOISE RATIO MEASUREMENTS		
Standard tape, Dolby off (dB)	58.0	Superb
Standard tape, Dolby on (dB)	67.0	Superb
Cobalt tape, Dolby off (dB)	57.5	Excellent
Cobalt tape, Dolby on (dB)	65.0	Excellent
MECHANICAL PERFORMANCE MEASUREMENTS		
Wow and flutter (% WRMS)	0.04% (0.07% unwt'd)	Superb
Fast wind and rewind time, C-60 tape (Seconds)	67	Very good
COMPONENT MATCHING CHARACTERISTICS		
Microphone input sensitivity (mV)	0.29	
Line input sensitivity (mV)	72	
Line output level (mV)	1000	
Phone output level (mV)	82 (8 ohms)	
Bias frequency (kHz)	100 kHz	
TRANSPORT MECHANISM EVALUATION		
Action of transport controls		Superb
Absence of mechanical noise		Superb
Tape head accessibility		Very good
Construction and internal layout		Excellent
Evaluation of extra features, if any		Excellent
CONTROL EVALUATION		
Level indicator(s)		Excellent
Level control action		Excellent
Adequacy of controls		Very good
Evaluation of extra controls		Excellent
OVERALL TAPE DECK PERFORMANCE RATING		Excellent

TABLE 2

OVERALL PRODUCT ANALYSIS

Retail price	\$1400
Price category	High
Price/performance ratio	Good
Styling and appearance	Superb
Sound quality	Excellent
Mechanical performance	Superb

Comments: All the characteristics that we expect of a top-quality stereo cassette deck are very much in evidence in the Denon DR-750. All, that is, except the three-headed configuration that would have permitted you to monitor recordings as they are being made. As for any design compromises that may have been necessary in a machine with a common record/play head, you can forget about them. The *Sensustip* head, is far less brittle than ferrite and can therefore be machined with a super-narrow gap of between 1.0 and 1.2 microns. With this narrow gap, less magnetic saturation and high linearity can be obtained, improving high-frequency playback characteristics. Yet the magnetic characteristics are such that despite the narrow gap, enough flux can be developed for proper recording when the head is in the record mode.

Aside from the slight difference in high-end frequency response, we found that using either low-noise ferric-oxide or cobalt-ferric (high-bias) tape yielded almost the same signal-to-noise ratios, evidence of a well-balanced and carefully calibrated design. We would have thought that a deck in this price category (obviously intended for a more sophisticated recordist) would include accessible Dolby record and play calibration points. After all, if tapes vary in their bias requirements and sensitivity, they will also vary insofar as optimum Dolby calibration is concerned. While we encountered no problems in this area with the tapes we tested, optimum Dolby usage with other tapes may be affected. The Denon DR-750 is an elegant, well constructed and good-looking machine, and, if price is no obstacle, it should produce excellent cassette recordings of even the best program source material available, including live recordings.

tive. A headroom of +4 dB above 200 pWb-per-mm (which also coincides with +4 dB above the Dolby calibration level) is quite respectable for a machine setup for low-noise ferric-oxide tape.

The signal-to-noise ratio (referenced to a 3% THD recording level) was almost identical for both types of tapes, measuring 65 dB or better with Dolby on.

Summary

Our overall product evaluation is shown in Table 2, along with our summary comments concerning this rather high-priced machine. Undoubtedly, some of the high cost of the model DR-750 can be attributed to its magnificent transport-control system, two-motor drive, and logic-control electronics. R-E



WIDE-RANGE AUDIO GENERATOR

A wide-spectrum source of audio signals is a necessity for much bench work. Here's one you can construct for about \$30.

RICHARD SCHROEDER

AS AN ELECTRONICS TECHNICIAN, I TEST and repair a large number of oscilloscopes, recorders, amplifiers, filters, etc. This work requires the almost continual use of an audio-type signal source.

I work in a shop where I can lay my hands on a lot of sophisticated test equipment, and yet I usually reach for my Wide Range Audio Generator. Why? Because it's small, light, easy to operate, and it supplies the signals I most often need. Besides, it's good-looking and I built it myself.

Whether you're a technician, engineer, or just an electronics hobbyist, I believe you'll find that the instrument described in this article is one of the most useful pieces of equipment you could own.

For instance, note its frequency range of 10 Hz to 50,000 Hz, without any range switching—that represents a spread of 3½ decades. This feature is really great for checking the frequency response of amplifiers or filters, because with just a twist of the wrist you can sweep the whole audio spectrum and then some. A FINE FREQUENCY control is also provided to give the extra frequency resolution that is sometimes needed.

The generator can supply a sinewave signal of over 4 volts RMS into a 1000-ohm load with a distortion figure of around 1%. It can also produce a simultaneous squarewave signal that will drive the popular 5-volt TTL circuits.

Another nice feature is its DC-coupled voltage-controlled-frequency input (VCF) so you can use the instrument as a sweep-frequency generator, a step-frequency generator, or an FM-theory demonstrator.

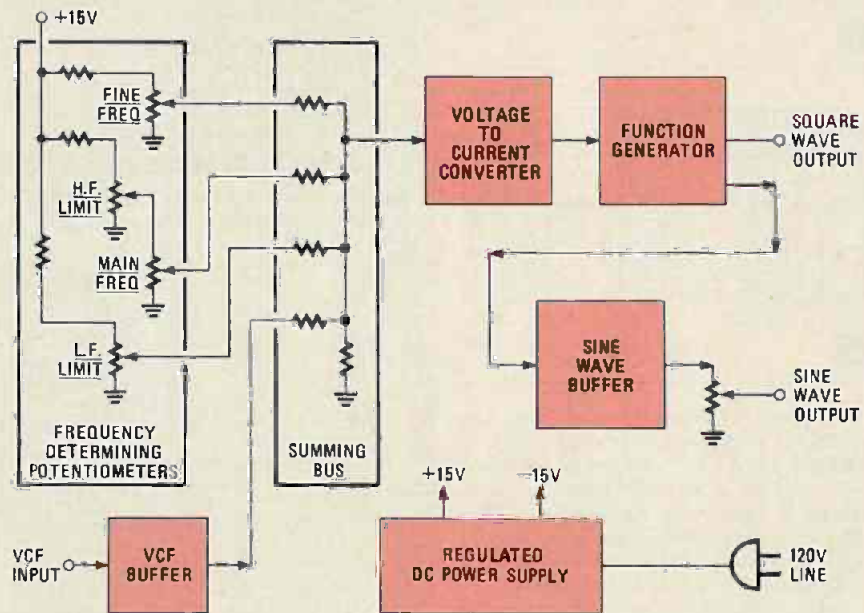


FIG. 1—BLOCK DIAGRAM of the Wide Range Audio Generator. Shaded areas indicate major components. Note, also, the frequency-determining section and summing bus.

All its input and output circuitry is fully buffered, protected and DC-coupled, which contributes to its super-flat (constant-amplitude) output over the entire frequency range (with a total variation of less than 0.25 dB).

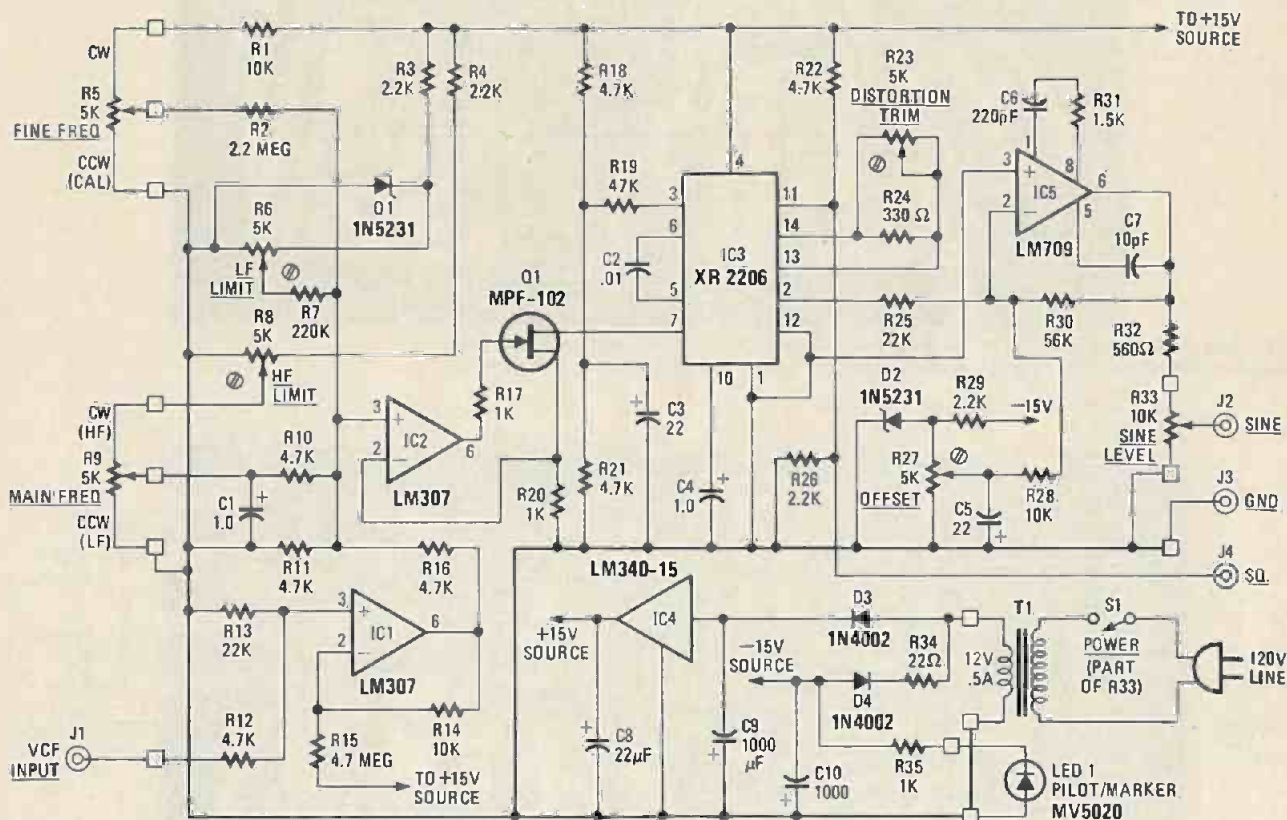
Its on-board regulated power supply ensures that its output frequency and amplitude remain constant even under adverse line-voltage conditions.

Add to all of this a 3- X 5-inch etched circuit board that contains most of the components, plus the fact that the whole instrument can be constructed for around \$30—and I think you'll agree it's a fine little instrument.

How it works

Refer to the block diagram in Fig. 1 and note the following basic components:

1. The frequency-determining potentiometers and their associated trimmers for setting the upper- and lower-frequency limits.
2. The VCF input with its associated buffer stage.
3. The summing bus that receives signals from the frequency-determining potentiometers and/or the VCF stage.
4. The voltage-to-current converter.
5. The function generator.



NOTE:
 IC1, 2, 5:
 PIN 4 TO -15V; PIN 7 TO +15V.
 CAPACITOR VALUES IN μF UNLESS OTHERWISE NOTED

FIG. 2—FULL SCHEMATIC of the Wide Range Audio Generator. Power supply appears at lower right. VCF input (J1) permits external control of output frequency.

6. The sinewave buffer stage and its associated output-level control and output terminal.

7. The regulated DC power supply.

Briefly, here's how the instrument works: The function generator produces the sinewave and squarewave signals. The sinewave signal is amplified, buffered and fed to the output control and terminal. The squarewave signal becomes attenuated and fed to its output terminal.

The frequency of these signals is controlled by the current that flows out of the frequency-control input of the function generator. This current is produced by the voltage-to-current converter, which is controlled by the summing-bus output. The summing-bus output level is controlled by signals reaching it from the frequency-determining controls and/or the VCF stage.

Let's analyze the circuit in more detail. The heart of the instrument, of course, is the XR2206 IC function generator.

Actually, two factors control its output frequency:

1. The value of the capacitor that is connected between pins 5 and 6 (in this case, $0.01 \mu\text{F}$).

WIDE-RANGE AUDIO GENERATOR SPECIFICATIONS

Frequency Range: (MAIN FREQUENCY CONTROL)	10 Hz—50 kHz, with no range switching
Frequency Range: (FINE FREQUENCY CONTROL)	100—200 Hz total, regardless of MAIN FREQUENCY control setting
Sinewave Output Level:	0—4 volts RMS into 1000 ohms
Sinewave Distortion:	Approximately 1% over entire frequency range
Sinewave Output Level Variation vs. Frequency Change:	Less than 0.25 dB over entire frequency range
Squarewave Output Level:	4 volts peak, positive from ground current-sink type compatible with most TTL circuits
Squarewave Rise and Falltimes:	Less than 0.5 μs
VCF (Voltage Controlled Frequency) Input:	27,000-ohm input impedance, DC-coupled, with a voltage-to-frequency relationship of 0.120 volt-per-kHz. A voltage swing of approximately 6.1 volts will sweep the frequency 3½ decades.
Size:	Approximately $5\frac{1}{2} \times 3 \times 6$ -inches

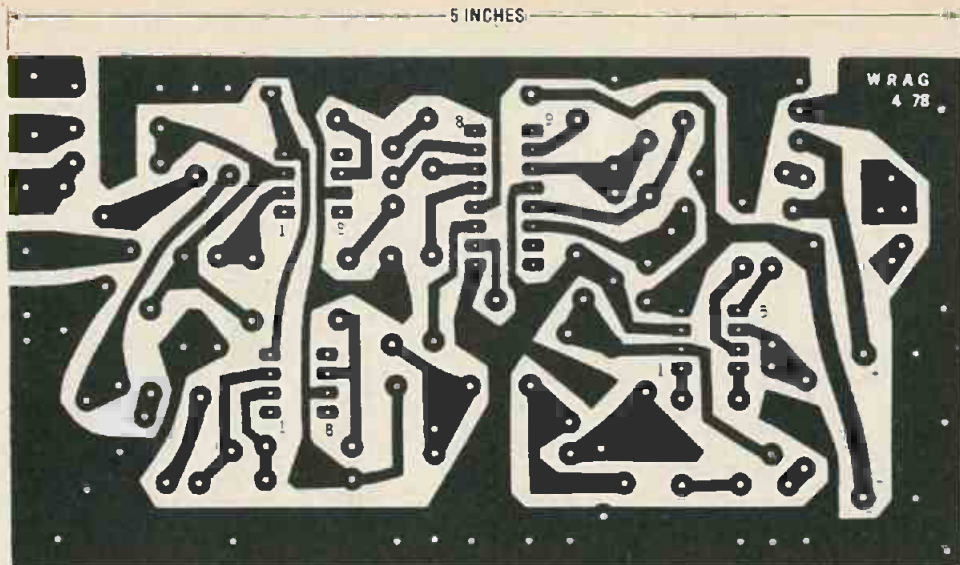


FIG. 3—FULL-SCALE reproduction of foil pattern of the Wide Range Audio Generator for those wishing to use PC board. Since parts placement is not critical, perforated board may also be used.

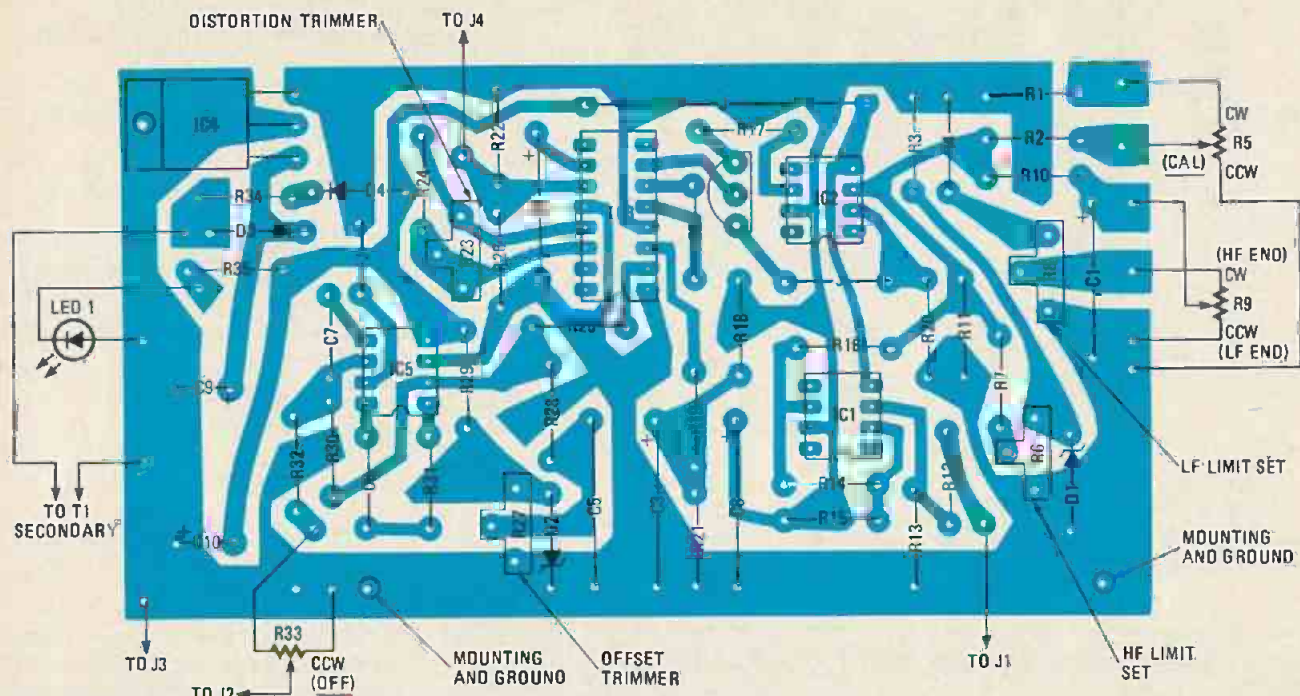


FIG. 4—PARTS PLACEMENT DIAGRAM for the Wide Range Audio Generator. Make certain that the polarities of diodes, transistors, IC's and electrolytics are observed!

2. The current that flows from its frequency-control point (pin 7) to ground.

To make the generator frequency respond to voltage instead of current, a voltage-controlled current-sink was added. It is shown as the voltage-to-current converter in Fig. 1. By referring to the schematic diagram of Fig. 2, you can identify its basic parts: op-amp IC2, R17, R20 and Q1.

The circuit design is such that the FET is inside the negative-feedback loop of the op-amp. Any current that flows out of the function generator's frequency-control point (pin 7) must also flow through the FET and the 1000-ohm resistor (R20) to ground. The positive voltage that is developed across the resistor is directly proportional to the current flowing through it

The op-amp supplies the same voltage across the resistor that it "sees" at its noninverting positive input.

This means that the current is proportional to the input voltage of the op-amp, and thus, we have a voltage-to-current converter. In this configuration, as the input voltage goes more positive, the frequency increases and vice versa. The voltage never goes negative with respect to ground.

Note the simple resistor summing bus connected to the input of the voltage-to-current converter. You can see from Fig. 2 that voltages from the frequency-control potentiometers and/or voltages from the VCF circuit will be summed and will affect the generator's frequency.

Both of the frequency-control potentiometers have positive voltage applied to

their elements. The voltage applied to the MAIN FREQUENCY control is set by trimmer R8, which determines the upper frequency limit. The lower frequency limit is set by trimmer R6, which adds a small positive voltage to the summing bus when both the frequency controls are in their fully counterclockwise position. The high-resistance value of R2 in the FINE FREQUENCY control circuit limits the frequency change to around 100 Hz, regardless of where the MAIN FREQUENCY control is set. The FINE FREQUENCY control has its full counterclockwise position labeled CAL (calibrated) to make the MAIN FREQUENCY dial calibration marks applicable.

The VCF stage consists of op-amp IC1 and several associated resistors. This stage is basically a noninverting amplifier with unity gain and an intentional DC

offset at its output. A voltage divider consisting of resistors R12 and R13 reduces the input signal level and also protects the op-amp. The output of this VCF stage feeds the summing bus and, of course, influences the generator frequency. The VCF input has a definite voltage-to-frequency relationship that works out to be 0.120 volts-per-kilohertz at any MAIN FREQUENCY control setting.

Now, let's look at the sinewave buffer/amplifier stage. Sinewave signals from pin 2 of the function generator are fed to

GENERATOR PARTS LIST

Resistors, 1/4 or 1/2 watt, 5%

R1, R14, R28—10,000 ohms
 R2—2.2 megohms
 R3, R4, R26, R29—2200 ohms
 R5, R9—5000 ohms, potentiometer, audio taper, panel mount (Radio Shack 271-1720 or equal)
 R6, R8, R23, R27—5000 ohms, trimmer, PC mount
 R7—220,000 ohms
 R10—R12, R16, R18; R21, R22—4700 ohms
 R13, R25—22,000 ohms
 R15—4.7 megohms
 R17, R20, R35—1000 ohms
 R19—47,000 ohms
 R24—330 ohms
 R30—56,000 ohms
 R31—1500 ohms
 R32—560 ohms
 R33—10,000 ohms, potentiometer, audio taper, panel mount with SPST switch (Radio Shack 271-215 or equal)

Capacitors

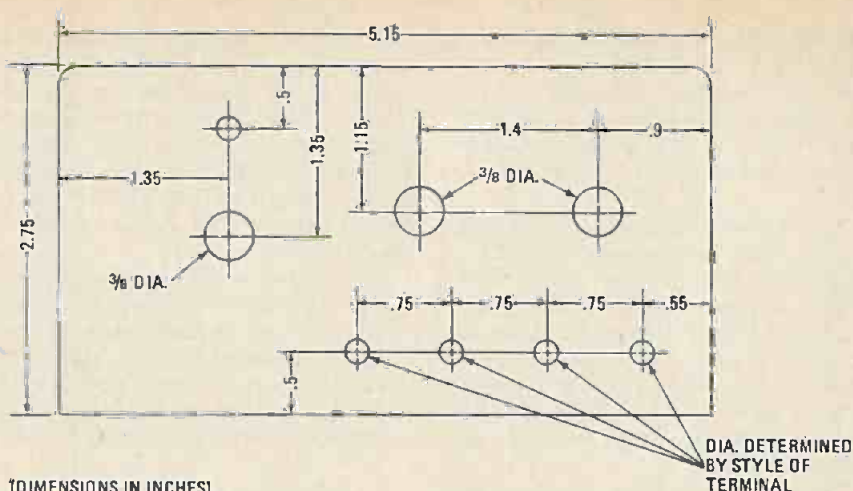
C1, C4—1 μ F, 25 volts, electrolytic, axial leads
 C2—.01 μ F, 50 volts, Mylar
 C3, C5, C8—22 μ F, 25 volts, electrolytic, axial leads
 C6—220 pF, 50 volts, Mylar or mica
 C7—10 pF, 50 volts, Mylar or mica
 C9, C10—1000 μ F, 25 volts, electrolytic, PC leads

Semiconductors

D1, D2—1N5231 or 1N751 Zener diode, 0.1 volts, 1/2 watt, 25% tolerance or better
 D3, D4—1N4001, rectifier diode, 50 PIV or better, 1 amp
 Q1—MPF102 FET transistor (Motorola)
 IC1, IC2—LM307
 IC3—XR-2206 (Exar), see Market Center ads in back of magazine
 IC4—LM340-15 or 7815 3-terminal voltage regulator, T-220 case
 IC5—LM709
 LED1—MV5020 or similar general-purpose type

Miscellaneous

T1—power transformer, 12-14 volts secondary, 500 mA
 S1—part of R33
 J1, J2, J4—RED Insulated banana jack or 5-way binding post
 J3—BLACK Insulated binding post or 5-way binding post
 Cabinet—Radio Shack 270-253 or equal
 Knobs—2 Radio Shack 274-415 or one 274-391
 IC sockets, line cord, small angle brackets, hookup wire, etc.



(DIMENSIONS IN INCHES)

FIG. 5.—DRILLING GUIDE for location of front panel components (not drawn to scale). Use masking tape over drilling areas to avoid scratching the finished surface.

the inverting (negative) input of op-amp IC5 through resistor R25. Feedback resistor R30 sets the gain of this stage at 2.5, which is adequate to produce an output of around 4.5 volts RMS (into an open-circuit load).

