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Adding sensors to your robot
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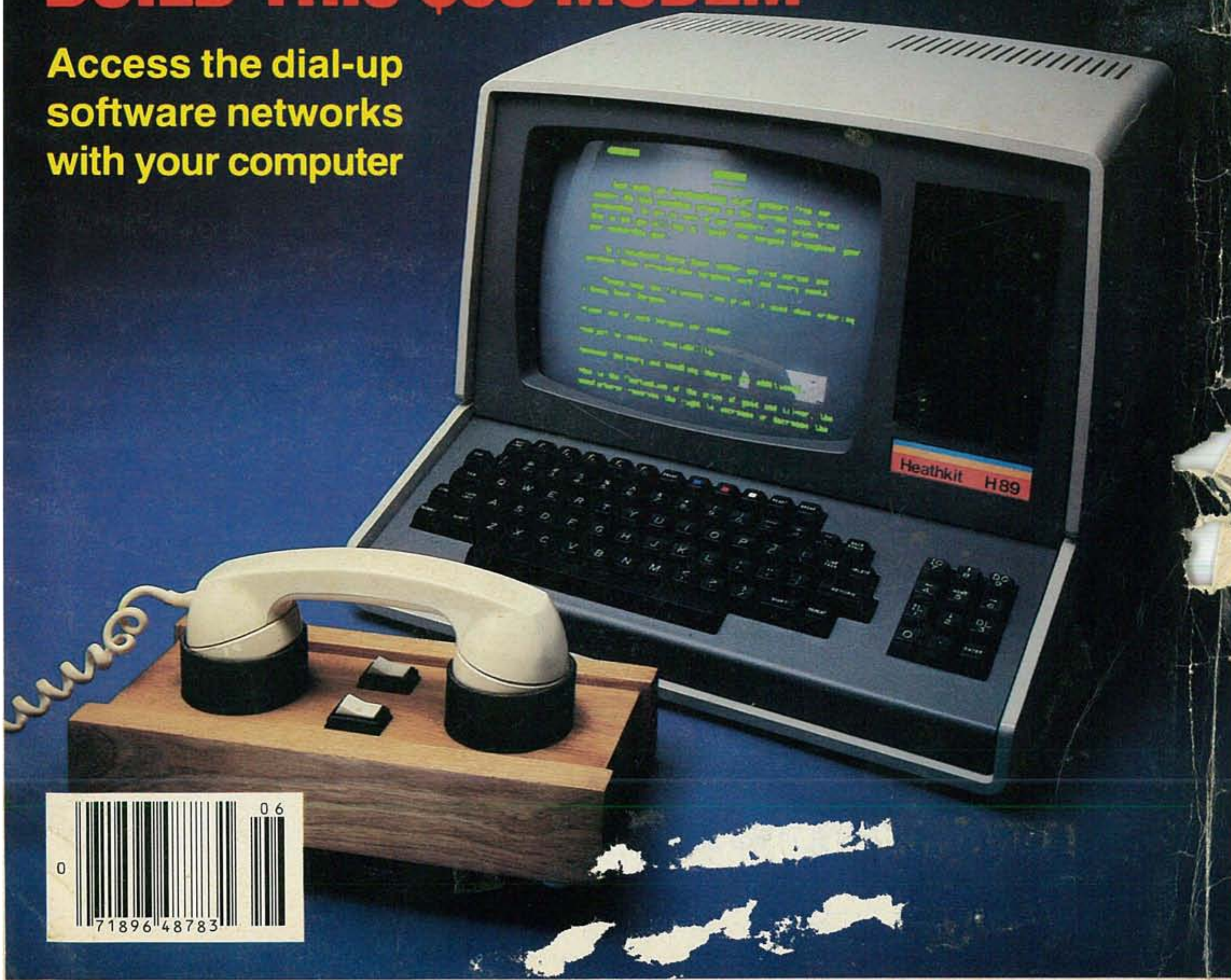

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The personal computer is the ultimate educational aid because it can entertain while it educates. Software available ranges from enhancing your children's basic math, reading and spelling ability, through tutoring high school and college subjects, to teaching the fundamentals of computers and computer programming.

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Radio-Electronics

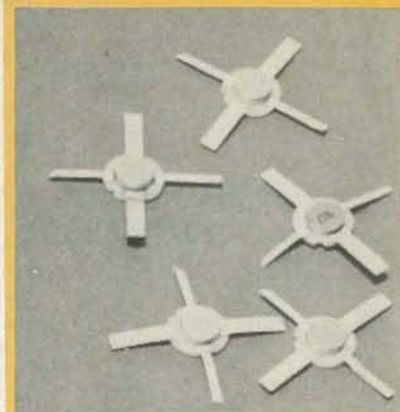
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

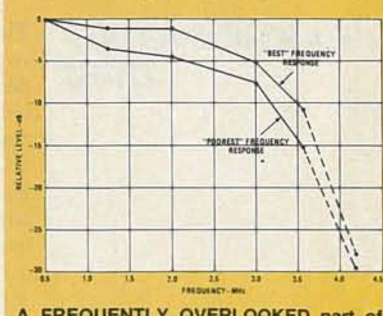
JUNE 1981 Vol. 52 No. 6

ON THE COVER

There are many things your computer can do when it can communicate with other computers. This modem—that you can build for under $60—will allow your computer to use the telephone to interact with computers all over the country. The project begins on page 39.



SOLID-STATE MICROWAVE DEVICES are vital to our efficient use of the upper end of the RF spectrum. A history of these devices, along with a description of how they function, starts on page 43.



A FREQUENTLY OVERLOOKED part of a videotape system is the tape itself. To find out what qualities you should be looking for, turn to page 54.

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looking ahead

METAL VIDEOTAPE

New recording tapes are being developed in Japan which promise to lead to more compact formats that could replace Beta and VHS as home VCR standards. Fuji's two new metal-particle videotapes, mentioned in this column last month, are now being studied by Japanese equipment makers. Fuji says its MV metal tape could make the recording of an hour's programming on a tape possible, using a package with the same area as a C60 audio cassette; or, if a tape with a thinner backing were used, it could get two hours in—in the size of an audio cassette. A new evaporated cobalt-metal VV lubricated tape can cut tape usage in half again—providing four hours of recording in audio cassette size. Change the tape width from 1/8 inch to 1/4 inch and it can accommodate eight hours, still in a shirtpocket-sized cassette.

Although VCR manufacturers have been proposing new mini recorders primarily for forthcoming camera/VCR combinations with relatively short recording time, developments such as Fuji's should hasten the day when mini-tapes take over the entire home VCR field, and when video recorders are as ubiquitous as audio recorders are today.

Note: Due for testing by video-recorder manufacturers are several brands of thinner-based tapes in the standard VHS configuration which will soon make possible a T-180 cassette that can record and play for a full eight hours on standard multi-speed VHS machines.

VIDEO VS. SUPER 8

The super-8 home movie business is hurting, and declining each year. It's difficult to determine whether that is the influence of videotape, but it's certain that Japan's major movie camera makers are going video. Canon's planned move into portable video recording, reported in this space last month, won't be the only one. At the recent Japan Camera Show, other leading manufacturers were staking their claims to the video field. Elmo said it would introduce its own home-video camera with a 2/3-inch pickup tube later this year, and is working with a large electronics manufacturer on a portable mini-VCR.

Chinon said it had developed a video camera with a pickup tube smaller than 2/3-inch, probably for introduction next year, but doesn't see the development of a practical one-piece camera/VCR for three or four years. Sankyo is also working on a home-video camera, and since it is a major supplier of tape-recording heads and micro-motors for VCR's, it can be assumed to be developing a video recorder as well. Canon, Chinon, and Sankyo also supply lenses to video camera makers. Eastman Kodak is also believed to have a home video project under way.

'PARTICIPATIVE' DISC

The first home videodisc to utilize the potential of the LaserVision optical system fully (Magnavox and Pioneer players) is Optical Programming Associates' new "First National Kidisc," designed to provide hours of fun for children aged 5 to 10. Although the single-sided disc runs only 27 minutes if played straight through, this "participative" record becomes an ideal rainy-day companion for kids when used with the optical system's special controls—such as random-access, stop-motion, frame advance, reverse, and dual soundtracks. One segment shows step-by-step examples of how to make a wide variety of paper airplanes which children can follow and emulate at their own pace by using the stop-motion control. Another gives instructions in how to dance the Irish jig with the teacher's verbal explanations on one soundtrack, the music on the other. The two tracks can be played separately or together. Another segment, which actually would take less than four seconds to play straight through, gives 101 jokes and riddles for on-screen reading at the child's own pace. Making a water-glass xylophone with selections to play by number, an airplane ride (which can be run forward, backwards, or speeded up for fun), knot-tying, and a trip to the zoo are among the 25 sequences on this single disc—each one of which can be called up immediately via random-access indexing. "Kidisc" retails for $19.95.

Also in videodiscs, Sharp Electronics announced that it will offer players in the VHD format developed by JVC and now embraced by Matsushita (Panasonic and Quasar), GE and Thorn EMI. Sharp was mistakenly listed here last month as having adopted the RCA-developed CED system for the U.S. market.

JAPAN VIDEODISC PLANT

Although almost all optical videodiscs are currently being mastered and pressed in DiscoVision Associates' plant in Costa Mesa, CA, that facility will be dwarfed by the new optical-disc plant being activated in Japan by Universal Pioneer, expected to have capacity for pressing 5,000,000 discs annually next year. Universal Pioneer is owned jointly by DiscoVision (in turn owned by IBM and MCA) and Pioneer Electronics of Japan. The facility will press discs for the American market as well as for Japan and other countries. Other optical disc plants are being built by Philips in England, Sony in Japan and 3M in St. Paul, MN.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

what's news

Automobile instrument board to be completely electronic

A prototype automobile instrument-panel, using only a new vehicular CRT for all display functions, was demonstrated by Zenith at the recent Society of Automotive Engineers (SAE) conference in Detroit.

The display is based on a new cathode-ray tube (the Zenith V-CRT) a 5-inch long, 110-degree deflection type designed for vehicular operation. Its peak brightness is ten times that of an entertainment tube, for reading in bright sunlight; the spot size is less than a quarter as large, and it has other design differences because of its special application.

The new system permits display of such operating data as speed, fuel, coolant levels and temperature and oil pressure, as well as time, turn signals, headlights, etc., in six colors, when used with the proper filters.

On push-button command, the V-CRT monitor can also display such data as miles-to-empty, estimated time of arrival, maps, travel information, and various diagnostic and service information.

Features that make the new system particularly interesting to automotive designers are the small number of interconnections required: only horizontal, vertical, video, power, and ground. Also, software control makes it possible to modify the display, if expedient, for annual model changes or to add other displays, without mechanical changes other than adding appropriate transducers for additional functions.

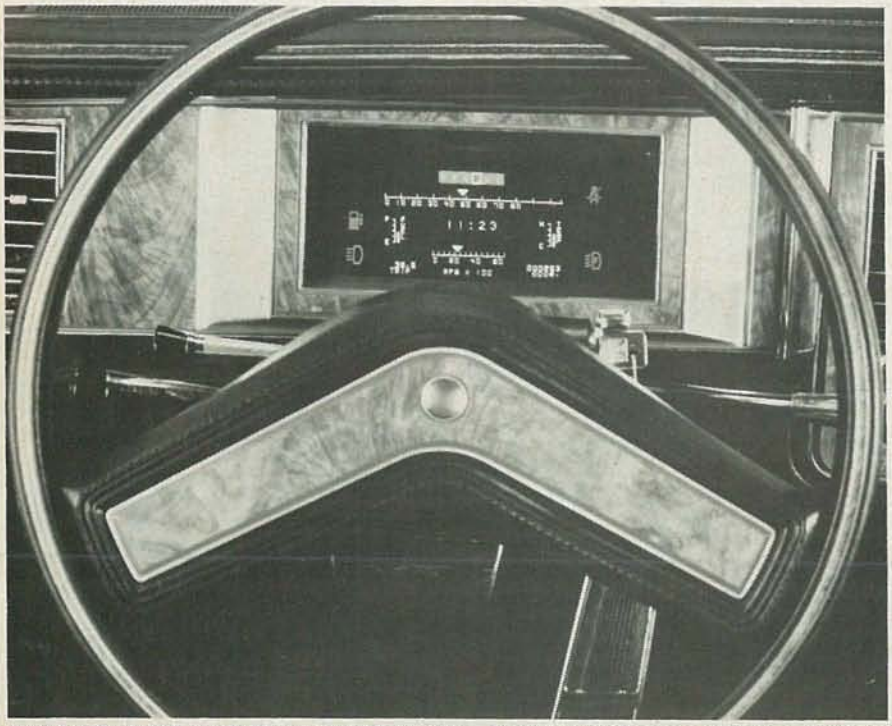
The total display is 3 inches high, 8 inches wide, and slightly less than 8 inches deep.

Help-for-the-handicapped contest

A contest for ideas and inventions through which personal computing may help the handicapped is being sponsored by grants from Radio Shack and the National Science Foundation. The awards include a $10,000 Grand Prize given by Radio Shack, TRS-80 computer systems, and other cash and equipment prizes.

Among the categories that will be considered by the judges are computer-based aids for the blind, deaf, or mentally retarded; for individuals with learning disabilities or with neurological or neuromuscular conditions, and for those with physical (orthopedic, etc.) disabilities.

Contestants have until June 30, 1981, to submit their entries. Additional information, including a descriptive flyer and contest application, is available from Personal Computing to Aid the Handicapped, Johns Hopkins University, P.O. Box 670, Laurel, MD 20810, or from Radio Shack stores and computer centers.



NEW AUTOMOBILE INSTRUMENT PANEL DISPLAY, Zenith's V-CRT, uses a cathode-ray tube to display all information, instead of electro-mechanical meters or gauges.

British Audio Pioneer passes

P.G.A.H. (Paul Gustavus Adolphus Helmut) Voigt, early developer of electronic phonograph recording apparatus, died in his sleep February 9, 1981, at his home in Brighton, Ontario. He was 79 years old.

As an undergraduate student, Voigt gained some reputation in radio design. After leaving college, he joined Edison Bell Works, manufacturers of phonographs and records, in 1922. He was to assist in setting up a radio section of the business, which the owners felt might be threatened by the new art.

While working with radio, Voigt realized that if recording artists could use the new microphones and amplifiers of radio instead of singing into trumpets, phonograph records might be improved greatly. He experimented with new electronic techniques, designing microphones, amplifiers, transformers, cutters, pick-ups, and monitoring loudspeakers, and used them to produce completely electronic records. His recording system was in commercial use by 1926, and in 1927 he went on a recording expedition, recording over 600 items with the new apparatus.

When Edison Bell went down in the depression, Voigt started his own business. He had developed an excellent laboratory speaker (the Tractrix horn, named after its curve of expansion) in his recording work. With a mouth four feet square, it was unsuitable for home use; but the new talking movies gave him an excellent market for a time. Meanwhile, he quartered the speaker longitudinally to reduce it to home size. That, with a few other modifications, resulted in the famous Voigt-Lowther corner speaker.

World War II struck a serious blow to the company, and Voigt went to Canada in 1950. He spent the rest of his life in various activities, including nearly ten years with the Canadian government's radio section, chiefly in anti-interference work.

Two RCA units join forces to make and sell videodiscs

RCA *SelectaVision* and RCA Records will develop and produce original music videodiscs for use with the RCA VideoDisc system, report RCA executive vice president Herbert Schlosser and Robert Summer, president of RCA Records. Specific video-music projects will be announced as agreements are made.

RCA Records has been producing, or co-producing, video projects for cable TV, pay television, and record retail outlets for several years. *SelectaVision* will be responsible for developing the program catalog for the company's videodisc system and for marketing the discs.

continued on page 12

Rickerson Returns

A print by a famous American space-age artist offers you a chance to help launch the AMSAT satellite.

The response was great. A few months ago JS&A offered a limited edition print by American artist, Mark Rickerson, in a similar style to the print shown above.

THE SUCCESS

There were only 300 prints available. Although we expected to get more orders than we had prints, we did not expect the several thousand responses we eventually received.

THE FAILURE

Another famous program, however, was not successful. A satellite, built by world amateur radio operators in 1980 and placed on a European rocket, crashed into the ocean almost immediately after take-off. The AMSAT satellite and the rocket were lost, along with the hopes of amateurs who had worked for years building their satellite.

The JS&A program was a success. But JS&A's program and the AMSAT failure have something in common—a great opportunity for the public. Let us explain.

AMSAT was a private venture based strictly on donations. No government money was used. In addition to the thousands of man hours contributed by amateurs world-wide, there was a total of $250,000 raised to buy materials.

Why do amateurs even need a satellite? Amateurs or ham radio operators (not to be confused with citizen band operators) are always the first on a scene in a major disaster. During the Italian earthquake, for example, amateurs were first to direct relief efforts.

But occasionally a disturbance in the ionosphere will interrupt this communication and render all radio communications inoperative, as was the case in the Alaskan earthquake. That's only one of the many reasons for AMSAT—positive communications in times of emergencies and not dependent on the ionosphere. JS&A thinks the venture deserves the support of all Americans, and we are providing our full financial and creative support to a program to help raise funds to build and launch a new AMSAT satellite.

THE PROGRAM

JS&A commissioned Mark Rickerson to paint "AMSAT"—a painting to be used exclusively for this space effort. From this painting, JS&A has arranged with Rickerson to produce limited edition prints signed by the artist. JS&A will contribute all prints and the full costs to produce these prints to the program. Only the cost to run the advertisement in a magazine will be covered by the initial proceeds.

Each print has a 26" x 35" image size on a 34" x 42" piece of museum-quality PH balanced 100% rag content paper. The print will be shipped in a well-protected circular cardboard double container. Your contribution of $300 will also entitle you to a handsome certificate suitable for framing to acknowledge your active participation in the new AMSAT launch. A certificate of authenticity will also accompany the print should you wish to sell or donate it to someone in the future.

Each color of this multi-colored painting will be faithfully reproduced in a special collotype process utilizing a continuous tone printing process, several printing plates and the artist's supervision and approval to provide an almost three dimensional reproduction.

Dr. Tom Clark, a NASA scientist and president of the AMSAT organization, says, "We need the cooperation of the American citizen to make this program a success. I urge all Americans to participate. Not only is the reproduction a beautiful piece of art, but the contribution is to a very worthwhile cause. In addition to its use during emergencies, we will be using AMSAT for educational purposes to train many of the potential young scientists in our country."

The edition will be limited to those who subscribe before the deadline date of June 30, 1981. The publication you are reading has helped us in this program by giving us a good position in their magazine and allowing us every available discount to keep the expense of this program low.

To order, send your check or money order for **$300** made payable to AMSAT to Dept.RA, JS&A Group, Inc., One JS&A Plaza, Northbrook, Illinois 60062. If for any reason you are not satisfied with your print, you may return it anytime this year for a prompt and courteous refund.

JS&A had a success with its limited edition print program earlier this year. The AMSAT program suffered a failure. Why not join with us to make their launch a huge success? Order your Rickerson AMSAT print, today.

JS&A

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Now NRI takes you inside the new TRS-80 Model III microcomputer to train you at home as the new breed of computer specialist!

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With NRI training, the programmer gains practical knowledge of hardware, enabling him to design simpler, more effective programs. And, with advanced programming skills, the technician can test and debug systems quickly and easily.

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NRI training is hands-on training, with practical experiments and demonstrations as the very foundation of your knowledge. You don't just program your computer, you go inside it...watch how circuits interact...interface with other systems...gain a real insight into its nature.

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

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

what's news

continued from page 6

Speech synthesis evaluated with two new TI kits

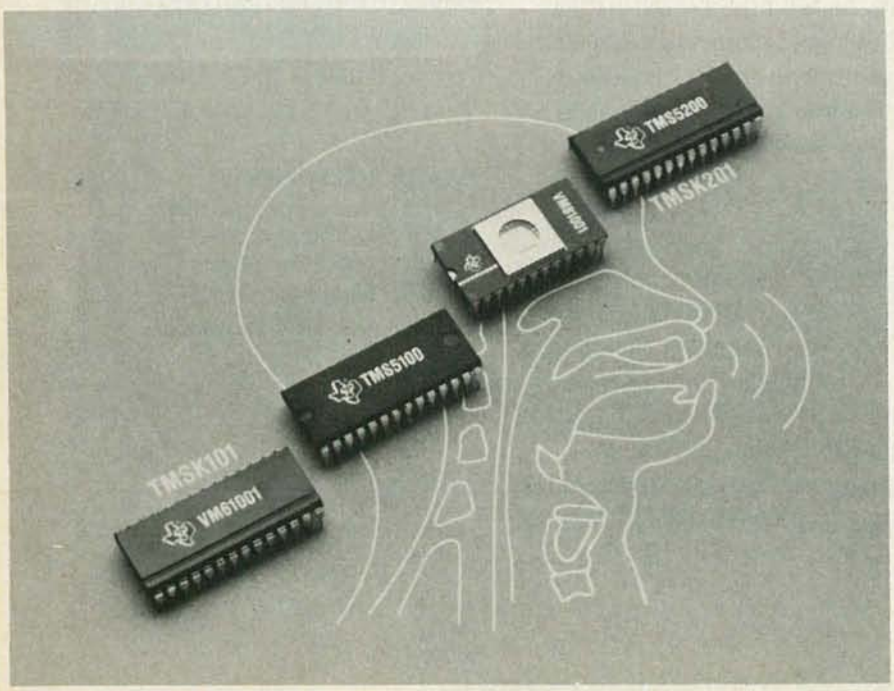
Texas Instruments has produced the first two of a series of speech-synthesis evaluation kits, the TMSK101 for evaluating the performance of the TMS5100 speech-synthesis chip for low-cost speech synthesis, and the TMSK201 to evaluate the TMS5200 chip, used for higher-performance speech applications. The TMSK201 kit permits the designer to evaluate TI's voice-synthesis capability on microprocessor-based systems (8 or 16-bit) and minicomputers.

The kit includes a TMS5200 voice-synthesis processor and a TMS5232 erasable programmable read-only memory (EPROM). The EPROM is programmed with a set of 35 items (32 words, two phrases, and one tone) each individually coded, using linear-predictive coding.

Linear-predictive coding (LPC) is a technique for analyzing and synthesizing human speech from original speech by specifying a time-varying, digital-filter model of the vocal tract. The filter is then excited by either periodic or random inputs corresponding to voiced and unvoiced human speech. Both the TMS5100 and TMS5200 combine LPC synthesis-capability with on-chip digital-to-analog converters to convert the filter output to an analog signal. In addition, the TMS5100 has an on-chip push-pull amplifier for direct speaker-drive, further reducing overall system costs.

The LPC technique provides the most natural-sounding, highest-quality synthetic speech available, and requires only 900-1600 bits per second of speech (or 450 to 1000 bits per word). Key to the high-quality voice synthesis of both of those kits is the patented advanced-design lattice filter within the TMS5100 and TMS5200. The filter is implemented with a single-stage, integrated array-multiplier coupled to the adder output. That provides a single monolithic IC which generates up to 10,000 speech samples per second, accurately approximating the spectral energy of the original speech.

Both kits come with the documentation necessary for implementation into a variety of applications. The kits are available now at a unit cost of $140 from TI authorized distributors.



SPEECH SYNTHESIS IC'S FROM TI

U.S. will hold its lead in electronic technology

Claims that Americans have grown "timid" in technology and innovation are inaccurate, general manager of RCA Broadcast Systems Stanley Basara told members of the Raleigh, NC, Kiwanis Club at a recent meeting. Blasting the assumption that the rapid growth of some foreign technologies may result in their overtaking us, he insisted that the United States will remain the world's leader in technology.

The high rate of development in some countries is not cause for alarm, thinks Mr. Basara. "Anyone familiar with statistics knows that growth generally starts strong and tapers off as it gets older."

One reason for what some see as timidity is that American technology has learned that new and better products will not necessarily be successful on the commercial market. Referring to RCA's new videodisc system as a successful innovation, he predicted that an electronic interpreter, capable of translating one language into another, would also succeed. Other probably successful innovations will be an electronic position-locator for automobiles and numerous new uses for home television including video conferences, education, home security, and electronic shopping.

Home-electronics users want information services

The biggest change that Americans would like to see in their homes in the '80's, a recent survey shows, is the development of systems that will allow people to select the information they want from a variety of data bases. That could be done on their TV sets or on separate computer terminals—in much the same way that a travel agent or stock broker can "call up" information for his clients. Such a home-information system could be used for a variety of functions: comparison shopping, world and local news, consumer reports, up-to-date budgeting and tax information, educational information, and medical and home health services.

Nearly half of the persons sampled wanted information systems to be two-way, or interactive. That would allow them to use their home computers for such additional transactions as making airline and hotel reservations, preparing tax returns, taking courses, paying bills, ordering merchandise, regulating lighting and heating in the home, turning appliances and security systems on and off, arranging bank loans, playing video games, participating in game shows at home, or sending messages to others who also have the system (an enormously popular feature in the few areas that already can provide that interactive capability).

The survey, conducted jointly for a number of large electronics concerns by the research firms of Dresner, Morris, and Tortorello; and Link, an electronic-media consulting company, noted some concerns about an interactive home-system particularly with regard to a fear of "Big Brother"—that one's privacy could be invaded. Almost one third of those in the sample were concerned about the possibility that too much information might be recorded about one person in one place. R-E

editorial

Cable vs. TV-Set Makers

Talk about a battle between giants. Picture the battle lines being drawn with Cable-TV companies on one side and TV-set manufacturers on the other. Among those set manufacturers are General Electric, Magnavox, Panasonic, RCA, Sharp, and Zenith. On the cable-TV company side are UA-Columbia, Viacom Communications, and other heavily-financed giant organizations.

What's the big hullabaloo about? It started when the set manufacturers began introducing "cable-ready" TV sets. Those receivers have tuners (with channel capacities ranging from 35 to 105 channels) that cover the cable channels without the need for a cable-company-supplied converter. Of course, the cable company must still run a cable to the customer's house. The cable company would charge the customer for the cable service, but—we hope—would subtract the rental charge for the now unnecessary converter. Another benefit the cable-ready sets provide the consumer with is the ability to use the TV set's remote control, a feature that is rendered useless by the cable company's external converter.

To emphasize the potential savings from a cable-ready TV, Sharp Electronics surveyed the 15 top U.S. cable TV companies. They found that an estimated $3.50 a month in savings could be passed on to cable customers who own cable-ready TV sets. That comes to $42 a year—no small amount to most consumers.

What has been the cable companies' response to the cable-ready sets? The president of the National Cable Television Association, Tom Wheeler, sent a letter dated March 9 to the set manufacturers listed above. In his letter, Mr. Wheeler points out that consumers are being led to believe that they can circumvent the need to purchase the cable service. Mr. Wheeler also states that the cable-ready sets are often incompatible with existing cable systems.

In response, RCA said that they can't be sure their cable-ready sets would be compatible with any future cable systems, but that their sets do work with any cable system in existence or planned. RCA went on to say that "cable operators are trying to defeat our efforts to supply cable-ready sets by making specific efforts to transmit their signals outside the standard cable bands."

Perhaps the strongest complaint of the cable-TV companies is that the cable-ready TV sets often permit theft of premium programs. The vice president of engineering for UA-Columbia said that the average person sees television as free. Many don't see stealing our signals as wrong—many see it as an intellectual pursuit. Frank Biss, of Viacom Communications, said, "I don't want my scrambled signals in the home to antagonize the viewer. He might get curious and defeat the system".

How will all this end? Only time will tell. But as usual in most of those confrontations, it is you, the consumer, that is the pawn. You should be the king. It's your dollars, and you should decide what you are willing to spend them on—not simply settle for what's available. And, as previously stated, it is our opinion that consumers should be allowed to purchase their own converters and decoders rather than be forced to rent those devices from the cable companies. To prevent customers from decoding scrambled signals, the cable companies can install individual traps and prevent the scrambled signals from entering non-subscriber homes.

Art Kleiman

ART KLEIMAN
Managing Editor

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TELETEXT SIGNALS ON SATELLITE

At least three satellite signals are being used to transmit teletext—and several more such teletext projects are in the works. Teletext is the words-and-graphics information service which is being embraced by many major media companies, a technology which allows viewers to pick off data transmitted within the vertical-blanking interval (usually lines 15 and 16) of the TV signal.

Satellite Syndicated Systems was the pioneer of such service, launching its "CableText" service on Satcom I Transponder 6—the channel it uses to carry WTBS-TV. Using Zenith Virtex equipment (a variation of the British teletext technology), SSS carries UPI and Reuters news feeds to cable-TV systems. United Video is testing transmission of Dow Jones Cable News to cable-TV systems using the vertical interval of its Satcom I transponder and employing French Antiope technology. That test, incidentally, is the subject of hot debate since WGN, the station that United Video retransmits, insists that the teletext bandwidth should remain the property of the TV station itself. WGN is conducting its own teletext tests in Chicago and wanted the signal sent via satellite to a cable system owned by the same company in New Mexico; but United Video has been deleting WGN's signal in order to insert its own teletext data.

Meanwhile, TV Ontario, a Canadian TV station that has been experimenting with teletext using Telidon format technology, successfully transmitted signals via Anik B direct broadcast satellite in the 12/14-GHz band. The signals were encoded within standard TV broadcasts.

Teletext will be transmitted on a full satellite channel by Time Inc., in an experiment due to get under way late this year. Time will use Telidon equipment, which has highly sophisticated alpha-geometric graphics capability. The signal will be transmitted on one of the transponders Time owns aboard Satcom I and other birds. The service, as yet unnamed, will include up to 2,500 pages of information arranged in about 20 "electronic magazines." All data will be edited and coordinated by a teletext team in New York and beamed to receivers at cable-TV systems, where they will be sorted out for various channels.

INNOVATIVE PROGRAMMERS

Broadcasters as well as cable-TV programmers are continuing to develop novel ways to use satellite facilities. You can never tell exactly what you'll find when flipping through the satellite tuner—although some of the projects are announced well in advance. For example, starting in September, Paramount TV (a subsidiary of the Hollywood studio) will begin beaming "Entertainment Tonight" to TV stations around the country. The show will be a video magazine covering news about show business, running 30 minutes on weekdays, and a full hour on Saturdays and Sundays (with the weekend editions including juicy highlights from the week's shows). "Entertainment Tonight" will be beamed at about 3 or 4 p.m. on weekdays, in time for airing at 7:30 p.m. on East Coast TV stations. Paramount, and its partners in the project (Taft Broadcasting, Cox Broadcasting, Telerep) are still deciding which satellite to use for the transmission—but it will probably be a Westar bird used by many TV stations.

Other examples of innovative satellite use abound: Wold Communications transmitted a stereo simulcast of this year's Grammy Awards show to about 60 FM-radio stations nationwide. The live program, originating from New York's Radio City Music Hall, was carried on the CBS-TV network. Wold intercepted the CBS video signal and uplinked it to Westar III, just to give it the same time-delay as the audio signal which was distributed via satellite.

Many news programmers are also using satellites—beaming stories during afternoon hours that are then used on evening newscasts. For example, Group-W TV stations transmit a one-hour nightly "Newsfeed" to stations owned by the company and to other stations.

HIGH DEFINITION TELEVISION

CBS has demonstrated its concept of "high definition" television, an impressive technology which includes 1125-line digital video, stereo sound, wide-screen TV and other features. Because of the broad bandwidth of the signal needed to carry such programming—30 MHz—the technology is ideally suited only to special applications, such as video in the 12/14-GHz satellite range. CBS engineers admitted it will be five to ten years until all the refinements are made and there will be problems introducing the service because of its technical incompatibility with existing TV.

The technology also includes high-density digital videotape. The screen is in a wide 3 by 5 ratio format (compared to the 3:4 ratio of today's TV screens). CBS brought together all the necessary equipment "for one time only" during a recent demonstration in Washington. New videotape devices were from Sony, video monitors from Matsushita, cameras from NHK (the Japanese TV network), while audio and other equipment came from CBS's labs.

GARY ARLEN
CONTRIBUTING EDITOR

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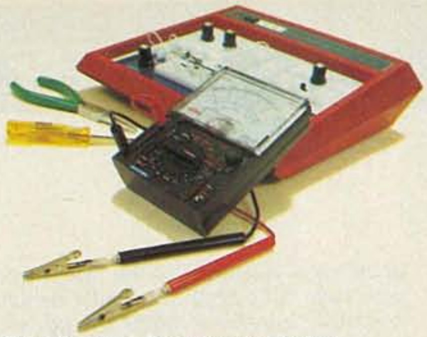

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letters

OBJECTIONS

While I find your magazine quite enjoyable and informative, I am appalled continuously by some of the attitudes frequently (and almost invariably one-sidedly) expressed in your pages.

For example: In the article "Electronics in Your Next Car" (March 1981), an automatic vehicle-identification system is described. Then there is the statement: "Unfortunately, it would also make computerized ticketing for such offenses as speeding a technological breeze. *Unfortunately* it would help enforce laws designed for public safety? That word should have been "fortunately." If law-enforcement agencies had such a system, thousands of victims of irresponsible individuals, who thought that the law shouldn't apply to them, might be alive today. Thousands of others have been permanently crippled because of people who wanted to get somewhere a few minutes quicker, at any cost.

On the same grounds, radar detectors are inexcusable. Their sole function is to encourage violations of the law. Anyone who pays $100-$200 for a radar detector obviously intends to break the law on a regular basis, because it would take quite a few speeding tickets to add up to that kind of money. If you are driving legally and safely, there is no need for you to know whether you are being watched at that moment.

The argument that the Communications Act forbids the banning of any kind of receiver is irrelevant. A radar detector is *not* a communications receiver: It merely detects the presence or absence of a carrier signal. No intelligence or data are recovered at all. Therefore, the Communications Act does not apply. Even if it did apply, the use of certain types of receivers may be banned legally under certain conditions (such as in moving vehicles).

Even if the possession of a radar detector could not be made illegal, transporting it across state lines can be restricted or stopped altogether, since the only function of the device is lawbreaking. And police use of radar is not an invasion of privacy by any stretch of the imagination. Exceeding speed limits is a publicly-visible act in a public place. There is no privacy to invade. (If I stand inside my house and fire a gun through the window, is it an invasion of my privacy to detect the bullet in any way?)

Radar detectors are reprehensible—a black eye on the electronics industry. They have no legal or morally-justifiable use. The support of such a device is irresponsible and dangerous to the public. I suggest that all supporters of radar detectors read over some of the statistics on the highway death-toll, and may they sleep well.

(If you're opposed to the 55-mph speed limit, that's another issue. But disagreeing with a law never gives anyone the *right* to violate it, or to encourage others to do so.)

On a somewhat less vital level, I feel that your publication of plans for a pay-TV decoder was also irresponsible. The majority of pay-TV stations do not use advertising. They are in business to make a profit, and the only way they can do that is to sell subscriptions. Encouraging people to receive their programs without paying

the admission price is simply an attempt (however unintentional) to drive honest businessmen out of business, and prematurely to stamp out a potentially exciting sub-industry that could offer a considerable amount of special programming that would not otherwise be available. True, that potentiality has not yet been realized— but wide-scale theft of service will only insure that it will *never* be realized. As the laws stand presently, it is legal. But the concept of the airwaves belonging to the public was formed at a time when such a system as pay-TV wasn't even considered. The laws need to be altered to allow for new developments.

Incidentally, I am in no way involved with either the legal profession or pay-TV. I am a concerned electronics technician who does not want to see the industry get a bad name because of irresponsibility. I think that a magazine of **Radio-Electronics**'s caliber should be above that sleazy level.

DELTON T. HORN,
Hollywood, FL

OOOOOOOOPS

There were some errors in the parts-placement guides in part two of "Audio-Signal Restoration Unit," in the April issue.

Page 74: the front board—the leftmost of the two R501's should be R507. The C213 at the bottom right of R202 (a slide control) should be C212. The C506 at the center top shold be C606. A jumper from near the lower end of D510 to near the left end of C216 is missing. D208 is drawn backwards.

Page 104: on the rear board, IC13 is drawn backwards. The R403 near the bottom left of IC5 should be R402. The R409 next to C401 should be R404. The C403 near C406 should be C405, with the "+" sign down; the C403 near IC7 should be C402. The left side of C602 is "+".

JOSEPH M. GORIN

ON NIKOLA TESLA

It's good to see an article on Nikola Tesla (February issue), but there was one inaccuracy: J. Pierpont Morgan did not give any money to Tesla for the Colorado experiment. John Jacob Astor and Crawford (from the Simpson & Crawford dry goods store) contributed, and some of his own money was used. The total investment was approximately $30,000. (See *Lightning in his Hand,* by Hunt & Draper, and *Prodigal Genius,* by O'Niell.)

When Tesla returned to New York with pictures similar to Golka's, he went to Morgan, who had invested $150,000 for a wireless transmitter on Long Island. Tesla's goal was to light the Paris Exposition of 1902 from Long Island. Tesla put in about $50,000 of his own money as well— so the $200,000 figure mentioned in your article relates to the Wardenclyffe plant on Long Island, which was never completed, and not the $30,000 experiment in Colorado, which was so successful that Tesla was able to light bulbs by wireless at distances of 26 miles. He sent *power* through the air.

In the last analysis, Morgan did not give

continued on page 80


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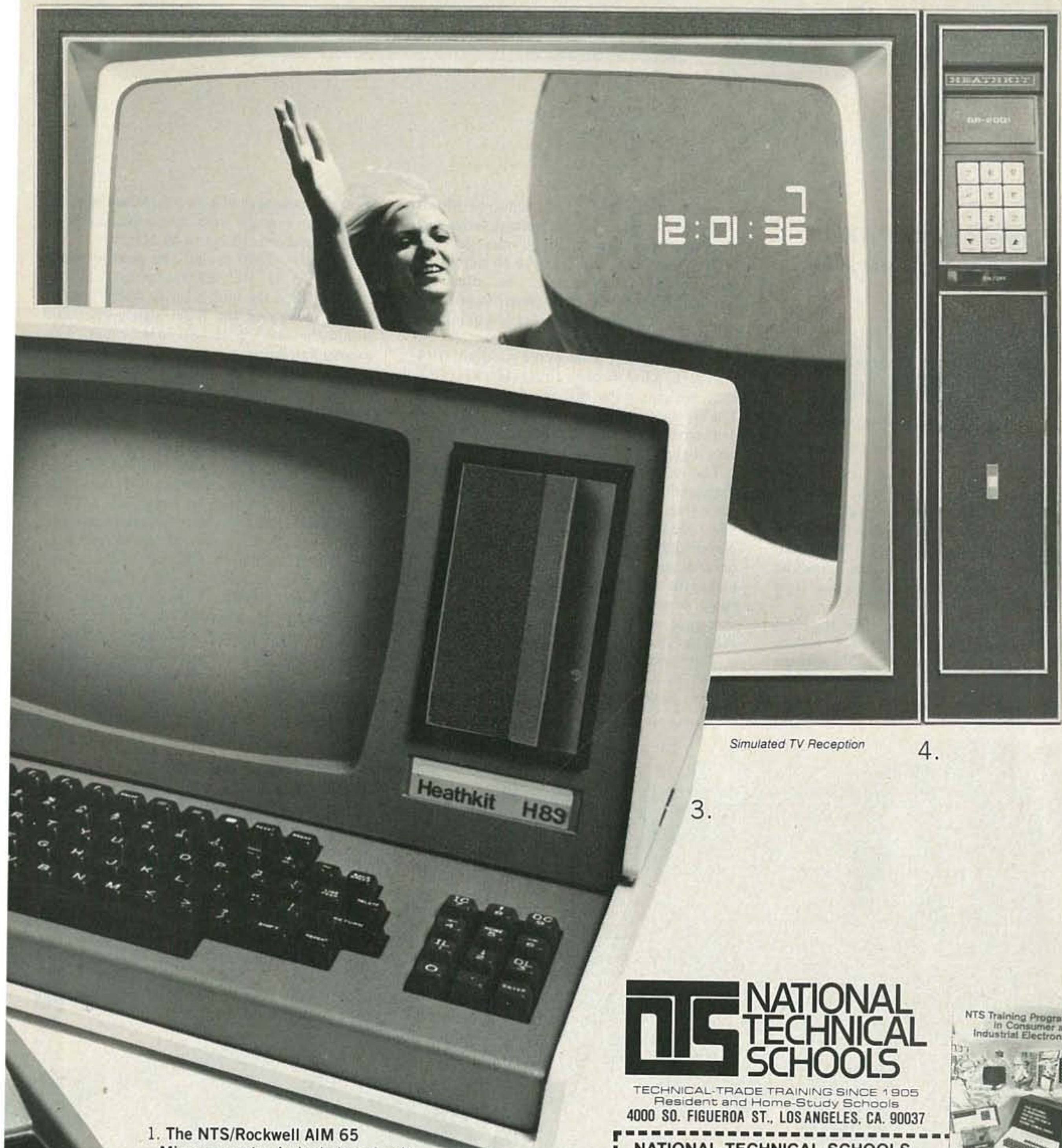

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Triplett Model 7000 Frequency Counter

CIRCLE 101 ON FREE INFORMATION CARD

THE TRIPLETT CORPORATION HAS RECENTLY introduced a new frequency counter. Called a "universal counter," the *model 7000* does more than just measure frequency. It will also determine the period of a waveform, count the number of events occurring during a time interval, and measure elapsed time.

Of course, measuring frequency is the most important function of the *model 7000.* It does so over a range of 5 Hz to 80 MHz with an accuracy listed as ±time base ±1 count when used in the HZ mode. The gate time is one second, and sensitivity is claimed to be 30 millivolts. The maximum input voltage varies with frequency but ranges from 200 volts (peak AC + DC) at 5 Hz (to 500 Hz), to 30 volts (peak AC + DC) at 80 MHz. An attenuator (switchable from the front panel) is provided to allow for optimum triggering and to prevent overloading the input stage.

All readings are shown on a six-digit, 0.43-inch high, LED display. Units (Hz, kHz, mS, etc.) are shown by discrete-LED indicators. The six least-significant digits of a reading are displayed in the HZ mode; the six most-significant digits are displayed in all other modes.

The AUTO FREQ mode takes the frequency measured and displays it in its most useful form (Hz, kHz, or MHz). For a frequency of 988,880 Hz for example, 988.88 would be displayed and the kHz indicator would be lit. The decimal point is positioned automatically. Accuracy in this mode is claimed to be ±time base accuracy ±1 least-significant digit ±trigger error. Resolution to one-part-per-million (ppm) can be expected.

The period of the input signal can be determined by switching the *model 7000* to the PERIOD mode. The period (period is the reciprocal of frequency) of a waveform can be measured over a range from 200 milliseconds to 12.5 nanoseconds (5 Hz to 80 MHz).

The *model 7000* can also be used to count events. Up to 999,999,000 events can be counted when the unit is in the EVENT mode. The frequency of the input signal must fall within the unit's 5 Hz–80 MHz range. The counter can be reset with a front-panel button or by remote control using a rear-panel connection. For counts over one million, the six most-significant digits and an M indicator are displayed.

The built-in timer measures elapsed time in hours, minutes, seconds, and fractions of a second, from 100 microseconds to 100 hours. The timer can be stopped by supplying a TTL-logic-level signal to a rear-panel connector and reset to zero by using the front-panel reset button. Timer accuracy is claimed to be ±time base accuracy ± 1 least-significant digit.

The *model 7000* has a built-in self-test feature. When the selector switch is turned to TEST, the unit will sequence through a series of preprogrammed steps to check that the microprocessor, control, and display circuits are all operating properly. Also, when the unit is turned on, regardless of switch position, the *model 7000* will do a brief check of its internal operation including a test of every segment of the readout.

The internal timebase uses a crystal oscillator operating at 10 MHz that, after a half-hour warm-up (at an ambient temperature of 25° C), boasts a stability of ±10 ppm (±0.001%) at temperatures ranging from 0° to 40° C. A switch-selectable, TTL-level, external timebase input is available on the rear panel. A TCXO (*T*emperature *C*ompensated *C*rystal *O*scillator) option is also available for the *model 7000*. With this option installed, the stability is better than ±one ppm (±0.001%) over a temperature range of 0° to 40° C. With the TCXO, no warm-up time is required.

The case measures $8\frac{1}{2} \times 9\frac{9}{32} \times 3\frac{7}{16}$ inches. The weight is listed as $4\frac{1}{2}$ pounds. The large carrying handle doubles as a tilt stand for bench use. The power required is 105-130 volts AC (210-260 volts AC using internal transformer jumpers) and there is a $\frac{1}{4}$-amp internal fuse. The grounded power cord is detachable.

Two cables are supplied with the unit. The input cable is 36 inches of coax with a BNC connector at one end (to mate with the connector on the front panel of the unit) and two alligator clips at the other. The 25-inch rear-panel accessory cable has a Molex connector at one end; the other end of the cable has stripped and tinned ends.

The instruction booklet is small but fairly complete. Specifications, operating instructions, theory of operation, calibration, and maintenance are covered. However, a schematic diagram is not included.

The only possible shortcoming you may find with the *model 7000* is its somewhat restricted frequency range. The 80-MHz limit will make the unit's usefulness in communications applications questionable as an outboard prescaler will have to be added and will result in a loss of resolution.

Aside from that limitation, the unit looks as if it would be a good addition to your service bench. The *model 7000* from Triplett (One Triplett Dr., Bluffton, OH 45817) has a list price of $300.00. **R-E**

Hickok Model MX 333 *Universal DMM*

CIRCLE 102 ON FREE INFORMATION CARD

THE *MODEL MX 333* UNIVERSAL DIGITAL MULTImeter from The Hickok Electrical Instrument Co. (10514 Dupont Ave., Cleveland, OH 44108) is not like ordinary DMM's found on the shelves of suppliers. The company claims that it: ". . . packs more measurement capability in a small 2.2 × 6.7 × 6-inch, 22-ounce case than any other electronic tool ever developed." Once you've had the opportunity to examine and use the *model MX 333*, you'll be convinced that the company's claims are well-founded.

One of the unique features of the *model MX 333* is called Vari-Pitch. That feature consists of a tone; its pitch is controlled by the value of the reading being made. It can be used in all modes. In normal operation, the frequency of the tone increases as the reading increases. However, when the meter is testing resistance, the tone will do the opposite and increase in pitch with *decreasing* readings. The instruction book fully describes use of this feature.

The Vari-Pitch feature seems to overcome (at least in part) the delays that are inherent in most digital multimeters. Generally, quick troubleshooting is done by making cursory checks of voltages or resistances without regard to the exact values until one is found to be significantly off or not there at all. The analog meter is a natural for that purpose since one must only notice a quick deflection of the needle to see if the proper voltage or resistance is present. If an erroneous reading is noted, you can then examine the circuit carefully to find the possible reasons for such a reading. The Vari-Pitch function will let you do your quick checks without looking away from your work.

Today, there is an ever-increasing need to troubleshoot logic circuitry and one of the more useful tools for this is the logic probe. That simple device will allow the operator to determine at a glance if the point being tested is at a high or low logic-state and whether there is any pulse activity. The same tests can be made with the Hickok *model MX 333* by using the Logi-Trak feature. In fact, the *model MX 333* is faster than most logic probes and will respond to signals up to 80 MHz. Using the Vari-Pitch circuit will give you an audible indication of either a low or a high logic-state which again will let you continue to watch your work rather than the meter.

The *model MX 333* can also be used to test diodes. To do that the SPECIAL FUNCTION and DIODE (marked with a diode symbol) buttons must be pressed. When that is done, the meter will read the voltage drop across the diode. That is useful for determining diode type (silicon or germanium) and for matching diodes.

When the SPECIAL FUNCTION and 20Ω/10A/20MΩ buttons are pressed, the *model MX 333* can be used to measure resistances as low as 10 milliohms. The resistance of the leads and connectors can be neutralized with the front-panel-mounted 20Ω NULL control for more accurate readings.

Automatic zero, polarity, and decimal-point placement, are some other features of this new instrument. The 3½-digit liquid crystal display (LCD) has a LOW-BATTERY indicator that will warn the user when 20% of the battery life remains. With a 9-volt alkaline battery, average battery life is approximately 140 hours.

Input impedance is listed at 10 megohms ($\pm$0.1%) on all ranges. The AC and DC voltage ranges are 200 millivolts and 2-, 20-, 200-, and 1000 volts full scale. Resolution on those ranges is 100 microvolts, 1 millivolt, 10 millivolts, 0.1 volt, and 1 volt respectively. Accuracy on the DC ranges is $\pm$0.1% of reading + 1 digit. The accuracy of the AC reading is $\pm$1% of reading + two digits from 45 Hz to 1 kHz on all ranges. From 1 kHz to 5 kHz, it will be $\pm$5% of reading + five digits (200 millivolt and 20 volt ranges).

Seven resistance ranges with full-scale readings of 20-, 200-, 2K-, 20K-, and 200K ohms, and 2- and 20 megohms are provided. Resolution will be as great as .01 ohm for the lowest range and will extend to 10K ohms for the highest range. Overload protection up to 500 volts is provided on all ranges in addition to a 2-amp fuse on the 20-ohm range.

If you look inside the *model MX 333*, you will find that most of the circuitry is on two good-sized epoxy-glass printed circuit boards. The LCD is mounted on a third board. There is no cramping of parts and the construction is excellent.

The plastic case features four large rubber feet for stability when used on a flat surface. The operating manual includes complete operating instructions, a schematic diagram, and calibration and operating theory information.

Accessories that come with the *model MX 333* include two heavy-duty test leads with specially designed safety connectors, a 9-volt battery, two screw-on alligator clips with insulator boots, and a special belt hook. Optional accessories include an AC adaptor and an 80-MHz oscilloscope probe.

The Hickok *model MX 333* has a suggested selling price of $249.00. **R-E**

Radio Shack Model 42-3019 Sound-Level Meter

CIRCLE 103 ON FREE INFORMATION CARD

SEVERAL YEARS AGO, RADIO SHACK (1400 One Tandy Center, Fort Worth, TX 76102) released a small sound-level meter designed to measure the acoustics of hi-fi installations. Now an improved version, the *model 42-3019*, is available. Although low-cost, the meter is quite flexible. Its accuracy is claimed as $\pm$2 dB (at 114 dB), and the frequency range of the electret microphone element and amplifier circuitry is said to be nearly flat from below 20 Hz through 8 kHz (within 2 dB).

The range of the instrument is step-selectable, covering 60-126 dB, overall. The meter movement is large and easy-to-read. A time-constant switch selects between fast and slow response times.

Selectable "A"- and "C"-weightings are also available: "A"-weighting modifies the frequency response of the instrument so that the frequency response is similar to that of the human ear and "C"-weighting flattens the response so that you can check the full frequency range of a sound system (or use the meter in other acoustical applications).

An RCA phono jack is provided if you want to use the electret microphone circuitry for high-fidelity recording. A standard threaded tripod-mount receptacle is provided so that the instrument can be rigidly mounted if that becomes necessary.

Calibration is factory-set for all ranges; should you want to recalibrate the instrument, a small access hole permits you to adjust an internal calibration trimmer.

The owner's manual provides 10 pages of introductory information. It lists the unit's specifications; briefly explains how the controls work; provides tables of typical environmental loudness levels, including the maximum permissible levels set by the U.S. Department of Labor; describes several techniques for making meaningful level measurements; and includes a schematic diagram.

A soft leatherette carrying pouch is included to protect the instrument when it's not in use.

As with any other new device, we could hardly wait to try it out. Naturally, the first tests were made in noisy locations. The cab of a pickup truck (with the windows rolled up) showed an internal noise level of 70 dB ("A"-weighted) while driving down a highway at maximum speed; with the windows rolled down, the noise level rose 10 dB. Testing the noise level of a high-school class showed approximately that same noise level (80 dB) as the students were chattering among themselves. And here's one you won't find in any published tables: A seven-year-old boy wrestling with a full-grown collie produces an 85-dB noise level (without either of them barking)!

Used with a frequency-test record or sine-wave audio generator, the meter can effectively evaluate sound-system installations: It can analyze the effectiveness of speaker output, placement, phasing, and other variables.

Although its sensitivity threshold in no way approaches that of the human ear, most irritating or distracting noises are well within the range of the sound-level meter. The *model 42-3019* sells for $39.95. **R-E**

McKay Dymek Model DR 33C General Coverage Communications Receiver

CIRCLE 104 ON FREE INFORMATION CARD

MOST RADIO HOBBYISTS DREAM OF OWNING an advanced-design receiver that doesn't require constant fiddling to keep a station tuned in, and one with which a frequency may be accurately dialed with assurance. Now, McKay Dymek has provided a realistically priced, high-quality communications receiver of advanced design. Although its cost may seem steep to the beginner, serious listeners will sense the quality built in to the *model DR 33C*.

The *model DR 33C* is styled to blend with office or living-room decor. It has a wood-grain cabinet and a brushed-aluminum front panel. For those who feel that nothing can be considered electronic unless it can fit into a rack, a 19-inch rack-mount version is available.

The unit's giant 6-digit LED display is hidden behind a stylish blackout panel. The desired frequency is selected by rotating a series of knobs (10-, 1-, .1-, and .005-MHz steps). The .005 MHz switch has 20 positions. There is also a 5-kHz continuous FINE TUNE control. A high-level RF front-end uses the CATV approach to broadbanding, producing an IF signal in a double-balanced diode-ring mixer. No antenna preselection or peaking is needed in most installations. The frequency range is continuous from 50 kHz through 30 MHz. Although reception below 50 kHz is possible, the sensitivity drops dramatically and outboard RF amplification will be necessary.

Frequency readout of the LED display is accurate to 100 Hz, with infinite tuning resolution provided by the kHz selector knob. Other front-panel controls include an RF attenuation switch, a selectable highpass RF filter to eliminate broadcast-band interference, and an AM/CW/RTTY/SSB MODE switch with selectable sideband. Additionally, an IF filter switch allows you to choose 4- or 8-kHz bandwidths, an upper- or lower-sideband Collins mechanical filter, and two optional positions for adding other filters later. Noise filtering is provided by automatic threshold-peak-limiters on all modes. A phone jack is also front-panel mounted. The backlighted S-meter includes a dB scale to be used for relative signal level measurements.

The rear apron has many useful inputs and outputs. High-impedance audio (a level control is provided) is available for recording or signal processing. An IF output may be fed into an oscilloscope or panoramic adaptor. High- and low-impedance antenna inputs are provided. There is also a muting jack and provision for connecting an external speaker.

The circuit board is carefully designed and assembled. High-quality components are neatly laid out on an epoxy-glass printed circuit board.

Specifications are equally impressive. Shortwave sensitivity averages about .5 microvolts, and the stability is ±40 Hz after a half-hour warmup period (assuming a stable ambient temperature). Image rejection is 70 dB. Cross-modulation and intermodulation are both down 65 dB (referenced to 1 microvolt, 20 kHz separation). Crystal filters are used in the first and second IF's; mechanical filters used in the third IF.

McKay Dymek prides itself in high-quality audio (they also manufacture high-fidelity tuners). Probably for that reason, they have carefully designed class-D envelope detection into the *model DR 33C*, with total harmonic distortion usually below 1%. Audio output is 2 watts into 4 ohms, and one volt RMS into 5000 ohms. An internal 4-inch speaker is used unless switched out of the circuit by a rear-apron slide switch that allows an outboard audio system to be used.

The first impression the user will have upon uncrating the *model DR 33C* may be one of awe at the design. The simplicity of the front panel reflects McKay Dymek's design philosophy. Instead of providing a bewildering array of manual controls, they design the receiver to make the appropriate adjustments itself when different modes are selected. Thus, when switching from CW to SSB, for example, the switch also automatically selects the optimum filter bandwidth.

We found the receiver to be very easy to use, and quite stable after the recommended initial warmup period. Dial-readout accuracy was well within 100 Hz. Mechanical stability is excellent. That would be expected in a switchable-synthesis arrangement such as the *model DR 33C* has.

Occasionally, we detected feedthrough over considerable bandwidths due to strong short-wave stations. Ordinarily, that did not pose a problem. The desired stations were much stronger, and a simple external antenna tuner totally removed the offending stations. McKay Dymek does offer an optional preselector for such stubborn cases.

There is a tremendous amount of satisfaction in dialing up a frequency, knowing that you'll tune precisely to the station you intend to hear. Similarly, it is nice to know that when you tune in an unknown station, the frequency readout will accurately tell you its transmitting frequency.

The IF and audio selectivity were very good, pulling weak signals out of the mire. The *model DR 33C* boasts 56 IC's, 31 FET's, 20 transistors, and 66 diodes.

Our test unit had two minor flaws (covered by the liberal warranty policy). One of the frequency-selector switches was slightly erratic, and one of the LED segments remained lighted when it shouldn't have. Other than that, the receiver performed faultlessly.

The accompanying manual is well worth mentioning. It contains page after page of circuit descriptions, operational details, alignment instructions, and schematic diagrams; just about everything you're likely to need to know about the unit.

All things considered, we were very impressed with the *model DR 33C*. This attractive receiver is just what the manufacturer claims it to be: a high-quality, general-coverage receiver intended for the serious user.

The *model DR 33C* sells for $1750.00. From McKay Dymek, 111 South College Avenue, Claremont, CA 91711. **R-E**

Moody Tools Model MMK6 Master Kit

CIRCLE 105 ON FREE INFORMATION CARD

IF YOU'RE PROFESSIONALLY INVOLVED WITH electronic design or servicing, you *know* how important it is to have a complete set of quality tools at your disposal.

If you're into electronics for the fun of it (or maybe with the hope of making a profit sometime), having the right tool at the right time can be just as important.

The Moody Tools *model MMK6 Master Kit* (Moody Tools, Inc., 42-60 Crompton Avenue, Greenwich, RI 02818) is a set of precision small tools. It can fill a gap in the arsenal of anyone building or repairing electronic equipment, especially as things become more and more miniaturized.

The *model MMK6* tool kit is a set of six "lipstick-type" capsules containing a variety of small-scale instruments, many of which are not included in a standard tool kit assortment, but that are sure to be needed if you don't have them.

The six capsules come in a small fitted, fold-open, case (good for slipping into your regular tool kit) and contain the following: a screwdriver/awl set, a tiny tap-drill set, a (matching) tiny tap set, an offset flat-wrench set, a Phillips-head and Allen wrench set, and a socket-wrench set.

Each set has its own jeweler's-type, chuck-grip and metal handle for the interchangeable tips; also, most of those are color-coded so that everything can go back where it belongs easily when you're done with it. A total of 30 different tips are provided.

These tools are really tiny! The *largest* tap size is No. 4-40, and there are four smaller ones. The five other sets follow pretty much the same design.

Anyone who works on small transistor radios, or cassette or microcassette recorders, will find this kit indispensible. It will also be useful for someone involved with occasional watch- or camera-adjustment and repair.

As an example of the usefulness of the kit: For some time I'd had a small telescoping antenna from a junked radio that I wanted to use in a project. I couldn't locate a mounting screw for it—it was metric and I had no metric hardware available. The drill and tap set let me rebore and tap the base of the antenna so I could use hardware that I had on hand. And that was an easy one! There are an almost limitless number of situations in which the tools would be useful. These tools, as are all Moody products, are well-made using high-quality materials so extensive use won't be a problem.