Trimmer R27 and its associated Zener diode, capacitor and resistor comprise a negative voltage system to null out or offset the positive DC component present at the sinewave-output point on the function generator. This adjustment is normally set so that the sinewave output of the instrument has a zero DC component.

The values of compensation capacitors C6 and C7 were chosen to give the amplifier stage a flat frequency response well beyond the 50-kHz upper limit of the instrument. Trimmer R23 provides a means of adjusting the sinewave for minimum distortion.

Note that the squarewave signal from the function generator is fed directly to its output terminal. Resistors R22 and R26 limit the peak voltage to around 4 volts, which is adequate to drive TTL circuits.

The power supply is fairly conventional, using a 12-15-volt transformer and two half-wave rectifiers to produce both positive and negative voltages. The positive voltage of around 20 is fed to a three-terminal voltage regulator (IC4) that produces a stable +15 volts. The negative voltage from the rectifier system is left unregulated, and, among other functions, it provides current for the LED pilot light.

Most of the other components we have not discussed yet are used for stability and biasing purposes.

Construction

Several construction methods are open to you. You can choose either the perforated-board, or the PC-board methods; however, the following information will, for the most part, apply to PC-board construction.

If you decide on using a PC board, you

can construct your own board using the foil pattern shown in Fig. 3.

If you plan to drill the circuit-board holes, a No. 60 drill bit works well for all the holes, except for the trimmer potentiometer holes, which should be drilled with a No. 55 bit. You will also need a 1/8-inch bit for the voltage-regulator mounting hole and the two circuit-board mounting holes.

After the drilling has been completed, thoroughly burnish the copper foil with fine sandpaper or steel wool to remove any photo-resist and tarnish.

Soldering should be done with a high-grade 60/40 solder and a pencil-type soldering iron with a 35-watt/650°-700° rating.

Take special care to properly install polarized components such as diodes, transistors, IC's and electrolytic capacitors. If you carefully follow the parts-placement diagram in Fig. 4, you should have no problem.

Sockets or Molex pins are recommended for installing the IC's. The IC's can be soldered in place, but with a sacrifice in their serviceability. Jumper wires should be made of around 22-gauge, solid, tinned wire and installed on the component side of the PC board.

When all the components have been installed on the board, it is wise to make a final close inspection to confirm the parts are properly placed and the soldering is complete. The board is now ready for installation in the cabinet and for testing and adjustment.

You may want to make some preliminary tests and adjustments on the circuit board out on the bench, by temporarily wiring the transformer, potentiometers, output terminals, etc., to the board; or you may want to install all the parts into the cabinet with the board in its finished form. In either case, you should use the following testing and adjustment procedure.

Testing and adjustment

The testing and adjustment procedure

requires a VTVM or DMM along with an oscilloscope and a frequency counter; however, if you don't own a counter or an oscilloscope, we'll show you a few tricks near the end of this article on how to adjust your instrument using only a meter.

Let's assume, however, that you have all the desired equipment. Connect the meter (set to the 5-10 VAC range), oscilloscope and counter to the sinewave output point on the circuit board. Preset all trimmers to their mid-range and apply power. If the LED pilot light has been wired, it should glow, indicating that the power supply is probably working correctly.

The oscilloscope should display a sine-wave (possibly distorted) that varies in frequency as the MAIN FREQUENCY control is turned. Use this control to set the frequency to around 1 kHz as indicated on the counter, and adjust distortion trimmer R23 to produce a sine-wave that "looks normal" on the oscilloscope. If you're a "purist," a distortion meter will achieve this adjustment best, but eyeballing works for most of us. At this point the meter should indicate a sine-wave level of around 4.5 volts that the oscilloscope will show as around 13 volts P-P.

If your oscilloscope is DC-coupled, adjust trimmer R27 for zero DC offset on the sine-wave. Next, use the oscilloscope to check the squarewave, it should look symmetrical and have a peak positive amplitude of around 4 volts.

Now, turn the MAIN FREQUENCY and FINE FREQUENCY controls to their full counterclockwise position (lowest frequency), and adjust low-frequency limit trimmer R6 for a 10-Hz frequency, as shown on the counter. Then, turn the MAIN FREQUENCY control to its full clockwise position, and adjust high-frequency limit trimmer R8 for a 50-kHz frequency. Check the range of the FINE FREQUENCY control. This control should vary the frequency around 100 to 200 Hz, regardless of where you set the MAIN FREQUENCY control.

Because of interaction between the low- and high-frequency limit adjustments, it may be necessary to repeat the adjustments several times. Also, if you have trouble getting the instrument to work at 10 Hz, try interchanging IC1 with IC2. This may provide a "better" op-amp in the somewhat critical voltage-to-current-converter circuit.

Once these upper and lower frequency-limit adjustments have been made, then you can place calibration marks on the MAIN FREQUENCY control knob. It's advisable for the instrument to be in its final form for this step.

The prototype unit was calibrated using small letters and a corresponding chart to identify the various frequencies. This system works well for many applications; however, you will have to decide on how many frequency-point markings you

will need or perhaps you may want to use conventional fine-line marks with their corresponding frequencies on the dial itself. You can obtain the press-on letters and numbers for this from most electronic-supply distributors or hobby-craft stores. To protect the lettering, apply several coats of clear acrylic lacquer on the front panel.

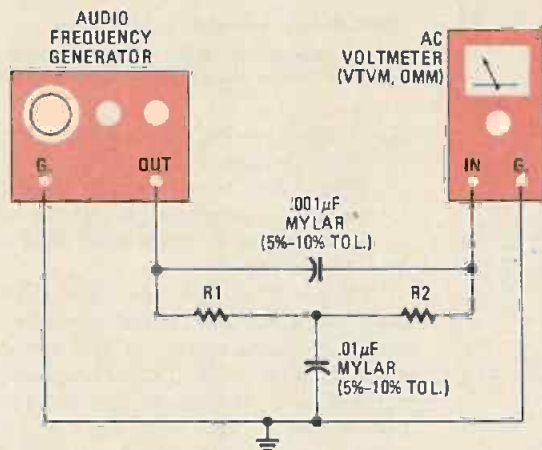
You can use the drilling guide shown in Fig. 5 to position the front-panel components. You will probably have to construct some angle brackets to mount the circuit board to the cabinet. Keep in mind that these brackets must hold the board so that its bottom edge is very close to the

cabinet floor, because otherwise the top edge of the board won't allow the cabinet cover to fit properly.

Make sure to expose some bare metal on the floor of the cabinet in the area around the angle brackets so as to ground the circuit-board foil to the cabinet for shielding purposes.

In our model, the LED pilot light/dial indicator was mounted in a small vinyl grommet and secured with glue, but you could use a standard LED mounting clip just as easily.

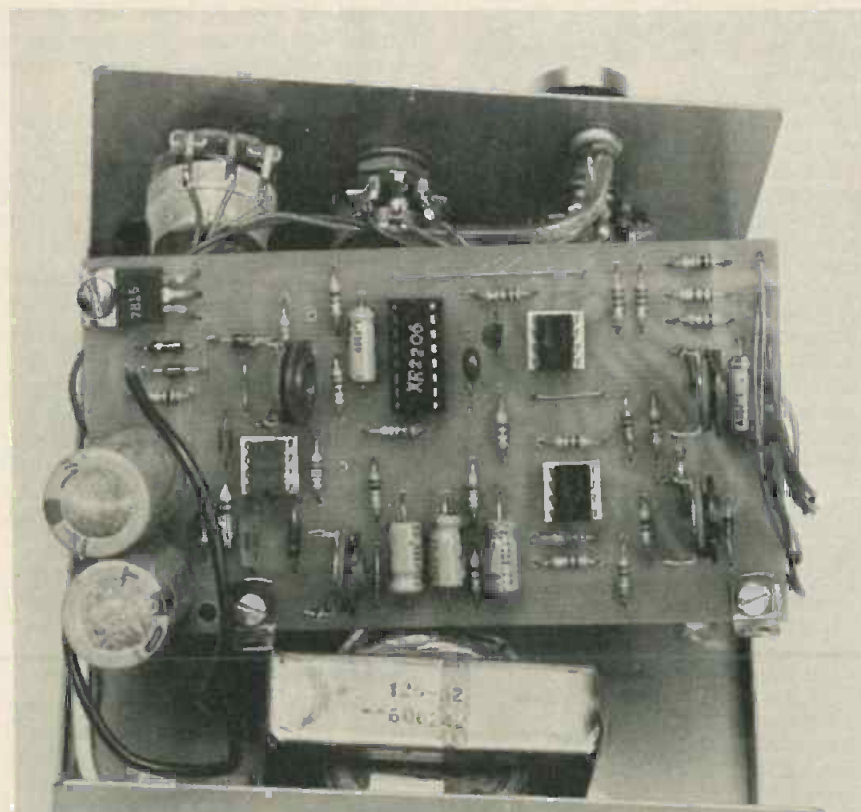
Although the Radio Shack cabinet (described in the Parts List) comes in attractive colors, you may want to repaint it to



NOTCH FREQUENCY		R1	R2
10	Hz	5.1 M	5.1M
22	Hz	2.4 M	2.4 M
34	Hz	1.5 M	1.5 M
51	Hz	1 M	1 M
82	Hz	620K	620K
130	Hz	390K	390K
190	Hz	270K	270K
220	Hz	240K	240K
340	Hz	150K	150K
510	Hz	100K	100K
820	Hz	62K	62K
1300	Hz	39K	39K
1900	Hz	27K	27K
2200	Hz	24K	24K
3400	Hz	15K	15K
5100	Hz	10K	10K
8200	Hz	6.2K	6.2K
13	kHz	3.9K	3.9K
19	kHz	2.7K	2.7K
22	kHz	2.4K	2.4K
34	kHz	1.5K	1.5K
51	kHz	1K	1K

R1 & R2: 5% OR BETTER, ¼ OR ½ WATT.

FIG. 6—DIAGRAM AND COMPONENT TABLE for use in construction of bridge network for calibrating Wide Range Audio Generator with only VTVM or DMM.



COMPLETED CIRCUIT BOARD prior to installation in cabinet. Note angle brackets at bottom of board for mounting purposes. The use of lockwashers is a good idea.

Useful hints

Here are a few miscellaneous hints you might find useful:

Although the Parts List calls for audio-taper-type potentiometers for the MAIN FREQUENCY, FINE FREQUENCY, and OUTPUT LEVEL controls, you can substitute linear-taper controls for at least the FINE FREQUENCY and OUTPUT LEVEL controls. The MAIN FREQUENCY control could also be a linear type, but the low-frequency end of the dial calibration would be so compressed that the marks would be difficult to read and the frequency hard to adjust.

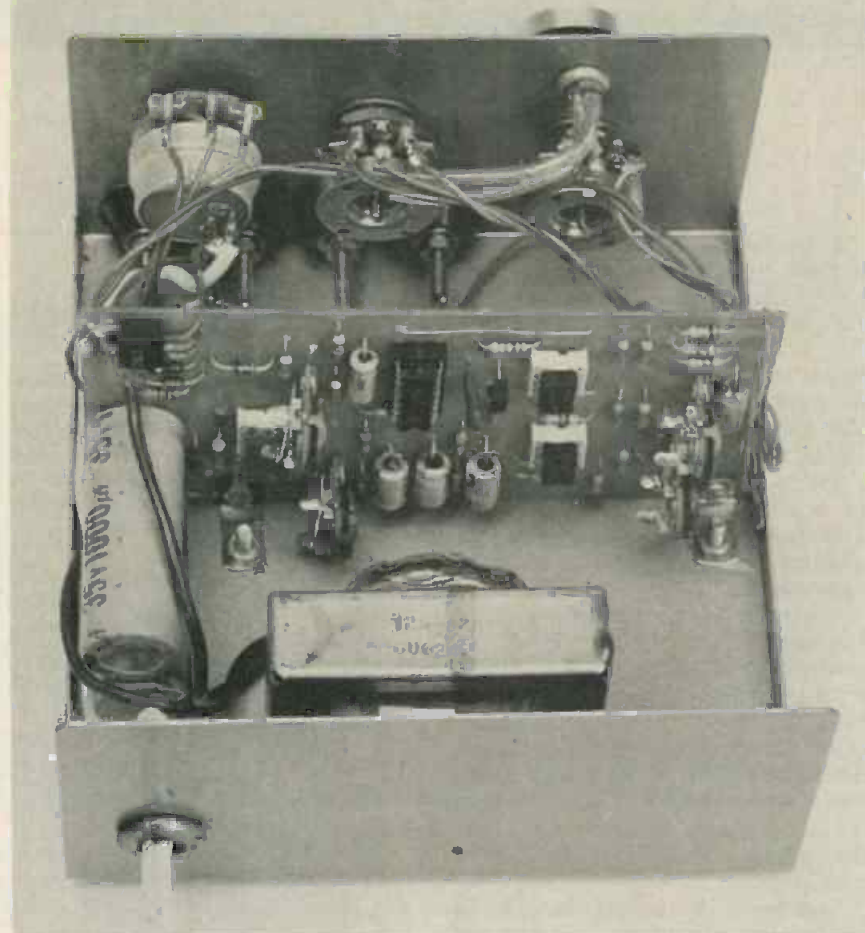
Because most AC meters (as well as some oscilloscopes and counters) work poorly at a 10-Hz frequency, try using an LED as a frequency indicator when calibrating the MAIN FREQUENCY dial at its counterclockwise, 10-Hz end. To do this, simply connect an LED to the sinewave-output terminals and adjust the output level high enough to provide a bright illumination. With the MAIN FREQUENCY dial set to its full counterclockwise position, slowly adjust low-frequency limit trimmer R6 to the highest frequency you can comfortably count by observing the LED flicker; this frequency will be about 4–6 Hz. Then, adjust trimmer R6 to slightly increase the frequency, just to the point where the LED flickers are beyond what the eye can follow, and the frequency will be close to 10 Hz.

When you wire the LED pilot light indicator, remember that the terminal closest to the flattened edge connects to R35 on the circuit board, and the other terminal connects to ground.

You can check the squarewave output without an oscilloscope by using a DC voltmeter. If all is correct, the meter will measure about +2 volts (if the waveform is four volts peak-to-peak, the portion of the waveform measured by a DC meter will be two volts). Also, the sinewave DC offset can be adjusted by connecting the DC voltmeter to the sinewave output and setting OFFSET TRIMMER R27 for zero DC on the meter.

If you want the instrument to cover a different frequency range from that specified here, you can do this easily by simply adjusting the low-frequency and high-frequency limit trimmers. For example, you can set the frequency range for 20 Hz—20 kHz, or 50 Hz—10 kHz, or other frequencies. Changing the value of C2 allows a 3¹/₂-decade spread in a different part of the frequency spectrum; for example, if C2 is changed to 0.005 μ F, the frequency can be set for 20 Hz—100 kHz; or if C2 is 0.1 μ F, the frequency range will be 1 Hz—5 kHz. So, by changing either the frequency limits or the value of capacitor C2, the instrument's frequency range can be altered to suit your needs.

With these hints, you should have no trouble at all in calibrating your instrument properly. R-E



INTERIOR VIEW of fully-assembled unit showing details of point-to-point wiring. Angle brackets should contact bare metal in cabinet to assure good ground for shielding purposes. Binding posts are located just beneath front panel controls.

cover up the small nicks and scratches that usually occur during drilling. This repainting also gives the instrument a customized look, and it seems to make the press-on lettering procedure work better. A tilt-up stand was made from an old rack panel handle mounted with two angle brackets.

Calibration without a counter

As promised, here are a few ways to calibrate the frequency dial without using a frequency counter.

If you have a well-calibrated signal generator and an oscilloscope, why not try the old Lissajous-pattern method of identifying an unknown frequency by comparing it with a known frequency? To do this, simply feed the known frequency signal to the vertical or Y-input of the oscilloscope, and feed the unknown frequency signal to the horizontal or X-input of the oscilloscope; then, when the unknown signal matches the known signal, you will observe a stationary or a slowly turning circle or ellipse pattern.

If your oscilloscope is a more professional model with a triggered, calibrated timebase, you can measure the unknown frequency (f_x) by reading the period or time of one or more cycles of the wave-

form, and then calculating the frequency by using the formula, $f_x = 1 \div t$ where t is the time interval measured in seconds (on the scope screen) of one complete cycle.

And here is another method to use if your *only* means of calibration is a VTVM or DMM:

This method uses a simple bridged-T network that acts as a notch filter or attenuator at its known resonant frequency. By connecting it between the generator's output and the voltmeter's input (as the unknown frequency is varied), it can be identified by the definite dip or null that appears on the voltmeter as the unknown signal approaches and reaches the known resonance of the filter.

Construct the network using the diagram and frequency-determining resistor chart shown in Fig. 6. Lay it out in such a way that you can easily change the resistors, which will be necessary to change the various resonant frequencies. Use as close-tolerance components as possible. The chart shown in Fig. 6 lists the resistors needed to produce 22 useful resonant frequencies. Connect the filter as shown in Fig. 6, and you should be able to identify at least these 22 frequency points on the instrument's dial.

STEREO REMOTE CONTROL UNIT

THIS IDEA DESCRIBES A PASSIVE STEREO remote-control unit. Nothing is more aggravating than to relax for the evening in your favorite chair, intent on enjoying your stereo system—and then the telephone rings, or someone comes to the door. That requires you to get up, dash to the stereo to turn the volume down, and then dart to the phone or the door. The unit described here eliminates the problem. Merely turn the volume down on the control beside your armchair, then attend to the disturbance. The control also eliminates the constant getting up and down to raise the volume for your favorite programs. Another handy feature is the remote balance control that permits you to achieve perfect stereo sound, regardless of where you are situated in the listening area.

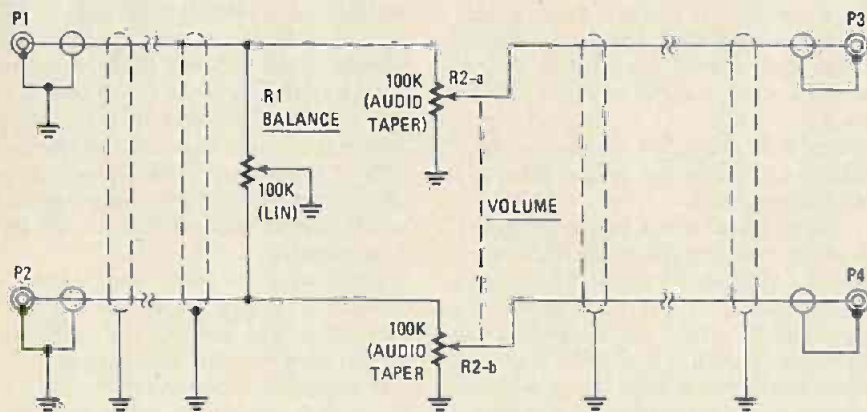
The remote-control unit takes advantage of the versatility of today's stereo components. It is connected between the preamplifier and power amplifier, or in the tape-monitor section—depending upon the configuration of your stereo system. The entire project can be built for about \$10.00:

The connecting cables used were two shielded two-conductor cables tied together. That turned out to be a quite flexible and compact bundle. The cables used were 15 feet long, but they could be up to 30 feet long without producing any drastic sound degradation. Be sure to terminate the stereo end of the cables in the proper connections.

The enclosure used for the project is a 2¼ × 4 × 1½ inch plastic utility box. The aluminum cover was brushed and aluminum knobs were used to match the stereo system.

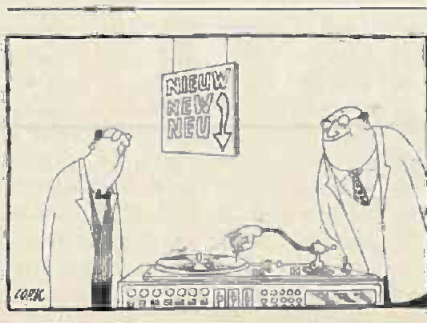
The performance of the remote control unit turned out to be quite good. The crosstalk is -62dB at 1 kHz and -55 dB at 20 kHz. The frequency response was totally unaffected for all practical purposes. Some experts claim that it is less detrimental to the sound quality of the system to extend the lead length between the preamplifier and power amplifier than it is to extend the speaker leads of the system.

That project has turned out to be an indispensable part of my stereo system and I am quite sure that it will be just as desirable for others, too, once they try it.—Dennis Eichenberg R-E



P1,2,3,4 - RCA TYPE PHONO PLUGS (OR WHATEVER IS COMPATIBLE)

The complete schematic diagram of the project is shown in Fig. 1. Both of the potentiometers used in the project were found in a potentiometer assortment obtained from a mail order outfit, although similar types can be purchased almost anywhere. An alternative to the two potentiometers would be a joy-stick control wired with one side potentiometer used for each channel and the front or rear potentiometer to be used for the balance control.



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 plus a Circuit Board Holder, Standard Base and Tray Base Mount from Panavise Products, Inc. (See photo below.) Selections will be made at the sole discretion of the editorial staff of Radio-Electronics.



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MAY 1980 87

What is frequency companding and how will it jam more channels into the RF spectrum?
HERB FRIEDMAN, COMMUNICATIONS EDITOR

UNLESS YOU'RE INTO READING THEORETICAL articles in the Journal of the Audio Engineering Society you have probably never heard of a device humorously called a *freakwee* (from *frequency*). It was originally intended to create high-pitched animation voices, such as the ones Walt Disney used for the Three Little Pigs when they sang "Who's afraid of the Big Bad Wolf." Notwithstanding the Three Little Pigs, Donald Duck, or Mickey Mouse, the *freakwee* is the latest tool for RF spectrum management—*spectrum management* being bureaucratic gobbledygook meaning "How in heck do we jam more channels into the RF spectrum."

The plain facts are that we are fast running out of frequencies for radiotelephone communications, and for several years we've been using all sorts of tricks to reduce the bandwidth required by a single channel. First, we restricted the bandwidth of AM stations; then we substituted SSB for AM, literally cutting the required bandwidth in half. For FM modulation, the FCC simply decreed "split channels" with a 5 kHz-maximum bandwidth. Yet with all this, we are gobbling up spectrum faster than we can free channel space.

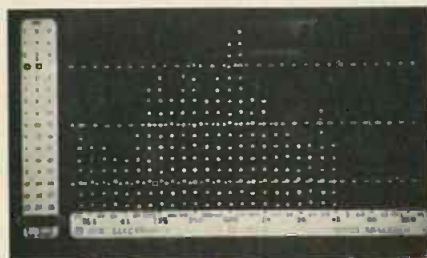


FIG. 1

The latest thoughts on spectrum management are to narrow the required bandwidth even farther through *voice frequency companding*, which is nothing more than the Hollywood animator's *freakwee* decked out in engineering expertise. A quick-and-dirty look at *companding* will give you a good idea of what to expect in communications for all services, probably including amateur and CB.

Let's start out with something we're all familiar with, SSB. You know that by varying either the receiver's tuning,

the frequency of any local oscillator or the BFO, will change the pitch of the received voice signal, yet the rate of speech—the syllabic rate—does not change. As the receiver is tuned towards the sideband frequencies the voice pitch increases, and the deepest *basso* can be changed to a lyric soprano by simply adjusting the tuning.

Now keeping this in mind, let's look at Hollywood. In the early days of ani-

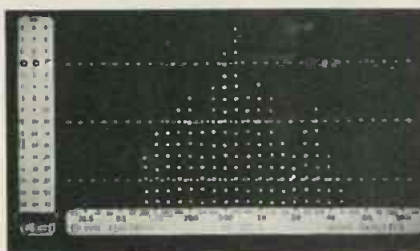


FIG. 2

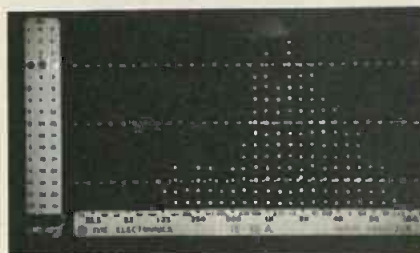


FIG. 3

imation the "pixie" voice was created by making a recording of a performer speaking or singing at a slower than desired syllabic rate: let's assume half the normal rate so the word SLOWLY was really spoken as S-L-O-W-L-Y. By playing the recording back at twice the normal speed the word would be reproduced at the "normal" syllabic rate while the pitch of the performer's voice would be twice normal—a "pixie" voice. Actually, Hollywood had no standard record/playback ratio; they used the one that worked the best, and music was rescored so the notes would be correct on playback.