The *model MMK6*, which carries a suggested retail price of $60.00, is not something you'll need in everyday use, but—believe me—someday you *will* need it and, if you don't have it, you'll regret it! **R-E**

By Netronics

ASCII/BAUDOT, STAND ALONE

Computer Terminal

COMPLETE FOR ONLY... $149.95

The Netronics ASCII/BAUDOT Computer Terminal Kit is a microprocessor-controlled, stand alone keyboard/terminal requring no computer memory or software. It allows the use of either a 64 or 32 character by 16 line professional display format with selectable baud rate, RS232-C or 20 ma. output, full cursor control and 75 ohm composite video output.

The keyboard follows the standard typewriter configuration and generates the entire 128 character ASCII upper/lower case set with 96 printable characters. Features include onboard regulators, selectable parity, shift lock key, alpha lock jumper, a drive capability of one TTY load, and the ability to mate directly with almost any computer, including the new Explorer/85 and ELF products by Netronics.

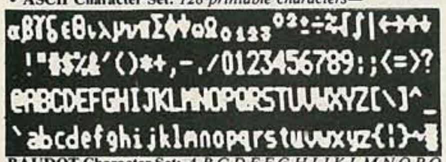
The Computer Terminal requires no I/O mapping and includes 1k of memory, character generator, 2 key rollover, processor controlled cursor control, parallel ASCII/BAUDOT to serial conversion and serial to video processing—fully crystal controlled for superb accuracy. PC boards are the highest quality glass epoxy for the ultimate in reliability and long life.

VIDEO DISPLAY SPECIFICATIONS

The heart of the Netronics Computer Terminal is the microprocessor-controlled Netronics Video Display Board (VID) which allows the terminal to utilize either a parallel ASCII or BAUDOT signal source. The VID converts the parallel data to serial data which is then formatted to either RS232-C or 20 ma. current loop output, which can be connected to the serial I/O on your computer or other interface, i.e., Modem.

When connected to a computer, the computer must echo the character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the screen.

Video Output: *1.5 P/P into 75 ohm (EIA RS-170)* • **Baud Rate:** *110 and 300 ASCII* • **Outputs:** *RS232-C or 20 ma. current loop* • **ASCII Character Set:** *128 printable characters—*



BAUDOT Character Set: *A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? : * 3 $ # ( ) . , 9 0 1 4 ! 5 7 ; 2 / 6 8* • **Cursor Modes:** *Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing* • **Cursor Control:** *Erase, End of Line, Erase of Screen, Form Feed, Delete* • **Monitor Operation:** *50 or 60Hz (jumper selectable.*

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- ☐ **Deluxe Steel Cabinet** for Netronics Keyboard/Terminal In Blue/Black Finish, **$19.95** plus $2.50 postage and handling.
- ☐ **Video Display Board Kit** alone (less keyboard), **$89.95** plus $3 postage & handling.
- ☐ **12" Video Monitor** (10 MHz bandwidth) fully assembled and tested, **$139.95** plus $5 postage and handling.
- ☐ **RF Modulator Kit** (to use your TV set for a monitor), **$8.95** postpaid.
- ☐ **5 amp Power Supply Kit** In Deluxe Steel Cabinet (±8VDC @ 5 amps, plus 6-8 VAC), **$39.95** plus $2 postage & handling.

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BREAKTHROUGH!

Netronics proudly announced the release of the first 1802 FULL BASIC, written by L. Sandlin, with a hardware floating point RPN math package (requires 8k RAM plus ASCII and video display boards), $79.95 plus $2 p&h. Also available for RCA VIP and other 1802 systems (send for details)!

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Regardless of how minimal your computer background is now, you can learn to program an ELF II in almost no time at all. Our *Short Course On Microprocessor & Computer Programming*—written in non-technical language—guides you through each of the RCA COSMAC 1802's capabilities, so you'll understand *everything* ELF II can do... *and how to get ELF II to do it!* Don't worry if you've been stumped by computer books before. The *Short Course* represents a major advance in literary clarity in the computer field. You don't have to be a computer engineer in order to understand it. Keyed to ELF II, it's loaded with "hands on" illustrations. When you're finished with the *Short Course*, neither ELF II nor the RCA 1802 will hold any mysteries for you.

In fact, not only will you now be able to use a personal computer creatively, you'll also be able to read magazines such as BYTE... INTERFACE AGE... POPULAR ELECTRONICS and PERSONAL COMPUTING and fully *understand* the articles. And, you'll understand how to expand ELF II to give you the exact capabilities you need!

If you work with large computers, ELF II and the *Short Course* will help you understand what they're doing.

Get Started For Just $99.95, Complete!

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ELF II connects directly to the video input of your TV set, without any additional hardware. Or, with an $8.95 RF modulator (see coupon below), you can connect ELF II to your TV's antenna terminals instead.

ELF II has been designed to play all the video games you want, including a fascinating new target/missile gun game that was developed specifically for ELF II. But games are only the icing on the cake. The real value of ELF II is that it gives you a chance to write machine language programs—and machine language is the fundamental language of all computers. Of course, machine language is only a starting point. You can also program ELF II with assembly language and tiny BASIC. But ELF II's machine language capability gives you a chance to develop a working knowledge of computers that you can't get from running only pre-recorded tape cassettes.

ELF II Gives You The Power To Make Things Happen!

Expanded, ELF II can give you more power to make things happen in the real world than heavily advertised home computers that sell for a lot more money. Thanks to an ongoing committment to develop the RCA 1802 for home computer use, the ELF II products—being introduced by Netronics—keep you right on the outer fringe of today's small computer technology. It's a perfect computer for engineering, business, industrial, scientific and personal applications.

Plug in the **GIANT BOARD** to record and play back programs, edit and debug programs, communicate with remote devices and make things happen in the outside world. Add **Kluge** (prototyping) **Board** and you can use ELF II to solve special problems such as operating a complex alarm system or controlling a printing press. Add **4k RAM Boards** to write longer programs, store more information and solve more sophisticated problems.

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 lightening 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!

ELF II Tiny BASIC

Ultimately, ELF II understands only machine language—the fundamental coding required by all computers. But, to simplify your relationship with ELF II, we've introduced an **ELF II Tiny BASIC** that makes communicating with ELF II a breeze.

Now Available! Text Editor, Assembler, Disassembler And A New Video Display Board!

The Text Editor gives you word processing ability and the ability to edit programs or text while it is displayed on your video monitor. Lines and characters may be quickly inserted, deleted or changed. Add a printer and ELF II can type letters for you—error free—plus print names and addresses from your mailing list!

ELF II's **Assembler** translates assembly language programs into hexidecimal 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.

The new **ELF II Video Display Board** lets you generate a sharp, professional 32 or 64 character by 16 line upper and lower case display on your TV screen or video monitor—dramatically improving your unexpanded $99.95 ELF II. When you get into longer programs, the Video Display Board is a real blessing!

Now Available!

☐ **A-D/D-A Board Kit** includes 1 channel (expandable to 4) D-A, A-D converters, **$39.95** plus $2 postage & handling.

☐ **PILOT Language**—A *new* **text-oriented** language that allows you to write educational programs on ELF II with speed and ease! Write programs for games... unscrambling sentences... spelling drills... "fill in the missing word" tests, etc.! PILOT is a must for any ELF II owner with children. *PILOT Language on cassette tape, only $19.95 postpaid!*

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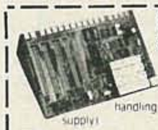

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☐ **Video Display Board** kit lets you generate a sharp, professional 32 or 64 character by 16 line upper and lower case display on your tv screen or video monitor—dramatically improving your unexpanded $99.95 ELF II. (Fits inside ASCII Keyboard cabinet.) **$89.95** plus $2 p&h

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☐ **Assembler** on cassette tape translates assembly language programs into hexidecimal machine code for ELF II use. Mnemonic abbreviations for instructions (rather than numerics) make programs easier to read and help prevent errors. **$19.95** postpaid

☐ **Disassembler** on cassette tape takes machine code programs and produces assembly language source listings to help you understand and improve your programs. **$19.95** on cassette tape

SAVE $9.90—Text Editor, Assembler & Disassembler purchased together, only **$49.95!** (Require Video Display Board plus 4k memory.)

☐ **ELF II Light Pen**, assembled & tested, **$7.95** plus $1 p&h

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☐ ELF II connects directly to the video input of your tv set without additional hardware. To connect ELF II to your antenna terminals instead, order **RF Modulator**, **$8.95** postpaid

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ROBERT WARD

THE HOME COMPUTER CAN OPEN DOORS not only to the realm of programming and electronics, but also to the rest of the world. You need only equip it with a serial port, a modem, and a telephone. Most computer hobbists have the serial port and the telephone. Unfortunately assembled modems can be quite expensive. The few kits available are notable for being difficult to align and quick to drift, and some don't even offer any real savings.

That need not be the case. Here is an easy-to-build, inexpensive crystal-controlled modem. Constructed on one side of a 3×4-inch printed-circuit, the design requires absolutely no adjustments. All passive components are readily available, having 5% and 10% tolerances. The circuit is so simple that, once assembled, its operation may be verified with only a logic probe or VOM. The enclosure and acoustic coupler (the part the phone handset fits into) can be built using readily available materials and require only a few hours work and a minimum of tools.

The completed project is a Bell 103-type, acoustically-coupled modem, easily capable of handling data at 300 baud. It has switch-selectable answer and originate modes. Each channel's input is equipped with a three-stage active filter, providing excellent noise immunity. You may jumper-select RS-232, CMOS, or TTL logic-levels, which simplifies interfacing to your machine. With answer and originate modes you can communicate not only with large time-sharing systems, but also with friends who may be restricted to originate-only equipment.

The project does not include a power supply, but if you already have a computer, it is almost certain that you can power the modem from it. The modem only requires about 20 mA at ±12-volts, and 20 mA at 5-volts. This design doesn't generate a local echo. Again if you have a computer, you can let it take care of that (one approach is detailed later in this article). Finally, certain "handshaking" signals often provided by commercial modems are not generated (but we show you how to do without them). For the most part those signals are not needed in an acoustically-coupled installation.

You don't get FCC-approved (or any other type) auto dial and auto answer and will have to do without those luxuries unless you design the circuits yourself.

The circuit

The circuit (see the block diagram in Fig. 1) consists of two distinct signal paths—the modulator and the demodulator. (That, by the way, is where we get the term *modem*. It's an acronym for *MO*dulator/*DEM*odulator.) The Motorola MC14412 is present in each path and, strictly speaking, provides all of the modulation and demodulation functions. That IC generates audio tones to be transmitted and demodulates the incoming signal, translating it to logic levels. Under ideal conditons it will operate at speeds of 600 baud. In the real world, though, reliable operation of the Bell 103 standard is limited to 300 baud.

The rest of the functions are provided by twelve individual op-amps housed in three LM348 (a quad package of the easy-to-use 741) IC's.

Refer to Fig. 2. The input buffer is a single op-amp (IC1-a2) operating at maximum gain. It increases the crystal microphone's −55 dB output level to essentially 0 dB. (Other transducers, such as electret microphones, may be used, provided they have at least −55 dB sensitivity.)

A carefully designed three-stage active filter (IC1-b, -c, -d and IC2-a, -c, -d) attenuates out-of-channel noise. The exact frequency response of the bandpass filter is not particularly critical, allowing the use of components with 5% and 10% tolerances. However, the filter is not easily modified (e.g. to handle the frequencies of the deaf communication network), since the phase delay across its passband must be consistent.

The limiter in Fig. 3 (IC3-b, D1) clamps the 20-volt peak-to-peak output of the filter to levels compatible with the MC14412's demodulator section.

The filter output also feeds the level detector. That block detects the enhanced input signal (at D2) and uses a simple lowpass filter (C2) to create an output voltage directly related to the strength of the incoming signal. An op-amp configured as comparator with a Zener-clamped output (IC3-a, D5) trips when that voltage exceeds a reference voltage determined by R15 and R8. That ouput signals the MC14412 that a usable carrier is present and that it should act as a demodulator. The demodulator is disabled in the absence of a carrier.

The modulator circuit is even more simple. The MC14412 modulator synthesizes a sinewave corresponding to the TX DATA input. A highpass filter (C3) compensates for the frequency characteristics of the acoustic network. A single op-amp (IC2-b) drives the 8-ohm speaker.

Two remaining op-amps, configured as comparators (IC3-c and IC3-d) pro-

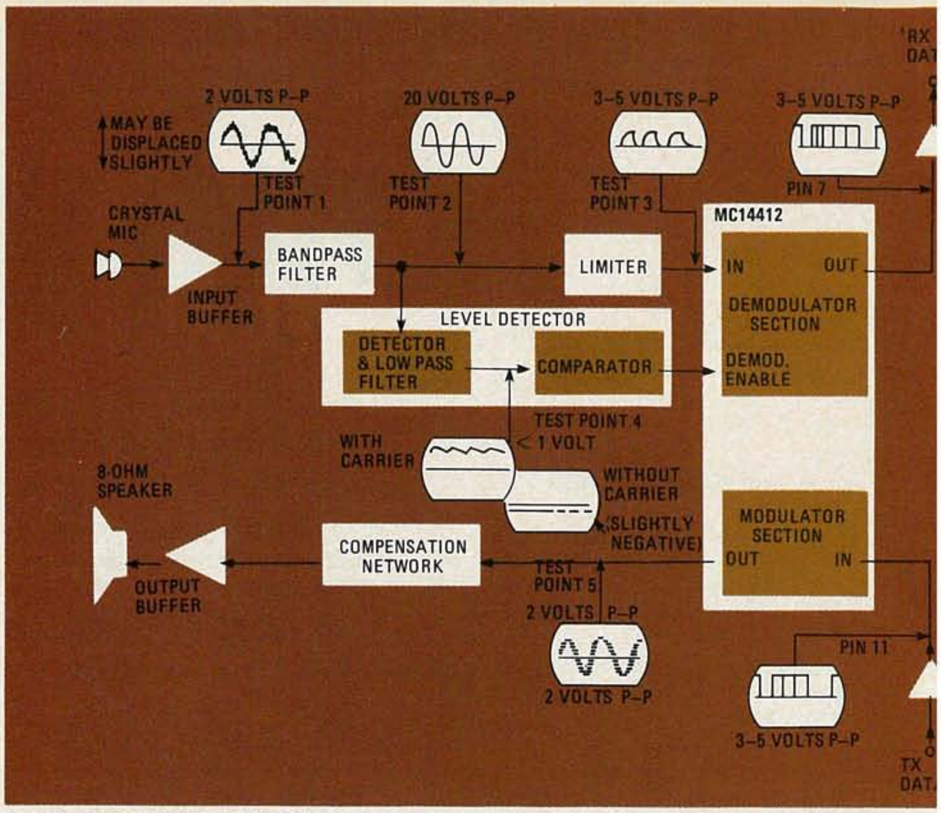


FIG. 1—BLOCK DIAGRAM OF the modem. The scope patterns shown are those that should be observed at the test points shown on the schematic (Figs. 1 and 2).

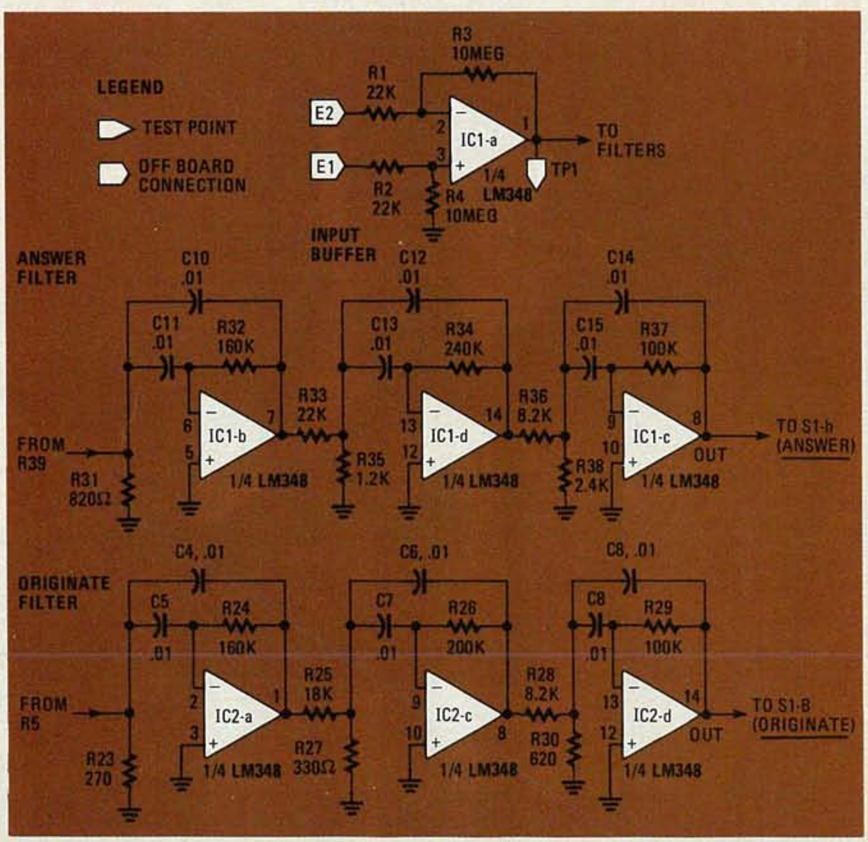


FIG. 2—THREE-STAGE ACTIVE FILTER (IC1-b, -c, -d and IC2-a, -c, -d) attentuates out-of-channel noise.

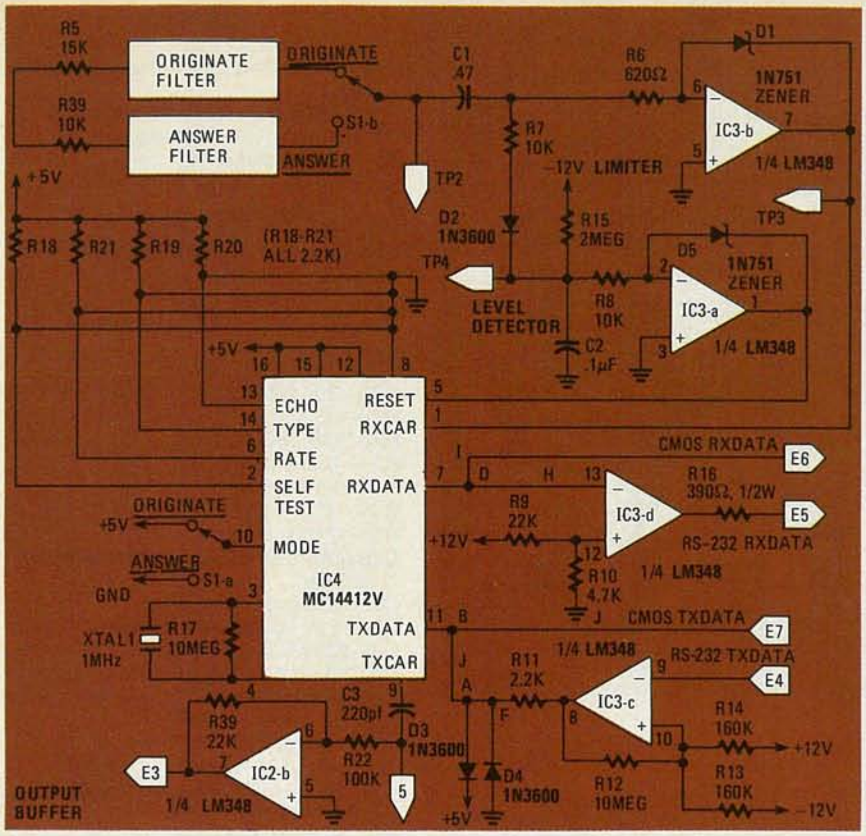


FIG. 3—HEART OF THE CIRCUIT is the MC14412 that performs all the modulation/demodulation functions.

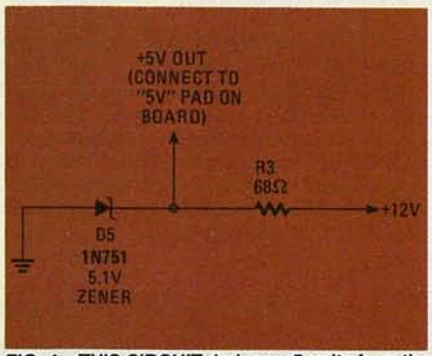


FIG. 4—THIS CIRCUIT derives +5-volts from the +12-volt line allowing you to use a DPDT switch to turn the unit on and off.

vide logic translation if desired. The buffer on the TX DATA line is designed with about 3-volts hysteresis (a "dead zone" between logic-∅ and logic-1), improving noise immunity on long transmission lines.

The unit requires three power supplies—+12-volts, −12 volts, and +5-volts. The maximum drain on any of the three is only about 20 mA, so there should be little difficulty in obtaining power from your computer. A 3PDT switch can be used to switch power to the modem if you do not want it on all the time.

If desired, the +5-volts can be derived from the +12-volt line through a 5.1-volt Zener diode and a 68-ohm resistor as shown in Fig. 4. This would allow you to use a more readily available DPDT switch to turn the unit on and off.

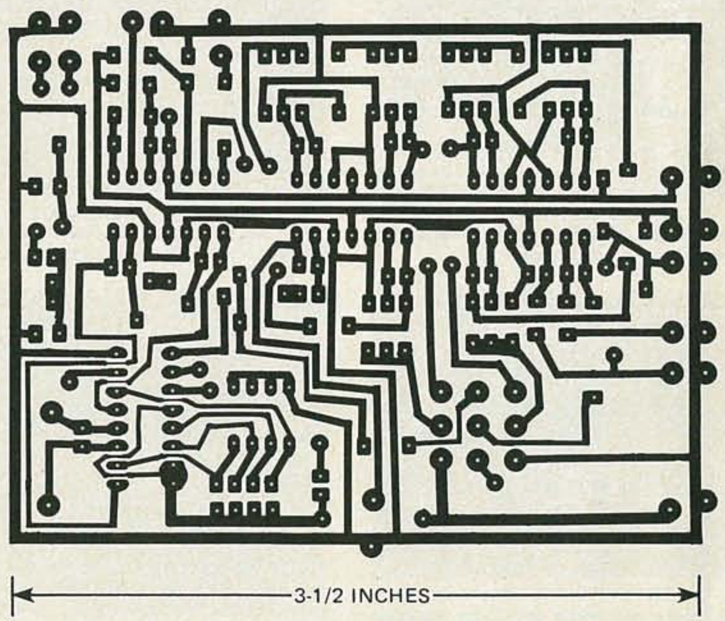


FIG. 5—THIS FOIL PATTERN can be easily reproduced, although the between-the-pin traces near IC4 may require special attention.

Assembly

While the circuit board is compact, the traces are easily reproducable with one possible exception. (The foil pattern is shown in Fig. 5.) There are several thin, between-the-pins, traces at IC4. These may not copy well using homebrew techniques. If you have trouble with these spots, use a knife to cut out the bad sections of trace and tack-solder short sections of wire-wrap wire to bridge the gaps. You should also pay special attention to the power runs near the three LM348's.

Once you have a circuit board, assembly is straightforward. A parts-placement diagram is shown in Fig. 6, and an interior view in Fig. 7. The design's most notable quirk is the extensive use of end-mounted components. All but a diode and a few resistors are mounted on end as shown in Fig. 8. You must be careful to align the exposed lead on those components so that it cannot short against another exposed lead. Except as noted, install the parts so that the exposed lead faces the nearest edge of the board.

Begin by installing all the flat-mounted diodes and resistors. Those are R6, R7, R8, R33, and D2. Be certain that the polarity of the diode is as indicated in the parts-placement diagram and schematic. Install the IC sockets, after checking carefully to make sure that they are correctly oriented.

The jumpers should be installed now as they may be hard to reach later.

The rest of the components (with the exception of the crystal) are either end-mounted resistors and diodes, or normally mounted capacitors. We suggest installing the resistors and diodes first, and then the capacitors.

Several end-mounted components require special attention. Resistor R17 is placed next to the crystal. If you wish the crystal to stand upright on the board you will need to form the leads of that resistor so that it can be mounted flat against the IC4 socket. A little tape over the resistor is a wise precaution.

If you prefer—and if your enclosure is large enough—you may mount this resistor like the other end-mounted components and simply leave enough lead on the crystal to allow it to be bent away

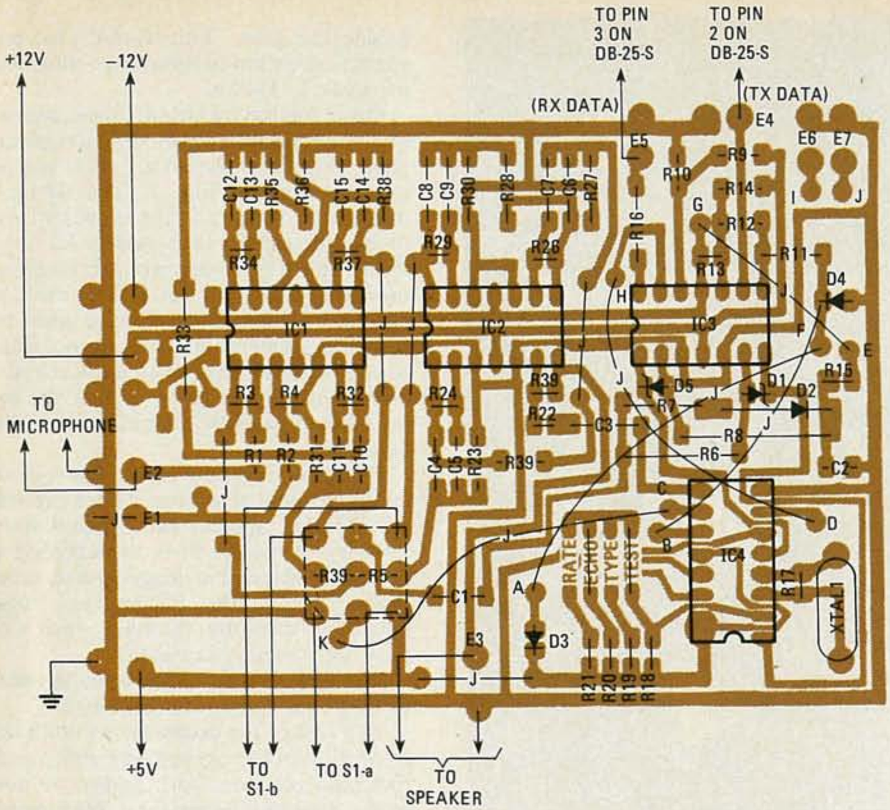


FIG. 6—MANY of the components shown in this parts-placement diagram are end-mounted. Board is shown jumpered for RS-232.

PARTS LIST

Resistors ¼ watt, 5% unless otherwise noted
R1, R2, R9, R33, R39—22,000 ohms
R3, R4, R12, R17—10 megohms
R5—15,000 ohms
R7, R8, R39—10,000 ohms
R10—4700 ohms
R11, R18-R21—2200 ohms
R13, R14, R24, R32—160,000 ohms
R15—2 megohms
R16—390 ohms, ½ watt
R22, R29, R37—100,000 ohms
R23—270 ohms
R25—18,000 ohms
R26—200,000 ohms
R27—330 ohms
R28, R36—8200 ohms
R31—820 ohms
R34—240,000 ohms
R35—1200 ohms
R38—2400 ohms
Capacitors 50-volt or greater working voltage
C1—.47 μF, ceramic disc
C2—.1 μF, Mylar, 10% or better
C3—220 pF, ceramic disc
C4-C15—.01 μF, Mylar, 10% or better
Semiconductors
D1, D5—1N751, Zener
D2-D4—1N3600
IC1-IC3—LM348 quad 741 op-amp
IC4—MC14412 low-speed modem
XTAL1—1.0 MHz crystal
S1—DPDT switch
S2—3PST or DPDT switch
Miscellaneous: PC board, crystal or electret microphone, 8-ohm speaker, lumber, tennis ball, radiator hose, hardware, etc.

NOTE: The following are available from Quest Electronics, PO Box 4430E, Santa Clara, CA 95054: Kit including PC board, all electrical parts except switches (speaker and microphone included), and 15 pages of documentation, $60; PC board and documentation only, $17.50. Add 5% for shipping. CA residents add 6% tax, MC and Visa accepted.

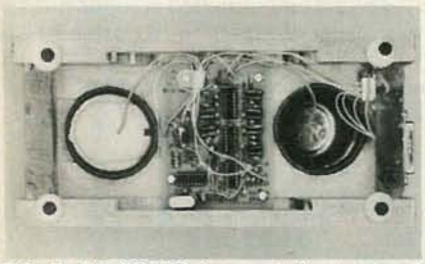


FIG. 7—PC BOARD is mounted, component-side-down, on short standoffs. Switches, hidden by board, are mounted on enclosure.

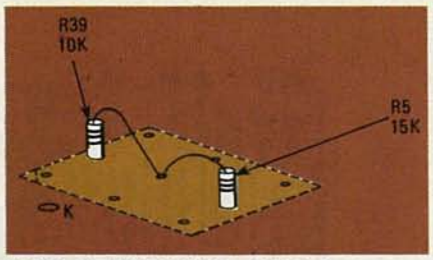


FIG. 9—RESISTORS R5 and R39 share a common hole. It may be necessary to make this hole larger than usual to accept both leads.

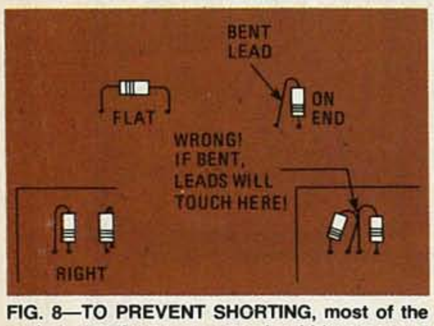


FIG. 8—TO PREVENT SHORTING, most of the end-mounted components should be mounted so that the exposed lead faces the nearest edge of the board.

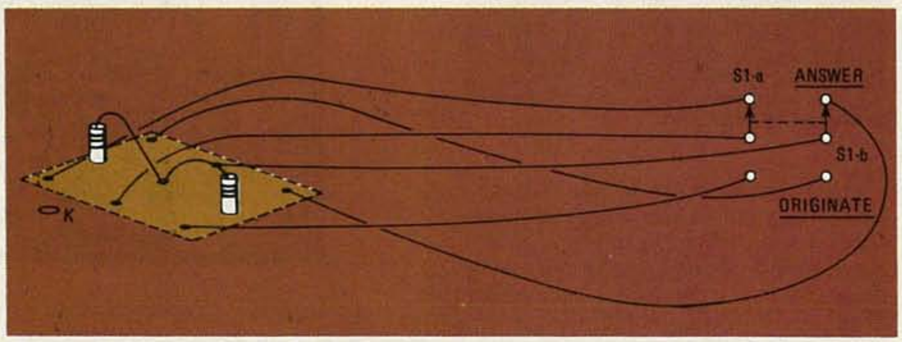


FIG. 10—A DPDT SWITCH, S1, is wired as shown for testing the modem. After testing is complete, rewire the switch to match the schematic.

from the resistor but the enclosure as detailed later in this article does not allow enough room for that approach.

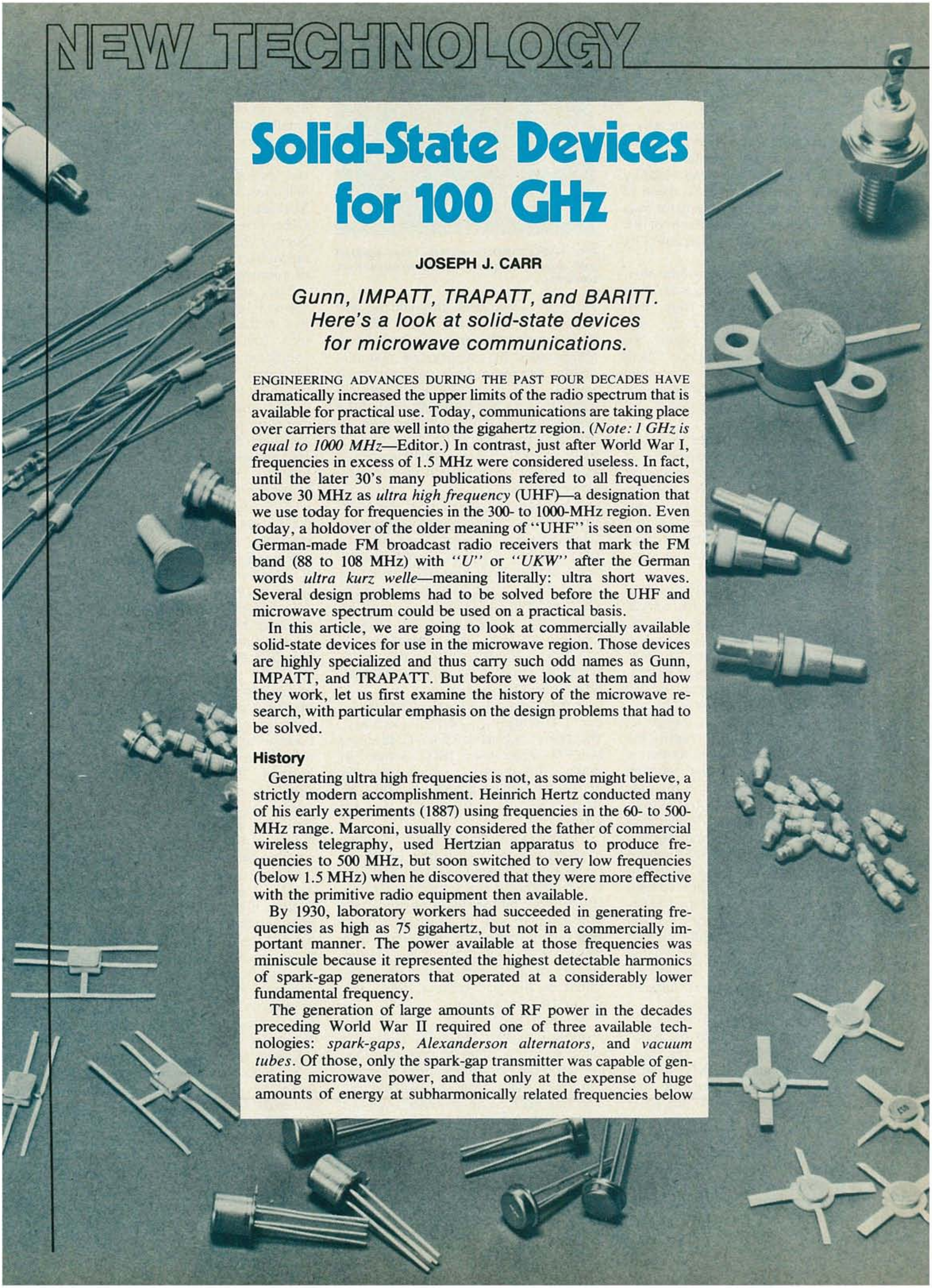
Also, unlike the rest of the end-mounted components, D4 should be mounted with the exposed lead toward the center of the board. Resistors R5 and R39 must share a common hole. You will probably need to enlarge it before it will accommodate both resistor leads. Install R5 and R39 as shown in Fig. 9.

When installing the capacitors, leave longish leads on C1 (a large .47 μF one) and bend it over the jumper so it is out of the way. Ceramic discs may not be substituted for the .01 μF filter capacitors—they must be Mylar. We also recommend a low-loss type such as Mylar for C2.

Be sure to install jumpers from G to E, from K to C, and across ECHO. After testing we will install a jumper across TEST. That four-jumper pad (RATE, ECHO, TYPE and TEST) will accept a 4PST DIP-switch if you wish. However, none of those settings are likely to be changed once testing is finished.

If your serial port requires RS-232 logic levels, follow this procedure: jumper from D to H, from A to F, and from B to the cathode (banded) end of D4. Pad E4 is now the TX DATA input and E5 is the RX DATA output.

To generate CMOS logic-levels, in-
continued on page 70



Solid-State Devices for 100 GHz

JOSEPH J. CARR

Gunn, IMPATT, TRAPATT, and BARITT. Here's a look at solid-state devices for microwave communications.

ENGINEERING ADVANCES DURING THE PAST FOUR DECADES HAVE dramatically increased the upper limits of the radio spectrum that is available for practical use. Today, communications are taking place over carriers that are well into the gigahertz region. (*Note: 1 GHz is equal to 1000 MHz*—Editor.) In contrast, just after World War I, frequencies in excess of 1.5 MHz were considered useless. In fact, until the later 30's many publications refered to all frequencies above 30 MHz as *ultra high frequency* (UHF)—a designation that we use today for frequencies in the 300- to 1000-MHz region. Even today, a holdover of the older meaning of "UHF" is seen on some German-made FM broadcast radio receivers that mark the FM band (88 to 108 MHz) with *"U"* or *"UKW"* after the German words *ultra kurz welle*—meaning literally: ultra short waves. Several design problems had to be solved before the UHF and microwave spectrum could be used on a practical basis.

In this article, we are going to look at commercially available solid-state devices for use in the microwave region. Those devices are highly specialized and thus carry such odd names as Gunn, IMPATT, and TRAPATT. But before we look at them and how they work, let us first examine the history of the microwave research, with particular emphasis on the design problems that had to be solved.

History

Generating ultra high frequencies is not, as some might believe, a strictly modern accomplishment. Heinrich Hertz conducted many of his early experiments (1887) using frequencies in the 60- to 500-MHz range. Marconi, usually considered the father of commercial wireless telegraphy, used Hertzian apparatus to produce frequencies to 500 MHz, but soon switched to very low frequencies (below 1.5 MHz) when he discovered that they were more effective with the primitive radio equipment then available.

By 1930, laboratory workers had succeeded in generating frequencies as high as 75 gigahertz, but not in a commercially important manner. The power available at those frequencies was miniscule because it represented the highest detectable harmonics of spark-gap generators that operated at a considerably lower fundamental frequency.

The generation of large amounts of RF power in the decades preceding World War II required one of three available technologies: *spark-gaps, Alexanderson alternators,* and *vacuum tubes*. Of those, only the spark-gap transmitter was capable of generating microwave power, and that only at the expense of huge amounts of energy at subharmonically related frequencies below the microwave region. It would not be unreasonable to assume that *microwatts* of energy in the low-microwave region required *kilowatts* of energy from a one-MHz spark-gap.

The Alexanderson alternator was a mechanical/electrical alternator that produced frequencies in the VLF region. The frequency was determined by the number of poles and the speed of rotation. Although the alternator was used to generate large amounts of RF power, it was limited in frequency by mechanical problems.

Ordinarily, vacuum tubes of the post-WWI era would not operate at UHF or microwave frequencies. They did, however, seem to represent the best approach to researchers hoping for UHF/microwave operation. There were two major problems with vacuum tubes that kept the operating frequency low: *interelectrode capacitance* and *electron transit time*.

There are two approaches to the reduction of interelectrode capacitance. One is the electrode size and geometry; the other is the inter-electrode spacing. Reducing the electrode size is not always possible, however, because that approach also limits the output power; small electrodes are not able to dissipate large amounts of heat.

Increasing the element spacing in a vacuum tube will decrease the capacitance, but will also increase the electron transit-time. Geometry, size, and spacing factors could account for some of the progress in vacuum-tube design, so that operating frequencies to 450 MHz were used in World War II.

As early as the 1920's, investigators had noted that electron transit-time seemed to be a fundamental limitation in the design of microwave vacuum tubes. Electron transit-time is the time required for an electron to travel from the cathode to the anode. Proper grid control of the electron stream requires that the period of the alternating voltage applied to the grid be long in relation to the electron transit-time. It proved relatively easy to design around the transit-time problem at frequencies to 200 MHz, with 750 MHz reportedly attained in the laboratory by Boyd and Phelps (1927). But operation at frequencies greater than 200 MHz proved difficult to achieve on a commercial scale.

A solution to the transit-time problem was proposed in 1920 by Barkhausen and Kurz (Germany). The Barkhausen-Kurz oscillator (BKO) used a special vacuum tube to generate 700-MHz signals. Figure 1 shows the BKO tube. Here, the grid is made positive with respect to the cathode *and the anode*, exactly the opposite of the usual arrangement. Electrons emitted by the cathode are attracted by the positive potential on the control grid. Some of those electrons will strike the grid, but

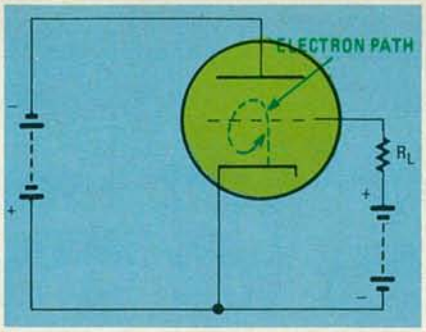


FIG. 1—ELECTRONS oscillate in an elliptical path around the grid in the Barkhausen-Kurz oscillator.

most are accelerated through the grid structure, towards the anode. Shortly after passing the grid, however, they are repelled by the negative potential on the anode, and are deflected back towards the grid. The electrons will oscillate in an elliptical path around the grid structure. Output power can be obtained by connecting the grid to a load, and will consist of that minority of electrons in the grid path that actually strike the grid.

American development of the BKO was hampered by an import embargo imposed upon non-American vacuum tubes during the famous radio-patent wars of the 20's. The BKO could be made from an ordinary vacuum tube, but required a cylindrical, coaxial, anode-grid configuration (as used in German vacuum tubes). Most American tubes, though, used a flat, sandwich-like structure that was not adaptable to BKO operation.

European work with the BKO, however, continued. Kohl, in Germany, succeeded in generating a 6-GHz signal in 1928. Esau used BKO devices to make full-duplex communications across the English channel in 1930. The frequency used in these tests was 1.6 GHz.

The BKO was one of the first devices to overcome the transit-time limitation by making it work to an advantage. The BKO overcame the transit-time problem by keeping the electrons oscillating in a circular path in an electric field. The vacuum-tube grid, however, was a factor that limited available output power; its small dimensions often resulted in the grid running white hot during BKO operation.

A solution to that problem was proposed in 1921 by A.W. Hull. His solution was to delete the grid altogether and keep the electrons in orbit by using a *magnetic* field. Hull's original *magnetron* has been much modified over the years, but the basic principle is still used today. Most microwave ovens, for example, use magnetron oscillators. One of the first modifications to the Hull magnetron was made by Yagi and Okabe, working in Japan. The Yagi-Okabe magnetron achieved greater output power, and higher operating frequencies, by splitting the Hull anode into two, or more, sections. There were, however, still considerable design problems to solve because the small dimensions of the components required for microwave operation made the output power somewhat limited. By the mid-30's, however, Cleeton and Williams, working at the University of Michigan, achieved operation at 50 GHz. Over the years, power and frequency have increased, making the magnetron one of the primary sources of microwave energy.

The power-vs-frequency dilemma seemed unsolvable for several years. But in the mid-30's, several investigators simultaneously reached similar solutions. Dr. W.W. Hansen (Stanford University) and Drs. A. and O. Heil began to think in terms of turning the transit time to advantage through the mechanism of *velocity modulation* of the electron beam. In 1935, the Drs. Heil proposed to use the electron transit-time to control the electron stream. The heating problem was not solved, but was *avoided* because the electrons would not actually strike the control electrodes.

Russell and Sigurd Varian extended Dr. Hansen's work into the practical world in 1937 when they used Hansen's calculations to build the first *klystron* vacuum tube. That device used the transit time, and the deceleration of bunched electrons, to generate microwave RF energy. Velocity modulation of the electron stream in the klystron produces the bunching effect. It is the time between the arrival of successive bunches at a collector anode that determines the operating frequency of the klystron. Arrival of each bunch represents one cycle of RF energy.

The background material presented thus far is intended to demonstrate some of the problems that required solution before microwave frequencies could be used properly. The development of semiconductor devices saw similar, if not identical, problems. The high-frequency response of bipolar transistors, for example, was limited by the transit time of charge carriers (electrons or holes) across the base region. Attempts at reducing the width of the base region in order to decrease transit time produced additional problems; i.e., increased capacitance and decreased tolerance to reverse bias potentials.

But even thin base-regions could not solve the problem. In semiconductor materials we will see a property called *electron saturation velocity*, which is analogous to a similar problem in vacuum tubes. That limitation seems to be a fundamental limit to the high-frequency operation of bipolar transistors. But, like the vacuum tube transit-time problem, we can turn that problem into an advantage and use it to create microwave energy.

Transfered electron devices

John Gunn, of IBM, was studying the properties of n-type gallium arsenide (GaAs) material in 1963. He noticed that the current through the material would become unstable if the applied voltage were increased above a certain threshold potential. It was discovered that the current would pulsate at microwave frequencies if the E-field were above that point.

Gunn suspected that a negative-resistance phenomenon was responsible for the effect he observed. Negative-resistance generators can be made to oscillate under the right circumstances. Gunn speculated that the negative-resistance phenomenon was due to a loss of electron mobility at the higher applied voltage. That theory can be inferred from the fact that some materials, such as GaAs, permit electrons to exist in either of two, rather than just one, conduction bands. In the lowest conduction band, the effective electron mass and electron energy are low. The electron mobility in that conduction band is high, so the material will act like an ordinary ohmic resistance.

If the electric field is increased to approximately 3 to 3.5 kV/cm, then the electrons will become more energetic, and will transfer to the higher conduc-

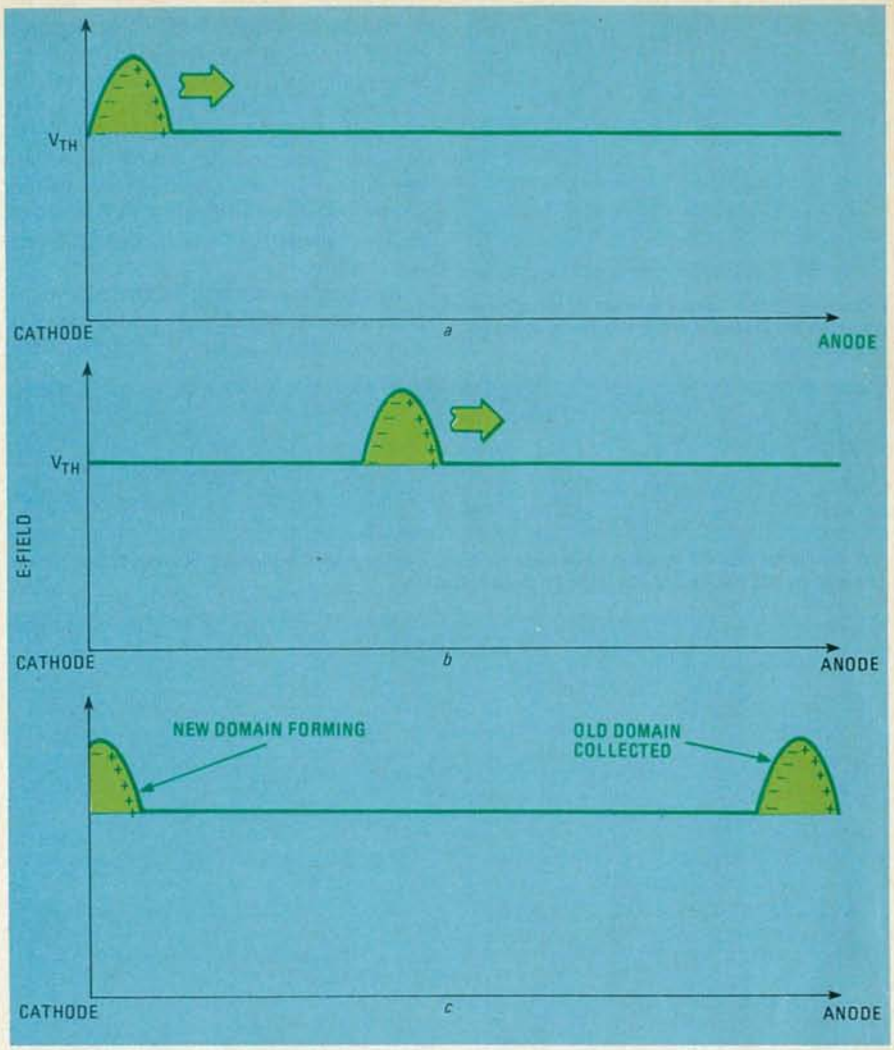


FIG. 4—WHEN the Gunn device is biased at V_{TH}, a domain builds up at the cathode end (*a*), drifts through the Gunn device (*b*), and is collected at the anode (c).

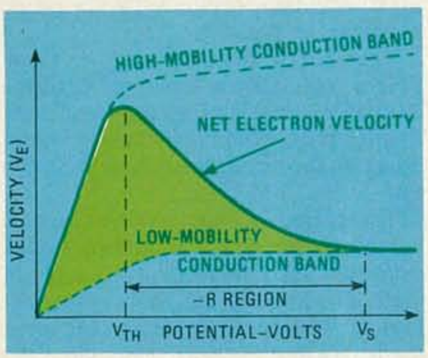


FIG. 2—AT POTENTIALS GREATER than V_{TH}, an increasing number of electrons are scattered into the low-mobility conduction band.

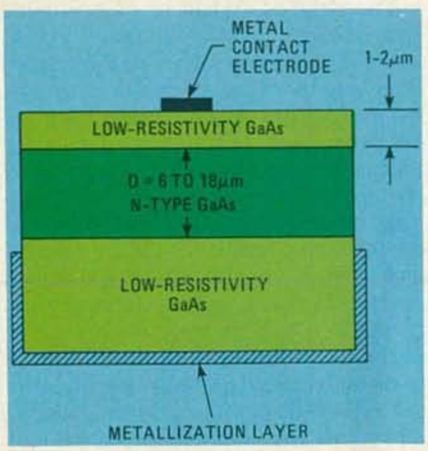


FIG. 3—THE GUNN DEVICE shows a diode-like structure although it is not a PN junction.

tion band. An energy level of 0.35 eV separates the minima of the two conduction bands. The effective electron mass increases in the higher-conduction band, while mobility decreases.

Figure 2 shows that an increasing number of electrons are scattered into the low-mobility (high-energy) conduction band as the applied potential increases above a certain threshold voltage V_{TH}. At potentials less than the threshold potential, the electron velocity increases linearly with the applied voltage. That behavior is exactly as expected in any material that obeys Ohm's law. But at potentials greater than V_{TH} the number of electrons transferred to the low-mobility conduction band increases with increasing voltage. That phenomenon causes the net electron velocity to drop, creating a negative-resistance region between V_{TH} and a saturation potential V_S.

Microwave oscillators that depend upon the transfer of electrons between high- and low-mobility conduction bands are called *transferred electron oscillators* (TEO).

The description of negative-resistance operation adequately justifies the claim that the GaAs material will oscillate, but does not explain the structure of the Gunn device or the mechanism of oscillations in those devices. There are two different *modes* of oscillation in the Gunn device.

Incidentally, it has become common practice to call the Gunn device a "Gunn diode," but that is not strictly correct: the Gunn device is *not* a diode. In the Gunn device we are using oscillations in a bulk medium, not a PN junction. The diode-like structure of the Gunn device shown in Fig. 3 is not an ordinary PN junction. The end sections are not active, but are intended to facilitate ohmic contact between the electrodes and the active center region. Also, it is the practice of some people to refer to most solid-state microwave oscillators as Gunn diodes, when, in fact, they are of an altogether different structure. One recent advertisement listed as a "Gunnplexer" a device that contained an IMPATT (*IMP*act *A*valanche and *T*ransmission *T*ime) diode. The Gunn device is a diode only in the sense that it has two (di-) electrodes (ode), but should not be confused with PN-junction diodes.

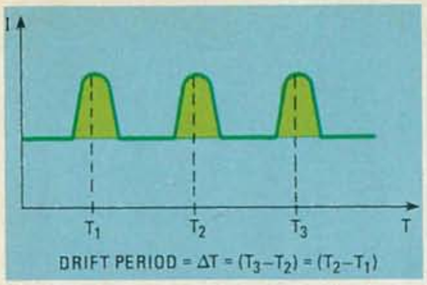


FIG. 5—A BRIEF output-current pulse is generated at the instant that the domain is collected at the anode.

metal contact electrode. That section is made out of material with a relatively low resistivity (i.e. 0.001 ohm/cm). Its purpose is to insure good contact with the end electrode and to prevent metallic-ion migration from the electrode into the active region. The thickness of that section is approximately 1 to 2 microns, and it is grown epitaxially onto the center section.

The center section is the active region in the Gunn device, and consists of n-type gallium-arsenide material. The oscillating frequency of the device in one of its two modes is dependent upon the thickness of that region, varying from 6 GHz at 18 μm to 18 GHz at 6 μm. The device's threshold voltage is also dependent upon the thickness of that region, and will vary from approximately 1.95 volts at 18 GHz, up to 5.85 volts at 6 GHz.

The last section is the substrate layer and is metallized to allow bonding to the device's support structure. Again, low-resistivity GaAs material is used.

Gunn devices are not very efficient, especially in the transit-time mode of operation. Those devices may require 20 to 50 times more DC power than they produce in RF output. As a result of the low efficiency, the substrate is usually bonded to a heatsinking package.

When oscillating, the Gunn device can operate in either of two different modes: *transit-time* (or *Gunn*) *mode* and the *limited space-charge* (or *delayed transit-time*) *mode*. In transit-time mode, the operating frequency is determined by the thickness of the active region. That mode does not require an external tank circuit for proper operation. In contrast, the delayed transit-time mode requires an external tank circuit (i.e., a tuned cavity) but is frequency-flexible and operates with more efficiency.

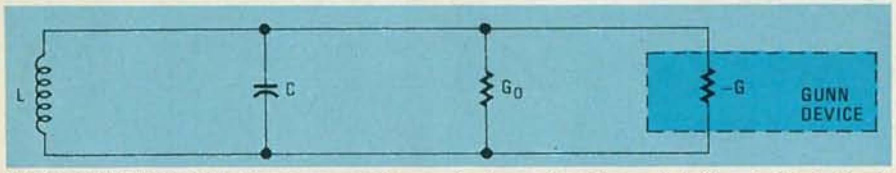


FIG. 6—GUNN DEVICE is shown as a negative conductance placed in parallel with an L-C tank circuit. The circuit will oscillate if −G is much greater than G_O.

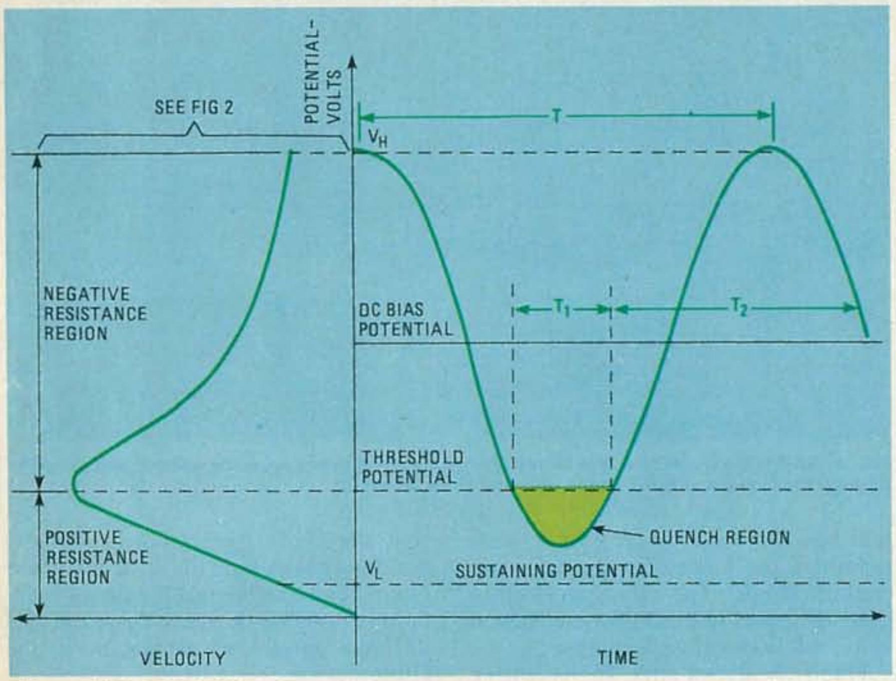


FIG. 7—THE DC BIAS VOLTAGE must be carefully selected so that the total bias drops below V_{TH} but remains above the sustaining potential on negative peaks of the RF cycle.

Gunn devices

The observations of Gunn in 1963 led to the invention of the Gunn device as a microwave oscillator. But negative-resistance oscillators were the subject of speculation by Shockley as early as 1954. Esaki (1957) produced a two-terminal "diode" device that had a negative-resistance property. That device is now known as the *tunnel diode* or *Esaki diode*. Sommers suggested in 1959 that the Esaki diode would have microwave applications; the prediction has proven to be accurate. It was against that background that the Gunn device was invented in the mid-60's.

The basic structure of the Gunn device is shown in Fig. 3. This device consists of three basic sections. The first section provides ohmic contact between the active center region and the

Transit-time (Gunn) mode

When a Gunn device is biased below the threshold potential V_{TH}, the electric field will be uniform throughout the device. The Gunn device will operate as an ordinary positive resistance in the region; i.e. the current will increase proportionally with the increasing voltage.

But consider the situation when the Gunn device is biased to the threshold potential V_{TH}. Under that condition, electrons are injected into the cathode end of the material faster than they are collected at the anode end. That causes a domain (or region) to build up that has an excess of electrons on the cathode side and a deficiency of electrons on the anode side as shown in Fig. 4-a. That domain drifts through the Gunn device (Fig. 4-b) until it is collected at the anode end. A new domain forms as the old domain is collected at the anode as shown in Fig. 4-c.

The output current from the Gunn device maintains a low level until the domain is collected at the anode. At that instant a brief current pulse is generated in the output circuits as shown in Fig. 5.

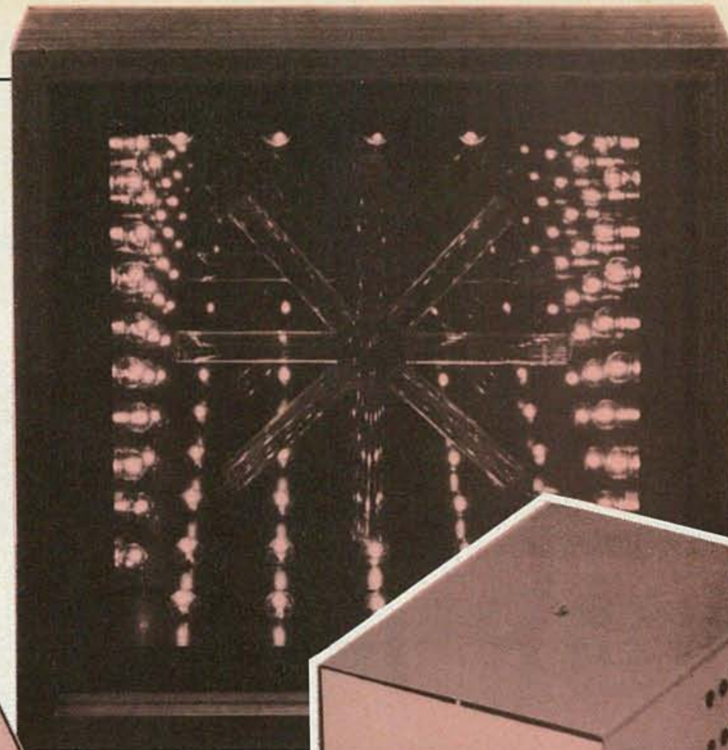
The period of time between output-current pulse peaks is known as the *drift time* for that particular sample of material. The period, hence the operating frequency, is dependent upon the length and the drift velocity (on the order of 10^7 cm/s) of the material.