As you might imagine, the procedure was cumbersome, taking much trial and effort to obtain the voice effects desired by the director.

Someone along the line, probably a radio amateur, realized that you could attain the same effect electronically

by simply combining an SSB exciter and receiver in the same cabinet, adjusting either the exciter or receiver's frequency to obtain special-effect voicing. Thus was born the *freakwee*, a device that can change the pitch of voice frequencies without changing the syllabic rate.

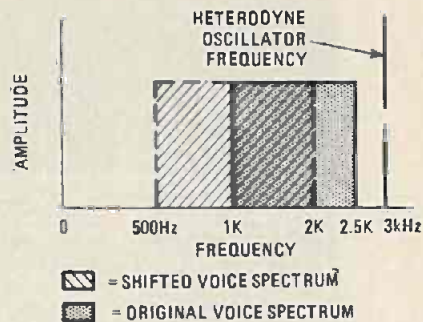


FIG. 4

If we split the *freakwee*, or whatever we chose to call the device, into two distinct sections called the frequency compressor and the frequency expander, we can compress the bandwidth during transmission, and expand it back to normal at the receiver. And this leads us directly to RF spectrum management and the *frequency compander*. (I bet that Walt Disney, for all his brilliance, never imagined that the Three Little Pigs would eventually provide the pathway for modern telecommunications.)

Normally, in SSB, there is no bandwidth compression. If the modulation frequencies are, say, 500 to 2500 Hz, the transmitted bandwidth is at least 2500 Hz. We get the frequency compression by giving up the voice frequencies not needed for intelligence and then sliding the required voice frequencies into the space of the unneeded frequencies, restoring the proper relationship at the receiver. It sounds complicated but it's easily understood by referring to Figs. 1 through 4.

Figure 1 is a photograph of a real-time analyzer's display of the voice frequencies of a male saying the word "follow". Note the considerable bass (low frequency) energy, and rather low high-frequency energy. Figure 2 is the same word, but the analyzer's response has been corrected to match the low frequency attenuation of the ear at "normal" listening level—virtually

continued on page 95

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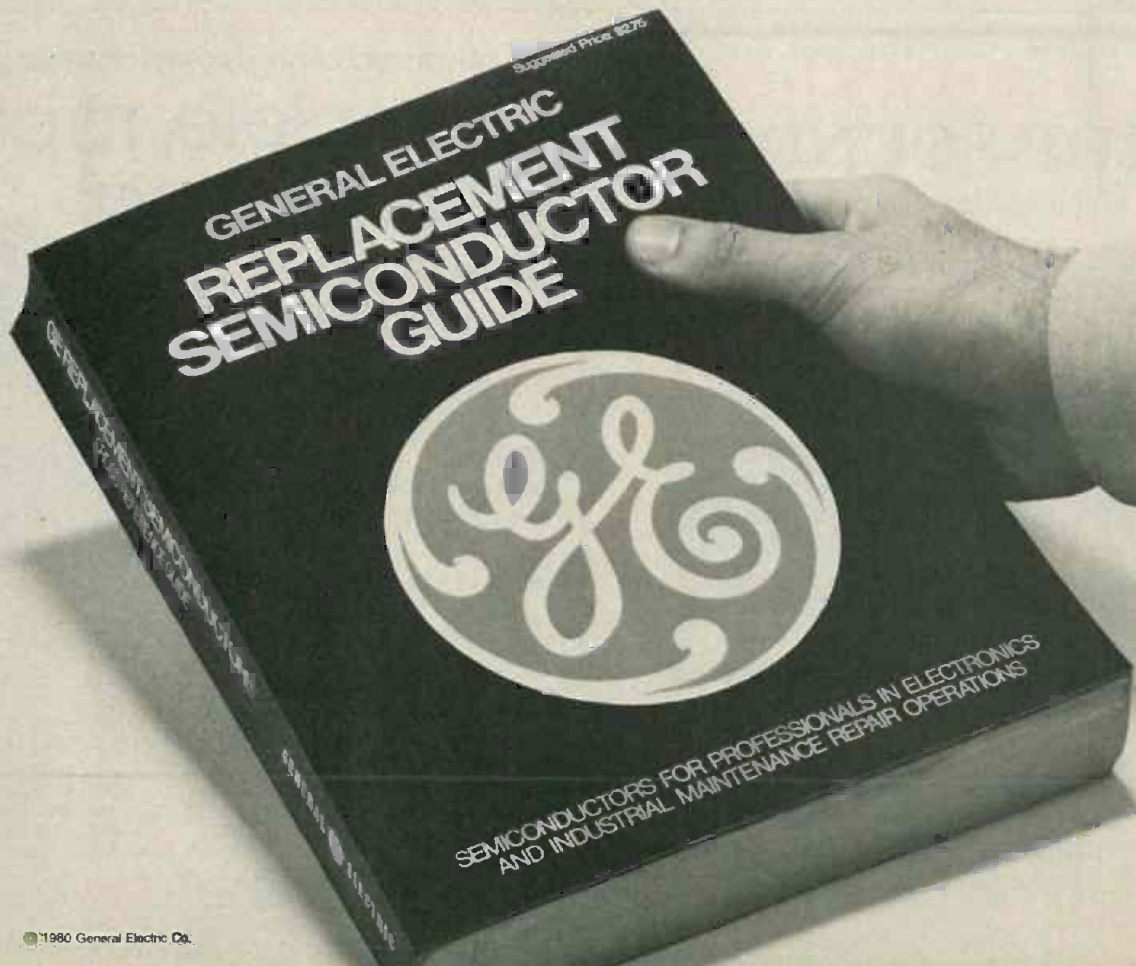
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grade transistors, a foldback circuit for overload sensing, plus an automatic over-temperature protection circuit. Ripple is maintained within a

10-mV level. Suggested retail price: \$27.95.—**Gold Line Connector, Inc.,** 992 Danbury Rd., Georgetown, CT 06829.

MOBILE TRANSCEIVERS, the VHF model C890L02R (25 watts) and the UHF model C790L02R (15 watts), each incorporate a "mini-



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control head" that permits remote mounting of the main transceiver module. Included in the head are a channel switch and an on-off switch, a channel-busy light and squelch control. The model C890L02R operates in the VHF frequency band between 150.8 MHz and 175 MHz, and the model C790L02R operates in the UHF frequency and between 450 MHz and 512 MHz. Both of these transceivers operate from an input voltage of 13.8 VDC. Suggested retail prices: model C890L02R, \$499; model C790L02R, \$839.—**Standard Communications Corp.,** Box 92151, Los Angeles, CA 90009.

GENERAL COVERAGE RECEIVER, model DR101, is designed so that the user can scan at any speed any part of the frequency range



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between 50 kHz and 29.7 MHz. When the desired station is heard, scanning may be stopped and the frequency monitored. Scanning is done in 100-Hz increments at any desired rate between

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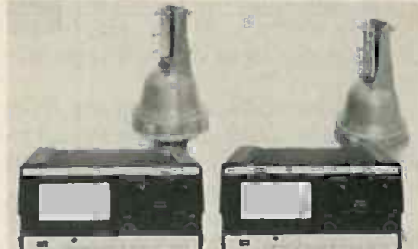
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100 Hz-per-second to 2 MHz-per-second. Any combination of reception mode (AM, SSB or CW) and IF filter (ceramic or Collins mechanical) may be used while scanning or monitoring. Price is \$1,150.00.—McKay Dymek Co., 111 S. College Ave., P.O. Box 5000, Claremont, CA 91711.

ANTENNA ROTOR SYSTEMS, models Ham IV and CD-45; the model Ham IV (on the right) is designed for tower-mounted arrays with a 15.0-square-foot wind load area, and features power braking, steel gears, and dual-transformer circuits. The model CD-45 (on the left) handles antenna arrays of up to 8.5-square-foot wind load area when tower-mounted, and has an illuminated readout, all-steel drive and automatic disc



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braking. Both units operate at safe voltage levels. Suggested retail prices: the model Ham IV, \$198.00; the model CD-45, \$109.95.—Cornell-Dubilier Electric Corp., 150 Avenue L, Newark, NJ 07101.

CB MICROPHONE, Model K40, contains a speech processor circuit. It uses a circuit to separate the loud and soft portions and then amplifies only the soft portions. It compresses the loud



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portions if they are too loud. The new mike prevents splatter and provides gain without distorting speech. Features include an automatic sensitivity adjustment and a high-low tone switch for use in congested and open areas. The mike does not require a battery and attaches magnetically to any steel surface. Suggested retail price \$42.50.—American Antenna, 1945 South St., Elgin, IL 60120.

WEATHER ALERT RADIO, is a compact and lightweight unit designed to monitor both warning tones broadcast by the National Weather Service. It is crystal-controlled for reliable RF reception and the circuitry minimizes interference caused by outside objects. Other features are an FET front end, a switch allowing operation in either the ALERT or MONITOR mode, an emergency battery power supply, and a flashing red light



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showing status of the battery. Price is \$199.00.—Motorola, inc., 1301 E. Algonquin Rd., Schaumburg, IL 60196.

REMOTE MOBILE CB RADIO, model 66GTL, is a 40-channel AM hideaway radio with the controls

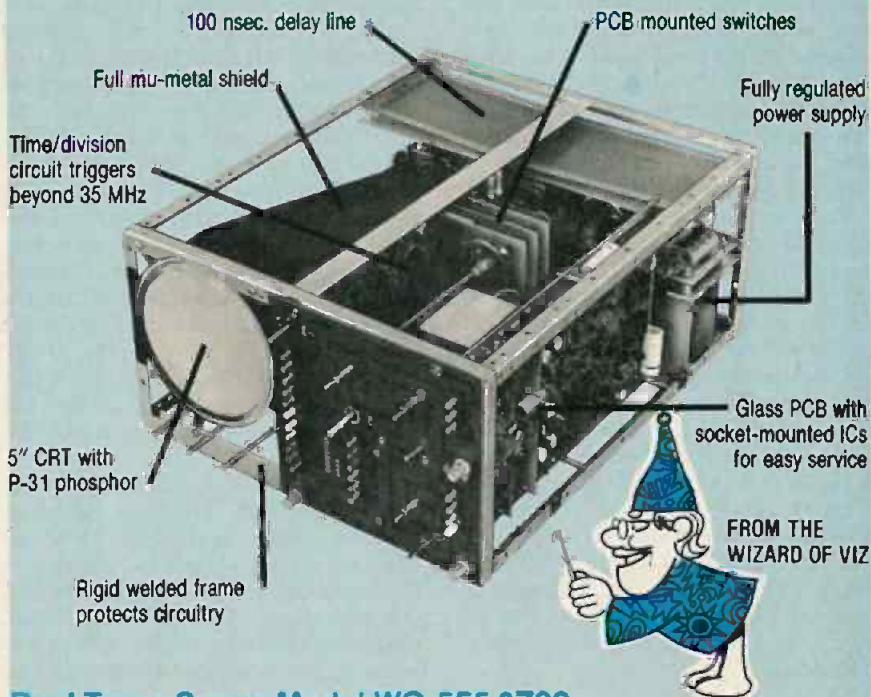
located in the microphone. These controls include an LED channel display and transmit/receive indicator, up/down channel selector, on/off switch volume control, squelch, RF gain, ANL, and an Instant Channel 9 switch. The remote



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chassis measures 7 3/4 X 5 1/2 X 1 1/4 inches. Suggested retail price \$199.95.—Cobra Communications, Dynascan Corp., 6460 W. Cortland St., Chicago, IL 60635. R-E

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Brightness problems and where to start checking first.

JACK DARR, SERVICE EDITOR

WE'VE JUST DONE A COUPLE OF COLUMNS on brightness-limiters (February and March 1980 issues.) Brightness problems, however, have been around for a long time before there were any brightness limiters! In general, brightness problems fall into two categories: too much, or too little.

As with all other stages, there are certain basic *key* tests that should always be done before making a diagnosis. There are some old basic reactions that are often overlooked. They key tests are reading *all* of the DC voltages on the picture tube. The fact is that this big bottle is just a plain *vacuum tube*, and works on the same principle that all the others do.

The key is the bias. If that is off, you've got problems. Make the grid of a tube too far negative with respect to the cathode, and it cuts off. No plate current flows. In a CRT, no beam-current. If the grid is too far positive with respect to the cathode, too much current flows and the tube is uncontrollable. In a CRT, the first problem cuts off the raster. The other makes it flare up; brightness can't be controlled even with the brightness control.

Let's look at some facts on raster cutoff problems. In all color picture tubes (and others for that matter), the bias is the voltage *difference* between the grids and cathodes. The cathode is always the reference point—the point to which all others are referred.

In many color-picture tubes, especially the older types, the cathodes will be at about +300 volts and the grids at about +200 volts. The net bias here is -100 volts. If anything happens to *either* voltage, the bias goes off value and upsets the brightness level.

Let's look at some actual problems. In one set the cathodes read +400 volts instead of +300 volts. The Grids were correct at +200 volts. No raster with the high-voltage OK. The higher voltage on the cathodes, instead of biasing the grids to -100 volts, biased the grids to -200 volts. The result was that the pix tube was cut off and no raster. The cause was a video-output tube with an open heater. If that tube draws no plate current, the B+ supply to the cathodes rises to the supply value. The plate current of the video-output tube is quite a bit greater than the beam-current (typically 1.5 mA for full brightness) of the picture tube. If the supply resistor or RF choke to the video-output tube plate opens, the tube does not draw any current and, of course, the bias level is upset.

In another set, we found the CRT cathode voltages high. The plate voltage of the video output was also high. Those circuits are almost always DC-coupled so that each one affects the other. In this one, tests showed that there was an open circuit between the cathode pin of the video-output socket and ground. In this

circuit, the contrast control was the cathode resistor. When varied, it moved the cathode-bypass capacitor nearer the cathode or farther away to control degeneration. The control itself was good, but the lead from chassis to the front panel was broken.

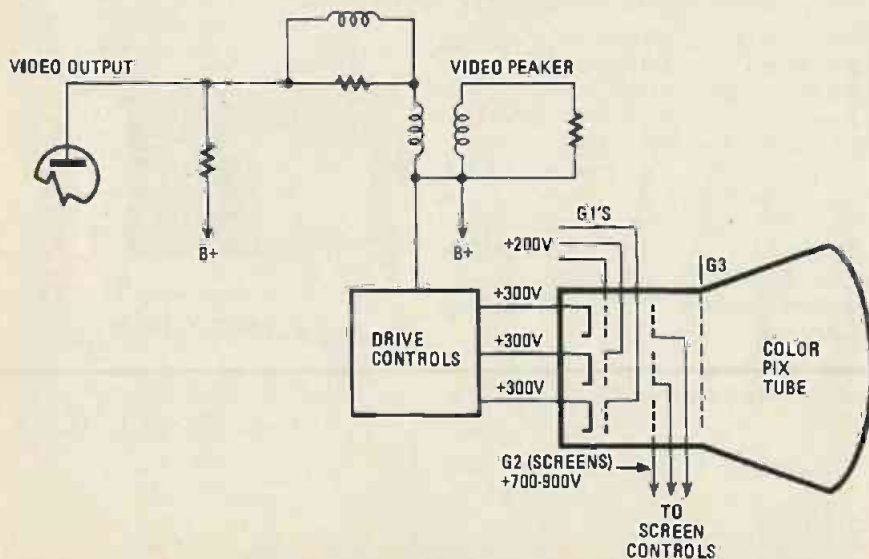
In a later-model set, using the RGB circuit where color and video are fed to the separate cathodes and all grids are common, the cathode voltages were OK, but the grid voltage was zero. The raster was cut off. The grids were supplied a DC voltage from B+ through a two-resistor voltage divider. The resistor to B+ was open. So, the grids were actually biased -200 volts and no raster. Incidentally if the ground-leg resistor had been open, the grids would have gone very high and the raster would flare; just the opposite reaction, but due to the same relationship between the voltages.

In the grid-voltage circuits, we ran into an odd one. The raster was out. Checking, we found the picture tube grids much too low; too far negative. The difference-amplifier tubes were drawing far too much plate current. The supply voltage and resistors were all normal. Further checking showed the cathode voltage (common to all three) was off value. Much lower than it should have been. That made the grids far too positive and the plate current too high, dropping the plate voltage.

The cause of that was an *open* coupling capacitor between the diff-amp cathode circuit and the horizontal blanker. Without the presence of the fairly high blanking pulse, which affected the total current-flow through the common cathode resistor, the bias went off. If you find that condition, scope for the presence of the blanking pulse on the cathodes of the difference-amplifiers.

One final case in the no-raster section. Not too common, but true. After checking around, we found that there was no focus voltage. No focus voltage at all, no raster. In a similar case, the diagnosis was easier; we could see great fuzzy blobs of color moving around on the screen. The focus voltage was down to about 1 kV instead of the normal 5 kV. In both of those cases, replacing the focus rectifier cleared up the problems.

Summing up; Whenever you run into problems associated with the brightness circuitry, be very sure to read *all* of the DC voltages on the picture tube (Don't forget the focus voltage!) It often helps to make a scratch-paper list of them and



then compare them with the voltages shown on the schematic. You must know what they should be, though! In one letter I received, a technician said "All of my voltages on the picture tube are off value! I measure only +200 volts on the grids when they should be +300 volts, and +300 volts on the cathodes when they should be +200 volts!" I pulled the schematic very quickly and looked. He was right; the schematic *did* say +200 volts on the cathodes and +300 volts on the grids! My schematic now has a note on it: Grid and cathode voltages *reversed!* Figure 1 shows the typical voltages found on the picture tube in practically all of the older color sets, and a lot of the new ones. It would be a good idea to memorize them, then you won't be booby-trapped as this poor feller was.

Next month we'll take up exactly the opposite problem: raster much too bright and flaring. R-E

service questions

VERTICAL JITTER

This Quasar has an intermittent vertical jitter, and pulls up from the bottom about an inch. Just got another one, same model—and it has the same problem! I've tried quite a few things, no luck. Help!—J.S., Newberry, SC.

There are two main suspects for this: one is a bad solder joint somewhere (be sure to check all ground connections on boards!) The second possibility is a resistor drifting under load. Both of these can sometimes be caught by heating/cooling things. Make sure that all socket contacts are very tight, too. Tubes, plugs and sockets, etc.

Scope the B+ lines feeding the vertical and sync stages. Look for signs of vertical-frequency pulses, indicating a bad filter. Also, before you go, try replacing that little 50-mF electrolytic capacitor in the vertical output cathode. This would seem to be in the convergence circuits, since the capacitor is over on the convergence board, but it's a vital part of the vertical output cathode circuit.

LED STEREO INDICATOR BLOWS DIODES

I've got one in for service now! It's a LED stereo level indicator, made by Formula International of California. Supposed to work up to 100 watts-per-channel. When I try it, I get up to almost full power, and it blows one of the diodes in the input! Schematic enclosed. Please help.—N.S., Virgin Islands.

Well, it's a good thing you sent the schematic! No listing of this in any of my data. That input circuit looks like a half-wave voltage doubler. They show IN60 germanium diodes used. These are rated

at only 30 volts PIV and 50 mA current: The most likely thing, it seems is that your voltage is too high at full power.

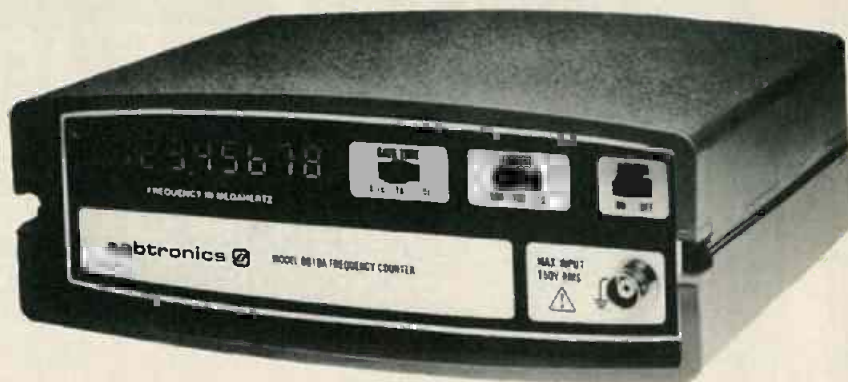
Try replacing these with stock silicon diodes; they ought to work well enough. Pick types with at least 100 volts rating, and something like 500 mA minimum current. While you're at it, make sure that both of those electrolytics are OK and matched.

NO HIGH VOLTAGE

We've got one that's simple, but we can't find it! Several men have had a run at it, and it isn't fixed yet! Problem: no high voltage, or none to speak of (about 1 kV). As you said, I tried a neon lamp near

the 1K3 high-voltage rectifier, and it glows brightly. Two new tubes did no good at all! We're still going in circles.—R.A.H., Ft Hood, TX.

Stop circling; that heat'll get you down. Now, you seem to have a case of RF on the high-voltage rectifier. The tube is OK. Try this; get a solid-state stick rectifier. RCA SK-3068, etc. Connect the anode of this to the 1K3 plate lead and the cathode to the high-voltage lead to the tube. Now check and see if you get high voltage. If you do, then you've got something wrong in the 1K3 socket. The tube probably isn't getting any heater voltage—bad socket contact, or something like that. R-E



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everything below 100 Hz is gone. Now it is a fact of hearing that the low frequencies provide the characteristic by which we recognize a voice—they contain little intelligence. It is the 500-to-2500 Hz range that carries the most intelligence. But look at Fig. 3, which is the same word spoken by the same male in a clear, distinct whisper; note how the energy is concentrated between approximately 1000 and 6300 Hz. Since there is little intelligence between 2500 and 6300 Hz we can eliminate everything above 2500 Hz. Now we're left with a band of frequencies approximately 1000-2500 Hz which is sufficient to convey information, and we have a "hole" between literally DC and 1000 Hz. For compression we slide the 1000-2500-Hz voice frequencies into the "hole", as shown in Fig. 4.

The "slide" is accomplished by beating the remaining voice frequencies against a 3000-Hz signal in a mixer. After filtering so that only the difference frequencies remain, we are left with the bandwidth of 500-2000 Hz representing the original bandwidth of 1000-2500 Hz. If the frequencies of 500-2000 Hz are used to modulate an SSB transmitter, the transmitted bandwidth is 500 Hz less than would be required for voice frequencies of 1000-2500 Hz.

At the receiver, the received 500-2000 Hz is again beat against a 3000-Hz signal that reinverts and expands the frequency range to 1000-2500 Hz, the original voice frequency bandwidth.

For simplification I have used nice round numbers and assumed a constant voice level. As shown in Figs. 1 through 3, however, the voice level is *not* constant. The actual voice energy to be companded will more closely resemble Fig. 3, the reduced high-frequency energy allowing us to slide the bandwidth even farther into the lower frequencies. Bandwidth savings up to 30% are feasible. In plain terms, that is translated into at least 12 additional CB channels in the space presently allotted to 40 channels. About 30% more QRM-free radiotelephone amateur radio frequencies, and certainly additional FM channel spectrum—though exactly how frequency companding will affect FM is unknown at this time.

With all the mixing and filtering required you can well understand why frequency companding had to wait for the IC and its large-scale integration. Figure a year or three and someone will come along with the entire compander system on one or two IC's. Come what may, when frequency companding does give us additional channel density for a given RF spectrum, keep in mind that it all started with the high-pitched voices of the Three Little Pigs. R-E

Explorer/85

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No matter what your future computing plans may be, Level "A"—at \$129.95—is your starting point.

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For just \$129.95 (plus the cost of a power supply, keyboard/terminal and RF modulator, if you don't have them already), Explorer/85 lets you begin computing on a significant level... applying the principles discussed in leading computer magazines... developing "state of the art" computer solutions for both the industrial and leisure environment.