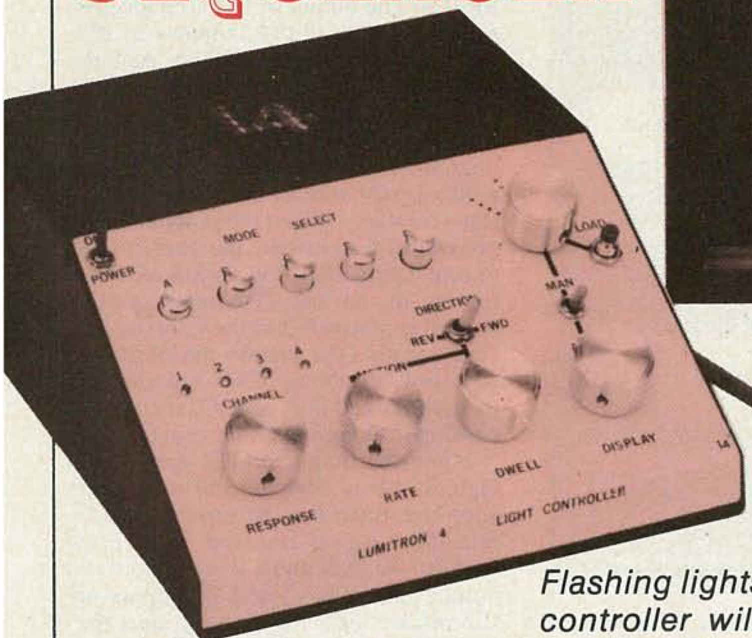
Delayed transit-time mode

The delayed transit-time, or limited space-charge accumulation (LSA) mode is more efficient than the transit-time mode. The transit-time mode, while elegantly simple, suffers from low efficiency and a frequency limitation. that is determined by the thickness of the active region. The delayed transit-time mode allows the Gunn device to adapt to the frequency of an external tank circuit, such as a high-Q resonant cavity. Figure 6 shows an equivalent circuit in which the negative resistance of the Gunn device is shown in a negative conductance placed in parallel with the L-C tank circuit. Conductance G_O represents the ohmic losses in the tank circuit. The circuit will oscillate if $-G$

continued on page 86

BUILD THIS
VERSATILE LIGHT SEQUENCER





DAVID L. HOLMES

Flashing lights do not a disco make. This four-channel light controller will sequence automatically or in time to the music, and will dazzle your eyes in other ways as well.

HAVE YOU EVER HOSTED OR ATTENDED A party and discovered that even though you were having a good time and enjoying the music and dancing, you felt that something was missing? Perhaps something *was* missing—a lighting system capable of translating the disco beat into a tantalizing light display. One factor probably responsible for the absence of such a system was its high price. The systems that are available—and these are for commercial use—cost hundreds of dollars. Now, however, you can build a multi-function lighting-display control system that will rival many commercial units, but for a fraction of their cost.

The system is called the Lumitron-4 and it has the following features:

- Four-channel control capability
- Separate function-control and opto-isolated power-switching units
- Manual and automatic bidirectional "light-chaser" action
- Manual and automatic "light-chaser" pattern selection
- Variable dwell-time for automatic change of "light-chaser" direction and light pattern
- Audio-response control
- Five pushbutton MODE controls that select the following:

1. All display lights on continuously
2. Sound-sync-controlled intensity of all display lights simultaneously
3. Sound-sync-controlled rate of light chasing
4. Constant "light-chasing" rate
5. Combination of modes 2 and 4

The power-switching system described in this article uses opto-isolated triac drivers having the capability to trigger any triac requiring less than a 100-mA gate trigger-current. The power-switching unit was designed to be located remote from the master-control unit and the two are interconnected by a five-conductor cable. Originally, a six-foot cable with five-pin DIN plugs was used, but the prototype has been operated with the two units separated by as much as twenty-five feet.

Channel-control signals output from the control unit have a nominal +5-volt level when they are inactive and a +.7-volt level when active. Each channel is designed to have a 25-mA current-sinking capability.

Figure 1 shows a block diagram of the system.

How it works

The heart of the Lumitron-4 (see Figs. 2 and 3) is IC1, a 74194 presettable 4-bit bidirectional shift register with modes (LOAD, SHIFT FORWARD, SHIFT REVERSE) and timing that are controlled by IC2 and IC3 respectively. Integrated-circuit IC2 is a 7472 JK flip-flop with AND-gated inputs, and IC3 is a 556 dual timer with each timer configured as an astable multivibrator. The shift rate of IC1 is controlled by IC3-b, with R14 serving as a RATE control, and IC3-a clocking IC2. Switch S2 (FORWARD/REVERSE/AUTO) and IC3-a control the shift-forward and shift-reverse signals generated by IC2. (The output of IC3-b is AND-ed with the JK inputs to IC2 so the shift-forward/reverse signals generated by IC2 do not change while the output of IC3-b is low; that is an operational constraint for IC1.) In its center AUTO position, S2 allows the Q and $\overline{Q}$ outputs of IC2 to change states alternately with each IC3-a clock pulse; this causes IC1 to alternate its shifting direction. Setting S2 to its other positions keeps the output of IC2 constant after one clock pulse and causes IC1 to continue shifting in one direction. For example, if

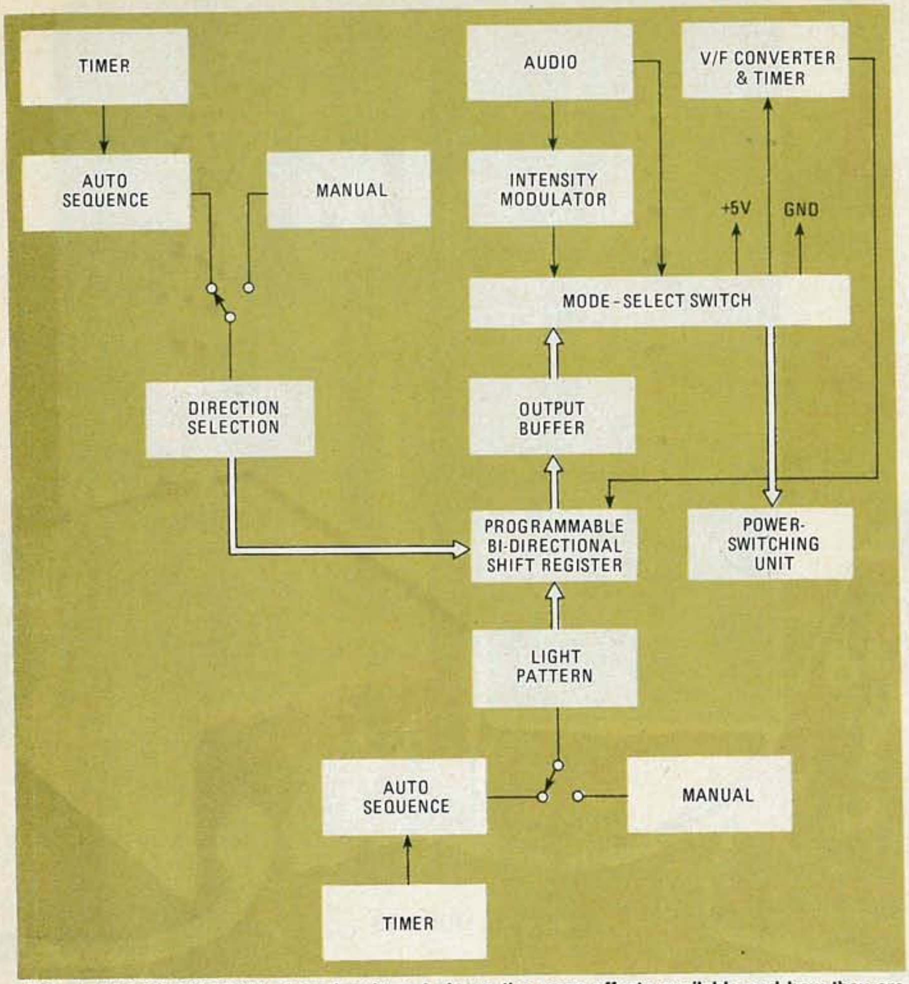


FIG. 1—BLOCK DIAGRAM of the Lumitron-4 shows the many effects available and how they are created.

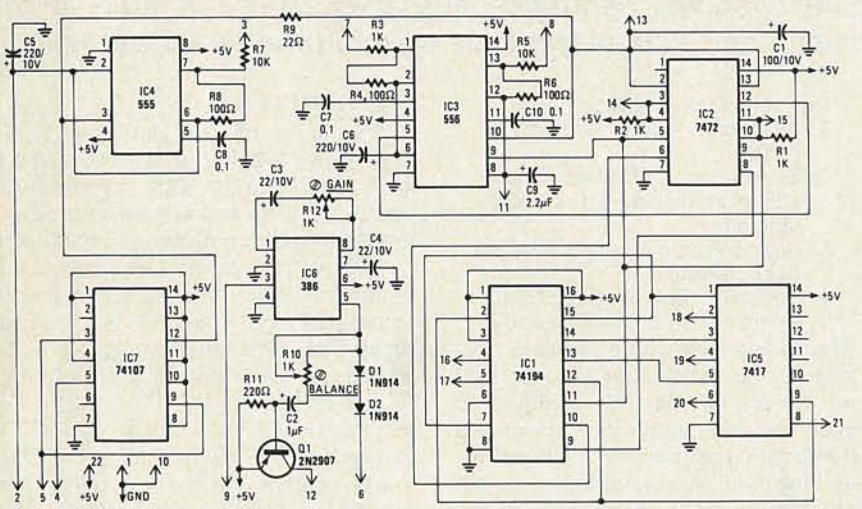


FIG. 2—GOOD DESIGN PRACTICE dictates that all unused IC pins be tied either to five-volts or ground. Numbers next to "<" symbols refer to PC-board finger numbers and to S6.

IC1 is shifting "forward" and S2 is switched to the REVERSE position, IC1 will continue to shift "forward" until the next clock pulse from IC3-a causes the IC2 outputs to change states. This state change will cause IC1 to start and to continue shifting in "reverse" until S2 is switched to a new position. The time interval between pulses from IC3-a is adjusted by the DWELL control, R15.

The desired display pattern is loaded into IC1 by applying four bits of data to IC1's parallel inputs and forcing both of its MODE-CONTROL inputs high. The new display pattern will appear at IC1's outputs after the positive transition of the clock pulse from IC3-b. Inputs A and D are permanently wired to high and low states respectively, with the states of inputs B and C being selectable. The "high" mode-control signals to IC1 are supplied by IC2 and are loaded by simultaneously taking IC2's PRESET and CLEAR inputs low. Those inputs are connected together and are taken low one of two ways, depending on the position of S3 (MANUAL/AUTO). When S3 is set to the MANUAL position, S4 (PATTERN-SELECT) selects the desired IC1-b and IC1-c iput levels and when S5 (LOAD) is momentarily depressed, PRESET and CLEAR inputs go low.

Switching S3 to the AUTO position connects the B and C inputs of IC1 to the Q outputs of IC7, a dual JK flip-flop configured as a modulo-4 counter, and ungrounds C5, the timing capacitor for IC4. The output of IC4 is connected to the PRESET and CLEAR inputs of IC2 and the ENABLE input of IC3-b. As long as C5 is grounded, the output of IC4 remains high, and IC2, and IC3-b function as described above. With IC5 ungrounded, IC4 functions as an astable multivibrator with its rate controlled by R16 (DISPLAY). When the output of IC4 goes low, that causes the PRESET and CLEAR inputs of IC2 to go low as well, forcing the Q and $\overline{Q}$ outputs of IC2 high; this places IC1 in the LOAD mode. Additionally, the enable pin of IC3-b goes low, disabling IC3-b and causing its output to go low, and IC7 is clocked causing it to increment its count.

When the output of IC4 again goes high, IC3-b is enabled and its output goes high providing the positive-transition clock signal required by IC1 to transfer the data on its input pins to its output pins. The Q and $\overline{Q}$ outputs of IC2 remain high momentarily after the "low" is removed from the PRESET and CLEAR inputs because of internal propagation delay and the time constant determined by R9-C1. Resistor R9 also serves as a current limiter for the output current of IC4, should S5 be depressed while IC4's output is high.

Sound activation of the Lumitron-4 is controlled by IC6, a 386 high-impedance, variable-gain audio amplifier. The setting of R12 together with the value of C3 determines the overall gain while the input-signal level to IC6 is controlled by R13 (RESPONSE). The output of IC6 is fed to Q1 and D1/D2. The manner in which Q1 and D1/D2 affect the operation of the circuit is controlled by S6 (see Fig. 4).

A description of the modes of operation of the Lumitron-4 follows:

With S6-a depressed, 5-volts is connected to the "common" output line and each output channel is connected to ground. The console LED's and light display will remain on continuously.

Depressing S6-b switches the collector of Q1 to the "common" output line and grounds each output channel. The intensity of the lights and console LED's will vary according to the audio input.

Switch S6-c causes 5-volts to be connected to the "common" output line,

PARTS LIST

All resistors ¼ watt, 5% unless otherwise specified
R1-R3, R17, R30-R33—1000 ohms
R4, R6, R8—100 ohms
R5, R7—10,000 ohms
R9—22 ohms
R10, R12—1000 ohms, trimmer potentiometer
R11—220 ohms
R13—5000 ohms, potentiometer, audio taper
R14-R16—1 megohm, potentiometer, linear taper
R18-R29—330 ohms
R34-R37—100 ohms, 1-watt
Capacitors
C1—100 μF, 10 volts, electrolytic
C2—1 μF, 10 volts, electrolytic or tantalum
C3, C4—22 μF, 10 volts, electroytic
C5, C6—220 μF, 10 volts, electrolytic
C7, C8, C10, C12-C14—0.1 μF, ceramic disc or Mylar
C9—2.2 μF, 10 volts, electrolytic (3.3 μF acceptable)
C11—1000 μF, 25 volts, electrolytic, axial leads
C15-C18—0.1 μF, 250 volts, Mylar
Semiconductors
IC1—74194 4-bit bidirectional shift register
IC2—7472 JK flip-flop
IC3—556 dual timer
IC4—555 timer
IC5—7417 hex buffer/driver
IC6—386 low-voltage audio amp
IC7—74107—dual JK flip-flop
IC8—IC11—MOC3031 optoisolated, zero voltage crossing, triac driver (Motorola)
IC12—7805 5-volt regulator
IC13-IC16—2N6342 8-amp, 200-volt, triac
Q1—2N2907 or equivalent
LED1-LED4—.125-inch red LED
BR1—one-amp, 50 PIV, bridge rectifier
D1, D2—1N914 or 1N4148
S1—SPST miniature toggle
S2—DPDT miniature toggle
S3—3PDT miniature toggle
S4—2P4T rotary
S5—SPST N.O. momentary pushbutton
S6—5 (or 6) PDT interlocking pushbutton bank
T1—8-12-volt, 500 mA, wall-plug transformer
J1, J2—5-pin DIN socket
J3—22-pin soldertail edge connector, .156-inch spacing
J4—miniature phone jack
SO1-SO4—chassis-mount AC receptacle
F1—fuse (see text)
Miscellaneous: PC boards, IC sockets, enclosures, 5-connector cable with DIN plugs, ribbon cable, hardware, terminal strips, materials for infinity mirror, etc.

The following are available from Design Specialty, 15802 Springfield St., Suite 80, Huntington Beach, CA 92649: Etched & drilled control unit PC board (879-2A), $18.00; etched & drilled S6 PC board (22280-1), $8.50; etched & drilled power-switching PC board (22280), $8.50; all three PC boards (580), $30.00; switch S6 (SW6), $16.00; all three PC boards plus S6 (580-SW6), $42.00; four 10-amp, 20-140 VAC zero-switching solid-state relays on aluminum base plate (PWR-4), $75.00. In U.S., Canada and Mexico add 5% shipping & handling; all others add 10%. CA residents add 6% sales tax. Please allow three weeks to process orders accompanied by personal checks.

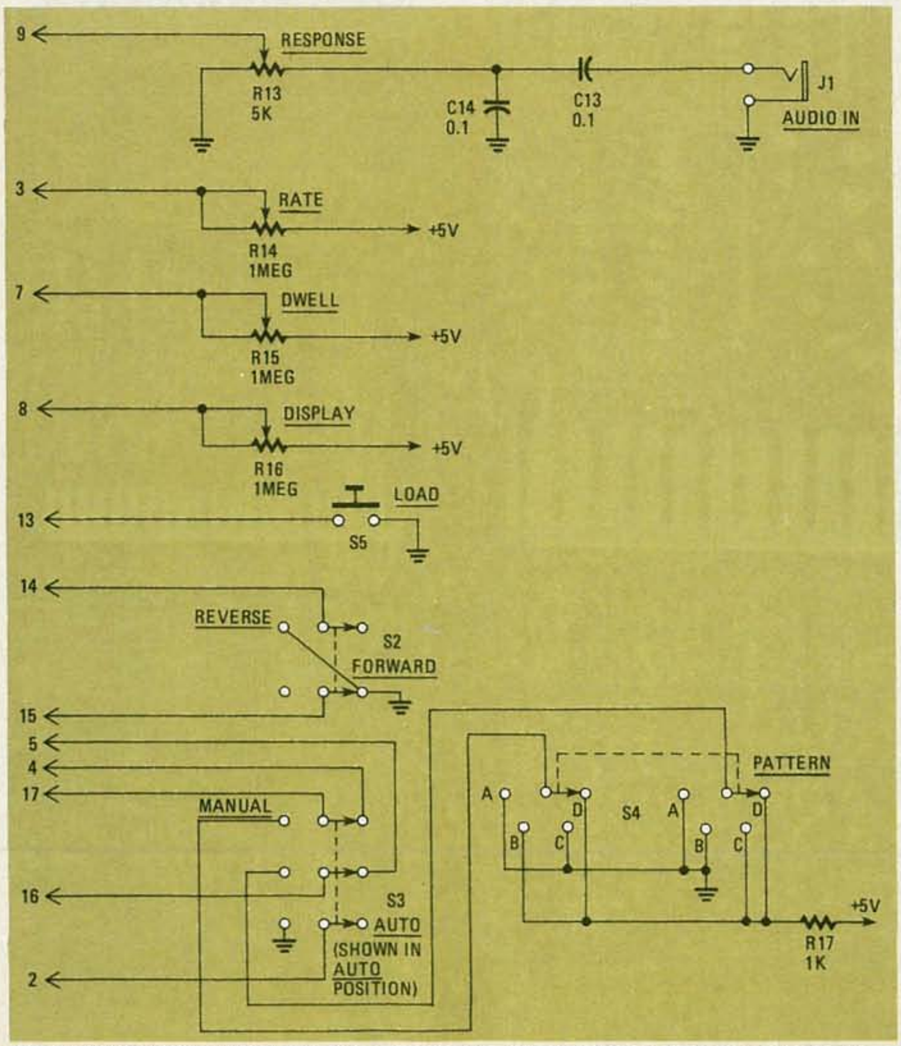
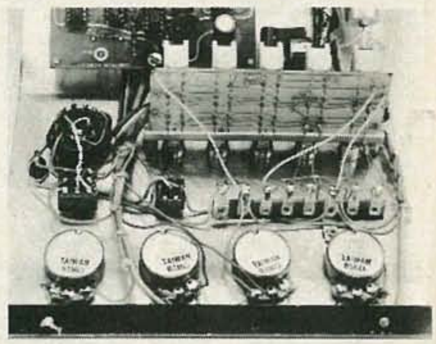


FIG. 3—MAIN FRONT-PANEL switches and potentiometers. Swich S2 is of the "center-off" type.



REAR VIEW OF CONTROL PANEL shows how controls are wired. Leads from LED's are visible behind terminal strip.

connects diodes D1/D2 to timer IC3-b and connects each output channel to a corresponding output of IC5. The displays will sequence at a rate that varies with the audio input. In the absence of any audio, the displays will sequence at a rate determined by the setting of R14 (RATE).

Depressing S6-d connects the collector of Q1 to the "common" output line and connects each output channel to a corresponding output of IC5. The lights will now sequence at a constant rate as determined by the setting of R14 but their intensity will vary in synchronization with the audio input.

With S6-e depressed, 5-volts is connected to the "common" output line and each output channel is connected to a corresponding output of IC5. The displays will sequence at a constant rate as determined by the setting of R14.

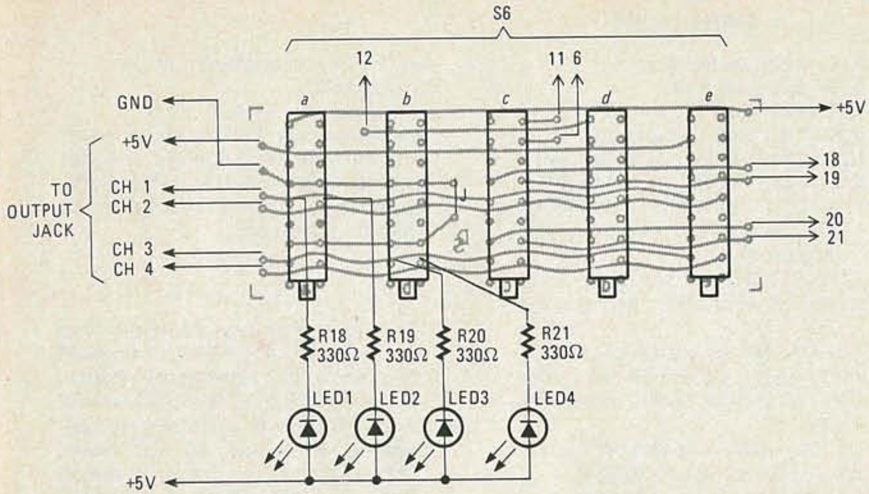


FIG. 4—SWITCH S6 is used to select one of five possible modes of operation. LED's indicate channel activity.

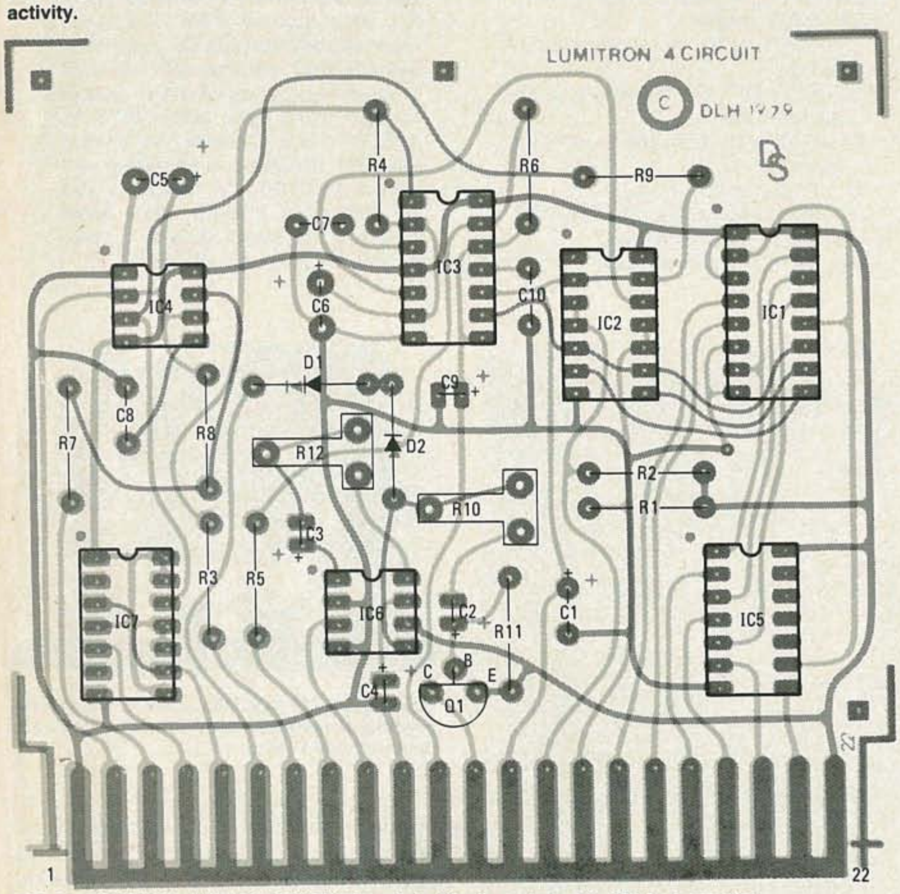


FIG. 7—CONTROL-UNIT PC BOARD plugs into 22-pin socket with .156-inch spacing.

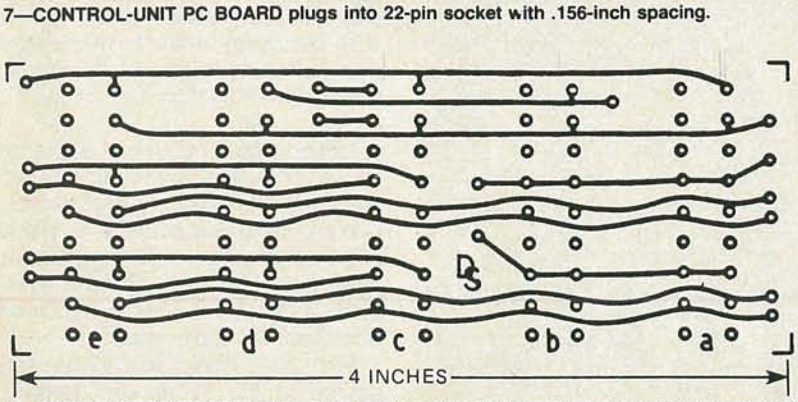


FIG. 8—SINGLE-SIDED BOARD is used to mount switch S6 (see Fig. 4 for connection details).

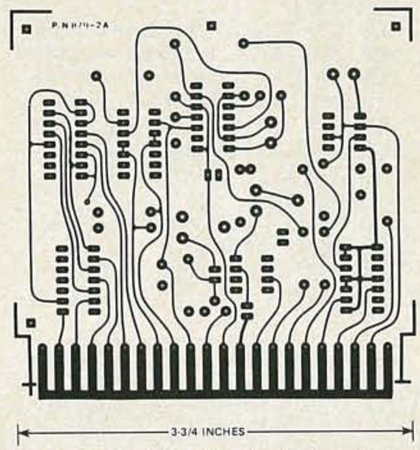


FIG. 5—FOIL SIDE of double-sided control-unit PC board. Connector finger 22 is at left.

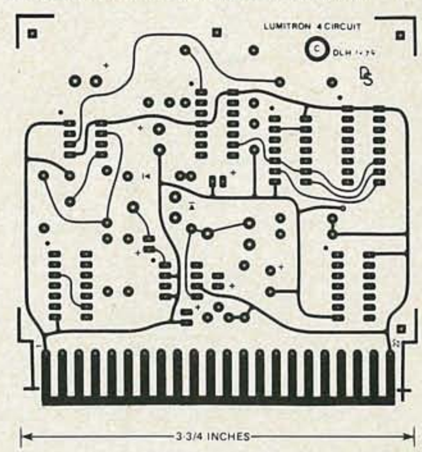


FIG. 6—COMPONENT SIDE of control-unit board. If you etch this board yourself, all holes that coincide on both sides will have to be jumpered through. Take special care at IC sockets.

Construction

Construction of the Lumitron-4 is straightforward and parts placement is not critical. A 22-finger double-sided, plated-through, PC board (Figs. 5, 6, and 7) is used for the control unit.

The mode-select switch, S6, is mounted on a single-sided PC board (Fig. 8). Parts placement and connections for this board were shown in Fig. 4.

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

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

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

Next month we'll finish construction of the Lumitron-4 and show you how to operate the device. We'll also give you a few ideas on how to create an eye-catching display. **R-E**

New Breakthrough In Headphone Design

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

This new series of lightweight headphones uses advanced engineering to deliver superb sound quality.

FIG. 1

MOST OF US INVOLVED IN AUDIO-PRODUCT DESIGN AND EVALUATION hear about "breakthroughs" in loudspeaker-system designs about once a week. Usually the so-called breakthrough turns out to be nothing more than a reworking of an established design principle.

In the case of stereo headphones, the claims for breakthroughs are fewer. In fact, the basic designs used for stereo headphones have remained fairly constant over the years. Some companies offer units that form a seal against the ear while others offer "open-air" phones. Of course, some companies make both types of phones to please everyone.