Level "A" Specifications

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an 8155 ROM-I/O—all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, plus generous prototyping space.

Level "A" makes a perfect OEM controller for industrial applications and is available in a special Hex Version which can be programmed using the Netronics Hex Keypad/Display.)

PC Board: glass epoxy, plated through holes with solder mask
• I/O: provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader... provision for 24-pin DIP socket for hex keypad/display... cassette tape recorder input... cassette tape recorder output... cassette tape control output... speaker output... LED output indicator on SOD (serial output) line... printer interface (less drivers)... total of four 8-bit plus one 6-bit I/O ports • Crystal Frequency: 6.144 MHz • Control Switches: reset and user (RST 7.5) interrupt... additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard • Counter/Timer: programmable, 14-bit binary • System RAM: 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems... RAM expandable to 64k via S-100 bus or 4K on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F800 leaving 0000 free for user RAM/ROM. Features include tape load with labeling... tape dump with labeling... examine/change contents of memory... insert data... warm start... examine and change all registers... single step with register display at each break point, a debugging/training feature... go to execution address... move blocks of memory from one location to another... fill blocks of memory with a constant... display blocks of memory... automatic baud rate selection... variable display line length control (1-255 characters/line)... channelized I/O monitor routine with 8-bit parallel output for high speed printer... serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Version): Tape load with labeling... tape dump with labeling... examine/change contents of memory... insert data... warm start... examine and change all registers... single step with register display at each break point, a debugging/training feature... go to execution address... move blocks of memory from one location to another... fill blocks of memory with a constant... display blocks of memory... automatic baud rate selection... variable display line length control (1-255 characters/line)... channelized I/O monitor routine with 8-bit parallel output for high speed printer... serial console in and console out channel so that monitor can communicate with I/O ports.

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Netronics R&D Ltd., Dept. RE-5

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Please send the items checked below—

- Explorer/85 Level "A" Kit (ASCII Version), \$129.95 plus \$3 p&h.
- Explorer/85 Level "A" Kit (Hex Version), \$129.95 plus \$3 p&h.
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- 8k Microsoft BASIC in ROM kit (requires Levels "B," "D," and "E"), \$99.95 plus \$2 p&h.
- Level "B" (S-100) Kit, \$49.95 plus \$2 p&h.
- Level "C" (S-100 6-card expander) Kit, \$39.95 plus \$2 p&h.
- Level "D" (4k RAM) Kit, \$69.95 plus \$2 p&h.
- Level "E" (EPROM/ROM) Kit, \$5.95 plus \$0.95 p&h.
- Deluxe Steel Cabinet for Explorer/85, \$49.95 plus \$3 p&h.
- ASCII Keyboard/Computer Terminal Kit (features a full 128 character set, upper & lower case, full cursor control, 75 ohm video output convertible to baudot output, selectable baud rate, RS232-C or 20 mA, I/O, 32 or 64 characters by 16 line format, and can be used with either a CRT monitor or a TV set (if you have an RF modulator), \$149.95 plus \$2.50 p&h.
- Hex Keypad/Display Kit, \$69.95 plus \$2 p&h.
- Deluxe Steel Cabinet for ASCII Keyboard/Terminal, \$19.95 plus \$2.50 p&h.
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- 16k RAM Expansion Kit (to expand any of the above up to 64k), \$139.95 plus \$2 p&h each.
- Intel 8085 cpu User's Manual, \$7.50 postpaid.
- Special Computer Grade Cassette Tapes, \$1.90 each or 3 for \$5, postpaid.
- 12" Video Monitor (10 MHz bandwidth), \$139.95 plus \$5 p&h.
- North Star Double Density Floppy Disk Kit (One Drive) for Explorer/85 (includes 3 drive S-100 controller, DOS, and extended BASIC with per-



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Hex Keypad/Display.

Hex Keypad/Display Specifications

Calculator type keypad with 24 system defined and 16 user defined keys, 6 digit calculator type display which displays full address plus data as well as register and status information.

Level "B" Specifications

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards and includes: address decoding for onboard 4k RAM expansion select-able in 4k blocks... address decoding for onboard 8k EPROM expansion select-able in 8k blocks... address and data bus drivers for onboard expansion... wait state generator (jumper select-able), to allow the use of slower memories... two separate 5 volt regulators.



Explorer/85 with Level "C" card cage.

Level "C" Specifications

Level "C" expands Explorer's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and cards are neatly contained inside Explorer's deluxe steel cabinet. Explorer's deluxe steel cabinet, Level "C" includes a sheet metal superstructure, a 5-card gold plated S-100 extension PC board which plugs into the motherboard. Just add required number of S-100 connectors

Level "D" Specifications

Level "D" provides 4k or RAM, power supply regulation; filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 0000 to FFFF in 4k blocks.

Level "E" Specifications

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for soon to be available RAM IC's (allowing for up to 12k of onboard RAM).

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STEREO PRODUCTS continued from page 98

rated at 20 watts per channel and has similar performance features. Suggested retail price for the Model CR-440 is \$320; Model CR-240 is \$250.—Yamaha Int'l. Corp., 6600 Orangethorpe Ave., Buena Park, CA 90620.

METAL PARTICLE CASSETTE TAPE, Metal Alloy, provides increased maximum output levels, especially at high frequencies. The tape is housed in a warp-resistant die-cast aluminum shell that features removable plugs, low-mass pressure



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pad and transparent slip sheet. The tape has a coercivity of 1050 oersteds, a remanence of 3000 gauss and is 16 µm thick. Suggested retail price, \$12.99.—TDK Electronics Corp., 755 Eastgate Blvd., Garden City, NY 11530.

PHONO CARTRIDGE, model 110MP, features a bonded elliptical stylus and uses a high-output Permalloy magnet to overcome interference problems. The cartridge provides a frequency



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response of 20 Hz-20 kHz and 25-dB channel separation at 1 kHz. Suggested retail price: \$45.—Osawa & Co., (USA) Inc., 521 Fifth Ave., New York, NY 10017.

MICROPHONE, model UC935, uses condenser technology to provide tight cardioid pattern. Specifications include: frequency response, 30 Hz-16 kHz; sensitivity, -68 dB at 1000 Hz (un-



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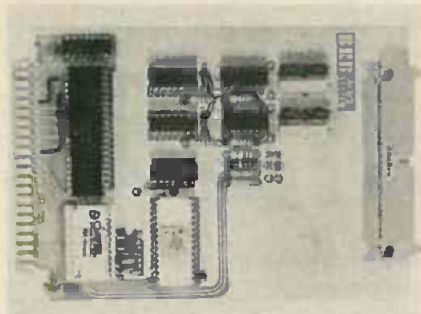
balanced line); Impedance, 600 ohms. Unit contains a foam windscreen. Suggested retail price: \$59.95.—Numark Electronics Corp., 503 Raritan Center, Edison, NJ 08817.

R-E

computer products

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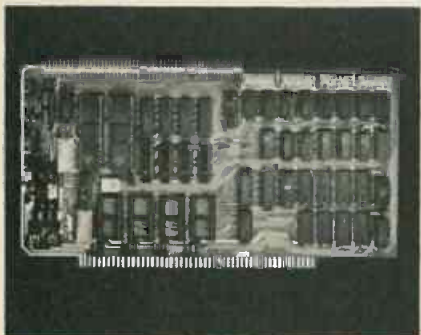
ANALOG INTERFACE MODULE can be used in data acquisition, environment control and DC motor-control applications. Module allows signals to be input from thermocouples, pressure transducers, etc., and output to motors, plotters and servomotors. Available options include a 16-channel multiplexer; 8-, 10- or 12-bit A/D converters; and either one or two 8-bit converters.



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Specifications include: maximum A/D conversion time—for the 8-bit converter, 1.8 μ s; the 10-bit converter, 6 μ s; the 12-bit converter, 24 μ s; D/A resolution, 8 bits; multiplex channel off-impedance, 100 milliohm minimum, 50-pF maximum; power requirements, +5 volts \pm 5% at 600-mA maximum. Prices: 16-channel, 12-bit A/D converter, \$257; 8-bit D/A option, \$19.—Wintek Corp., 1801 South St., Lafayette, IN 47904.

SWITCHABLE I/O BOARD, Switchboard, comes assembled or in kit form, has four parallel ports and two RS232/TTY serial ports, plus strobe and attention ports. Switch-programmable parallel ports can be switched for input or latched output;



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serial ports are switchable to any of 16 baud rates from 110-19K; and strobe and attention port flip-flops can be switched for positive or negative pulsing. The eight I/O addressed can be located on any boundary divisible by 8. All parts are fully guaranteed for life. Suggested retail prices: kit, \$199; assembled, \$259.—Morrow Designs/Thinker Toya, 5221 Central Ave., Richmond, CA 94804.

16K MEMORY EXPANSION KITS, Simple Apple II, Simple Sorcerer, and Simple TRS-80 up-grade kits are designed for use with Apple II, Sorcerer and TRS-80 computers. Each kit contains 8

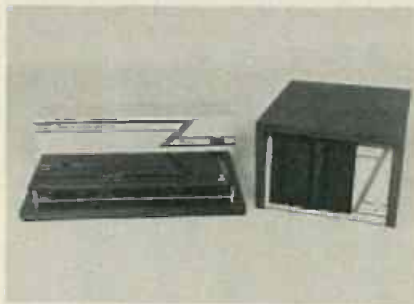
tested 16K RAM's, plus the proper jumper shunts or memory units: components are foam-pro-



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tested. Simple Installation instructions come with each kit. The Switchboard is fully compatible with the new IEEE S-100 bus standard. Suggested retail price: \$119.—Ithaca Intersystems Inc., Box 91, Ithaca, NY 14850.

COMPUTER SYSTEM, 90 Micro Work Station, is a desk-top system suitable for system development or personal and business applications. The system includes either the Z80-based 90MPS or the 90F/MPS board, and power supply, and comes on a wood-grain base with a hinged plastic



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cover. The 90MPS board contains the Z80 CPU; up to 65K bytes of dynamic RAM; up to 14K bytes of ultraviolet erasable PROM (with 2708/2716 sockets); PROM programmer; 1K byte of static RAM; eight 8-bit programmable I/O ports; four counter/timer channels; an RS-232C or 20-mA serial port with selectable baud rate; 2.5 MHz or 4-MHz operation; and a resident PROM monitor with debug capabilities. Also included is a resident DMA-based floppy-disc controller supporting up to four multidensity drives. Available accessories include a floppy-disc subsystem compatible with Digital Research's CP/M soft-

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COMPUTER PRODUCTS
continued from page 101

ware, and an S-100 bus adapter. Single unit prices: for the *Work Station* with 90MPS with 4K bytes dynamic RAM, \$1050; with 90F/MPS with 16K bytes RAM and floppy-disc interface, \$1675.—Quay Corp., P.O. Box 386, Freehold, NJ 07728.

PERSONAL COMPUTERS, Atari 400, Atari 800, for educational, recreational, and home or small business applications. The *Atari 400* (shown) features a 6502 CPU, 8K of RAM, 8K of ROM expandable to 16K, 57-key alphanumeric keyboard with graphic and edit capabilities and 4 function keys, a TV channel 2-3 selector, user-definable graphics modes, a single solid-state cartridge slot, built-in speaker, and a serial I/O port. It also provides a cassette tape drive with 300-600 baud rate, automatic tone and volume

controls, and 2 audio/digital data channels; and is user-programmable in BASIC. The optional tape drive also provides 2 audio/digital channels, a 3-digit tape counter, pushbutton controls, a cable, and a 400K-byte data-storage capability per 120-minute cassette.

The *Atari 800* is the top-of-the-line home computer system. It contains a keyboard console (with processor and memory) that features a 57-key alphanumeric keyboard with built-in RF modulator, power indicator/low line voltage indicator, 4 controller ports, on/off switch, TV Channel 2-3 selector, built-in speaker, 2 external and 4 internal cartridge slots, and a video display controller IC. The cassette features 2 audio/digital channels, 3-digit tape counter, pushbutton controls, cable, and a 400K-byte data-storage capability per cassette. Other optional system elements include a dot matrix high-impact printer and a disc memory. The *Atari 800* system has a total memory content of 8K bytes of RAM expandable



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to 48K bytes; 8K bytes of internal ROM and 8K bytes of ROM in cartridge form (BASIC), 2 ROM cartridge slots, 400K bytes of cassette memory. Software includes two program cartridges, user-programmable in Atari BASIC, Atari Disc BASIC and alternate languages. Suggested retail prices: *Atari 400*, \$529; *Atari 800*, \$949.—Atari Inc., Div. Warner Communications Inc., 1265 Borregas Ave., Sunnyvale, CA 94086.

MINI-DISC DRIVE SYSTEMS are add-on data storage systems for the TRS-80 computer and include both 40-track and 77-track drives. Single, dual or three-drive TRS-80 systems can be fitted with 40-track *TFD-100* drives or 77-track *TFD-200* drives. The *TFD-100* units increase disc storage capacity to about 250K bytes. Disc drive



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interfacing to the TRS-80 is accomplished via TRS-80 expansion interface. Both the *TFD-100* and *TFD-200* include the drive, power supply and enclosure. Each system comes with a *Patch Pak No. 1* mini-disc containing patch programs for TRSDOS for both 44- and 77-track configurations. Prices: *TFD-100*: single drive, \$399; dual-drive, \$795; three-drive, \$1195; *TFD-200*: single drive, \$675; dual drive, \$1350; three-drive, \$2025.—Percom Data Co., 211 N. Kirby, Garland, TX 75042.

PRINTER, Quick Printer II, is a 5 X 7 dot matrix printer designed for use with Level II TRS-80 systems and other computers. It makes hard copies on 2 1/4-inch-wide aluminum-coated paper, is software-selectable for 16 or 32 characters-per-line and produces 120 lines-per-minute at a 64-character-per-second speed. Provides 96 modified ASCII characters with upper and lower case and 6 lines-per-inch vertical spacing, plus all 32 ASCII codes. TRS-80, RS-232C and 8-bit parallel interfaces are featured, and the printer can be connected to the TRS-80 CPU directly or via cable to TRS-80 expansion interface. The unit measures 3 1/2 X 6 X 9 1/4 inches, and sells for \$219.—

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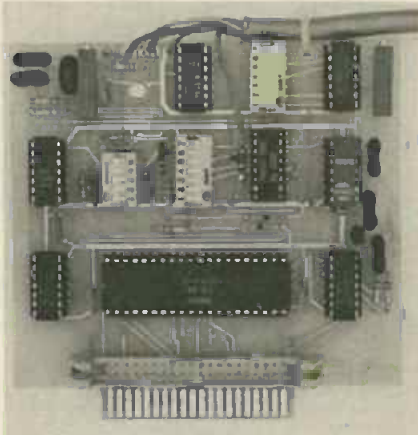
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Radio Shack, 1300 One Tandy Center, IFort Worth, TX 76102.

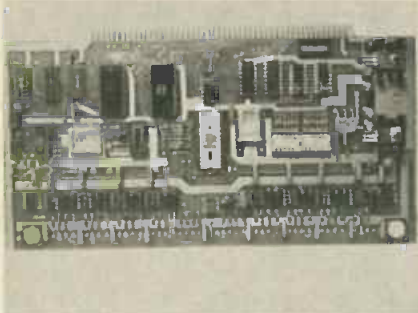
SERIAL INPUT/OUTPUT BOARD, kit or assembled, is designed for the TRS-80 and is RS-232 compatible; board can be used with or without expansion bus. Board provides switch-selectable baud rates of 110, 150, 300, 600, 1200, and 2400; parity-odd or parity-even, or nonparity bits; from 5 to 8 data bits; and either 1 or 2 stop bits. Prices:



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board only (Part No. 8010) \$19.95; kit with components, (Part No. 8010A) \$59.95; assembled (Part No. 8010C) \$79.95.—**Electronic Systems**, P.O. Box 21638, San Jose, CA 95151.

TRANSCIVER BOARD, the *MK-II*, interfaces *Touch-Tone* telephones and S-100-bus computers. The 5 X 10-inch board converts Bell System's Dual-Tone Multi-Frequency (DTMF) into binary format and binary into DTMF format. On incoming calls, vectored interrupts detect ring



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signals and DTMF signals, thus permitting phoning into the computer and executing programs by punching correct tone-pad sequence on the remote phone. Additional features include single-tone generation, memory-mapped or isolated I/O addressing, 4-bit I/O ports, status flags for ring detection and valid DTMF detection, FIFO buffered output, and automatic gain control on input. Suggested applications for the *MK-II* include monitoring and tabulating outgoing calls, home-security "dialing," and PABX systems. The unit comes fully assembled, includes applications data and manual, and sells for \$425.—**MK Enterprises**, 8911 Norwick Rd., Richmond, VA 23229.



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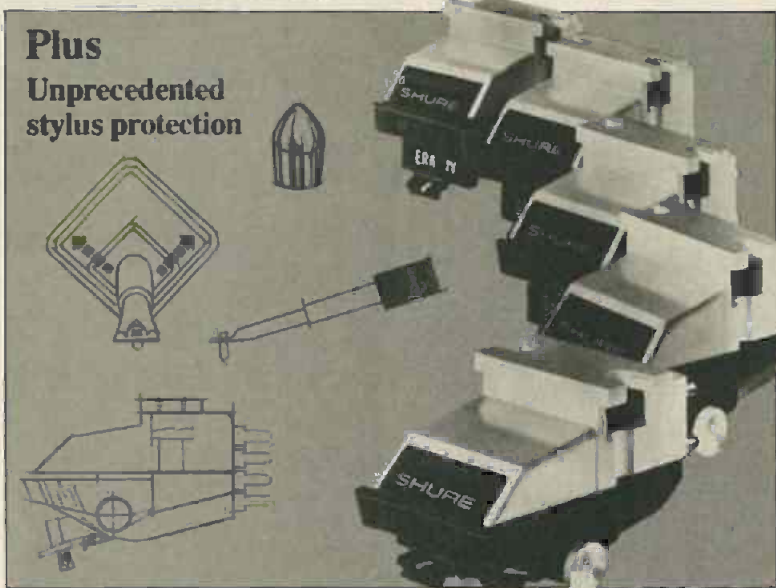
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This little booklet takes a look at an interesting phenomenon: biomusic. What is it? A combination of sounds, natural resonances and vibratory energies associated with life and consciousness. Logic and empirical evidence are given to show how synthesized biomusic can help mental and physical efficiency.

HOME AUDIO SYSTEMS SCHEMATIC SERVICING MANUAL, VOLUME 1: CAPEHART, ZENITH, edited by TAB Editorial Staff. TAB Books, Blue Ridge Summit, PA 17214. 200 pp. 7 X 10 in. Softcover \$5.95; hardcover \$8.95.

HOME AUDIO SYSTEMS SCHEMATIC SERVICING MANUAL, VOLUME 2: CORONADO, CHANNEL MASTER, HITACHI, edited by TAB Editorial Staff. TAB Books, Blue Ridge Summit, PA 17214. 200 pp. 7 X 10 in. Softcover \$5.95; hardcover \$8.95.

HOME AUDIO SYSTEMS SCHEMATIC SERVICING MANUAL, VOLUME 3: ADMIRAL, AUTOMATIC RADIO, MIDLAND, SHARP, edited by TAB Editorial Staff. TAB Books, Blue Ridge Summit, PA 17214. 200 pp. 7 X 10 in. Softcover \$5.95; hardcover \$8.95.

These three volumes contain a compilation of data from nine separate service/repair manuals for more than 400 stereo sound systems. Some of the equipment covered includes AM/FM multiplex radios, cassette and 8-track tape recorders, add-on cassette decks, etc.

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THE HOME VIDEO HANDBOOK, by Charles Bensinger. Comprehensive Video Supply Corp., 148 Veterans Drive, Northvale, NJ 07647. 206 pp. 5½ X 8½ in. Softcover \$9.95.

This book was written for both consumer VCR dealers and their customers in response to the need for clear, easily understood reference material on home VCR's. It concerns itself with such areas as VCR compatibility, differences in playing time and the purchase of video cameras. The book tells you how to use your VCR in the most effective way, and includes chapters on advanced video systems; video projectors; basic sound, lighting and graphics techniques; and where to purchase prerecorded video programs.

HOME RECORDING FOR MUSICIANS, by Craig Anderton. Guitar Player Books, P.O. Box 615, Saratoga, CA 95070. 182 pp. 8½ X 11 in. Softcover \$9.95.

This book is designed for all those professional and amateur musicians who are interested in "rolling their own" in home sound recording. Topics covered are taped decks, multichannel recorders, mikes, studio setups, tapes, mixing, etc. The clear, easily understood text is accompanied by many illustrations; there are several appendixes in the back; and a free demo record is included that lets you hear the sorts of sounds heard in a home studio.

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THE BEST OF CREATIVE COMPUTING, Volume 1, edited by David H. Ahl. Creative Computing Press, P.O. Box 789-M, Morristown, NJ 07960. 326 pp. 8 1/2 X 11 in. Softcover \$8.95.

THE BEST OF CREATIVE COMPUTING, Volume 2, edited by David H. Ahl. Creative Computing Press, P.O. Box 789-M, Morristown, NJ 07960. 326 pp. 8 1/2 X 11 in. Softcover \$8.95.

Both volumes contain hundreds of articles, stories and features culled from *Creative Computing* magazine and reflect a hands-on approach to computer usage. Volume 1 focuses on the educational computer applications and the impact of computers on modern society. Volume 2 reflects the increasing trend away from purely educational aspects toward microcomputer kits, microprocessors and home applications; there's a section on how to build MITS Altair 8800. Both books contain myriads of learning activities, programs, computer games, book reviews, puzzles, poetry, and computer art.

6800 ASSEMBLY LANGUAGE PROGRAMMING, by Lance A. Leventhal. Osborne & Associates, Box 2038, Berkeley, CA 94702. 454 pp. 5 1/2 X 8 in. Softcover \$8.50.

This book is an assembly-language primer for those who have little or no background in the field; it does however require a familiarity with computers, addressing methods and instruction sets. Chapters covered include such topics as basic instructions, assemblers, and their functions, 6800 instruction set, simple programs, program loops, code conversion, interrupts and debugging.

HOW TO BUY, INSTALL AND MAINTAIN YOUR OWN TELEPHONE EQUIPMENT, by Joseph La Carruba and Louis Zimmer. Almar Press, 4105 Marietta Dr., Binghamton, NY 13903. 50 pp. 5 1/2 X 8 1/2 in. Softcover \$3.00.

You do not have to have any prior knowledge of telephone installation work to use this planning guide and reference to the installation of phone equipment in home, apartment or business—just a familiarity with the FCC regulations governing such installation. The text provides a step-by-step description of the installation procedure involved with each piece of equipment, each item is defined as it is used and wire connections are described carefully. There are chapters dealing with both servicing and troubleshooting telephone equipment, and the text is accompanied by illustrations.

BASEX, A SIMPLE LANGUAGE AND COMPILER FOR 8080 SYSTEMS, by Paul Warner. Byte Books, Div. of Byte Publications, Inc., 70 Main St., Peterborough, NH 03458. 97 pp. 8 1/2 X 11 in. Softcover \$8.00.

BASEX is a new compiled language that can be run on 8080, Z80 or 8085 microcomputers. The general operation is described, and a comparison is shown of BASEX, BASIC and assembly languages. The book also includes a description of commands, suggestions for user modifications and directions on how to use the loader to relocate and compress programs. Appendices include error messages, a sample program, plus Paperbyte Bar-Code Formats of object codes for the BASEX compiler and loader. R-E

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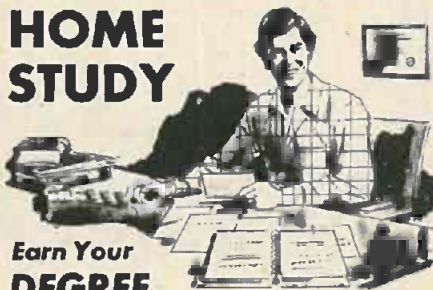
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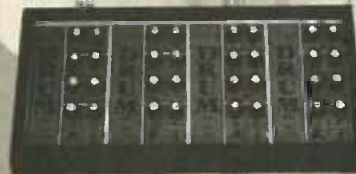
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new lit

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

INSTRUMENTS, Catalog 4900, is a 60 page, four-color catalog covering a complete line of stock analog and digital panel meters, meter relays, controllers and test instruments. New products include a compact liquid crystal digital multimeter and a universal temperature adapter probe.—**Simpson Electric Co.**, 853 Dundee Ave., Elgin, IL 60120

CIRCLE 141 ON FREE INFORMATION CARD

OUTDOOR TV ANTENNAS, a series of 3 full-color wall charts outline the features of RCA's full line of Permacolor TV Antennas. One covers the complete line of UHF-VHF/FM, VHF-FM, UHF, and FM antennas. The second covers UHF-VHF/FM combination and FM antennas, and the third covers VHF/FM and FM antennas.—**RCA Distributor and Special Products Div.**, Sales Promotion Services, Deptford, NJ 08096.