The design of any pair of headphones involves some conflicting requirements. Ideally, stereo phones should be lightweight so that the wearer does not experience fatigue or discomfort with extended use. On the other hand, for any transducer to be able to deliver good bass at high amplitude levels, the drivers must be of sufficient size and highly efficient. I was therefore quite surprised the first time I tried on a pair of Sony's (9 West 57th St., New York, NY 10019) new *model MDR-7* headphones at the most recent Consumer Electronics Show. Those phones, shown in Fig. 1, are so lightweight (55 grams, or just under two ounces) that you hardly know you are wearing them, even after several hours of listening. But more important, the sound quality of the phones is so superb that I found myself removing the phones to examine them every once in a while to make certain that the excellent sound I heard was really coming from them. I was so curious about the phones (there are four sets of phones in the new series, with the low-end *model MDR-2* units carrying a suggested price of $39.95, ranging up to the *model MDR-7's* that I have been listening to that are priced at $79.95) that I asked the people at Sony Corporation of America to quiz the engineering department back in Japan and to ask them how they were able to come up with such excellent sound from such lightweight drivers. The following is their explanation of how the new phones are able to deliver such excellent sound.

First, if you want to design a compact-sized driver unit for a set of headphones, you have to use a very powerful magnetic circuit. Sound pressure from any driver is proportional to the excursion and the area of the diaphragm (πr^2). Sound-pressure therefore, is proportional to the square of the radius of the diaphragm and, as the radius of the driver's diaphragm is reduced, sound pressure is drastically reduced. The only way to overcome that reduction in sound-pressure level is by increasing the diaphragm excursion of the driver unit by using a very strong magnet. Of course another way to increase sound-pressure (assuming the voice coil of the driver system could withstand it) is to increase the amount of power fed from the amplifier to the headphone driver. In most cases however, the power available at the headphone jack of an amplifier or receiver is limited by a series resistor that acts as a voltage divider in series with the headphone's own impedance. That leaves only the magnet as a means of increasing sound pressure.

In the past the most popular permanent magnets used in drivers were Ferrite and Alnico. Recently, however, rare-earth magnets using a samarium-cobalt alloy have been developed. Let us examine three types of magnetic material. The most important characteristic to examine is the so-called demagnetization curve. If we examine a typical hysteresis curve for a magnetic circuit, like the one shown in Fig. 2, the demagnetization curve corresponds to the second quadrant of the hysteresis curve, as shown in Fig. 3. The energy product for a specific magnetic material is the product of flux density (B) and magnetizing force (H), and is very different for different magnetic materials.

In Fig. 4 we see the demagnetization curves and the energy product curves for all three magnetic materials: Ferrite, Alnico, and samarium-cobalt. The relative quantities (1, 2, 4, 12, 16, etc.) in the second quadrant are called the permanence factor. The permanence factor is approximately 1.8 for the Ferrite magnet, 12 to 16 for Alnico, and 1 for samarium-cobalt. When magnetic materials are used at their maximum energy-product point, it makes it possible to produce a magnet having optimum shape or smallest size. In material having a small permanence factor, like the samarium-cobalt used in the Sony *MDR*-series phones, self-demagnetization is small. That makes it possible to make a very small magnet that is nevertheless quite strong.

High compliance diaphragm for extended bass

Figure 5 is a typical response curve obtained for a speaker system. Every speaker system has a minimum resonant frequency, f_0, which can be calculated from the following formula:

$$f_0 = \frac{1}{2\pi\sqrt{MC}}$$

The quantity M represents the moving mass of the diaphragm, while C represents its compliance. Since sound pressure decreases rapidly at frequencies below f_0, it is important to keep f_0 as low as possible to extend bass response. To do that, it is necessary to increase the value of either M or C. If you were to increase the moving mass,

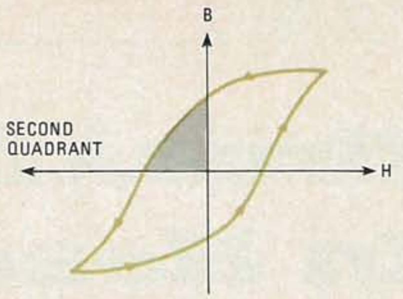


FIG. 2—THE DEMAGNETIZATION CURVE corresponds to the second quandrant of the hysteresis curve.

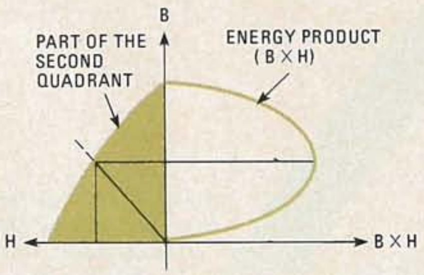


FIG. 3—THE ENERGY PRODUCT is the product of flux density and magnetizing force, and is very different for different materials.

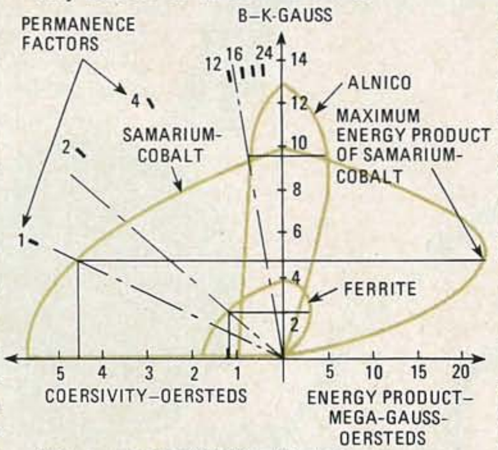


FIG. 4—THE DEMAGNETIZATION and energy-product curves for Ferrite, Alnico, and samarium-cobalt.

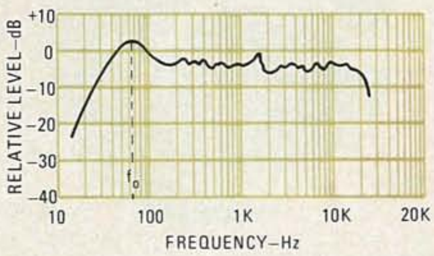


FIG. 5—TYPICAL RESPONSE CURVE for a speaker system. The frequency f_0 is the minimum resonant frequency.

M, the heavier moving mass would decrease the high-frequency response of the single-diaphragm system and the overall efficiency would also be lower. Thus, increasing compliance, C, represents the only way to extend bass response. One way of increasing the compliance of the diaphragm is to make it very thin and flexible (assuming that the surrounding material and the diaphragm material both remain constant). The thickness of the diaphragm used in the *MDR*-series headphones is only 12 micrometers, or about one-tenth the thickness of an average sheet of typewriter paper!

Protecting the driver against high-level inputs

From the relationships established earlier regarding driver size and amount of excursion as they relate to sound-pressure levels, we have seen that it is necessary to increase the excursion if you want to have a small-diameter driver. However, a small-diameter driver with a large excursion can develop a problem with the flexible wires that lead to the voice coil. The voice-coil leads on the smaller diaphragm will naturally be under greater stress than will the leads connected to the voice coil of the larger-diaphragm driver (see Fig. 6) and, if conventional methods are used the added stress will lead to reliability problems.

To overcome this, Sony adopted a new technique for attaching the voice-coil leads to the diaphragm, as shown in Fig. 7. The effective span of the voice-coil leads is much longer with the new technique than with the conventional method and the stress on the wires is substantially reduced. Using that connection method, Sony found that the *MDR*-series drive units will accept a 40-milliwatt input continuously for a period of 500 hours without damage.

Acoustically transparent earpads

From a sound-quality point of view, it would be ideal if earpads could be eliminated from stereo headphones. Coupling from the driver to the listener's ear would be more direct and there would be no material between the driver and the listener's ear to absorb sound and deteriorate audio quality. Just as listening to a loudspeaker system through a curtain tends to degrade sound quality because the curtain acts as an acoustical filter, foam earpads tend to block sound transmission to some degree. Yet, foam pads are necessary for wearer comfort in the *MDR*-series phones.

After examining existing earpad material, Sony found that the cavities in conventional foam earpads contain many cell walls that block a certain amount of sound going through the cavity, as shown in Fig. 8-*a*. Accordingly, they developed a new type of material that has no walls in the cavities across the sound path, as shown in Fig. 8-*b*. According to Sony, a special chemical technique was required to make the foam material from which the *MDR*-series phone earpads were made.

Even the flexible 9¾-foot connection cord used in the *MDR*-series phones was

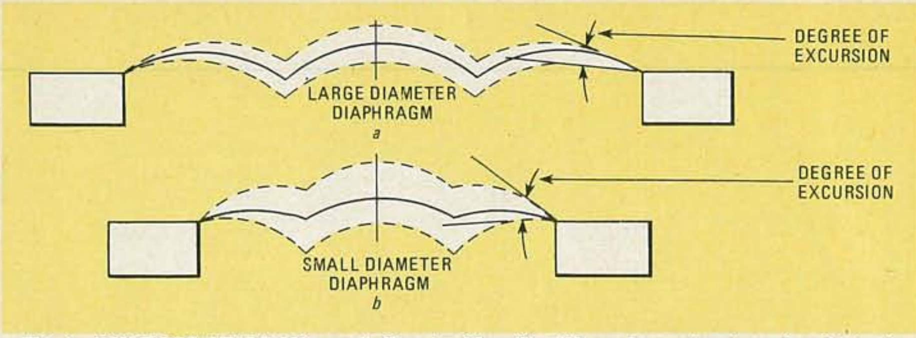


FIG. 6—VOICE-COIL LEADS ON a small-diameter driver (*b*) will be under greater stress than the leads on a larger-diameter driver (*a*).

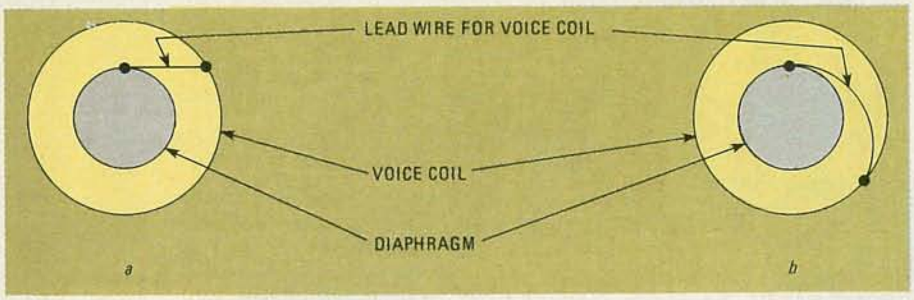


FIG. 7—LENGTHENING the effective span of the voice-coil leads (*b*) reduces the stress on those leads in the *MDR*-series headphones.

FIG. 8—NEW FOAM MATERIAL (*b*) developed for the *MDR*-series headphone earpads has no walls across the sound path, improving sound quality.

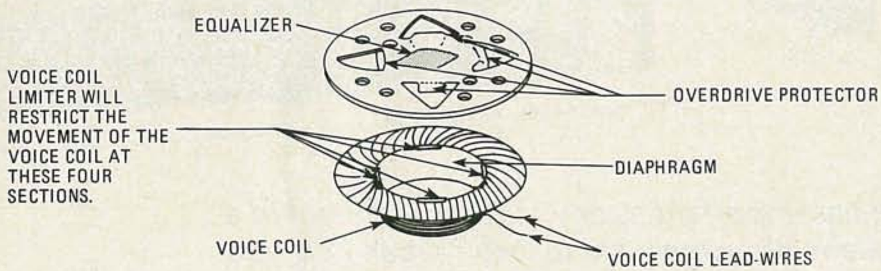


FIG. 9—THE DIAPHRAGM is covered by a small plate that acts as an acoustic equalizer as well as a protective device.

given special attention to insure that it would not degrade the signal coming from the amplifier or receiver. A special "chemically-pure oxygen-free" copper wire is used in making the cord to minimize signal losses between the amplifier and the drivers. According to Sony, conventional copper wire is only 99.5% pure, with an oxygen content of 0.035%; the copper wire used in the *MDR*-series connection cords however, has a purity (copper content) of 99.995% and an oxygen content of only 0.0006%. While that quest for pure copper wire may be thought of by some as a bit of "overkill" it does serve to illustrate the extremes to which the designers of those phones went to insure top performance.

Equalizer with overdrive protection feature

The top-of-the-line *model MDR-7* phones have one additional construction feature that is worth mentioning. The diaphragm of that model is covered with a metal plate that has several holes in it, as shown in Fig. 9. The center section of that plate compensates for the phase differences of sounds emanating from the center and sounds coming from the outer edges of the diaphragm and therefore acts as an acoustic equalizer. That phase-shift correction is especially important in maintaining good high-frequency response.

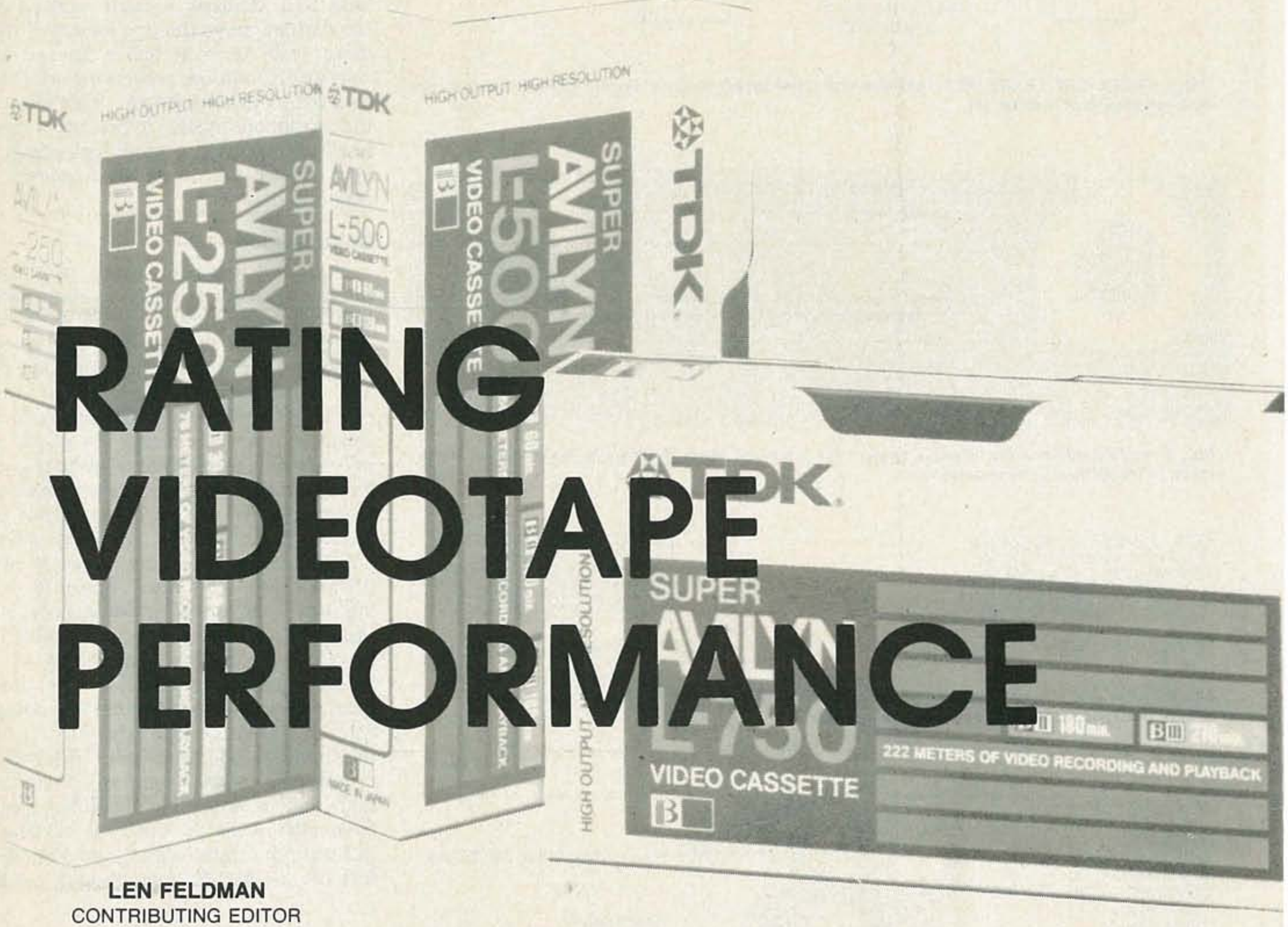
The same plate also serves as a protection device for the driver in case it is overdriven by the amplifier. There are four small metal sections (indicated by four arrows), that will come in contact with four similarly located sections of the diaphragm so that movement of the driver will be restricted in case of an overload condition, preventing possible damage to the diaphragm. That allows the headphone system to produce a high level of bass from a small high-compliance driver unit, without requiring a separate damper.

Specifications

You will have to listen to those phones yourself in order to appreciate how much of an improvement the new design is. But just to give you some idea of what to expect, here are some of the published specifications of the *model MDR-7* phones. The phones are dynamic types of course. The driver is only 28 mm in diameter (lower-priced models in the line have an even smaller, 23-mm diameter driver). Impedance is 55 ohms at 1 kHz. Perhaps most amazing is the sensitivity, which is 101 dB/milliwatt. The rated power is 40 milliwatts and at that power input-level, the units will produce a sound pressure level of 117 dB. The maximum power-handling capacity is 100 milliwatts. Frequency response is quoted as extending from 16 Hz to 22 kHz (the flatness of the curve is not specified). Headband pressure is only 100 grams, far lower than that of any other headphone we have ever worn and one of the chief reasons why those phones are so comfortable to wear for long periods. **R-E**

"My husband built it as a retreat from noise, air pollution, the general unrest, and me."

RATING VIDEOTAPE PERFORMANCE



LEN FELDMAN
CONTRIBUTING EDITOR

Videotape is just as important as any other component in a home-video system. Knowing what to look for can help you choose the right one.

THE STATEMENT ABOUT A CHAIN BEING only as strong as its weakest link applies as much to videotape recording as it does to anything else. In any home video-recording system, there are several elements that can prove to be the limiting factor in determining the picture and sound quality that you ultimately obtain.

If you are taping a TV program, the elements involved include: the quality and signal-strength of the received signal; the signal-to-noise ratio of the TV-tuner section of your VCR; the quality of the record-electronics of the VCR; the characteristics of the videotape being used; the characteristics of the playback electronics of the VCR; the performance of the RF modulator that allows you to connect from the VCR's RF output directly to the antenna input of your TV set, and finally, the quality and performance characteristics of the TV set on which you view the playback of the videotape.

If you are using a video camera as a program source, that extra element (or rather, its ability to provide a noise-free, high-resolution video signal to the input of your VCR) must also be considered a part of the "chain." In either event, the tape you use is a critical link in the video chain. To be sure, all manufacturers of videotape intended for home use claim that their product is "the best" and that you would be ill-advised to use any other.

In fact, though, there are substantial variations among the different videotapes—variations great enough so that the viewer can easily distinguish between pictures recorded on one type of tape and those recorded on another, inferior type. There are mechanical differences among the cassette housings as well as differences between the tapes themselves, but for this discussion we will just concentrate on the differences among tapes. Theoretically, the cassette shells or housings used for either the Beta format or the VHS format of videotape must conform, within fairly tight tolerances, to the requirements of the licensors who have signed agreements with the various tape manufacturers. (Sony licenses tape makers to package videotape in Beta-type housings while JVC licenses those who wish to package tape in VHS-type cassettes.)

Criteria for good performance

Assuming that you could separate the various elements of a videotaping system so that you can examine the performance of just one of those elements (in this case, the tape), what performance criteria would you evaluate? To begin with, you would want to know something about the storage-density capability of the given tape. The more densely packed with magnetic particles a given tape surface is (and the smaller those particles), the better the frequency-response capability of the given tape. And better frequency response means better picture definition or picture resolution.

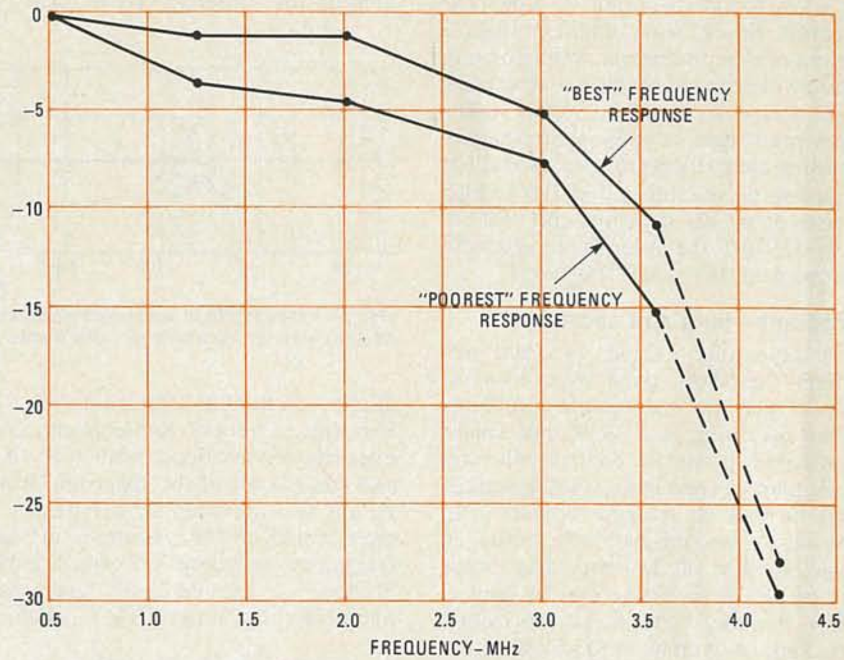


FIG. 1—VIDEO FREQUENCY-RESPONSE of the best and worst videotapes tested differed by almost 5 dB at same frequencies.

One test signal that has been used to evaluate frequency response of both videotape and videotape decks is a multiburst test tone, containing six bursts at frequencies of 0.5 MHz, 1.25 MHz, 2.0 MHz, 3.0 MHz, 3.58 MHz, and 4.2 MHz each. Normally, that type of test signal includes a 3.58-MHz color-burst signal. In checking the frequency response of a sample of videotape, though, it is a good idea to omit the color-burst signal. If it were present it would activate the color circuitry in the reference videotape recorder being used to make the tests. That circuitry, if activated, blocks the passage of frequencies beyond 3.58 MHz in many home-video recorders.

Speaking of reference recorders used in testing videotapes, it is fairly obvious that you would want to use a VCR that is, in each of the characteristics (signal-to-noise ratio, for example) to be examined, significantly better than those of the tape(s) being tested.

In a recent test of a group of video cassette tapes performed by a qualified and well known video laboratory, the frequency-response capability of the tapes tested ranged from the response shown in the upper curve of Fig. 1, to the lower curve of the same figure. Note that the two plots are not to be regarded as continuous curves, since only six discrete frequency points were measured for each of the tapes. Interestingly, none of the tapes did very well above 3.0 MHz, though there is no easy way to tell whether that was the fault of the video deck (a high-performance "industrial" model was used so that it would not be a limiting factor) or the tapes themselves. From our own experience with home-type videotape recorders we are fairly certain that at least up to the 3.0-MHz test frequency, those results are indicative of the tape's frequency response capabilities and not of the machine's. That is because no home machine we have ever encountered has had such a good response that it was down only about 5.0 dB at 3.0 MHz. (Typically, response of the entire loop—record/play via tape, and including the tape machine's electronics—is down anywhere from 7.5 to 15 dB at that frequency.)

Signal-to-noise ratios

In discussing the signal-to-noise ratio of audio tape, one establishes some reference signal-level (usually the level that causes a 3% total harmonic-distortion content during playback of a mid-range-frequency signal) and measures "tape hiss" or noise relative to that level. In the case of videotape, it is a bit more complicated than that. To begin with, there are *two* kinds of noise that are of interest: noise relative to a reference luminance-(brightness) signal and noise relative to a reference chroma-(color) signal. Beyond that, the chroma signal-to-noise ratio can be further broken down into AM (*A*mplitude *M*odulation) and PM (*P*hase *M*odulation) noise, since both of those will affect the color signal.

In the tests referred to earlier, the range of signal to noise with respect to a luminance reference-signal was between a high of 45.5 dB and a low of 40.5 dB. Note that signal-to-noise ratios in video are lower than they are in audio. Obviously, our eyes are more tolerant of "snow" or noise in a video picture than our ears are of audible "hiss." Interestingly, most home video cassette recorders have a video signal-to-noise ratio of between 40 and 45 dB, indicating that, in that respect at least, it is a toss-up as to whether the tape or the tape deck will prove to be the limiting factor.

In the case of signal-to-noise ratios relative to a chroma signal, the signal-to-noise measurement in the above-mentioned tests was made using the red output of a color-bar generator as a reference. Both AM and PM chroma noise was measured from 100 Hz to 500 kHz. Results of the chroma AM-noise tests ranged from a high (best) of 42 dB to a low (poorest) of only 33.5 dB. The poorest figure was obtained from a brand of tape that is not well known or widely distributed in this country; but if such a tape were used it would yield a very poor signal-to-noise ratio when recording color-TV pictures. Chroma PM signal-to-noise ratios varied from a high (best) of 40 dB to a low (poorest) of only 33.5 dB, the latter figure again obtained from the same "off brand."

Dropouts—long and short

A tape may exhibit excellent frequency response, good signal-to-noise ratios, and no mechanical problems when operating in a VCR, but unless that tape is uniformly coated with magnetic particles and has a smooth surface that remains in intimate contact with the video record/playback heads, a large number of dropouts may occur during playback. Those may be seen as noise streaks, occasional horizontal breakup, or even as vertical roll of the picture in extreme cases. The effect will depend largely upon the duration of the dropouts as well as upon how frequently they occur. A short dropout would be 5 microseconds in duration or less. Medium-length dropouts would last for about 10 microseconds, while long dropouts would be 15 microseconds or longer. Typically, over a period of one minute of observation, superior videotapes will have 10 or fewer short dropouts, as few as 6 medium-length dropouts, and no more than 2 to 4 long-term dropouts. At the other end of the quality scale, we have seen tapes with as many as 100 short, medium and long-term dropouts in the same one-minute period. Severe dropouts in a tape may be more annoying to viewers than poor frequency response, inferior signal-to-noise ratios, or less-than-perfect audio performance.

Audio performance of videotapes

In general, we have found that the audio-performance qualities of videotapes closely follows their video performance. That is, tapes that exhibit good characteristics in video, have good audio tracks as well. Still, there are considerable variations in audio performance, even among the better, well known, brands. Of primary interest in the case of audio is frequency response, or the frequency extremes at which response falls off by 3 dB from some midrange-frequency reference level (such as 1 kHz).

Figure 2 shows the range of response capabilities measured in tests of eighteen different brands of tape. Variations in bass response were minimal, with the best tapes having good response down to 47 Hz and the poorest only somewhat worse, having their −3dB roll-off points at 49 Hz. At the high end of the audio spectrum, however, variations among the different tapes were far greater: from 10.8 kHz (poor) to a 12.1 kHz (much better). Subjectively, however, those variations (both at the bass and treble ends of the spectrum) would be far less obvious to a typical user than would be the variations in video frequency response described earlier because of the generally inadequate audio sections in most TV receivers.

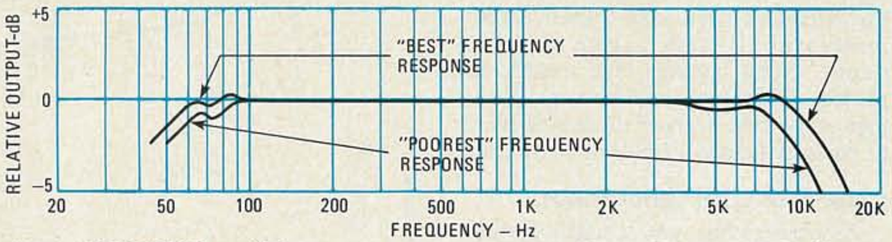


FIG. 2—VARIATIONS in audio frequency-response among the various videotapes tested will not be as noticeable as variations in video frequency-response to the average user.

Audio signal-to-noise ratios

Although there are substantial variations in audio signal-to-noise capabilities of videotapes, we have found that in general the tape itself is not the limiting factor when considering audio S/N in a home video system. Remember, even at the fastest speed (shortest record/play time) for the VHS videorecorder format, the tape is traveling at a very slow 1.31 inches-per-second. At longer record/play formats, the speed, of course, is reduced even further. Beta speeds are not much different from VHS tape speeds. Add to this the fact that not one of the machines commonly available for home use is equipped with any sort of electronic noise-reduction system (such as *Dolby B*), and it is not surprising that the best audio signal-to-noise ratios of most home VCR's range from 40 dB to, perhaps, 45 dB. Contrast that with the audio S/N range of tapes (typically 52 dB to 55 dB when measured on a professional or industrial type of VCR) and you can see that audio signal-to-noise is more likely to be a function of the VCR on which the tape is being used than of the tape's own limitations.

Mechanical considerations

Home videotape users will also want to consider the mechanical reliability of the tapes that they use in their VCR machines. One of the chief advantages of videotape (as opposed to videodiscs that are much less expensive than equivalent lengths of videotape) is the ability of the user to erase previously recorded material and use the tape over and over again. In order to fully realize that advantage, the tape must remain intact and unstretched with repeated use. In addition, the tape housing must be molded to precise tolerances and internal parts (as many as thirty or more in better-made cassettes) must not cause tape jamming or increased friction as the cassette ages and is used repeatedly. In general, most of the available tapes we have seen and used have no serious problems in that regard, but of course the entire home VCR field is still too new to be able to say, with any certainty, that "videotapes should last a lifetime. **R-E**

What's News

Reactors can fail safe

The American Nuclear Society, in a recent policy statement, expresses confidence that emergency core-cooling systems (ECCS) can keep the nuclear fuel from overheating when the regular coolant is lost. That confidence, the Society states, is based on understanding the requirements of those systems, extensive experimental verification, . . . and frequent inspection and testing, both during construction and when in service.