CIRCLE 142 ON FREE INFORMATION CARD

TEST INSTRUMENTS CATALOG, contains 60 pages of complete features, specs and applications for more than 50 instruments, in addition to probes and other accessories. Described are oscilloscopes, digital frequency counters, audio

test instruments, meters and bridges, video generators and a series of instruments designed for special applications.—**Leader Instrument Corp.**, 151 Dupont St., Plainview, NY 11803.

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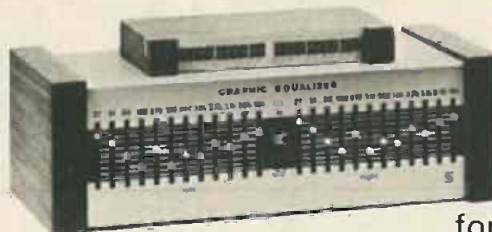
STUDIO SOUND EQUIPMENT, Sound Studio Series, contains 6 pages covering control units such as studio mixers, a frequency equalizer, a sound control fader, and a combination mixer and equalizer. Also included are dynamic mikes and a broadcast monitor headphone and dynamic mike combo. Features are described and technical specifications are given.—**Numark Electronics Corp.**, 503 Rariton Center, Edison, NJ 08817.

CIRCLE 144 ON FREE INFORMATION CARD

SEMICONDUCTOR MASTER REPLACEMENT GUIDE, No. ECG212J, provides 350 pages of ECG replacement devices and provides cross-references for other manufacturers' part numbers. The contents also include an introductory section that explains semiconductors, how to mount them and how to select the proper transistor; as well as a section that deals with test proce-

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dures of solid-state devices. An index/product list is given together with detailed descriptions of transistors, diodes, rectifiers, etc., all accompanied by schematic diagrams. Price: \$2.95.—GTE Sylvania Inc. Distributor & Special Markets Div., 1025 Westminster Drive, Williamsport, PA 17701.

ANTENNA ACCESSORIES, *Catalog PC-80*, contains 19 pages covering 72 antenna accessories for ham, CB, and home TV innovators. Included are baluns, traps, insulators, CB invisible antennas, filters and home TV hook-up accessories. Price list and order form are enclosed.—Unadilla/Reyco Div., Microwave Filter Co., Inc., 6743 Kinne St., East Syracuse, NY 13057.

CIRCLE 145 ON FREE INFORMATION CARD

KITS CATALOG, *Catalog No. 791*, contains 8 pages of kits for scanner accessories, such as unscramblers, a 2 watt audio amplifier, VOX switch, a recording coupler that is used with tape recorder to record scanner traffic. Other kits described are an SCA decoder, VHF pre-amplifier and a regulated power supply. Order form is included.—Capri Electronics, Rt. 1, Box 91-1J, Canon, GA 30520.

CIRCLE 146 ON FREE INFORMATION CARD

COILS AND CHOKES, *General Catalog 79*, contains 96 pages covering a large selection of coils, along with frequency listings, specifications, illustrations of coil types and schematics. Other products include transformers, audio filters, interference filters and bandpass filters. An index and a price list are included.—Bell Industries, J.W. Miller Div., 19070 Reyes Ave., P.O. Box 5825, Compton, CA 90224.

CIRCLE 147 ON FREE INFORMATION CARD

SPEAKER KITS, catalog contains 48 four-color pages describing 10 stereo speaker kits along with photos, specs, and price information. Also covered are woofers, tweeters, midranges and fullrange drivers, crossovers, speaker enclosures, accessories, complete stereo systems, and new publications. New products include an active subwoofer system and midrange and tweeter horns using the Wave Aperture principle.—Speakerlab, 735 N. Northlake Way, Seattle, WA 98103.

CIRCLE 148 ON FREE INFORMATION CARD

REPLACEMENT SEMICONDUCTORS, *Catalog X79*, 217 pages, is an updated manual (80 new types) that now contains over 150,000 listings of replacement semiconductors and IC's. This comprehensive catalog provides quick and easy selection plus accurate cross referencing. Included is a guide to usage of semiconductors, symbols and terminology used, specifications, product descriptions and Index, and diagrams of case styles and accessories. Available for \$2.00 prepaid.—Workman Electronic Products, Inc., P.O. Box 3828, Sarasota, FL 33578.

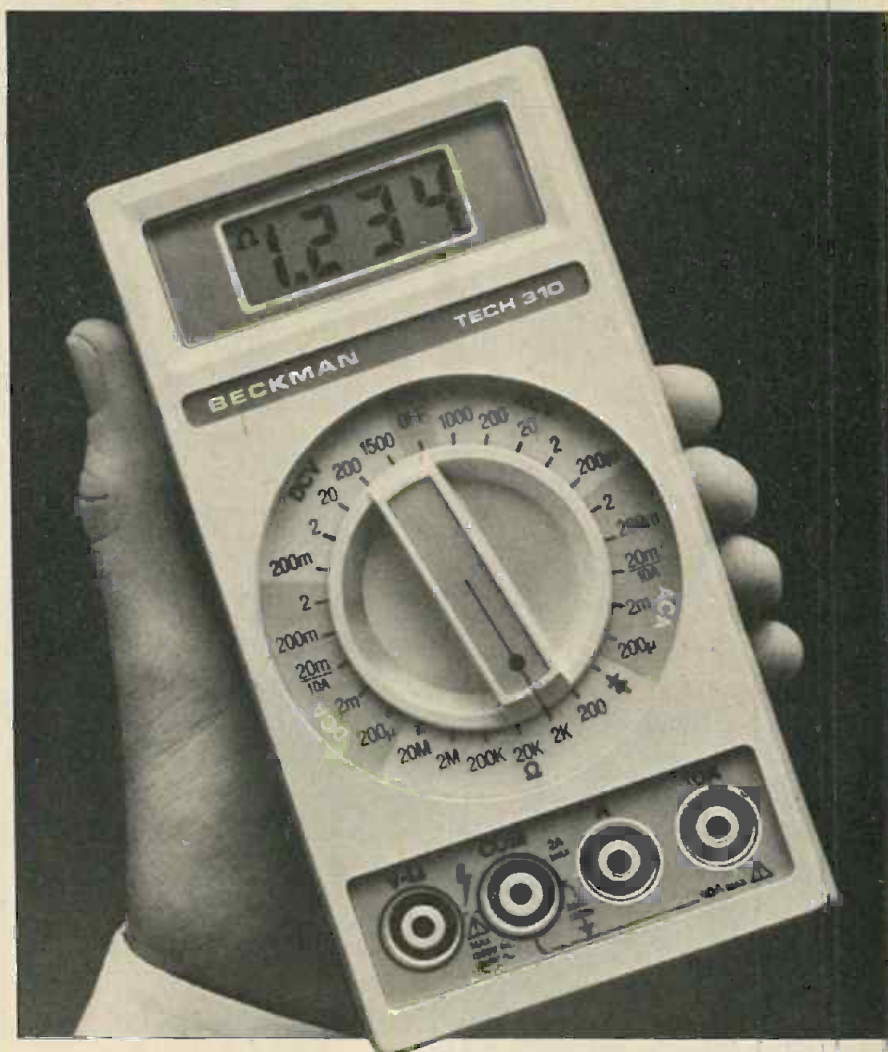
CASSETTE TAPES, is a 6-page color brochure featuring the FX-I ferric oxide tape with normal bias and 120 μ s equalization, and the FX-II Berridox with high bias and 70 μ s equalization. It includes detailed descriptions of the tapes, specifications, test conditions, and graphs showing frequency response and distortion characteristics.—Fuji Photo Film U.S.A., Inc., Magnetic Tape Div., 350 5th Ave., New York, NY 10001.

CIRCLE 149 ON FREE INFORMATION CARD

SOFTWARE CATALOG, 32 pages, lists over 300 programs for the PET, Apple, and TRS-80 micro-computers, covering a wide range of applications from science, education, and business, to entertainment and use in the home. Included for each program listed is a description of its contents, a photo of the computer screen during operation, and specs for system and memory. Also provided is a cross-reference of contents by use and an index of software for each system.—Instant Software, Inc., Catalog Dept., Peterborough, NH 03458.

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NETWORKS

continued from page 71

a feature called CHAT. The CHAT program allows one user to communicate directly with another. To use it, the word CHAT is typed followed by the account number of the party being called. Anything typed after that appears on the called party's screen and if he wishes to talk to you all *he has to do* is type CHAT and the conversation can begin.

Other information services offered by The Source include directories of emergency telephone number and toll-free "800" numbers, a discount shopping service, a guide to restaurants (with ratings) and wines.

The Source also offers subscribers free membership in the Travel Club, which allows the user to make airline, hotel and car rental reservations from his own home, with all transactions automatically billed to his credit card.

CCBB's are very popular

While The Source and MicroNET are growing in popularity because of all the services they offer—with more appearing every day—many hobbyists are finding that they would rather communicate with other computer users simply by means of Computer Community Bulletin Boards (CCBB's). Currently there are well over 100 computer bulletin boards set up throughout the country. These are operated by a variety of people ranging from individuals to computer stores, computer clubs and even manufacturers. There is no fee for the use of these bulletin boards and anyone may post or read messages. The limitations of these bulletin boards, however, is that they are *just that*, bulletin boards, and no two-way chatting nor can CB-like communications be

FOR MORE INFORMATION

You can obtain further information about getting your computer "on-line" to these information utilities by writing or circling the corresponding numbers on the Free Information Card inside the back cover.

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CompuServe (MicroNET)
Personal Computing Division,
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5000 Arlington Centre Blvd.
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rently there are well over 100 computer bulletin boards set up throughout the country. These are operated by a variety of people ranging from individuals to computer stores, computer clubs and even manufacturers. There is no fee for the use of these bulletin boards and anyone may post or read messages. The limitations of these bulletin boards, however, is that they are *just that*, bulletin boards, and no two-way chatting nor can CB-like communications be

established. Another big disadvantage is that if the bulletin board is not local, you have to pay for the long distance call, something which is not necessary on the information utility networks since they have exchanges in most major cities. Still, computer bulletin boards are growing in popularity very rapidly.

These bulletin boards are not an expensive proposition to get started. All it takes is a home computer, a modem and some software. One company offers bulletin board software for the Apple computer for only \$65. This will perform all the tasks necessary to convert an Apple into a community bulletin board. Programs for other computers are comparably priced.

A special consideration

If you are going to be using the information utilities regularly, or setting up your own computer community bulletin board, you might want to consider having another telephone line installed. The reason for this is that once you start, you will be surprised at how much time you spend on these various systems and pretty soon your friends will be telling you that it's impossible to get you because the phone is always busy. Also, your family may object to not being able to use the telephone. RE

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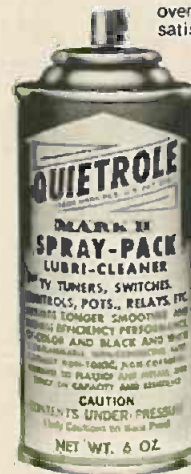
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in the amateur 40-meter band. For example, a European broadcaster wishing to use a frequency in that band to broadcast to the Americans, could schedule a transmission during prime time in the Americas in a westward direction. In registering the frequency, the broadcaster could show its target area as Australia, and transmit in English. If the signal just happened to cross the Americas—why, that would simply be a coincidence. The amateurs, in light of the "contrants" footnote, would have little recourse.

As a result of the above, it is feared that some degradation of the 40-meter band is inevitable when the Final Acts come into force.

AM broadcasting

In the western hemisphere the AM band was expanded from the present 1605- to 1705-kHz. The band from 1605- to 1625-kHz will be allocated exclusively to broadcasting, and remainder to be shared with LORAN services. The additional frequency space is to become available after a western-hemisphere regional AM Broadcasting conference to be held by 1985 which will plan the use of the band.

The extension of the AM bands from 1605- to 1705-kHz was consistent with United States policy to increase the number of stations operating on medium wave. In particular, it is expected that one result of that expansion will be a significant increase in the number of minority owners operating AM stations. Specific frequency assignments will be made at the planning conference.

Space services

WARC-79 recommended the convening of a Conference to plan the use of various space services, and for the use of geostationary satellites. The developing countries are in favor of planning that would guarantee all countries orbital slots and the necessary frequencies to go with them. Some developing countries fear that unless such planning takes place they will be frozen out of orbital slots and spectrum space permanently. It has been the position of the United States that such planning is wasteful because it would, in effect, permit both orbital slots and frequencies to lie fallow while countries to whom these had been assigned developed the technology and economic wherewithal to initiate space services. The United States supported the concept of equal access by all countries, and the issue will be discussed further at the upcoming space conference.

WARC-79 also approved a more than threefold increase in the number of

continued on page 110



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ELF II add-ons already include the ELF II Light Pen and the amazing ELF BUG Monitor—two extremely recent breakthroughs that have not yet been duplicated by any other manufacturer.

The ELF BUG Monitor lets you debug programs with lightning speed because the key to debugging is to know what's inside the registers of the microprocessor. And, with the ELF BUG Monitor, instead of single stepping through your programs, you can now display the entire contents of the registers on your TV screen. You find out immediately what's going on and can make any necessary changes.

The incredible ELF II Light Pen lets you write or draw anything you want on a TV screen with just a wave of the "magic wand." Netronics has also introduced the ELF II Color Graphics & Music System—more breakthroughs that ELF II owners were the first to enjoy!

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ELF II's Assembler translates assembly language programs into hexadecimal machine code for ELF II use. The Assembler features mnemonic abbreviations rather than numerics so that the instructions on your programs are easier to read—this is a big help in catching errors.

ELF II's Disassembler takes machine code programs and produces assembly language source listings. This helps you understand the programs you are working with... and improve them when required.

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CIRCLE 10 ON FREE INFORMATION CARD

WARC-79

continued from page 409

fixed and broadcast satellites that will be able to operate in the 12 GHz portion of the spectrum in the western hemisphere.

The 11.7- to 12.1-GHz band will be allocated to the Fixed Satellite Service (space-to-earth) shared with other services; the 12.0- to 12.7-GHz band will be allocated to broadcasting and broadcasting satellites, shared with other services. The specific frequencies to be assigned to the broadcasting satellite service will be allocated at a Conference scheduled to be held in 1983. That will be followed by a general satellite conference as mentioned above.

The overriding issue of the 80's will be the movement on the part of developing countries to plan the assignment and use of orbital slots and frequencies in such a way as to assure all countries an equal "slice of the pie." WARC-79 did not address that issue completely, but only deferred it to subsequent space conferences which will be held in this decade. Major battles on the issue of equal rights may loom ahead.

R-E

OSCILLOSCOPE

continued from page 56

uator switch S403 at 0.4 V/div, connect a 20-kHz squarewave to the external horizontal input and adjust R230 so the display consists of two dots on the screen. Misadjustment will cause "tails" at the outside or inside of the dots indicating overshoot or rounding. Now apply a 1.41-volt RMS (4.0 V P-P) 100-Hz sine wave and adjust R226 for a ten-division horizontal line. Change S403 to 2 V/div and apply a 1-kHz squarewave, adjusting C403 for two dots with no tails as above.

Sweep: First set SWEEP LENGTH control R325 for an 11-division horizontal line. Then, with variable SWEEP TIME control R317 at minimum resistance and a 60-Hz line display, set SWEEP RANGE switch S304 to 4 ms/div and adjust SWEEP CALIBRATE control R319 so two complete cycles occupy 8.33 divisions. Now display a 100-kHz squarewave, set S304 to 1µs/div, and adjust C314 for one full cycle over ten divisions. Finally, vary the generator frequency slowly. If double traces appear at the right of the screen it will be necessary to lower the value of R327 to hold off trigger during retrace. If R327 is too low, the 555 will not trigger at all.

Now that the scope is calibrated, it's ready to be put into active duty on your workbench. You should recalibrate the scope periodically to be sure of optimum performance, but the scope should provide years of trouble free service. R-E

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THE RADAR DETECTOR

I should like to comment on the letter, "Radar Detector," by John W. Ecklin, which appeared in your June 1979 issue.

When Mr. Eckland stated that we have the "erroneous idea that not even light can travel faster than 186,000 miles-per-second or c," he said a mouthful. Scientists across the country are in hot debate, and are doing intense research, on the possibilities of mass and/or energy moving at a speed greater than that of light, or any known electromagnetic energy for that matter.

In his theory of relativity, Albert Einstein stated that no object can exceed the speed of light. And since energy is directly related to an object (mass) by the equation $E=mc^2$ we can see that energy in the form of electromagnetic radiation would also be subject to the limit of the speed of light.

Mr. Eckland mentioned that the electromagnetic radiation would pick up the speed of its source, and thus gain additional velocity. He also asked how the Doppler effect could occur unless the speed of the electromagnetic radiation—in this case radar waves—picked up or lost some speed because of its source's velocity.

The Doppler effect is directly related to time, and not the velocity of the radiation but the velocity of the source. Suppose that a radiation source were moving a hundred miles-per-second forward and the radiation were moving c (the speed of light) in the opposite direction. When the radiation was picked up by a detector, the detector would register a frequency change—thus the Doppler effect. But in no way was the radiation's velocity increased or decreased; it merely arrived later than it would have if it had been moving toward the detector. And since time is directly related to frequency in this case, the Doppler effect can occur without an increase in the velocity of the radiation.

To put it simply: An electromagnetic wave leaving its source does not gain additional speed, no matter how fast its source is moving forward. The velocity of the source only determines *when* the wave will arrive with reference to the source's velocity. A star is a moving electromagnetic source. When it emits electromagnetic radiation, that radiation leaves the star at c, no matter what the velocity of the star itself may be—even if it were a million miles a second, the wave remains constant at c.

By the way, there is one thing that can exceed the speed of light—or possibly is not governed by any laws of motion, energy, mass, etc., and that is—Time. Figure that one out.

As the saying goes: "It's all in your relative position-Relativity."

MICHAEL A. ALVARADO II,
Norwalk, CT.

THERMO-ACTIVE DRUGS

In reference to "The Fight Against Cancer:" (September 1979) *RF hyperthermia* is also used in conjunction with *thermo-active drugs*. Thermo-active drugs become activated at slightly higher-than-normal body temperatures. The drugs are injected into the bloodstream; then the cancerous area is heated via RF-hyperthermia methods.

Note that the drugs are only activated in the heated cancerous area.

Indeed, as you say, it is experimental—but it shows great promise! I read your editorial every month.

ROBBIE CAVE
Princeton, Texas

OOOOOOOOPS!

Sharp-eyed Eloy Marez, of *Radio Control Modeler Magazine* spotted two errors in digital clock article in the February 1980 issue. In Fig. 1, the emitter of transistor Q1 should connect to the line common to the cathodes of all the LED's; not to the emitter of Q8. In the component placement layout, Fig. 3, add a jumper from the open pad at the emitter of Q1 across to the pad on the

line connecting the cathodes of all the LED's. Thanks Eloy.

CLOCK IC's

Earl Savage's article on the use of clock IC's for long-term alarm and other specialized purposes was very good. It should be noted, however, that the outputs cannot be decoded by the methods shown in the August issue if the displays are multiplexed. Most of the clock IC's—especially the cheaper units—are multiplexed. Decoding those outputs is extremely complicated, if not impossible.

Some of the newer IC's are direct drive and can be used as he describes.

WARREN H. CLARK
Balboa, CA







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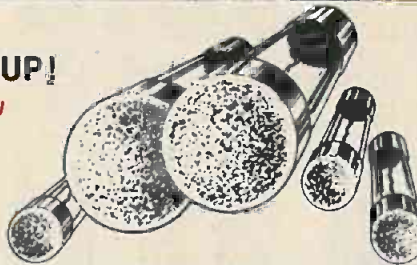
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116	.20	183	3.75	284	4.30	612	.35	749	2.90	1003	1.30	1046	3.20	1096	3.85	1142	1.40
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129	2.20	197	1.50	295	.60	714	1.50	802	8.80	1014	1.90	1060	1.30	1106	2.70	1160	2.30
130	1.00	198	1.50	297	.55	715	3.20	803	4.80	1016	2.20	1061	3.95	1108	2.80	1161	6.60
131	1.00	199	.30	298	.70	718	1.50	804	4.20	1019	1.30	1062	4.20	1109	3.90	1162	2.40
132	.60	220	1.60	299	.75	719	1.50	805	3.20	1020	2.20	1063	4.90	1110	7.60	1163	3.90
133	.60	221	1.40	300	.70	720	1.50	808	3.80	1021	2.20	1067	5.70	1115	2.40	1164	5.40
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158	.40	231	4.90	310	7.40	725	1.50	824	2.50	1028	9.20	1073	1.60	1123	6.10	1169	3.00
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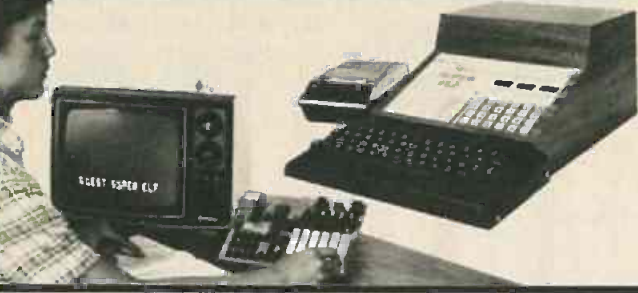
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Remember, other computers only offer Super Elf features at additional cost or not at all. Compare before you buy. Super Elf Kit \$106.95, High address option \$8.95, Low address option \$9.95. Custom Cabinet with drilled and labeled plexiglass front panel \$24.95. Expansion Cabinet with room for 4 S-100 boards \$41.00. NiCad Battery Memory Saver Kit \$6.95. All lots and options also completely assembled and tested. Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for \$12.00 per year. Issues 1-12 bound \$16.50.

An RCA 1861 video graphics chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a speaker system included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

Tiny Basic Cassette \$10.00, on ROM \$38.00, original Elf kit board \$14.95, 1802 software; Moewis Video Graphics \$5.50, Games and Music \$3.00, Chip 8 Interpreter \$5.50.

Super Expansion Board with Cassette Interface \$89.95
This is truly an astounding value! This board has been designed to allow you to decide how you want it optioned. The Super Expansion Board comes with 4K of low power RAM fully addressable anywhere in 64K with built-in memory protect and a cassette interface. Provisions have been made for all other options on the same board and it fits neatly into the hardware cabinet alongside the Super Elf. The board includes slots for up to 6K of EPROM (2708, 2758, 2716 or TI 2716) and is fully socketed. EPROM can be used for the monitor and Tiny Basic or other purposes.

subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the Super Expansion Board and Super Monitor the monitor is up and running at the push of a button.

Other on board options include Parallel Input and Output Ports with full handshake. They allow easy connection of an ASCII keyboard to the input port. RS 232 and 20 ma Current Loop for teletype or other device are on board and if you need more memory there are two S-100 slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. Parallel I/O Ports \$9.85, RS 232 \$4.50, TTY 20 ma I/F \$1.95, S-100 \$4.50. A 50 pin connector set with ribbon cable is available at \$15.25 for easy connection between the Super Elf and the Super Expansion Board.

A 1K Super ROM Monitor \$19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette reader/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with

Power Supply Kit for the complete system (see Multi-volt Power Supply below).