"Even in the Three-Mile Island accident," the paper noted, "the ECCS functioned and remained fully capable of performing its function of cooling the fuel."

In a second statement, the Society proposes that nuclear fuel-cycle centers "be developed and operated under international safeguards, and that fuel-cycle services—including spent-fuel storage, reprocessing, and waste management—should be available as soon as possible to utilities and the international community."

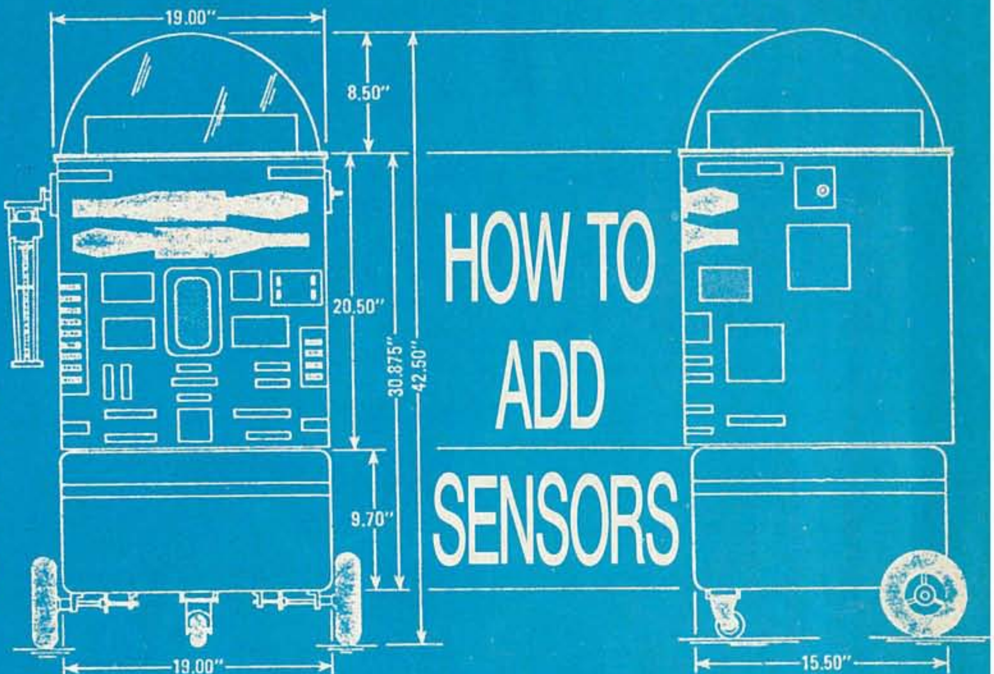
Copies of the policy statements can be obtained from the American Nuclear Society, 555 North Kensington Ave., La Grange Park, IL 60525. **R-E**

BUILD THIS

Part 11—The better your robot can respond to the world around it, the more useful it will be. Here are two sensors that will enable the robot to "see" and "feel" objects that are in its vicinity.

UNICORN-1 ROBOT

JAMES A. GUPTON, JR.



HOW TO ADD SENSORS

UP UNTIL THIS POINT, ANY REACTION THAT the robot has shown to events happening around it have actually been those of its operator. Radio- or computer-control has been possible only to the extent that the operator could observe the robot's environment and make the robot react to it. And, even operating in that way, there has been the danger that the robot could "stumble" into something that could not be seen by the operator.

In this installment of the Unicorn-1 series we'll describe two types of sensors that will enable the robot to detect objects in its immediate vicinity and to react to them.

The first is a contact-type sensor that will give the robot a limited sense of "feel" and allow it to know when it has bumped into something.

There are times, though, when it would be better for the robot to be able to sense when it was *about to bump into* something—running into brick walls is one thing; running into people, another!

The second sensor, then, will be of the proximity-type, giving the robot a rather restricted sort of "vision."

Contact sensor

The robot should be equipped with two contact-sensors—front and rear. They are extremely simple in design, as can be seen from Fig. 86, consisting of lever-actuated switches that are connected to rods projecting from the mobility base. Note that the rear sensor-rod is about twice as long as the one for the front sensor. This compensates for the fact that the large driven wheels of the mobility base may project behind it and, naturally, we want the sensor to come into contact with an obstacle before any part of the robot does.

The sensor rods are made from pieces of wire coat hanger, with the paint or lacquer removed to permit good solder joints. The front rod is about $1\frac{1}{2}$-inches long and the rear rod about twice that length. The compression springs can be "liberated" from dried out ball-point pens. The springs are held in place by 4-40 washers soldered to the rods.

A 4-40 cap nut (the kind with a rounded end) can be soldered to the end of each rod to prevent it from scraping or impaling whatever it may come into contact with. Better protection can be provided by applying a liberal amount of silicone sealant to the cap nut to provide a soft, protective surface.

Even better, a small bumper, with a soft covering made from a piece of foam rubber or inner tube, can be constructed and affixed to the end of the sensor rod.

The bushings that fit into the mobility base and allow the sensor rods to move in and out are nothing more than 10-32 $\times$ $\frac{3}{8}$ machine screws that have been drilled out with a No. 42 drill bit (use a drill press and vise, if you possibly can) and had their heads filed flat to remove the screwdriver slot. Leave enough head, though, to hold the screw in place. Use 10-32 nuts to secure the bushings to the mobility base.

A helpful hint: Fig. 86 shows a half-inch brass washer soldered to the "inside" end of each sensor rod. (The washers are especially necessary if more than one switch is used for each sensor—see below.) *Those* washers should be the last part to be attached.

The end-nut (or bumper), spring and 4-40 spring-stop-washer should be attached to the rod first, and the unit inserted into the bushing. Then, using a wooden block to compress the assembly, and holding the brass washer with a pair of pliers, solder the washer to the end of the rod. Doing this will prevent your getting your fingers burned.

The brackets for the switches can be made from almost any material at hand—metal, plastic, or wood. They support the switches in the proper position and, if two switches are mounted side-by-side, allow the brass washer to contact both switch-levers at the same time.

The original Unicorn-1 used brackets made from scraps of $1\frac{1}{2} \times 1\frac{1}{2} \times .0625$-inch aluminum, bent as shown in Fig. 86, and drilled to accept two 4-40 mounting screws. The section that fits flush with the mobility base need be no larger than $\frac{1}{4}$-inch if 4-40 hardware is used but should be at least $\frac{3}{8}$-inch long for 6-32 hardware.

If the mounting holes in the switches are too small for 4-40 hardware, they can be enlarged with a No. 33 drill bit. Be sure to use a vise and to use either a hand drill or a *very slow* electric drill to prevent damage to the plastic switch case.

The completed front and rear contact-sensor assemblies are shown in Fig. 87. If larger switches are used, mounting brack-

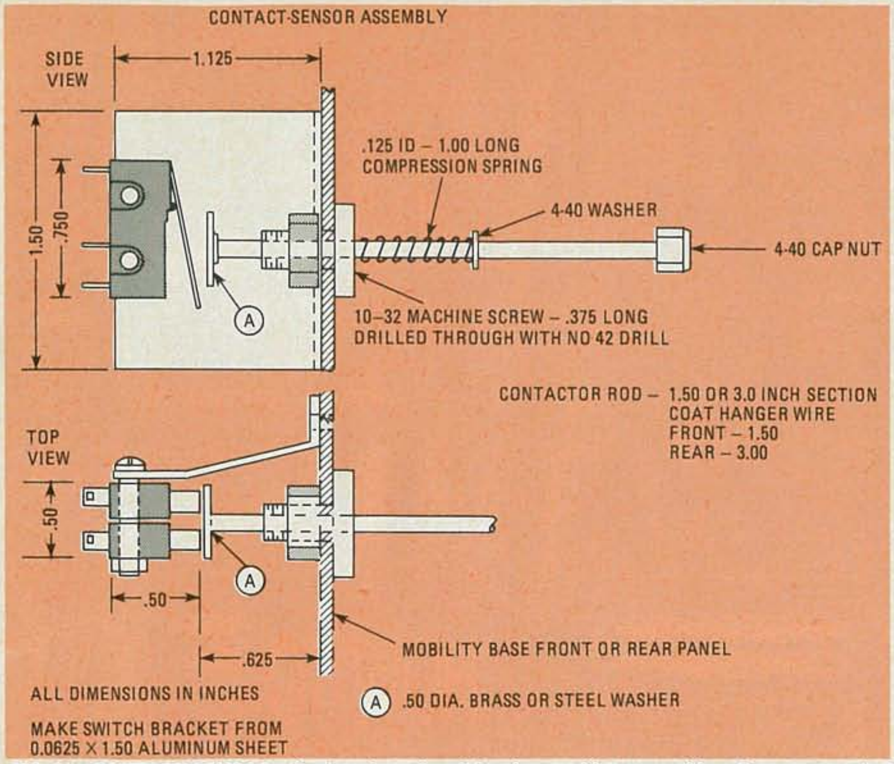


FIG. 86—CONTACT SENSOR tells the robot when it has bumped into something. Cap nut at end of rod should be provided with cushioning material (see text).

ets may not be necesary since the switches can be mounted directly on the bottom plate of the mobility base.

Connection of the switches will be discussed later.

Proximity sensor

While the contact-type sensor described above is extremely useful, there are times when it could prove embarassing (or worse) to have the robot collide with something. It would be better if it

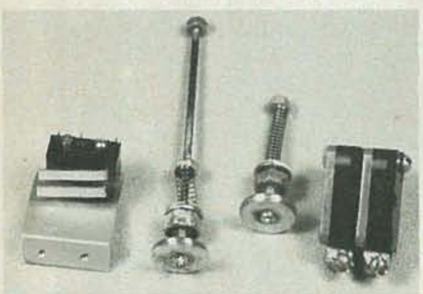


FIG. 87—COMPLETED CONTACT SENSORS used in original Unicorn-1. In this case, dual switch-assemblies were used.

could sense the proximity (nearness) of an object and either stop or, if under computer control, take evasive action.

Figure 88 shows how an infrared-light-type proximity sensor would work. The transmitter, mounted on the robot's right side and angled slightly inward, projects a beam of infrared light that will be reflected by a nearby object to the infrared detector, mounted on the robot's left side and also angled toward the target.

The distance between the transmitter and the detector, and the angle they form, will determine the distance, D, from the robot that the object can be sensed. The transmitter and detector must be aimed inward at equal angles for accuracy. (Remember that "the angle of reflection equals the angle of incidence;" and, the larger the angle, the farther away—up to about 20 inches in this case—an object can be detected.)

Using infrared light means that the system can be used under almost any lighting conditions since the infrared detector is not very sensitive to visible light. For that matter, the robot could even detect obstacles in the dark—it carries its own "flashlight."

Figure 89 shows the infrared-projector assembly used on Unicorn-1. When used with a lens, the 2174D infrared lamp generates a beam that is usable to a distance of about 20 inches.

The dimensions shown for the lens tube are only approximate, since there are so many variables (lens type, detection distance required, etc.) involved. The best way to find the dimensions you will need is to set up the lamp in its housing at one end of a ruler and to move the lens back and forth until you can see the beam focused into a spot on a screen or sheet of paper placed at distance D—your target distance. Don't forget that D is measured from the front of the robot, and not from the transmitter (or receiver).

Note the distance between the lens and the aperture of the transmitter assembly and make the lens tube that length. Critical adjustments can be made later by adjusting the position of the lamp housing slightly. The final assembly step, before mounting the projector on the robot, is to glue the lens in place in the tube using either epoxy or lens cement. Take care

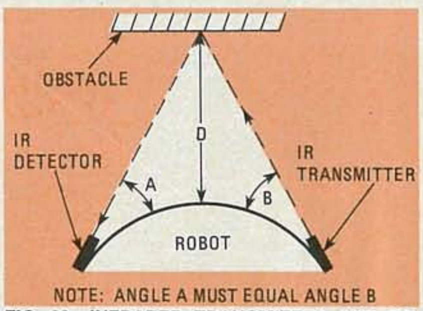


FIG. 88—INFRARED TRANSMITTER AND DETECTOR are mounted on sides of robot's body or dome. Angle A must be equal to angle B.

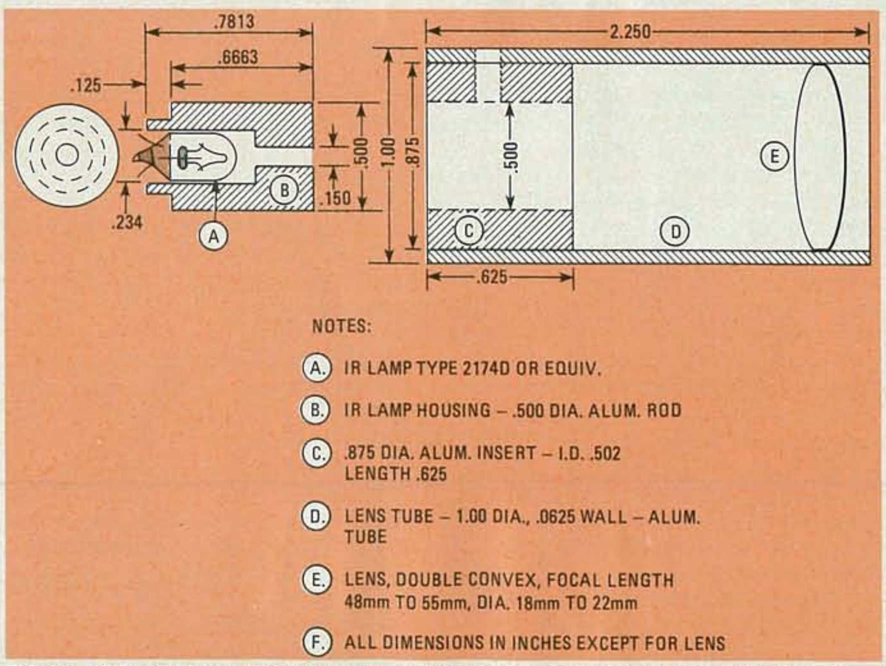


FIG. 89—INFRARED LAMP HOUSING can be held in position in lens tube by set screw, once proper position has been determined.

PARTS LIST—CONTACT SENSORS		
Item	**Description or quantity**	**Source**
Contact rod	1.5 inches	coat-hanger wire
"	3.0 inches	"
Mobility-base bushing	10−32 × ⅜ flat-head screw, (2)	hardware store
"	10-32 nut (2)	"
Cap nut	4-40 (2)	"
Compression spring	.125 I.D., 1 inch long (2)	ball point pen
Washer	4-40 steel (2)	hardware store
"	.5-inch brass (2)	"
Lever-type switch	2 or 4	**Radio Shack** (catalog No. 275-016) or equivalent
Switch bracket	1.5 × 1.5 × .0625 aluminum (2)	scrap or hardware store

PARTS LIST—PROXIMITY SENSOR		
Item	**Description or quantity**	**Source**
TRANSMITTER:		
Infrared lamp	2174D, 12-volts	electronic-supply house
Lamp housing	.5-inch aluminum rod	hardware store
Lens tube	aluminum tubing, 1-inch O.D. × 2.25 inches long	"
Lens & lens cement	double-convex, 48-55mm focal length, diam. to fit lens tube	**Edmund Scientific** 101 E. Gloucester Pike Barrington, NJ 08007

Item	Description or quantity	Source
RECEIVER:		
Sensor housing	5-inch aluminum rod & washer	hardware store
Lens tube	aluminum tubing, 1-inch O.D. × 2 inches long	"
Lens & lens cement	double-convex, 20-30mm focal length, diam. to fit lens tube	**Edmund Scientific**
PC board	1 ($2.50 + $1.50 S&H if total order less than $15.00)	**Hal-Tronix** P.O. Box 1101 Southgate, MI 48195
R1	68 ohms, ½-watt	
R2	22,000 ohms, ¼-watt	
R3	10,000 ohms, ¼-watt	
R4	4700 ohms, ¼-watt	
IC1	7404 hex inverter	
Q1	2N2222 or equivalent	
Q2	FPT-100 or equivalent (Radio Shack 276-130)	
D1	1N5227 3.6-volt Zener diode	
D2	1N5231 5.1-volt Zener diode	
D3	1N4001, 50PIV, 1-amp diode	
RY1	5-volt DPDT DIP relay (Radio Shack 275-215 or equivalent)	

not to get any of the adhesive on the lens. The completed transmitter assembly is shown in Fig. 90.

A diagram of the infrared-receiver assembly is shown in Fig. 91. As in the case with the transmitter, the dimensions are approximate. To determine the final dimensions, a method similar to the one outlined above is used.

First, cover the aperture of the detector housing with a translucent material, such as *Scotch* brand *Magic Tape*, to make a focusing screen. Attach the detector housing to a ruler and aim the ruler at a white or light gray surface placed at distance D. When making your final calculations, don't forget about the angles involved! Move the lens back and forth along the ruler until a sharply defined spot is seen on the focusing screen. The distance between the lens and the end of the detector housing will determine the length of the lens tube.

As in the case of the projector, cement the lens to the focusing tube and perform the critical focusing adjustment with the detector housing.

In performing these measurements, the projector and receiver assemblies should be placed in the positions they will occupy when mounted on the robot, and be angled accordingly. If this is not done, the results of the measurements will be invalid.

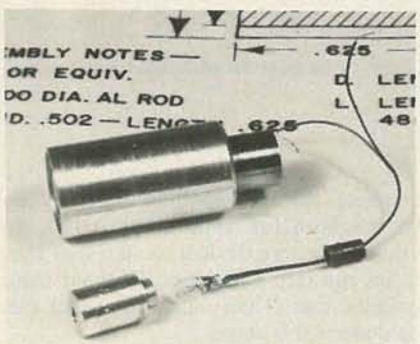


FIG. 90—UNICORN-1's infrared transmitter. Note insulating sleeve for lamp.

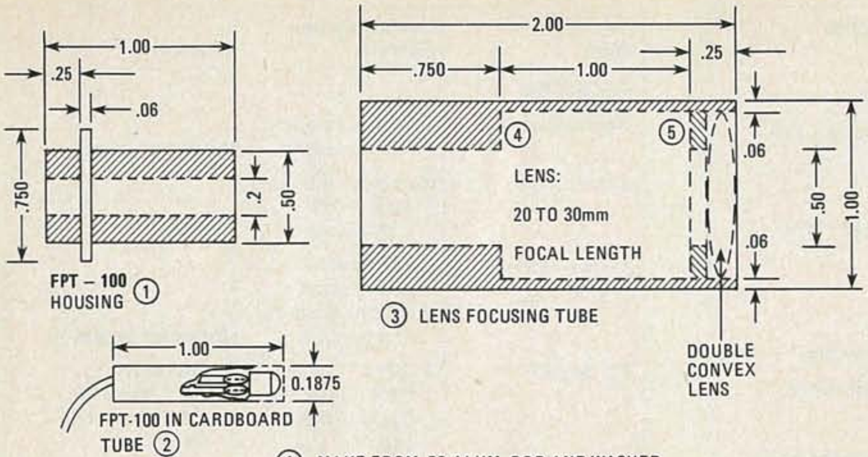
Receiver circuit

Both the transmitter and receiver can be operated from the robot's 12-volt power supply. A schematic for the receiver is shown in Fig. 92 (and the foil pattern and parts-placement diagram in Figs. 93 and 94, respectively).

The heart of the receiver is an FPT-100 infrared phototransistor (Radio Shack part No. 276-130 is an acceptable substitute). Its collector is connected to the 12-volt supply through a 10K load resistor, R3. The collector is also connected to pin 1 of IC1 through a 22K series resistor and through a 1N5227 3.6-volt Zener dioide (D1). That keeps pin 1 at a logic "high" when the detector is receiving no input.

The IC supply voltage of 5.1 volts is provided by D2, a 1N5231 Zener diode. This diode also provides the coil-voltage for RY1, a DIP relay of the same type used on the relay board described in Part 7 of this series. The circuit operates as follows:

When the infrared sensor, Q2, is at the optimum distance from a reflective obstacle, the reflected infrared light is at a maximum. The sensor is biased into a state of saturation and its collector voltage drops to zero. The 3.6-volts present at pin 1 of IC1 also drops to zero, causing the output at pin 2 to go from 3.6- to five volts (logic "high"). This biases transis-



① MAKE FROM .50 ALUM. ROD AND WASHER

② CUT FPT-100 LEADS TO .25", SOLDER 18" CONNECTING WIRES TO PC BOARD

③ MAKE FROM 1.00 O.D., .06 WALL, ALUM. TUBE

④ MAKE FROM .86 O.D. WOOD OR ALUM. ROD

⑤ MAKE FROM 1.00 O.D., .50 I.D., FIBER WASHER

⑥ ALL DIMENSIONS IN INCHES EXCEPT FOR LENS

FIG. 91—USE A CARDBOARD OR PLASTIC sleeve to prevent FPT-100 leads from shorting to metal housing.

We've been receiving a lot of correspondence from readers who are building—or contemplating building—their own versions of Unicorn-1. We'd like to see more, along with nice sharp photographs, so we can publish a segment showing off those robots and presenting some of the innovations that you've come up with. Write to **Radio-Electronics,** 200 Park Avenue South, New York, NY 10003 and mark your envelope "ROBOT UPDATE."

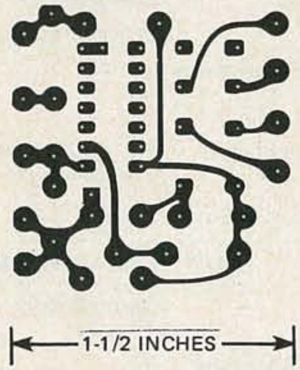


FIG. 93—YOU CAN ETCH detector board yourself from this pattern. Ready-made boards are also available (see parts list).

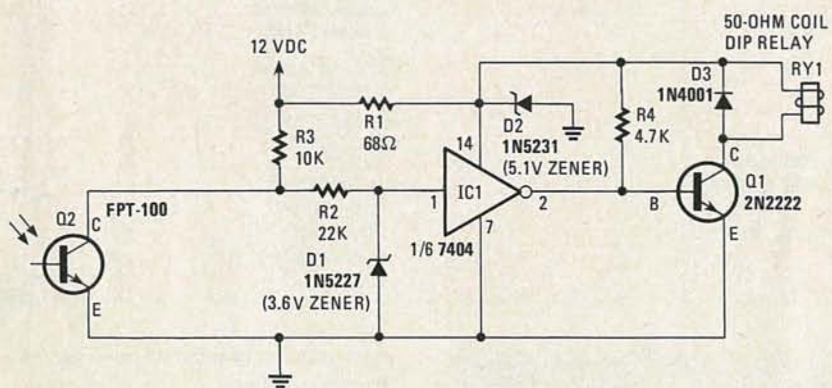


FIG. 92—INFRARED-DETECTOR circuit is simple enough to be built on perforated construction board.

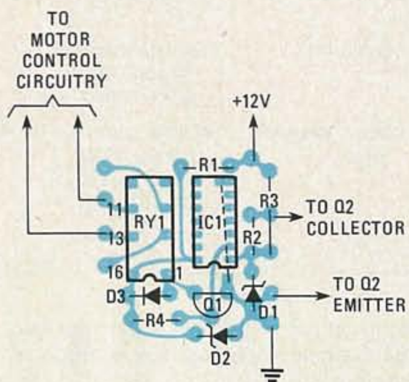


FIG. 94—DETECTOR BOARD is connected to FPT-100 sensor by 18-inch leads. See text for motor-control connections.

tor Q1, a 2N2222, into saturation, causing current to flow through the coil of the relay and opening the relay's normally-closed contacts, thereby cutting off power to the appropriate control circuitry.

Connection to robot

Depending on how advanced your own robot is, the signals provided by the sensor circuitry can be used in several ways.

If the robot is still operating at the end of a "tether," the contact-sensor switches and the proximity-sensor relay can simply be connected in series with the motor circuits (like the limit switches) and used to cut power to the motors when an obstacle is detected. This is why you might wish to use two switches each for the front and rear contact-sensors—one switch can control the right-hand wheel, and one the left-hand one. Unused switch or relay contacts can be used to actuate the robot's horn (or some other audible or visible signaling device) to alert you that it has run into difficulties. Without logic circuits, there's not much more that can be done at this stage.

If the robot is using radio- or computer-control, the output of the detectors can be connected to the appropriate "drop-dead" sections of the latch board (see Part 9) to achieve the same results.

Finally, if you are using a computer, a program can be written to make use of the "drop-dead" signal. For example, the computer could be programmed to respond to that signal and make the robot back up a bit, make a 45-degree turn, and check again for an obstacle. If none were present, it could continue its travel. And that just scratches the surface of the responses that could be programmed.

The rest is up to you, for this is the end of the Unicorn-1 series. We've shown you how to build a working robot, and how to enhance it with radio- and computer-control. As you continue to work with your robot you'll find its capabilities limited only by your imagination and resources.

Those of you who have built your own robots can take pleasure in knowing that you are advancing the science of robotics. In the near future, much of the hazardous and tedious work now performed by humans will be carried out by robots.

Even now we are seeing robots explore parts of the solar system that man will not visit in person for tens—or hundreds—of years. Enormous progress is being made in creating robots to serve in areas where man's help is either unnecessary or impossible to provide. What will be *your* contribution to the age of robotics? **R-E**

MOST OF US REMEMBER *HAL*, THE UNlikely star of Stanley Kubrick's *2001: a Space Odyssey*. When the film was made in the late 1960's, the idea of conversing with a computer was pure science fiction. But as has happened so often, yesterday's science fiction is today's technology. Speech synthesis by computers is familiar to most of us by now, but what about the area of speech recognition?

While speaker-independent recognition of connected speech by a computer is still a decade off, firm toeholds have been established in developmental areas important to its eventual success.

We're going to take a look at some of the speech-recognition systems now available, and what's being done to improve the state of the art.

A simplified explanation

Speech-recognition systems rely on the matching of a spoken word to a stored model of that word. In practice, the way words are modeled is the key to the success and accuracy of a system—as well as to its expense, speed, and more.

Generally, the user of the system is asked to speak each word in the system's limited vocabulary several times. Those spoken samples are analyzed by a variety of techniques, and the samples of each word or phrase are compared to one another. Differences are minimized, similarities maximized, and the resulting model (called a *template*) is stored in the system's memory.

Once the "training" has been completed, any word or phrase spoken into the system is analyzed using the same techniques used in deriving the templates. That analyzed data is compared with the stored templates, and a score assigned to each match. If no score is high enough to be accepted as a *fit*, the system gives a "non-recognition" message or asks to have the word repeated. If more than one word is scored high enough so that there are several possible fits, the system can ask which is correct or ask to have the word repeated. However, in about 98% of all attempts, a single word is recognized uniquely.

Since it's important in matching a word to know precisely where a word begins or ends, there is usually some hardware or software incorporated to give that information. Also, there is usually some provision for normalizing the time distribution of the word—that is to say, the duration of the voiced sounds within the word. Without time normalization, variations in the ways we pronounce a given word would make matching it against its template very difficult.

Generally, both time-dependent and time-independent analyses are done. The time-independent analysis is usually concerned with the spectral distribution of the word. For example, a spectral distribution analysis (called a *histogram*) of the word "six" would show that the word has a lot of "s" sound within it, but not that the "s" sound occurs twice, once at each end of the word. Rather, the spectral histogram would show how much energy appeared at any one frequency during the speaking of the word. In practice, narrow bands of frequencies are usually sampled—although there is some progress in the Fourier analysis of speech through new hybrid analog/digital microprocessor technology, but that's a subject best left until it can be covered somewhat more meaningfully.

How it works

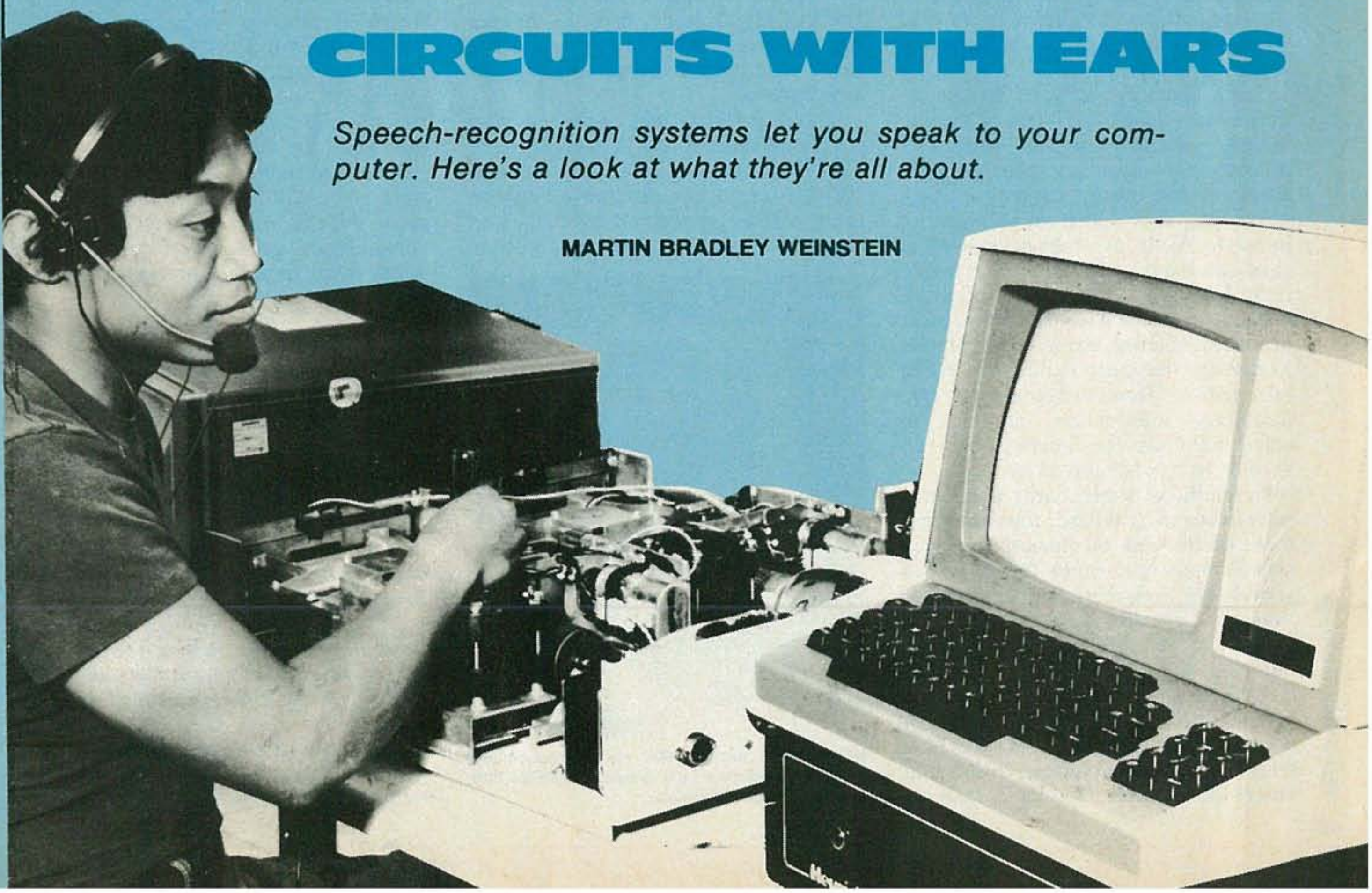
Let's take a look at the elements of most of today's speech-recognition hardware in a little more detail. (see Fig. 1) The first step is to provide as favorable a signal-to-noise ratio as possible. A noise-cancelling mike close to the speaker's mouth (often on a headset) and push-to-talk operation help to accomplish that.