Same day shipment. Firstline parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

INTEGRATED CIRCUITS

74001	LM3236	5	85	CD4027	1.28
74002	LM3237	17	85	CD4027	1.10
74003	LM3238	15	50	CD4023	74
74004	LM3239	18	80	CD4024	73
74005	LM3240	18	80	CD4025	73
74006	LM3241	18	80	CD4026	73
74007	LM3242	18	80	CD4027	66
74008	LM3243	18	80	CD4028	66
74009	LM3244	18	80	CD4029	66
74010	LM3245	18	80	CD4030	66
74011	LM3246	18	80	CD4031	66
74012	LM3247	18	80	CD4032	66
74013	LM3248	18	80	CD4033	66
74014	LM3249	18	80	CD4034	66
74015	LM3250	18	80	CD4035	66
74016	LM3251	18	80	CD4036	66
74017	LM3252	18	80	CD4037	66
74018	LM3253	18	80	CD4038	66
74019	LM3254	18	80	CD4039	66
74020	LM3255	18	80	CD4040	66
74021	LM3256	18	80	CD4041	66
74022	LM3257	18	80	CD4042	66
74023	LM3258	18	80	CD4043	66
74024	LM3259	18	80	CD4044	66
74025	LM3260	18	80	CD4045	66
74026	LM3261	18	80	CD4046	66
74027	LM3262	18	80	CD4047	66
74028	LM3263	18	80	CD4048	66
74029	LM3264	18	80	CD4049	66
74030	LM3265	18	80	CD4050	66
74031	LM3266	18	80	CD4051	66
74032	LM3267	18	80	CD4052	66
74033	LM3268	18	80	CD4053	66
74034	LM3269	18	80	CD4054	66
74035	LM3270	18	80	CD4055	66
74036	LM3271	18	80	CD4056	66
74037	LM3272	18	80	CD4057	66
74038	LM3273	18	80	CD4058	66
74039	LM3274	18	80	CD4059	66
74040	LM3275	18	80	CD4060	66
74041	LM3276	18	80	CD4061	66
74042	LM3277	18	80	CD4062	66
74043	LM3278	18	80	CD4063	66
74044	LM3279	18	80	CD4064	66
74045	LM3280	18	80	CD4065	66
74046	LM3281	18	80	CD4066	66
74047	LM3282	18	80	CD4067	66
74048	LM3283	18	80	CD4068	66
74049	LM3284	18	80	CD4069	66
74050	LM3285	18	80	CD4070	66
74051	LM3286	18	80	CD4071	66
74052	LM3287	18	80	CD4072	66
74053	LM3288	18	80	CD4073	66
74054	LM3289	18	80	CD4074	66
74055	LM3290	18	80	CD4075	66
74056	LM3291	18	80	CD4076	66
74057	LM3292	18	80	CD4077	66
74058	LM3293	18	80	CD4078	66
74059	LM3294	18	80	CD4079	66
74060	LM3295	18	80	CD4080	66
74061	LM3296	18	80	CD4081	66
74062	LM3297	18	80	CD4082	66
74063	LM3298	18	80	CD4083	66
74064	LM3299	18	80	CD4084	66
74065	LM3300	18	80	CD4085	66
74066	LM3301	18	80	CD4086	66
74067	LM3302	18	80	CD4087	66
74068	LM3303	18	80	CD4088	66
74069	LM3304	18	80	CD4089	66
74070	LM3305	18	80	CD4090	66
74071	LM3306	18	80	CD4091	66
74072	LM3307	18	80	CD4092	66
74073	LM3308	18	80	CD4093	66
74074	LM3309	18	80	CD4094	66
74075	LM3310	18	80	CD4095	66
74076	LM3311	18	80	CD4096	66
74077	LM3312	18	80	CD4097	66
74078	LM3313	18	80	CD4098	66
74079	LM3314	18	80	CD4099	66
74080	LM3315	18	80	CD4100	66
74081	LM3316	18	80	CD4101	66
74082	LM3317	18	80	CD4102	66
74083	LM3318	18	80	CD4103	66
74084	LM3319	18	80	CD4104	66
74085	LM3320	18	80	CD4105	66
74086	LM3321	18	80	CD4106	66
74087	LM3322	18	80	CD4107	66
74088	LM3323	18	80	CD4108	66
74089	LM3324	18	80	CD4109	66
74090	LM3325	18	80	CD4110	66
74091	LM3326	18	80	CD4111	66
74092	LM3327	18	80	CD4112	66
74093	LM3328	18	80	CD4113	66
74094	LM3329	18	80	CD4114	66
74095	LM3330	18	80	CD4115	66
74096	LM3331	18	80	CD4116	66
74097	LM3332	18	80	CD4117	66
74098	LM3333	18	80	CD4118	66
74099	LM3334	18	80	CD4119	66
74100	LM3335	18	80	CD4120	66
74101	LM3336	18	80	CD4121	66
74102	LM3337	18	80	CD4122	66
74103	LM3338	18	80	CD4123	66
74104	LM3339	18	80	CD4124	66
74105	LM3340	18	80	CD4125	66
74106	LM3341	18	80	CD4126	66
74107	LM3342	18	80	CD4127	66
74108	LM3343	18	80	CD4128	66
74109	LM3344	18	80	CD4129	66
74110	LM3345	18	80	CD4130	66
74111	LM3346	18	80	CD4131	66
74112	LM3347	18	80	CD4132	66
74113	LM3348	18	80	CD4133	66
74114	LM3349	18	80	CD4134	66
74115	LM3350	18	80	CD4135	66
74116	LM3351	18	80	CD4136	66
74117	LM3352	18	80	CD4137	66
74118	LM3353	18	80	CD4138	66
74119	LM3354	18	80	CD4139	66
74120	LM3355	18	80	CD4140	66
74121	LM3356	18	80	CD4141	66
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74123	LM3358	18	80	CD4143	66
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74125	LM3360	18	80	CD4145	66
74126	LM3361	18	80	CD4146	66
74127	LM3362	18	80	CD4147	66
74128	LM3363	18	80	CD4148	66
74129	LM3364	18	80	CD4149	66
74130	LM3365	18	80	CD4150	66
74131	LM3366	18	80	CD4151	66
74132	LM3367	18	80	CD4152	66
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74134	LM3369	18	80	CD4154	66
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74137	LM3372	18	80	CD4157	66
74138	LM3373	18	80	CD4158	66
74139	LM3374	18	80	CD4159	66
74140	LM3375	18	80	CD4160	66
74141	LM3376	18	80	CD4161	66
74142	LM3377	18	80	CD4162	66
74143	LM3378	18	80	CD4163	66
74144	LM3379	18	80	CD4164	66
74145	LM3380	18	80	CD4165	66
74146	LM3381	18	80	CD4166	66
74147	LM3382	18	80	CD4167	66
74148	LM3383	18	80	CD4168	66
74149	LM3384	18	80	CD4169	66
74150	LM3385	18	80	CD4170	66
74151	LM3386	18	80	CD4171	66
74152	LM3387	18	80	CD4172	66
74153	LM3388	18	80	CD4173	66
74154	LM3389	18	80	CD4174	66
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74156	LM3391	18	80	CD4176	66
74157	LM3392	18	80	CD4177	66
74158	LM3393	18	80	CD4178	66
74159	LM3394	18	80	CD4179	66
74160	LM3395	18	80	CD4180	66
74161	LM3396	18	80	CD4181	66
74162	LM3397	18	80	CD4182	66
74163	LM3398	18	80	CD4183	66
74164	LM3399	18	80	CD4184	66
74165	LM3400	18	80	CD4185	66
74166	LM3401	18	80	CD4186	66
74167	LM3402	18	80	CD4187	66
74168	LM3403	18	80	CD4188	66
74169	LM3404	18	80	CD4189	66
74170	LM3405	18	80	CD4190	66
74171	LM3406	18	80	CD4191	66
74172	LM3407	18	80	CD4192	66
74173	LM3408	18	80	CD4193	66
74174	LM3409	18	80	CD4194	66

7400 74LS00

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SN7401N	22	SN74125N	39	74LS01N	20	74LS166N	2.49
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SN7403N	22	SN74128N	59	74LS03N	20	74LS169N	1.89
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SN7413N	29	SN74148N	1.20	74LS15A	39	74LS193N	.99
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SN7425N	20	SN74157H	.60	74LS32N	39	74LS242N	2.29
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SN7442N	87	SN74172N	5.95	74LS74N	50	74LS259N	2.99
SN7443N	79	SN74173N	.79	74LS75N	88	74LS260N	.99
SN7444N	79	SN74174N	.99	74LS78N	45	74LS261N	2.49
SN7445N	79	SN74175H	.99	74LS79N	65	74LS261N	.99
SN7446N	79	SN74176H	.85	74LS83AN	90	74LS273N	1.75
SN7447N	59	SN74177H	.85	74LS85N	1.10	74LS275N	4.40
SN7448N	79	SN74179H	.85	74LS86N	.45	74LS279N	.99
SN7450N	23	SN74180H	.70	74LS89N	75	74LS283N	1.10
SN7451N	23	SN74181H	.75	74LS92N	79	74LS290N	1.29
SN7453N	23	SN74182H	.75	74LS93N	75	74LS292N	1.99
SN7454N	23	SN74184H	.95	74LS95N	88	74LS295N	1.10
SN7455N	23	SN74185H	.95	74LS96N	98	74LS296N	1.29
SN7456N	23	SN74186H	1.95	74LS107N	45	74LS324H	1.79
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SN7473N	36	SN74190N	1.15	74LS113N	49	74LS352N	1.65
SN7474N	36	SN74192N	.85	74LS114N	55	74LS353N	1.65
SN7475N	36	SN74193N	.85	74LS122N	55	74LS363N	1.40
SN7476N	36	SN74194H	.95	74LS123N	65	74LS366N	1.40
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SN7482N	1.10	SN74198N	1.39	74LS132N	70	74LS373N	2.75
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SN7485N	85	SN74211N	1.39	74LS136N	.89	74LS375H	.99
SN7486N	30	SN74251N	.95	74LS137N	.89	74LS377N	1.55
SN7489N	1.75	SN74273N	8.05	74LS145N	1.25	74LS385N	1.65
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SN7491N	39	SN74281H	2.15	74LS151N	1.85	74LS386N	.99
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SN7493N	49	SN74285H	3.90	74LS164N	2.49	74LS396N	1.70
SN7494N	72	SN74290N	1.25	74LS166N	1.19	74LS399N	2.95
SN7495N	65	SN74298N	.95	74LS169N	.99	74LS424N	2.05
SN7496N	72	SN74299H	.99	74LS176N	.99	74LS426H	1.75
SN7497N	3.10	SN74366H	.68	74LS156N	75	74LS426H	2.29
SN74100N	99	SN74367H	.79	74LS160N	.98	81LS95N	1.99
SN74107N	32	SN74369H	.79	74LS161N	1.15	81LS96N	1.99
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ATARI 800 Includes: Computer Console, BASIC Lang. Cartridge, Education System Master Cartridge, BASIC Language Programming Manual, 800 Operator's Manual w/Plotbook, Atari 410 Program Recorder, 8K RAM Module, Power Supply, TV Switch Box.

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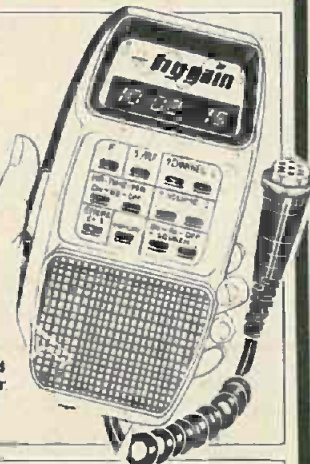
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LM 308H	.85	LM 1310	1.75
LM 308	.85	LM 1391	2.00
LM 310	.80	LM 1414	1.50
LM 311H	.80	LM 1800	.70
LM 317K	2.25	LM 1808	2.50
LM 318H	1.10	LM 1829	2.50
LM 320K 15	1.10	LM 1828	2.00
LM 320K 12	1.10	LM 1830	2.25
LM 324	1.10	LM 1841	2.50
LM 325	1.35	LM 1848	2.00
LM 339J	1.00	LM 1889	2.50
LM 340K 12	1.00	LM 2111	1.15
LM 341P 12	.80	LM 2113	1.75
LM 343H	3.50	LM 2907	2.00
LM 373	2.50	LM 2917	2.00
LM 377	2.00	LM 3046	1.50
LM 380	1.00	LM 3054	1.50
LM 381	1.25	LM 3054	2.00
LM 384	1.50	LM 3065	2.50
LM 386	1.20	LM 3057	2.50
LM 389	1.20	LM 3070	2.50
LM 390	1.65	LM 3071	2.00
LM 746	2.50	LM 3075	1.25
LM 748CN	.30	LM 3089	1.25

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25A 473	.45	.55	.80	25B 346	.30	.35	.40	25C 693F	20	27	30	25D 1226A	.50	.55	.60	25D 234	.60	.70	.80
25A 483	2.00	2.25	2.50	25B 357	1.10	1.25	1.40	25C 696	1.00	1.20	1.30	25D 1237	1.80	2.00	2.25	25D 235	.50	.70	.80
25A 484	1.50	1.75	1.95	25B 368B	1.80	2.00	2.25	25C 708	1.30	1.45	1.60	25D 1239	2.20	2.70	2.90	25D 261	.35	.40	.45
25A 485	1.40	1.60	1.80	25B 379	.70	.80	.90	25C 710	.30	.27	.30	25D 1279	.50	.55	.60	25D 287	2.50	2.70	2.90
25A 489	1.10	1.25	1.40	25B 381	.30	.35	.40	25C 711	.20	.27	.30	25D 1306	1.30	1.45	1.60	25D 300	4.50	5.00	5.60
25A 490	.70	.80	.90	25B 400	.30	.35	.40	25C 712	.20	.27	.30	25D 1307	1.90	2.10	2.40	25D 313	.60	.70	.80
25A 493	.45	.53	.59	25B 405	.30	.35	.40	25C 715	.30	.35	.40	25D 1310	.20	.27	.30	25D 315	.80	.70	.80
25A 495	.30	.35	.40	25B 407	.80	.90	1.00	25C 717	.35	.40	.45	25D 1312	.20	.27	.30	25D 325	.60	.70	.80
25A 496	.50	.64	.70	25B 415	.30	.35	.40	25C 730	1.00	1.20	1.30	25D 1316	4.20	4.40	4.80	25D 350	3.80	4.00	4.40
25A 497	1.00	1.20	1.30	25B 434	.80	.90	1.00	25C 731	2.50	2.70	2.90	25D 1317	.20	.27	.30	25D 380	5.20	5.40	5.95
25A 505	.50	.64	.70	25B 435	.90	1.10	1.20	25C 732	.20	.27	.30	25D 1318	.35	.40	.45	25D 381	.50	1.00	1.10
25A 509	.30	.35	.40	25B 440	.40	.53	.59	25C 733	.20	.27	.30	25D 1325A	6.50	6.90	7.60	25D 424	3.80	4.00	4.40
25A 525	.50	.64	.70	25B 449	1.30	1.45	1.60	25C 734	.20	.27	.30	25D 1327	.20	.27	.30	25D 425	2.90	3.20	3.40
25A 530	1.50	1.70	1.90	25B 461	.90	1.10	1.20	25C 734	.20	.27	.30	25D 1330	.50	.55	.60	25D 426	3.10	3.30	3.60
25A 537A	1.50	1.70	1.90	25B 463	.90	1.10	1.20	25C 735	.20	.27	.30	25D 1332	.50	.55	.60	25D 427	1.80	2.00	2.25
25A 539	.40	.45	.50	25B 471	1.10	1.25	1.40	25C 738	.20	.27	.30	25D 1335	.50	.55	.60	25D 525	.90	1.10	1.20
25A 545	.45	.53	.59	25B 472	2.70	2.50	2.80	25C 756	1.50	1.80	2.00	25D 1342	.45	.53	.59	25D 526	.60	.70	.80
25A 561	.30	.35	.40	25B 473	.80	.90	1.00	25C 756A	1.50	1.80	2.00	25D 1344	.45	.53	.59	25K 19BL	.50	.55	.60
25A 562	.30	.35	.40	25B 474	.70	.80	.90	25C 763	.35	.40	.45	25D 1358	4.20	4.40	4.80	25K 22Y	1.40	1.60	1.80
25A 564A	.20	.27	.30	25B 481	.90	1.10	1.20	25C 763	.35	.40	.45	25D 1359	.30	.35	.40	25K 39	.90	1.10	1.20
25A 565	.70	.80	.90	25B 482	.60	.70	.80	25C 771	.30	.35	.40	25D 1360	.50	.55	.60	25K 40	.90	1.10	1.20
25A 566	2.50	2.70	3.00	25B 509	.80	.90	1.00	25C 774	1.00	1.20	1.30	25D 1362	.35	.40	.45	25K 41	1.30	1.45	1.60
25A 606	1.00	1.20	1.30	25B 511	1.10	1.20	1.30	25C 775	1.40	1.60	1.80	25D 1364	.35	.40	.45	25K 45	1.30	1.45	1.60
25A 607	1.10	1.25	1.40	25B 514	.70	.80	.90	25C 776	2.00	2.20	2.50	25D 1367	-9.20	3.40	3.70	AN 203	1.40	1.60	1.80
25A 624	.70	.80	.90	25B 517	.70	.80	.90	25C 777	2.00	2.20	2.50	25D 1383	.30	.35	.40	AN 2110	1.50	1.70	1.90
25A 627	3.10	3.30	3.60	25B 523	.70	.80	.90	25C 778	2.00	2.20	2.50	25D 1384	.35	.40	.45	AN 239	.45	.53	.59
25A 628	.30	.35	.40	25B 526C	.70	.80	.90	25C 781	1.90	2.10	2.40	25D 1386	.45	.53	.59	AN 247	2.50	2.70	3.00
25A 634	.40	.45	.50	25B 527	.50	1.10	1.20	25C 783	2.10	2.50	2.80	25D 1398	.70	.80	.90	AN 274	1.50	1.75	1.95
25A 640	.30	.35	.40	25B 528D	.70	.80	.90	25C 784	.30	.35	.40	25D 1400	.35	.40	.45	AN 313	3.00	3.20	3.40
25A 642	.30	.35	.40	25B 529	.70	.80	.90	25C 785	.30	.35	.40	25D 1402	3.00	3.20	3.40	AN 315	1.80	2.00	2.25
25A 643	.30	.40	.45	25B 530	3.20	3.40	3.70	25C 789	.90	1.00	1.00	25D 1403	3.20	3.40	3.70	BA 511A	1.60	2.00	2.25
25A 653	1.90	2.10	2.40	25B 531	1.80	2.00	2.25	25C 790	1.00	1.00	1.00	25D 1407	.30	.35	.40	BA 521	1.90	2.00	2.10
25A 659	.35	.40	.45	25B 536	1.00	1.20	1.30	25C 791	2.00	2.20	2.50	25D 1419	.50	.70	.80	HA 1151	1.50	1.75	1.95
25A 661	.50	.64	.70	25B 537	1.00	1.20	1.30	25C 799	2.00	2.20	2.50	25D 1444	1.00	1.80	2.00	HA 1156W	1.60	1.80	2.00
25A 663	3.65	3.80	4.20	25B 539	3.20	3.40	3.70	25C 828	.20	.27	.30	25D 1445	2.00	2.70	2.90	HA 1306W	2.00	2.20	2.50
25A 666	.35	.40	.45	25B 541	3.20	3.40	3.70	25C 829	.20	.27	.30	25D 1447	.60	.70	.80	HA 1339	2.50	2.70	3.00
25A 671	.80	1.00	1.00	25B 544	5.00	6.00	6.60	25C 830H	2.50	2.70	3.00	25D 1448	.50	.55	.60	HA 1339A	2.50	2.70	3.00
25A 672	.30	.35	.40	25B 556	3.00	3.40	3.70	25C 831	.35	.40	.45	25D 1451	1.30	1.40	1.50	HA 1366W	2.50	2.70	3.00
25A 673	.35	.40	.45	25B 557	2.10	2.50	2.80	25C 839	2.00	2.20	2.50	25D 1454	3.20	3.40	3.70	HA 1366WR	2.50	2.70	3.00
25A 678	.35	.40	.45	25B 561B	.35	.40	.45	25C 853	.70	.80	.90	25D 1475	.60	.70	.80	LA 4031P	1.80	2.00	2.25
25A 679	4.20	4.40	4.90	25B 564	.40	.53	.59	25C 867	4.20	4.40	4.90	25D 1509	.50	.55	.60	LA 4032P	1.80	2.00	2.25
25A 680	4.20	4.40	4.90	25B 595	1.10	1.25	1.40	25C 867A	4.20	4.40	4.90	25D 1519	.60	.70	.80	LA 4051P	1.80	2.00	2.25
25A 682	.80	.90	1.00	25B 599	1.10	1.25	1.40	25C 870	.35	.40	.45	25D 1527	.60	.70	.80	LA 4000	.90	2.10	2.40
25A 683	.80	.90	1.00	25B 600	5.00	6.00	6.60	25C 871	.35	.40	.45	25D 1584	6.00	6.30	7.00	LA 4420	2.00	2.20	2.50
25A 684	.35	.40	.45	25C 183	.40	.53	.59	25C 895	4.20	4.40	4.90	25D 1586	6.00	6.30	7.00	LA 4420	2.00	2.20	2.50
25A 695	.40	.53	.59	25C 184	.40	.53	.59	25C 897	2.00	2.20	2.50	25D 1624	.60	.70	.80	LD 3001	2.00	2.20	2.50
25A 697	.40	.53	.59	25C 281	.30	.35	.40	25C 898	2.50	2.70	3.00	25D 1626	.60	.70	.80	MS 1513L	2.00	2.20	2.50
25A 699A	.50	.64	.70	25C 283	.40	.53	.59	25C 900	2.00	2.20	3.00	25D 1628	.60	.70	.80	STK 011	3.80	4.00	4.40
25A 705	.40	.53	.59	25C 284	.80	.90	1.00	25C 923	.70	.80	.90	25D 1634	.70	.80	.90	STK 013	7.50	8.00	8.90
25A 706	1.00	1.10	1.20	25C 285	1.50	1.60	1.80	25C 917	.70	.80	.90	25D 1637	.70	.80	.90	STK 015	4.20	4.40	4.90
25A 715	.60	.70	.80	25C 352A	2.00	2.20	2.50	25C 930	.70	.80	.90	25D 1647	.70	.80	.90	STK 435	4.50	5.00	5.60
25A 719	.30	.35	.40	25C 353A	1.80	1.60	1.80	25C 941	.20	.27	.30	25D 1674	3.00	3.20	3.40	STK 435M	7.30	8.00	8.80
25A 720	.30	.35	.40	25C 367	.30	.35	.40	25C 943	.35	.40	.45	25D 1675	.20	.27	.30	TA 7045M	2.00	2.20	2.50
25A 721	.30	.35	.40	25C 369	.30	.35	.40	25C 945	.20	.27	.30	25D 1678	3.10	3.25	3.40	TA 7061AP	.90	1.10	1.20
25A 725	.30	.35	.40	25C 370	.20	.27	.30	25C 959	1.00	1.20	1.30	25D 1681	.30	.35	.40	TA 7062P	2.10	2.20	2.50
25A 726	.30	.35	.40	25C 371	.30	.35	.40	25C 961	.70	.80	.90	25D 1682	.30	.35	.40	TA 7203P	2.50	2.70	2.90
25A 733	.20	.27	.30	25C 372	.20	.27	.30	25C 982	.70	.80	.90	25D 1684	.30	.35	.40	TA 7205P	1.60	1.80	2.00
25A 738	.40	.53	.59	25C 373	.20	.27	.30	25C 983	.50	.64	.70	25D 1708	.30	.35	.40	TA 7310P	3.10	3.55	3.90
25A 740	1.50	1.70	1.90	25C 374	.30	.35	.40	25C 990	.35	.40	.45	25D 1728	.70	.80	.90	TBA 8105H	1.90	2.10	2.40
25A 743A	.85	1.00	1.10	25C 375	.30	.35	.40	25C 992	1.20	1.40	1.50	25D 1730	.45	.53	.59	TC 5080P	5.00	5.20	5.80
25A 744	4.30	4.40	4.90	25C 377	.35	.40	.45	25C 1013	.50	.64	.70	25D 1756	1.60	1.75					

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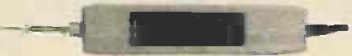
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STRONG, LIFETIME MAGNET

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LOGIC PROBE KIT



SPECIFICATIONS

Input Impedance: 300,000 Ohms.
Thresholds: "Lo" 30%Vcc - "Hi" 70%Vcc
Maximum Speed: 300 nsec., 1.5MHz
Input Protection: ±50VDC continuous 117VAC
for 15 sec.
Power: 30mA @ 5V - 40mA @ 15V - 25V max.
reverse voltage protected; 36" cable with color
coded clips included.
Operating Temp.: 0-50°C.
Dimensions: 5.8L x 1.0W x 0.7D in.
(147 x 25 x 18mm)
Weight: 30 oz. (85 gm)
LPK-1 \$21.95/Kit

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14-PIN CLIP PC-14 \$ 4.50
18-PIN CLIP PC-18 \$ 4.75
24-PIN CLIP PC-24 \$10.00
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Proto Boards

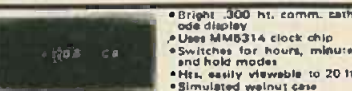


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Jumbo 6-Digit Clock Kit

- Four 6.3" ht. and two .300" ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Includes all components, case and wall transformer.
- Size: 6 1/2" x 3 1/4" x 1 1/4"

JE747 \$29.95



JE701

6-Digit Clock Kit \$19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3 1/2" x 5" x 2 1/4"

JE200 \$14.95



ADAPTER BOARD
-Adapts to JE200-
±5V, ±9V and ±12V

DC/DC converter with +5V input. Toroidal hi-speed switching XMF8. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3 1/4" x 2" x 9/16"

JE205 \$12.95

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8216 Priority Interrupt Controller	5.95	MP-285C User Manual	5.00
8224 8-bit Directional Bus Driver	3.49		
8228 Clock Generator Drivers	4.95		
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8253 Prog. Interval Timer	1.95		
8255 Prog. Parallel I/O (PPI)	1.95		
8257 Prog. DMA Control	19.95		
8259 Prog. Interrupt Control	19.95		
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MC6800CP MPU with Clock and Ram	24.95	2513(3211) Character Generator (lower case)	9.95
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MC6821 Paralle. Inter. Adapt. (MC6820)	7.49	M45200Z 2048 Bit Read Only Memory	1.95
MC6824 Paralle. Interrupt Controller	12.95		
MC6830L8 1024KB Bit ROM (MC6830-B)	14.95		
MC6850 Asynchronous Conv. Adapter	4.95		
MC6852 Synchronous Serial Data Adapt.	9.95		
MC6860 8 8001 Ops. Digital MCODEM	12.95		
MC6862 2400 bps Modem	14.95		
MC6880A Quad 3-State Bus Trans. (MC6780)	2.25		
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Z801780C CPU	\$13.95	1101 256K1 Static	\$1.49
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TMS9902A 16-Bit MPU w/hardware multiply & divide	49.95	2114-3 (1024X4) Static 300ns low power	11.95
		2560K Static	7.95
		3208X1 Dynamic	4.95
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		745200 256X1 Static Tristate	4.95
		83421 256X1 Static	2.95
		UPD414 4K	Dynamic 16 pin
		UPD416 16K	Dynamic 16 pin 250ns
		(8M416)	
		TMS4044 4K	Static
		450K	Static
		TMS4048 1024X4 Static	14.95
		16.384X1 Dynamic 350ns	9.95
		2117 16.384X1 Dynamic	4/1.00
		MM5262 20K1 Dynamic	
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		50 1702A 2048 FAMOS	\$5.95
		50 2764AHEL 18K1 EPROM	59.95
		89 TMS2916 16K1 EPROM	39.95
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		*Requires 3 voltages, -5V, +5V, +12V	
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		UART'S	
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JE600 HEXADECIMAL ENCODER KIT

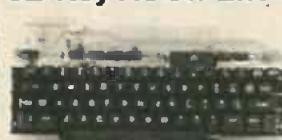
FEATURES:
• Full 8 bit latched output for microprocessor use
• 3 User Define keys with one being bi-stable operation
• Debounce circuit provided for all 19 keys
• LED readout to verify entries
• Easy interfacing with standard 16 pin IC connector
• Only ±5VDC required for operations

FULL 8 BIT LATCHED OUTPUT-19 KEYPAD
The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three additional keys are provided for special operations with only one 4 pinable module available. The 16 pin DIP latched and monitor with LED readouts. Also included is a key entry arrow.

JE600 Hexadecimal Keypad only \$59.95

JE300 \$39.95

62-Key ASCII Encoded Keyboard Kit



The JE610 62-Key ASCII Encoded Keyboard Kit can be interfaced into most any computer system. The JE610 is complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and -12V @ 10mA for operation.

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• Automated zero, offsets and auto-range indicators • 100-mV DC F.S. sensitivity • 1% basic accuracy
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SPECIFICATIONS: DC voltage 500 mV nominal 0.1mV to 1000V; Resistance 0.5k to 10M; AC voltage 100V nominal 100V to 1000V; Frequency 50 Hz to 100 kHz; Duty Cycle 100%; Accuracy: 1% (typ) to 0.5% (typ) for 1000 Hz; DC Current 100 mA nominal 100 mA to 10 A; Accuracy: 1% (typ) to 0.5% (typ) for 1000 Hz; DC Voltage 100V nominal 100V to 1000V; Accuracy: 1% (typ) to 0.5% (typ) for 1000 Hz; DC Current 100 mA nominal 100 mA to 10 A; Accuracy: 1% (typ) to 0.5% (typ) for 1000 Hz; DC Voltage 100V nominal 100V to 1000V; Accuracy: 1% (typ) to 0.5% (typ) for 1000 Hz; DC Current 100 mA nominal 100 mA to 10 A; Accuracy: 1% (typ) to 0.5% (typ) for 1000 Hz.

PART NO.	DESCRIPTION	PRICE
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Data Rate 300 Baud
Data Format Ascii/Decimal/Hex (return to main level required between each character)
Receive Channel Frequencies 2025 Hz for space, 2225 Hz for mark
Transmit Channel Frequencies Switch selectable Low (normal) = 1070 space, 1270 mark, High = 125 space, 2725 mark
Receive Sensitivity -46 dbm accurately coupled
Transmit Level -15 dbm nominal Adjustable from -8 dbm to -20 dbm
Receive Frequency Tolerance Frequency reference automatically adjusts to allow for operation between 1600 Hz and 2400 Hz
Digital Data Interface EIA RS-232C or 20 mA current loop (Receiver is unisolated and non-polar)
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Physical All components mounted on a single 5' by 9' printed circuit board. All components included.
Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope for align.

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23514	14 pin solder tail, 1/4"	1.75	2.10
23520	16 pin solder tail, 1/4"	2.00	2.40
23526	18 pin solder tail, 1/4"	2.25	2.70
23532	24 pin solder tail, 1/4"	3.00	3.60
23538	28 pin solder tail, 1/4"	3.50	4.20
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Part No.	Description	100	1000
23550	8 pin gold inlay, 1/4"	1.40	1.70
23556	14 pin gold inlay, 1/4"	2.10	2.55
23562	16 pin gold inlay, 1/4"	2.40	2.90
23568	18 pin gold inlay, 1/4"	2.70	3.20
23574	24 pin gold inlay, 1/4"	3.60	4.30
23580	28 pin gold inlay, 1/4"	4.20	5.00
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23620	28 pin wire wrap, 1/4"	3.80	4.60
23626	32 pin wire wrap, 1/4"	4.30	5.20

GOLD INLAY WIRE WRAP

Part No.	Description	100	1000
23630	8 pin gold inlay, 1/4"	1.60	1.90
23636	14 pin gold inlay, 1/4"	2.30	2.80
23642	16 pin gold inlay, 1/4"	2.60	3.10
23648	18 pin gold inlay, 1/4"	2.90	3.40
23654	24 pin gold inlay, 1/4"	3.80	4.50
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94-34	34 pin	3.60	4.50
94-38	38 pin	4.00	5.00
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94-46	46 pin	4.80	6.00
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94-54	54 pin	5.60	7.00
94-58	58 pin	6.00	7.50
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94-66	66 pin	6.80	8.50
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94-86	86 pin	8.80	11.00
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FM MINI MIKE

A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electric mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

FM-3 Kit \$14.95
FM-3 Wired and Tested 19.95

Color Organ

See music come alive! 3 different lights flicker with music. One light each for, high, mid-range and lows. Each individually adjustable and drives up to 300 W. runs on 110 VAC.

Complete kit, ML-1 \$8.95

Video Modulator Kit
Converts any TV to video monitor. Super stable, tunable over ch 4-6. Runs on 5-15V, accepts std. video signal. Best unit on the market! Complete kit, VD-1 \$7.95

Led Blinky Kit
A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts. Complete kit, BL-1 \$2.95

Super Sleuth
A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2 W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker. Complete kit, BN-9 \$5.95

CPO-1
Runs on 3-12 Vdc 1 wall out, 1 KHZ good for CPO, Alarm, Audio Oscillator. Complete kit \$2.95

CLOCK KITS

Your old favorites are here again. Over 7,000 Sold to Date. Be one of the gang and order yours today!

Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six .4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors: silver, gold, black (specify).

Clock kit, 12/24 hour, DC-5 \$24.95
Clock with 10 min. ID timer, 12/24 hour, DC-10 \$29.95
Alarm clock, 12 hour only, DC-8 \$29.95
12V DC car clock, DC-7 \$29.95

For wired and tested clocks add \$10.00 to kit price.

FM Wireless Mike Kit

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.

FM-1 kit \$3.95 FM-2 kit \$4.95

Whisper Light Kit

An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Includes mike, controls up to 300 W, runs on 110 VAC. Complete kit, WL-1 \$6.95

Tone Decoder
A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts. Complete kit, TD-1 \$5.95

Car Clock

The UN-KIT, only 5 solder connections

Here's a super looking, rugged and accurate auto clock, which is a snap to build and install. Clock generated by completely assembled, you only solder 3 wires and 2 switches. Takes about 15 minutes! Display is bright green with automatic brightness control photocell - assures you of a highly readable display, day or night. Comes in a satin finish anodized aluminum case which can be attached 5 different ways using 2 sided tape. Choice of silver, black or gold case (specify).

DC-3 kit, 12 hour format \$22.95
DC-3 wired and tested \$29.95

Universal Timer Kit

Provides the basic parts and PC board required to provide a source of precision timing and pulse generation. Uses 555 timer IC and includes a range of parts for most timing needs.

UT-5 Kit \$5.95

Mad Blaster Kit

Produces LOUD ear shattering and attention getting siren like sound. Can supply up to 15 watts of obnoxious audio, runs on 6-15 VDC. Complete kit, MB-1 \$4.95

Siren Kit

Produces upward and downward wail characteristic of a police siren. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker. Complete kit, SM-3 \$2.95

80 Hz Time Base
Runs on 5-15 VDC. Low current (2.5ma) 1 min/month accuracy TB-7 Kit \$5.50
TB-7 Assy \$9.95

Calendar Alarm Clock

The clock that's got it all. 6-5" LEDs, 12/24 hour, snooze, 24 hour alarm, 4 year calendar, battery backup and lots more. The super 7001 chip is used. Size 5x4x2 inches. Complete kit, less case (not available) DC-9 \$34.95

Under Dash Car Clock

12/24 hour clock in a beautiful plastic case features: 6 jumbo RED LEDs, high accuracy (100%), easy 3 wire hookup, display blanks with ignition, and super instructions. Optional dimmer automatically adjusts display to ambient light level. DC-11 clock with mtg. bracket \$27.95 kit
Dim-11 dimmer adapter \$2.50
Add \$10.00 Assy and Test

PARTS PARADE

IC SPECIALS

LINEAR

301	\$.35
324	\$1.50
380	\$1.50
555	\$.45
556	\$1.00
565	\$1.00
566	\$1.00
567	\$1.25
741	10/\$2.00
1458	\$.50
3900	\$.50
3314	\$2.95
8038	\$2.95

CMOS

4011	20
4013	25
4046	\$1.85
4049	.40
4059	\$9.00
4511	\$2.00
4518	\$1.35
5639	\$1.75

TTL

74S00	\$.40
7447	\$.65
7475	\$.50
7490	\$.50
74196	\$1.25

SPECIAL

11C90	\$13.50
10116	\$1.25
7208	\$17.50
7207A	\$ 5.50
7216D	\$21.00
7107C	\$12.50
5314	\$ 2.95
5375AB/G	\$ 2.95
7001	\$ 6.50

FERRITE BEADS
With info and specs 168/21
6 Hole Bead Beads \$3/1.00

Resistor Ass't
Assortment of Popular values - 1/4 watt. Cut lead for PC mounting. 1/2" center, 1/8" leads, bag of 300 or more. \$1.50

Switches
Mini toggle SPDT \$1.00
Red Pushbuttons N.O. 3/\$1.00

Earphones
3" leads, 8 ohm, good for small tone speakers, alarm clocks, etc. 10 for \$1.00

Mini 8 ohm Speaker
Approx 2 1/2" diam. Round type for radios, mike etc. 3 for \$2.00

Slugs Tuned Coils
Small 3/16" Hex Slugs turned coil. 3 turns. 15/\$1.00

Crystal Microphones
Small 1" diameter 1/2" thick crystal mike cartridge \$7.75

Coax Connector
Chassis mount BNC type \$1.00

9 Volt Battery Clips
Nice quality clips 5 for \$1.00
1/2" Rubber Grommets 10 for \$1.00

Connectors
6 pin type gold contacts for mA-1003 car clock module price .75 ea.

Varactors
Motorola MV 2209 30 PF Nominal cap 20-80 PF - Tunable range - .50 each or 3/\$1.00

Audio Prescaler

Make high resolution audio measurements, great for musical instrument tuning, PL tones, etc. Multiplies audio UP in frequency, selectable x10 or x100, gives .01 Hz resolution with 1 sec. gate time! High sensitivity of 25 mv, 1 meg input z and built-in filtering gives great performance. Runs on 9V battery, all CMOS.

PS-2 kit \$29.95
PS-2 wired \$39.95

600 MHz PRESCALER

Extend the range of your counter to 600 MHz. Works with all counters. Less than 150 mv sensitivity, specify -10 or -100

Wired, tested, PS-1B \$59.95
Kit, PS-1B \$44.95

READOUTS

FND 359 4" C.C.	\$1.00
FND 507/910 5" C.A.	1.00
MAN 72/HP7730 33" C.A.	1.00
HP 7651 43" C.A.	2.00

Sockets

8 Pin	10/\$2.00
14 Pin	10/\$2.00
16 Pin	10/\$2.00
24 Pin	4/\$2.00
28 Pin	4/\$2.00
40 Pin	3/\$2.00

DC-DC Converter
+5 vdc input prod. 9 vdc @ 30ma
+9 vdc produces -15 vdc @ 35ma \$1.25

25K 20 Turn Trm Pot \$1.00
1K 20 Turn Trm Pot \$.50

Crystal Microphones
Small 1" diameter 1/2" thick crystal mike cartridge \$7.75

Mini RG-174 Coax
10 ft. for \$1.00

Trimmer Caps
Sprague - 3-40 pf Stable Polypropylene .50 ea.

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain. 1 W in for 8 out, 2 W in for 15 out, 4W in for 30 out. Max output of 35 W, incredible value, complete with all parts, less case and T-R relay.

PA-1, 30 W pwr amp kit \$22.95
TR-1, RF sensed T-R relay kit 6.95

Power Supply Kit

Complete triple regulated power supply provides variable 6 to 18 volts at 200 ma and +5 at 1 Amp. Excellent load regulation, good filtering and small size. Less transformers, requires 6.3 V 1A and 24 VCT. Complete kit, PS-3LT \$6.95

TRANSISTORS

2N3804 NPN C-F	158/1.00
2N3906 PNP C-F	158/1.00
2N4403 PNP C-F	158/1.00
2N4410 NPN C-F	158/1.00
2N4916 PNP C-F	4/\$1.00
2N5401 PNP C-F	5/\$1.00
2N4628 C-F	48/1.00
2N3371 NPN Silicon	3/\$2.00
2N5179 NPN NPN	3/\$2.00
Power Tab NPN 40W	3/\$1.00
Power Tab PNP 40W	3/\$1.00
16PF 102/2N5484	1.98
NPN 3904 Type T-R	80/\$2.50
PNP 3906 Type T-R	50/\$2.50
2N3055	1.80
2N2646 LJT	3/\$2.00

25 AMP 100V Bridge \$1.50 each

Mini-Bridge 50V 1 AMP 4 for \$1.00

Diodes

5.1 V Zener	20/\$1.00
1N914 Type	50/\$1.00
1KV 2Amp	8/\$1.00
100V 1Amp	15/\$1.00

Parts Bag
Ass't of chokes, disc caps, tantal resistors, transistors, diodes, MICAs, caps etc. sm bag (100 pc) \$1.00, med (300 pc) \$2.50

Leds - your choice, please specify
Mini Red, Jumbo Red, High Intensity Red, Illuminator Red 8/\$1
Mini Yellow, Jumbo Yellow, Jumbo Green 6/\$1

Mini RG-174 Coax
10 ft. for \$1.00

9 Volt Battery Clips
Nice quality clips 5 for \$1.00
1/2" Rubber Grommets 10 for \$1.00

Connectors
6 pin type gold contacts for mA-1003 car clock module price .75 ea.

Shrink Tubing Nubs
Nice pre-cut pieces of shrink size 1" x 1/4" shrink to 1/8". Great for splices. 50/\$1.00

Mini TO-92 Heat Sinks
Thermalloy Brand 5 for \$1.00
To-220 Heat Sinks 3 for \$1.00

RF actuated relay senses RF (1W) and closes DPDT relay.

For RF sensed T-R relay TR-1 Kit \$6.95

OP-AMP Special

BI-FET LF 13741 - Direct pin for pin 741 compatible, but 500,000 MEG input z, super low 50 pa input current, low power drain.

50 for only	\$9.00
10 for	\$2.00

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FREE 8 pc. Tool Set (value \$14.95) with \$200.00 purchase of merchandise from this ad.

Logic Probe

Compact circuit powered
Detects pulses as short as 50
 μ sec • DTU/TTL/ULCMOS
compatibility
\$44.95



Model LP-1

Function Generator

Model 2001
Reg. \$185.95
Sine, square,
triangle and
separate TTL
square wave
output
\$157.95



100 MHz 8-Digit Counter

20 Hz to 100 MHz range • LED display
Fully automatic
Model MAX100
Reg. \$150.00
\$127.50



Preassembled Proto Boards

Model PB-104
Fully assembled breadboard
contains four QT-59S sockets,
seven QT-59B bus strips and four
5-way binding posts
\$49.95



Proto Board with Built-in Power Supplies

Regulated
Short-proof
Reg. \$154.95
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3 1/2-Digit 0.1% Digital Capacitance Meter

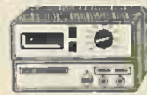
9 ranges from 1999 pF to 199.9 μ F
0.1% of reading accuracy • Auto
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Model 3001
Reg. \$190.00
\$170



Portable Digital Capacitance Meter

Measures capacitance from
0.1pF to 1 Farad • Resolves to
0.1pF • 10 ranges for
accuracy and resolution • 4
digit easy-to-read LED display
• 0.5% accuracy
Model 829

BK PRECISION



3 1/2-Digit DMM with LCD Readout

0.1% DC accuracy • 0.5%
LCD display for high
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range • 1000V/100mA/0.01
 Ω resolution • Battery life of
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stay accurate in RF fields •
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Model 2815



Dual Trace 5" 30 MHz Triggered Scope

Rise time 11.7 nS or
less • Built-in signal
delay line • Flat
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Probes included
Call for Discount Prices



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Reg. \$60.95
\$49.95

Hickok
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22 M Ω input
resistance • 10 Amp
AC/DC • 1500V Overload
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Complete with nickel-
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leads
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LEADER



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Dual Trace
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RF Wide Band Signal Generator

Model LSG-18
Solid state FET oscillator circuitry •
100 kHz to 100 MHz freq. range • 300
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with Calibrated Variable Delay

Model LBO-515A with probes •
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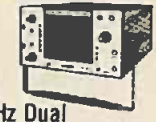
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Highly accurate 3 digit readout •
Operates on one 9V battery or with AC
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Model LBO-508A with probes
Call for Discount Prices



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\$471



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Spring balanced arms •
Tension control knobs • Baked
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Player with AM/FM/MPX Radio
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Model CAS-888
\$57.50

Stereo Power Booster

Model POW-40
40W stereo
20W per channel
Bass boost
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BP2000-69TR
20 oz ceramic magnet
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Miniature High Fidelity 3-Way Stereo Speakers

MINI speakers
MAXI
SOUND
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BK PRECISION

30 MHz Portable Frequency Counter

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HICKOK Digital CB In-Line Tester

Measures all 4
transmitter output
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Frequency • Power
• SWR • Modulation %
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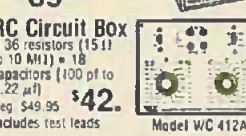
20 K Ω VDC
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\$19.95
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Model WR-536A
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36 resistors (15 Ω
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includes test leads
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Portable Printer with
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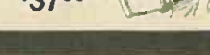
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Call Control
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Model 1500
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Reg. \$349.95
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4 Pc Standard Starter Kit • One (1) Standard Command
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Command Console • One (1) Hand Held Remote Unit • Two
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JUMBO RED LED .20" diffused	10/\$1.00
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RESISTORS	
R-CHIP RESISTOR (R660) ±1% 50ppm/°C	1-999 .25
1/4W MIL-R-10509 250V/70°C	1000- .25
.130" dia X .35" long (body)	5000- .25
ALL STANDARD DECADE VALUES	10000- .25
FROM 10ohm to 475K	

5" RED LED DISPLAY 7 segment RHD FR500 Common Cathode	\$5.89ea 10/\$17.75 25/\$17.00 100/\$62.00
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IC BREADBOARD 2 5/16" X 6 9/16"	
UNIVERSAL BREADBOARD 3 3/16" X 5 1/16"	\$1.15ea 10/\$10.00 100/\$75.00

TANTALUM CAPACITORS solid dipped ±20%	
1-9 10-	1-9 10-
.10uF/35V .30 .25	4.7uF/16V .38 .30
.22uF/35V .30 .25	4.7uF/25V .45 .35
.33uF/35V .30 .25	6.8uF/6V .45 .39
1uF/20V .30 .25	10uF/16V .40 .30
2.2uF/20V .35 .25	10uF/20V .42 .35
2.2uF/35V .38 .28	15uF/6V .42 .35
3.3uF/35V .40 .30	15uF/20V .50 .40

TANTALUM CAPACITOR ASST. 2ea. of above - 48 caps. \$20.00	
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1N4001 rectifier 12/\$1.00 100/\$7.00	
1N4007 rectifier 10/\$1.00 100/\$9.00	
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2N3904 NPN TO-18 10/\$1.50	
2N3906 PNP TO-18 25/\$3.00	
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DIPSWITCH - 8 sw 16 pin DIP SPST 1-9 \$2.10ea 10-24 1.95ea 25- 1.85ea	

POWER SUPPLY KIT PS-29 provides simultaneous outputs of plus & minus 5V, 12V, & 15V. uses 115/230VCT transformer - 1amp total output. kit includes PC board (2 1/8" X 3 1/2"), all parts incl transformer, schematic & layout dwg. \$14.95ea	
10-24	13.50ea
25-	12.50ea

PLL TONE DECODER \$3.99ea 567 8 pin DIP 10/\$8.55 100/\$80.00	
TRANSISTOR - 2N2222A general purpose NPN TO-18 1-9 \$.39 pk-10 2.95 pk-100 27.50	
WARRANTY 16028 \$3.95ea 10/\$35.00 100/\$275.00	

CRYSTAL CONTROLLED TIME BASE KIT provides accurate 1 Hz, 10 Hz & 60 Hz double buffered outputs from 9VDC input. CMOS compatible. kit includes PC board, (1 5/8" X 3 1/2"), all parts (except battery), schematic, layout dwg. & instructions. \$15.50ea	
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25-	12.50ea

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DON'T FORGET



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Power @ 13 amps
SURPLUS UNITS IN LIKE NEW CONDITION

INPUT: 115 vac 43-53 Hz
OUTPUT: 12 vdc 0-13 amps
REGULATION: 0.1% ± 5 mV
NL-FL. ± 0.1% ± 5mV for 10%
Input change
RIPPLE: 2mV RMS max., 20 mV
P-P max.
STABILITY: Typically 10 mV for
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79.00 per unit

REMOTE SENSING, REMOTE VOLTAGE ADJUSTMENT,
OVERLOAD PROTECTION and OVERVOLTAGE PROTECTION
ALSO AVAILABLE in 2 VDC @ 25 AMPS \$79.00 per unit

10 MEG POTS
Standard & Watt Size
3/4" Long Shaft
1/4" Dia
25 For \$5.00 4 For \$1.00

50K AUDIO SLIDE POTS
Knobs for Slide
Pots 20s each 75c Each

22/44 EDGEBOARD CONNECTOR
TIN SOLDER TAIL .186" x .200"

LARGE QUANTITIES AVAILABLE
\$1.35 each 10 for \$12.50

PHOTO - FLASH CAPACITOR
100 MFD 330 VOLTS
3/4" x 1 1/4" \$1.50 Each

REED RELAYS
9-15 VOLT D.C.
NORMALLY OPENED
CONTACTS: 1 amp max.
switch - 2 amp max. carry
BODY SIZE: approx. 1 inch
long 1/4 inch high

S.P.S.T. 1500 ohm coil \$1.15 each
D.P.S.T. 1200 ohm coil \$1.30 each

POTTER BRUMFIELD 4PDT RELAYS

- 14 pin style
- 3 amp contacts
- 24 Volt d.c. coil
- 120 volt a.c. coil
- Used but fully tested

\$1.25 each
Specify coil voltage
LARGE QUANTITIES AVAILABLE

3x5" OAKTRON SPEAKER
3oz. Magnet
8 OHM Impedance
\$2.50 each

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4030 .45 4028 .80 4081 .22 74C107 1.75	
4039 .65 4029 .87 4032 .60 74C100 1.20	
4041 .33 4030 .38 4518 .10 74C101 1.65	
4059 .22 4034 2.25 4518 .10 74C103 1.50	
4013 .40 4036 .87 4032 1.00 74C104 1.25	
4114 1.30 4040 1.00 74C08 .27 74C173 1.50	
4018 1.30 4042 .88 74C08 .27 74C174 1.50	
4018 .45 4045 .65 74C08 .30 74C175 1.50	
4017 .06 4046 1.96 74C10 .27 74C181 1.30	
4018 .88 4048 .65 74C10 .27 74C193 1.40	
4019 .45 4049 .45 74C10 .27 74C191 1.30	
4022 1.10 4061 1.10 74C12 .20 74C202 1.50	
4021 1.10 4062 1.10 74C12 .20 74C214 1.90	
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PRINTED CIRCUIT BOARD	
4" x 6" DOUBLE SIDED EPOXY BOARD 1/16" thick 8.50 ea. 50/\$42.00	
EPOXY glass vector board 1/16" thick with 1/10" spacing \$1.95	
74500 - 30	74515 - 40
74502 - 30	74532 - 40
74508 - 40	74586 - 85
74511 - 35	745112 - 45
7 WATT LD 65 LASER DIODE IR \$8.95 25 watt Infra Red Pulse ISG 2008 equiv. Laser Diode (Spec sheet included) \$24.95	
MINIATURE MULTI-TURN TRIM POTS 100K, 5K, 10K, 20K, 250K, 1 Meg, 5.75 each \$32.00	
2N3820 P-FET 0.45	
2N5467 N-FET 0.45	
2N5246 LUT. 0.45	
2N 900 TRIGGER DIODES 4.91 00	
2N 5028 PROG. LUOT. 0.65	
FP 100 PHOTO TRANS. 0.50	
RED, YELLOW, GREEN LARGE LED's 2" 0.91 00	
RED, GREEN BIPOlar LED's 2" 0.95	
TL-118 OPTO ISOLATOR 0.75	
MCT-6 OPTO ISOLATOR 0.80	
1 WATT ZENERS, 3.3, 4.7, 5.1, 5.6, 9.1, 10, 12, 15, 18, or 22V 0.61 00	

TRANSISTOR SPECIALS	
2N4235 NPN SWITCHING POWER	\$1.95
MPS 6004 1 CB PNP Transistor NPN	0.75
2N3772 NPN Si TO-3	\$1.00
2N4308 PNP Si TO-3	\$1.00
2N4508 PNP Si TO-3	\$41.00
2N3713 NPN Si TO-3	\$1.50
2N3818 NPN Si TO-3 RR	\$1.50
2N1422 NPN Si TO-8	\$91.00
2N3707 NPN Si TO-98	1.70
4022222 NPN Si TO-18	5.91 00
2N3055 NPN Si TO-3	0.60
2N0084 NPN Si TO-82	0.31 00
2N3005 PNP Si TO-92	0.81 00
2N5296 NPN Si TO-220	0.55
2N1546 PNP GERM TO-3	0.95
2N1305 PNP 68 TO-8	1.40

DATEL'S DAC 08BC - 8 BIT DAC - \$9.95	
8" DISKETTES - HARD SECTOR 15/\$1, 10/\$16.00	
CRYSTALS \$3.45 ea	
2.000 MHz 6.144 MHz	FLAT COLOR CODED
4.000 MHz 8.000 MHz	±30 VARI
3.571 MHz 10.000 MHz	25 cond. - 50psec foot
6.000 MHz 20.000 MHz	40 cond. - 75psec foot
8.000 MHz	50 cond. - 90psec foot

SILICON SOLAR CELLS \$10.00	
4" diameter 4V at 1 AMP	
IN 4148 (IN914) 15.91 00	
.1 or .01 uF 25V ceramic disc. caps. 18/81 00, 100/95 00	
RS232 CONNECTORS	
DB 25M male	\$2.95
DB 25S female	\$3.50
HOOKS	\$1.50

TTL IC SERIES	
7400 - 17	7448 - 75
74101 - 17	7450 - 75
7402 - 17	7472 - 38
7403 - 17	7473 - 35
7405 - 24	7474 - 42
7406 - 34	7475 - 45
7405 - 30	7476 - 48
7407 - 35	7480 - 48
7408 - 27	7483 - 80
7409 - 24	7486 - 75
7410 - 17	7488 - 42
7411 - 22	7489 - 100
7412 - 22	7490 - 50
7413 - 42	7491 - 100
7414 - 80	7492 - 50
7415 - 23	7493 - 50
7417 - 27	7494 - 50
7420 - 17	7495 - 60
7425 - 38	7496 - 60
7426 - 33	7497 - 35
7427 - 35	7497B - 35
7430 - 17	7498 - 60
7432 - 27	7499 - 42
7437 - 27	7499B - 45
7438 - 27	7499B - 45
7440 - 17	7499B - 45
7441 - 35	7499B - 45
7442 - 35	7499B - 45
7443 - 35	7499B - 45
7444 - 70	7499B - 45
7447 - 75	7514 - 110

UNIVERSAL 4Kx8 MEMORY BOARD KIT 425.00	
32 2Kx2-1 fully buffered, 16 address lines, on board decoding for any 4 of 64 pages, standard 64 pin buses, may be used with E-8 or 25P	
LEO READOUTS	
FCS 8024 - 4 digit	
C.C. 8" display	\$5.95
FND 503 C.C. 8"	\$8.00
FND 504 C.C. 8"	\$8.00
DL704-C.C. 8"	\$8.00

SCR'S	
1.5A	6A
4.0	1.40
7.0	1.90
1.20	1.40
1.80	2.60

TRIACS	
1.5A	6A
4.0	1.40
7.0	1.90
1.20	1.40
1.80	2.60

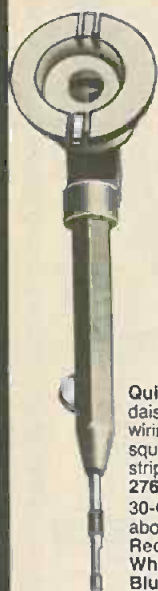
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Pro-Quality Wiring

Quick-Wrap Tool™ is ideal for daisy chain or point-to-point wiring between std. 0.025" square wrapping posts. Cuts, strips, easy to load!

276-1572 12.95
30-Gauge Kynar Wire. For above. 50 ft. spool.
Red. 278-501 1.99
White. 278-502 1.99
Blue. 278-503 1.99

Project Case With Panel

Flip-Open Cover

Only
2⁹⁹



Easy-to-work reversible inner panel accepts a meter, switches or readouts.
5½x3¾x2"
270-290 2.99

8-Position DIP Switch

1⁹⁹



8 SPST sections. Fits standard 16-pin DIP socket. Ideal for digital and low current circuits.
275-1301 1.99

Tricolor and Pulsing LEDs

Low As **1²⁹**



[A] Red on DC, green on reverse DC, yellow on AC! 25 mA max. at 2.2VDC. T-1½ case. 276-035 1.39
[B] Red. Built-in 3 Hz flasher! 20 mA max. at 5VDC.
276-034 1.29

Accurate Sensitive VOM

29⁹⁵



• 27 Ranges
• 30K Ohms/Volt

Ideal for testing solid-state circuits! 4"-wide color-coded, mirrored scale. Reads DC Volts: 0 to 0.3-1-3-10-30-100-300-1000. AC Volts: 0 to 10-30-100-300-1000. DC Current: 0 to 100µA-3mA-30mA-300mA-10A. Resistance: 0 to 1K-10K-1 Meg-10 MegΩ. Decibels: -10 to +62 in 5 ranges. Accuracy: ±3% DC, ±4% AC. 6½x4½x1½". With 47" leads. Requires one 9V, one "AA" batteries. 22-203 29.95

Alarm Clock/Thermometer Module



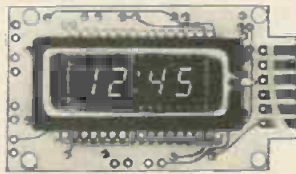
User Programmable
12 or 24-Hour Format!

24⁹⁵

Bright 0.7"-tall LED readout displays 12/24-hour time plus temperature in degrees C or F! 24-hour alarm and snooze features. With complete data. 277-1006 24.95
Temp. Sensor IC. LM-334. 276-1734 1.99
Power Transformer. For above. 273-1530 4.99

12-Hour Auto Clock Module

Reg. 21.95
Save 21% 16⁹⁵



For all 12V neg. ground vehicles. Mounts in dash or with case (below). Bright green display has automatic dimmer, leading zero blanking. With data. 277-1003 Sale 16.95
Pushbutton Switches. For above. 275-1547 Pkg. 5/2.49
Custom Case. 270-303 (Reg. 5.95) Sale 3.95

High Performance Op Amps



Low-As **1⁸⁹**

[A] LF353N. Dual. Low noise JFET inputs, wide bandwidth. Fast 13V/µS slew rate. ±18V supply. 8-pin DIP. 276-1715 1.89
[B] TL084C. Quad. 13V/µS slew rate. ±18V supply. 14-pin DIP. 276-1714 2.99

Engineer's Notebook of IC Circuits

1⁹⁹

Sold Only At Radio Shack

This "must-have" sourcebook gives applications and circuit examples for most popular linear and digital ICs. 128 pages. 276-5001 1.99

Sound Generator IC



2⁹⁹

SN76477. Creates music and sound effects from phaser guns to steam whistles! Line level audio output. Microprocessor compatible. 28-pin DIP. With data. 276-1765 2.99

Semiconductor Reference Handbook

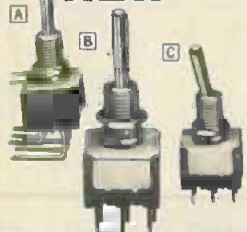
Only **1⁹⁹**

Cross reference/substitution listings for over 100,000 devices! Pin outs and data for transistors, ICs, diodes, SCRs, LEDs and more. 224 pages. 276-4003 1.99

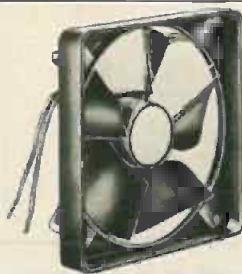
NEW

Mini DPDT Switches

Low As **1⁹⁹** Contacts Rated 6 Amps @ 125VAC



[A] DPDT Right Angle. Ideal for PC board mounting. On-Center Off-On contacts. 275-665 1.99
[B] DPDT. PC mtg. On-Center Off-On contacts. 275-668 2.19
[C] DPDT. Solder lugs for panel mounting. On-None-On contacts. 275-669 2.29



4" 120VAC Cooling Fan

12⁹⁵

Very Quiet Operation

Ideal for cooling power supplies, Ham and hi-fi gear, computers and more! Delivers 70 CFM. Sealed bearings. Diecast venturi. U.L. recognized motor. Corrosion-resistant metal parts. Low power consumption — only 11 watts! 273-241 12.95

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MAY 1980

129

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.L.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: 1V max.
- Power supply: ±40V @ 5 amp



TA-1000 KIT
\$51.95
Power
transformer
\$15.00 each

PROFESSIONAL 10 OCTAVE STEREO GRAPHIC EQUALIZER!!



Graphic equalizer have been used for years in sound studios and concert arenas but were too expensive to be considered for home use. Now we offer you the facility at an affordable price. This unit can extend your control of your Hi-Fi system by minimizing the non-linearities of the combined speaker/room system. Fantastic features as follows:

- 10 double slide controls for two channels
- Cut out rumble, surface noise and hiss
- Minimizes speaker/room non-linearities
- Frequency response from 30Hz to 16KHz
- 10 tone controls plus defeat, monitor and tape selector.
- Control range ± 12dB in 10 octaves (30Hz, 60Hz, 120Hz, 240Hz, 500Hz, 1KHz, 2KHz, 4KHz, 8KHz, 16KHz.)
- Operating voltage 117V 50/60Hz.

FACTORY ASSEMBLED UNIT, NOT A KIT
SPECIAL PRICE \$117.00 ea

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

NEW MARK III LED VU

9 Steps 4 Colors

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

IN KIT FORM \$18.50

MARK II SOUND ACTIVATED SWITCH KIT



A new designed circuit employed 2 I.C., a DPDT relay with a led indicator. A condenser microphone comes with the kit. The relay can handle up to 200 watts contact to allow to control most things. Just click the finger, the relay will close, the second click will release it. Sensitivity can be adjusted by an on board trim-pot. Operating voltage 9V D.C. TY-18
\$8.50 PER KIT

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

30W + 30W STEREO HYBRID AMPLIFIER KIT

It works in 12V DC as well! 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 100Hz and 10KHz.



\$32.50 PER KIT

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 illumination of the lantern.

\$10.50 EA

STEREO AMPLIFIER



60 W
+
60 W

COMPLETED UNIT - NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8Ω. Power supply is 24 - 36V AC or DC. Complete unit. Assembled \$49.50 ea. Power transformer \$ 8.50 ea.

SW AUDIO AMP KIT

2 LM 380 with Volume Control
Power Supply 6 18V DC



ONLY \$6.00 EACH

PROFESSIONAL PANEL METERS



Twoe MU-52E

- A. 0-50UA 8.50 ea.
- B. 0-30VDC 8.50 ea.
- C. 0-50VDC 8.50 ea.
- D. 0-3ADC 9.00 ea.
- E. 0-100VDC 9.00 ea.

All meters white face with black scales. Plastic cover.

SPECIAL 0.5" LED ALARM CLOCK MODULE

ASSEMBLED! NOT A KIT!
Features: • 4 digits 0.5" LED Displays • 12 hours real time format • 24 hours alarm audio output • 59 min. countdown timer • 10 min. snooze control.



ONLY \$7.00 EACH
SPECIAL TRANSFORMER FOR CLOCK (FREE)

DIGITAL AUTO SECURITY SYSTEM

4 DIGITS
PERSONAL CODE!!
SPECIAL \$19.95



- proximity triggered
- voltage triggered
- mechanically triggered

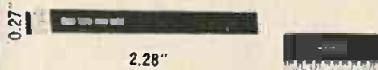
This alarm protects you and itself! Entering protected area will set it off, sounding your car horn or siren you add. Any change in voltage will also trigger the alarm into action. If cables within passenger compartment are cut, the unit protects itself by sounding the alarm. 3-WAY PROTECTION!

All units factory assembled and tested - Not a kit!

A NEW LED ARRAY AND DRIVER FOR LEVEL METERS

This series covers a wide range of level indication uses, output and input voltage, time related change, temperature, light measurement and sound level. The problem of uneven brilliance often encountered with LED arrangements as well as design problems caused by using several units of varying size are substantially reduced. 12 LEDs in one bar:

LED ARRAY	
GL-112R3 Red, Red, Red	\$5.50
GL-112N3 Green, Yellow, Red	\$6.50
GL-112M2 Green, Green, Red	\$6.50
GL-112G3 Green, Green, Green	\$6.50



LED DRIVERS

1R 2406G is an I.C. specially designed to drive 12 LED. The number of LED is linearly illuminated according to the control voltage input terminal 21. Operating voltage is 9 12V D.C. \$5.35 EACH

PROFESSIONAL FM WIRELESS MICROPHONE

TCT 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 6 1/4" long. With a standard FM radio, can be heard anywhere on a one-acre lot; sound quality was judged very good.

\$16.50

FLASHER LED

Unique design combines a jumbo red LED with an IC flasher chip in one package. Operates directly from 5V-7V DC. No dropping resistor needed. Pulse rate 3Hz @ 5V 20mA.

2 for \$2.20

BIPOLAR LED RED/GREEN

2 colors in one LED, green and red, changes color when reverse voltage supply. Amazing!
2 FOR \$1.60

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) \$24.50 EA.

NIC2400 (24 hr) \$26.50 EA.

MINI-SIZED I.C. AM RADIO

Size smaller than a box of matches!
Receives all AM stations.
Batteries and ear phones included.

Only \$10.50

12 DC MINI RELAY

6V	SPDT	2 AMP	1.30
12V	SPDT	3 AMP	1.60
12V	DPDT	2 AMP	2.50
12V	4PDT	3 AMP	3.50



LINEAR SLIDE POT

500Ω SINGLE
Metal Case 3" Long
2 FOR \$1.20



FLUORESCENT LIGHT DRIVER KIT



With Case Only
\$6.50 Per 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!

SUPER FM WIRELESS MIC KIT — MARK III



FMC-105
\$11.50 PER KIT

This new designed circuit uses high 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.

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



Super Buy
Only \$18.50

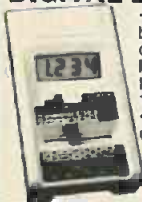
MAIN AMP (15W x 2)
Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply ± 16V DC (not included). Power band with (KF 1% ± 3dB). Voltage gain 33dB. 20Hz - 20KHz.

SUPER 15 WATT AUDIO AMP KIT

Uses STK-015 Hybrid Power Amp
Kit includes: STK-015 Hybrid IC, power supply with power transformer, front Amp with tone control, all electronic parts as well as PC Board. Less than 0.5% harmonic distortion at full power 1/2dB response from 20-100,000 Hz. This amplifier has QUASI — Complimentary class B output. Output max is watt (10 watt RMS) at 4Ω. ONLY \$23.50 each



HICKOK LX303 DIGITAL LCD MULTIMETER



3 1/2 digits multimeter • 200 hours 9V battery life • Auto zero; polarity; overrange indication • 100MV DC F.S. sensitivity • 19 ranges and functions • D.C. volt: 0.1 MV to 1000V • A.C. volt: 0.1 V to 600 V • Resistance: 0.1Ω to 20 MΩ • D.C. current: 0.01 A to 100 MA

OUR PRICE \$71.45

PUSH-BUTTON SWITCH



N/Open Contact
Color: Red, White, Blue, Green, Black
3/\$1.00
N/Close also Available
50¢ each
LARGE QTY. AVAILABLE

HEAVY DUTY CLIP LEADS



10 pairs — 5 colors Alligator clips on a 22" long lead. Ideal for any testing.
\$2.20/pack

MANY SOUND DECISIONS!

Solid state sound indicator operating voltage 6V DC 30mA. Small size approximately 3/4" x 1 1/4".

Model EB2116 (Continuous)
Model EB2126 (Slow Pulse)
Model EB2136 (Fast Pulse)



"C" SIZE BATTERY PACK

10 C size ni-cd battery in dng pack, gives out 12.5V D.C. 1.8 amp per hour. All fresh code, pull-out from movie cameras. Can be disconnected to use as single c cells. Hard to find \$15.00 per pack of 10 batteries

ELECTRONIC ALARM SIRE COMPLETE UNIT

Ideal for use as an Alarm Unit or hookup to your car back-up to make a reverse Indicator. Light Output up to 130dB. Voltage supply 6 12V

AU-999 \$7.50

SUB MINIATURE TOGGLE SWITCH

SPST 2 FOR 2.80 SPDT 2 FOR 3.20
6 AMP 125V AC CONTACT

TRANSFORMERS ALL 117 VOLT INPUT

30V	4 AMP	\$8.50 EA.
36V CT	3 AMP	\$10.50 EA.
48V CT	3 AMP	\$10.50 EA.
24V CT	3 AMP	\$10.50 EA.
24V CT	0.8 AMP	\$2.50 EA.
12V CT	0.5 AMP	\$2.50 EA.
12V CT	120 MA	\$1.80 EA.

AC POWER SUPPLY

12V AC	Output 200 MA	\$2.75 EA.
16V CT AC	Output 100 MA	\$2.10 EA.
6V DC	Output 120 MA	\$1.90 EA.
12V DC	Output 100 MA	\$1.90 EA.

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

COMPLETE TIME MODULE

0.3" digits LCD Clock Module with month and date, hour, minute and seconds. As well as stop watch function! Battery and back up light is with the module. Size of the module is 1" dia. Ideal for use in auto panel, computer, instrument and many others!
\$8.95 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. 2 for \$3.00

FM WIRELESS MIC KIT

It is not a pack of cigarettes. It is a new FM wireless mic kit! New design PC board fits into a plastic cigarette box (case included). Uses a condenser microphone to allow you to have a better response in sound pick-up. Transmits up to 350 ft. With an LED indicator to signal the unit is on #FMM2 KIT FORM \$7.95

REGULATED DUAL VOLTAGE SUPPLY KIT

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

RECHARGEABLE BATTERIES
LIMITED QUANTITY AVAILABLE
4 FOR \$3.60

BECKMAN FET LIQUID CRYSTAL DISPLAY

Overall size 2" x 1.2" 0.5" characters reflective type.

Model 737-01 — for clock 4 digits with PM, alarm, snooze, colon indicators.
Model 739-04 — for panel meter 4 digits.

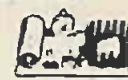
Model 739-03 — for panel meter 3 1/2 digits with ± sign and over range indicator.

All displays include zeber connectors and front bezel. With data sheets.
Your choice — any model \$7.50 EACH



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.
Transformer for Power Supply, 0-30 Power Supply 2 AMP 24V x 2 \$8.50 \$10.50 each



I.C. TEST CLIPS

Same as the E-Z clips \$2.75
With 20" Long Leads
In Black and Red Colors per pair



SOUND GENERATOR I.C.

Creates almost any type of sound — gun shot, explosion, train, car crash, star war, birds, organ ext. A built-in audio amplifier provides high level output. Operates from one 9V battery, 28 pin dip; we supply the datas. \$2.90 EACH



ELECTRONIC SWITCH KIT

CONDENSER TYPE
Touch On Touch Off
uses 7473 I.C. and 12V relay
\$5.50 each



1 WATT AUDIO AMP

All parts are pre-assembled on a mini PC Board. Supply Voltage 6 9V D.C. SPECIAL PRICE \$1.95 ea.

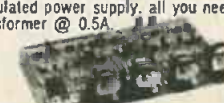


LOW TIM DC STEREO PRE-AMP KIT TA-10 20

Incorporates brand-new D.C. design that gives a frequency response from 0Hz — 100KHz ± 0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuation!

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