Also, there is usually some preemphasis and shaping of the incoming audio to help eliminate background noise and help accentuate some of the

CIRCUITS WITH EARS

Speech-recognition systems let you speak to your computer. Here's a look at what they're all about.

MARTIN BRADLEY WEINSTEIN



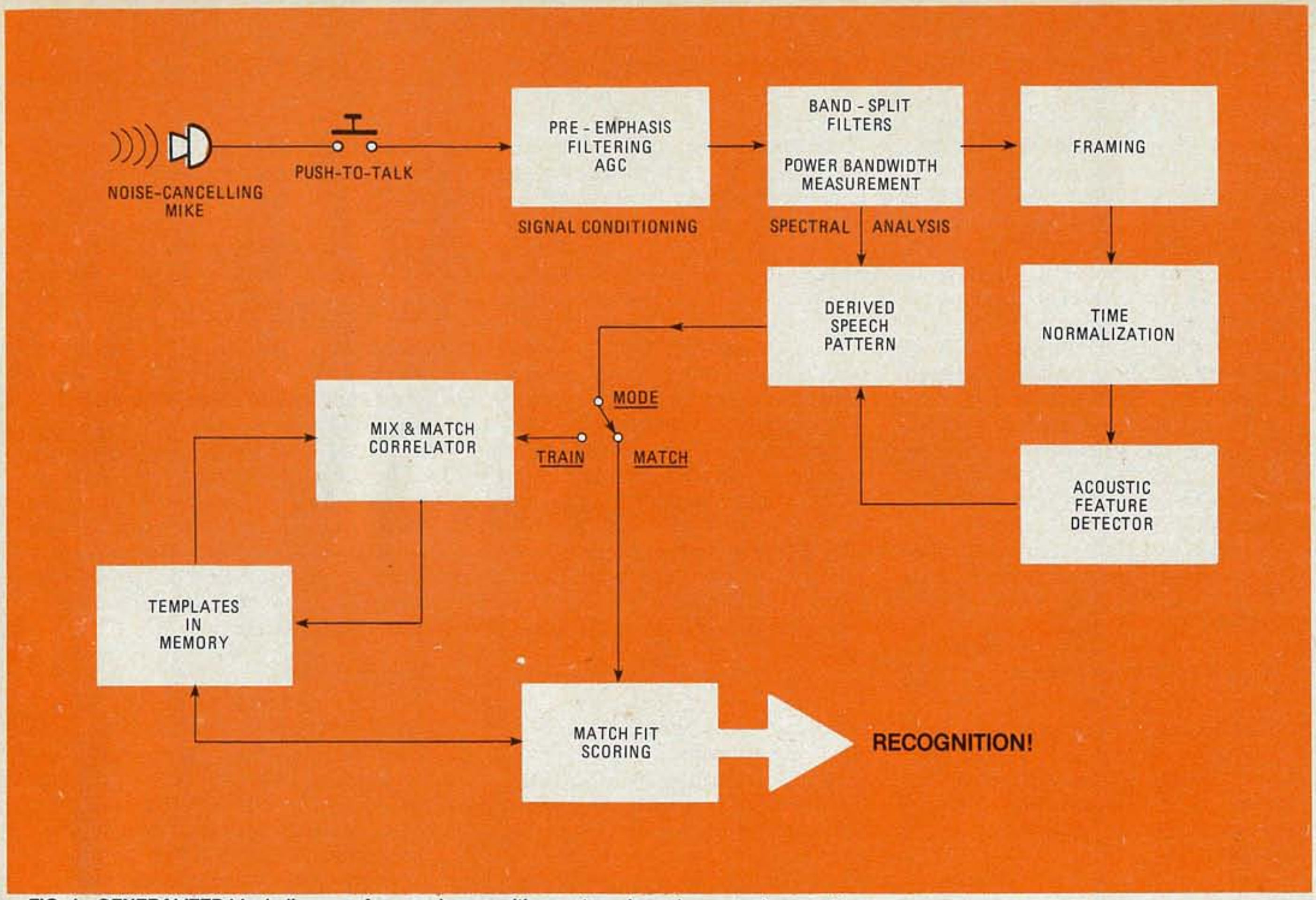


FIG. 1—GENERALIZED block diagram of a speech-recognition system shows how a spoken word is processed so that it can be recognized by a computer.

weaker segments of the speech spectrum. Some form of automatic gain control is usually used, either in the form of an analog compressor or as a part of the computer's task.

Since spectrum analysis is time independent—and since it can be used to indicate whether or not speech is present—the incoming speech is first analyzed for energy content in each voice-frequency spectrum sub-band of interest. While the energy content in each sub-band is significant, the amplitude variations of speech overall are generally of no help in analyzing speech; instead, zero-crossings have been found to convey the most significant speech information. Those are counted to give frequency information, although in some methods the interval between zero crossings is counted instead.

In addition to the energy content in each frequency sub-band, some measurement of the rate of change of speech spectrum-energy (rapid for explosive sounds for example, and gradual for vowels) might also be made.

Once the end of the word has been detected, the word is *framed,* defining its beginning and end, and time-related acoustic phenomena are analyzed. An acoustic-feature detector extracts key features, including pauses, vowels and vowel-like sounds, formants, and so on. Then the word is divided into a number of equal parts (Threshold Technology, for example, uses 16 samples that are spaced equally in time) to obtain a time normalized pattern of those key features.

Those patterns are compared with the templates stored in memory; the algorithms that are used for those comparisons are a key difference between the various speech-recognition systems. In all systems, the input word is compared against the stored vocabulary, and the similarities and differences are weighted into a correlation score. Those scores might be expressed as a product, a vector distance, a probability evaluation, or a figure of merit. The score is a numerical characterization of how good the match is.

HEURISTICS *model 5000* speech-recognition system transforms Lear Siegler's *ADM-3A* into a voice-actuated terminal.

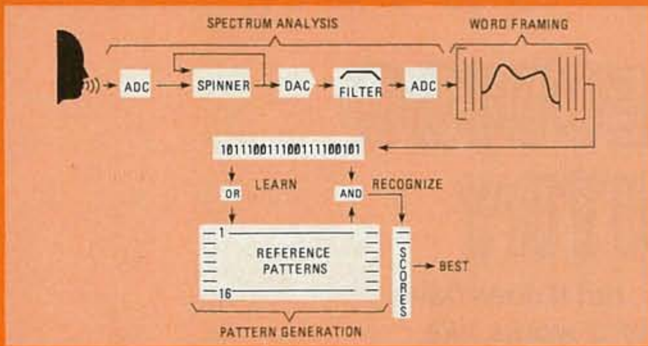
Most systems require that the match—or "fit"—exceed some minimum value in order to be valid. Larger vocabularies, or more critical applications, often require a higher minimum value.

Speaker dependence

Let's consider the problem of recognizing more than one voice. For the speaker-dependent recognition systems available today (speaker-dependent means that the system can only effectively recognize words spoken by the person who trained it), there is an easy answer: trade-off vocabulary for more voices. A system capable of recognizing one speaker and a vocabulary of eighty words could just as well accommodate two speakers, each training it to a list of forty words—or eight speakers and ten words, five speakers and sixteen words, and so on.

Bell Labs has successfully made speech-recognition systems capable of recognizing isolated "utterances"

HOW *MIKE* OPERATES



Mike learns and recognizes patterns derived from spectrum-analysis data. When learning a word, *Mike* stores patterns in memory for future reference. When attempting to recognize a word, *Mike* compares the incoming pattern to each reference pattern and generates a set of "closeness of fit" scores. Above a certain threshold, the highest score is taken to indicate successful recognition.

The spectrum analysis is performed every 25 milliseconds to measure the energy in 19 logarithmically spaced frequency bands over the 300-Hz to 3,000-Hz range. *Mike's* approach to that analysis is unique. The data to be analyzed is spun past a single filter 16 times, each time at a different frequency, so that the frequency of interest matches the center frequency of the filter. That is in contrast to the conventional approach, which involves using 16 individually tuned filters operating in parallel.

The spectrum-analysis data is digitized and passed to the word-framing process. When a sufficient level of spectral activity is detected, the beginning of a word is marked. When that activity falls below a threshold, the end of the word is marked. Since *Mike* is an isolated-word recognition device, a silent interval of approximately 100 milliseconds is required at the end of a word to frame it adequately.

Noise-canceling and time-base normalization are integral parts of the word-framing process. During silent intervals, constant (ambient) noise is measured; during word framing, that constant noise signal is subtracted from the input signal. When a word or segment of sound has been isolated, it is normalized to a fixed time-duration to compensate for different speaking rates.

The pattern-generation process further operates on the framed word to extract features of interest and to reduce it to a string of approximately 240 bits. The pattern is then generated using a proprietary mapping algorithm.

In training *Mike*, patterns are logically OR'ed with the patterns of previous repetitions of the word being learned. Typically, two or three repetitions of each vocabulary word suffice for reliable recognition. When *Mike* is attempting to recognize, patterns are compared by AND'ing them in turn with each of the previously learned reference patterns. The matching ones are tallied to form a set of scores for each comparison.

Mike recognizes a word if its score is both above a threshold and greater than the next highest score by a prescribed increment. A code indicating the identity of the recognized pattern is transmitted to a host device. If a word is framed but does not meet the recognition criteria, a no-recognition code is transmitted.

Centigram's recognition approach is patented in the United States (Patent number 4,087,630), and patents have been applied for in 15 other countries.

spoken by designated speakers. Those systems use eighth-order LPC (*L*inear *P*redictive *C*oefficient) analysis. You may recognize LPC analysis as the technique used by Texas Instruments to translate speech into much-compressed data, and back again, in their *Speak & Spell* and elsewhere.

The object of the Bell Labs investigation is an automatic directory assistance system, but they found that the limited vocabulary and speaker dependence of contemporary speech recognizers made the recognition of spoken names impractical, if not impossible.

Limiting the vocabulary to the "names" of the letters used in spelling names makes the task more manageable, but there are still drawbacks. One is that the names of the letters are short compared to most words and so they don't give a recognizer much to go on. There are also many letters whose names sound a great deal like each other.

Bell Labs found an answer. They decided that even if they don't know for certain what a given letter is, it's enough to know that it's one of say five probable candidates. A string of six letters gives enough information that an exact match to a recorded directory listing can be made most of the time, at least under experimental conditions.

VOICE-ENTRY TERMINAL, the *VET-2* from Scott Instruments, is compatible with a *TRS-80 Model 1*.

But what about speaker *in*dependence?

Slurring

In the same way that a system maximizes the similarities and minimizes the differences between successive samples of a spoken word during training, samples of the same word spoken by different individuals produce an even broader template. In that way, differences between one speaker's articulation of a word and that of another are slurred together. By extension, a system could become speaker-independent if any such thing as a "universal" template (an absolute set of similarities in the ways all people say a word) could be found.

Unfortunately, slurring also blurs the recognition capabilities of a system by making dissimilar words sound more like each other. It may become impossible to discriminate between similar-sounding words.

Just as today's speaker-dependent systems are evaluated in terms of their accuracy—a 98% matching rate, for example—future speaker-independent systems may be rated both for overall accuracy and for the percentage of the population that the accuracy figure applies to.

Speaker independence is the first priority in improving coming generations of speech-recognition systems according to most manufacturers we talked to. One promising approach involves producing speaker-adaptive systems that in some way modify stored templates to help adjust them into a closer match with the particular voice characteristics of the speaker. For example, a brief initial sample of the voice might determine if it is that of a man, woman, or child and whether it is basso,

continued on page 86

RCA VIDEODISC CIRCUITRY

It may be a videodisc, but it does have an audio track; and it works like nothing you've ever seen before

CHESTER H. LAWRENCE

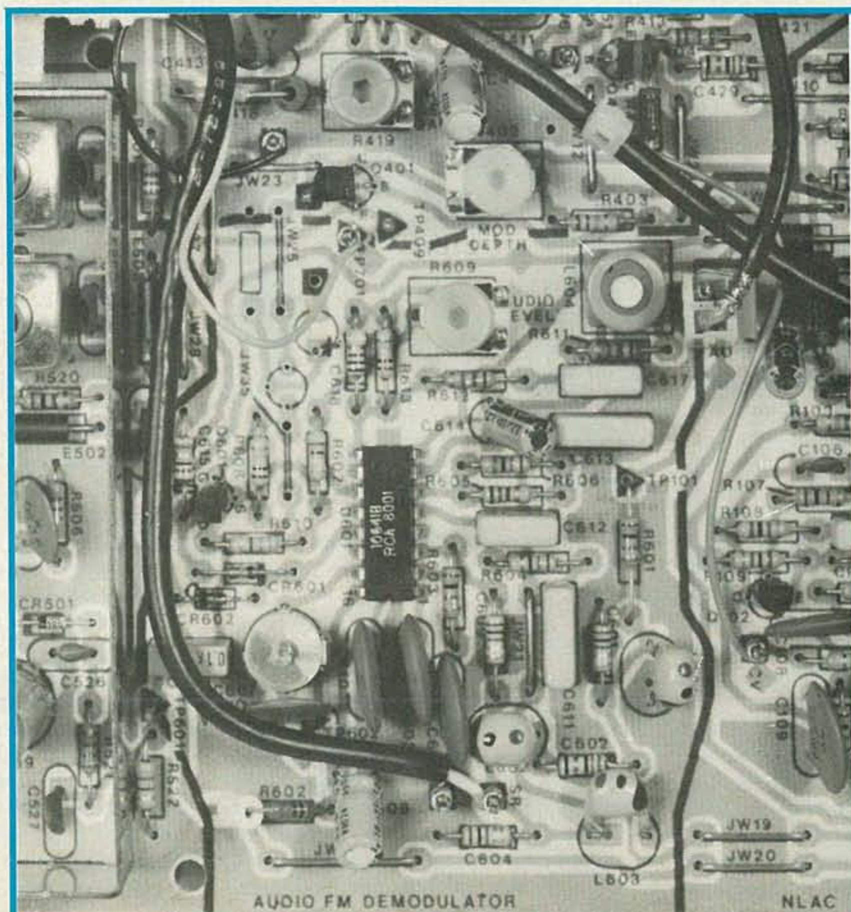
THERE'S NO QUESTION THAT THE MOST startling thing that a videodisc does is to deliver color pictures from information on a disc. But a superb quality sound channel is equally important. RCA's *STF100 VideoDisc* player is designed to deliver full-spectrum monaural audio as well as a first-rate picture. This article will cover how the sound channel is extracted from the disc.

The *STF100* delivers monaural audio over the full range of 20 Hz to 20,000 Hz. Future units will offer stereo sound. But at the moment, all the initial videodiscs offered by RCA have mono sound tracks. As demand for stereo sound increases, we're likely to see a *Model STF200* with stereo sound and a reissue of discs with stereo sound tracks—either real stereo or artificial stereo, depending upon the original sound track.

On the RCA type videodisc the sound information is placed on a 716-kHz FM carrier. This signal along with the video FM carrier and a 260-kHz signal for the servo system are part of the arm output signal developed by the resonator cavity and preamplifiers in the pickup arm.

The simplified block diagram in Fig. 1 shows what happens to this signal. You'll note that it is first passed through a bandpass filter that has its response centered about 716 kHz. This filter rejects the 260-kHz servo signal and the 5-MHz video carrier. The only signal that gets through the bandpass filter is the 716-kHz FM audio carrier. It is then fed to a PLL (*P*hase-*L*ocked *L*oop) demodulator.

In the demodulator, a 716-kHz VCO (*V*oltage *C*ontrolled *O*scillator) is phase-locked to the FM carrier input signal.



The resulting audio signal is amplified and then used to drive a sample-and-hold circuit. The output from the sample-and-hold circuit is then fed to the RF modulator stage where the audio information frequency modulates a 4.5-MHz carrier that is later combined with the processed composite video information. This combined audio and video signal is fed to a modulator tuned for channel 3 or channel 4 and delivers an appropriate RF carrier that can then be connected to the antenna terminals of any conventional color TV receiver.

As part of the audio processing circuitry there is a defect detection and correction system. It prevents momentary loss of the audio FM signal carrier that might otherwise be caused by specks of dust interfering momentarily with the retrieval of the videodisc signal. Any loss of the carrier signal is detected by the defect detector circuit, which then generates an output that is fed to the sample-and-hold circuit to prevent impulse noise from appearing in the audio channel during the defect. As a result the audio reproduction remains noise-free even if much of the carrier signal is lost.

Audio demodulation

A block diagram showing the audio-demodulation circuitry is in Fig. 2. As mentioned earlier, the arm output signals are fed through a bandbass filter that passes only the 716-kHz audio carrier signal. This signal is fed from the bandbass filter to the input (pin 3) of audio demodulator U601. Inside this IC the first stage is a limiter. It removes any amplitude variations in the carrier signal.

Next, the amplitude-limited signal is fed to one of the inputs of the PLL detector. The other input to the PLL is a 716-kHz reference signal generated by a VCO. The center frequency of this VCO signal is set by the value of C607, a variable capacitor.

The phase detector generates an error signal that is filtered by the PLL filter network (connected to pins 5 and 6 of U601). This causes the VCO to track the frequency deviation of the FM carrier, which, of course, is the audio modulation. The demodulated audio appears at pin 7 of U601 and is further filtered by a lowpass network.

The filtered audio signal now re-enters U601 at pin 9 and is amplified and inverted. The audio output now appears at pin 11. Potentiometer R609 the AUDIO MODULATOR LEVEL CONTROL sets the amplitude of the audio signal that is now fed to Q601, the sample-and-hold circuit.

The carrier-limiter output is also fed to a defect-detector circuit inside U601. This circuit compares the carrier signal to the 716-kHz VCO signal and generates a negative output pulse at pin 13 whenever a defect in the carrier signal is spotted. If this was not done, a defect in the arm output signal would cause a noise impulse in the audio output signal at pin 11. This noise would appear as popping or cracking in the sound.

The output from the defect detector forces the sample-and-hold circuit to maintain the previous value of the audio signal until defect-free audio information is received. When we take a look at Fig. 3, we can see that the audio signal from pin 11 of U601 is fed to the source (S) terminal of Q601, an FET sample-and-hold circuit.

Q601's gate terminal is held at the same voltage as its source terminal. This causes the FET (Q601) to turn on, conducting the audio signal to the drain (D) terminal of Q601. Capacitor C616 filters the signal which is then capacitively coupled via C619 to the RF modulator.

If a defect occurs in the audio carrier, pin 13 of U601 goes to logic LO. This pulls the gate of Q601 LO by forward biasing CR601. Q601 then turns off causing C616 to hold the same charge it had prior to Q601 turning off. Noise spikes that occur in the audio output at U601 pin 11 are not conducted to the modulator.

When the audio carrier is restored, the defect output at pin 13 returns to HI. Now CR601 is reverse-biased allowing C615 to charge rapidly to the Q601 source voltage through R608. This turns Q601 on, thereby conducting the audio signal through Q601 to the coupling capacitor and on to the modulator.

When the videodisc player is in the SCAN mode (either SCAN FORWARD or SCAN REVERSE) it is desirable to mute the audio. The stylus in these modes is moving across the disc at 16 times faster than normal and the sound would not be decipherable. So during either SCAN mode the microcomputer mutes the audio demodulator by pulling the NOT-AUDIO MUTE output of the microcompu-

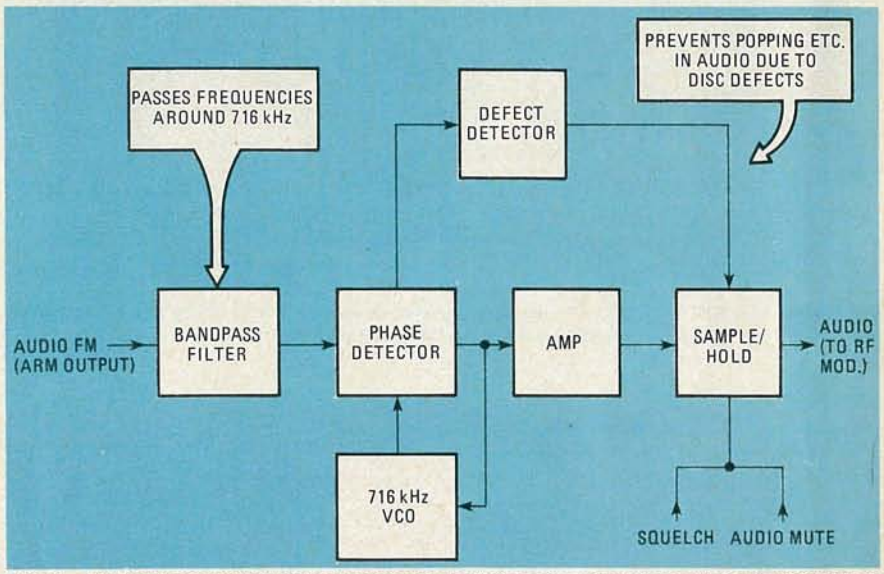


FIG. 1—AUDIO PROCESSING CIRCUITRY for the RCA videodisc player is shown in simplified block diagram form here. The defect detector is an audio circuit you've never seen before.

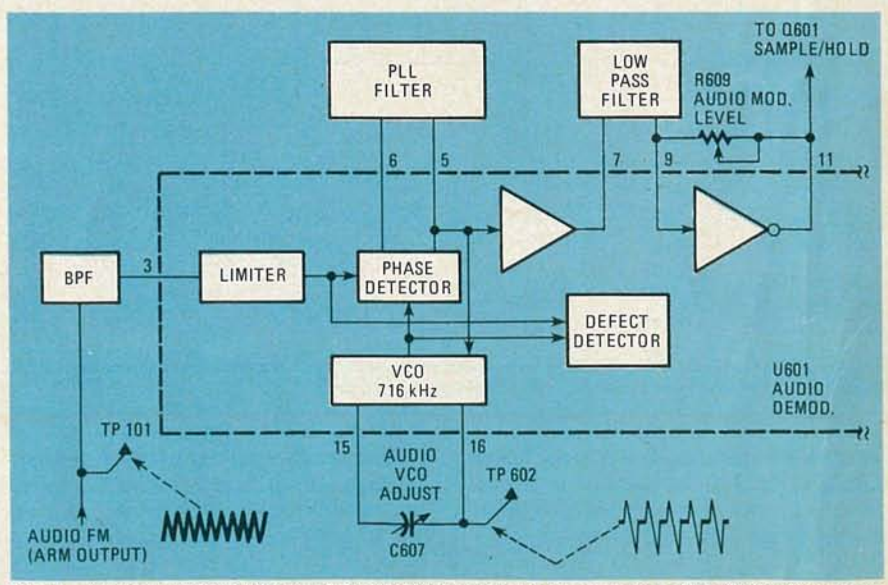
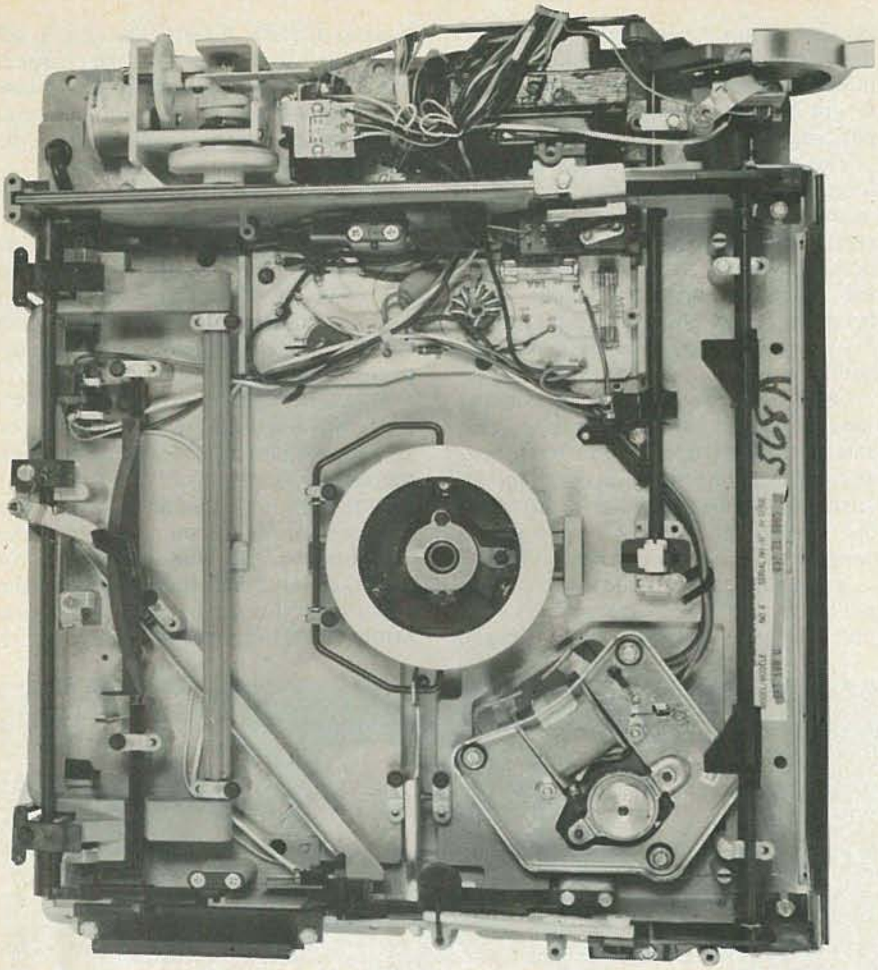


FIG. 2—AUDIO DEMODULATOR OPERATION is shown in this block diagram. Note that audio appears on a 716-kHz FM carrier. The bandpass filter rejects all other signals.



STF100 PLAYER WITH TURNTABLE removed. It tends to look a lot like the inside of a record player because it is just that. Only difference is that the records this plays are video discs.

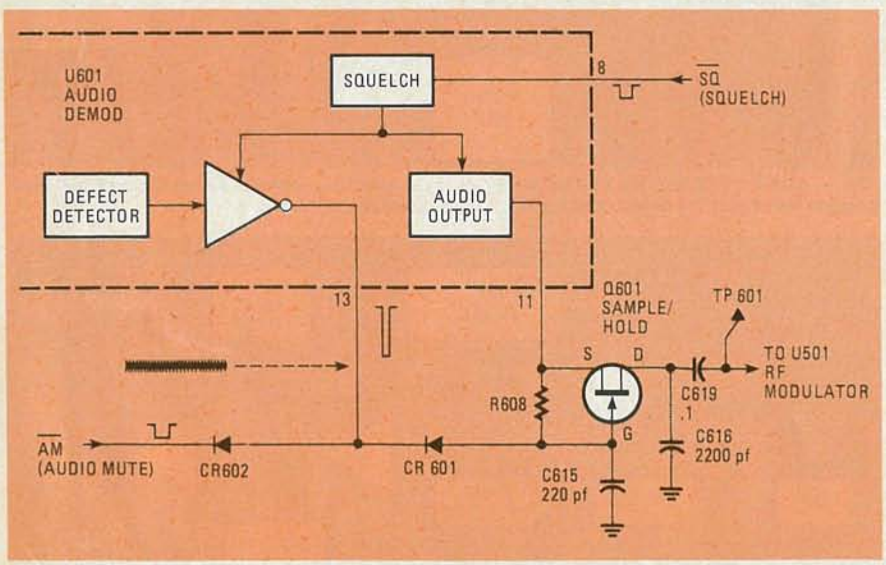


FIG. 3—AUDIO DEFECT CORRECTION and squelch circuits. They prevent pops and crackles caused by defects in the disc from appearing in the audio during playback.

ter LO. This signal is shown to the left of CR602 in Fig. 3. It forward biases CR602, which, in turn, forward biases CR601 pulling the gate of sample-and-hold FET Q601 to 0 volts or logic LO. This cuts off the flow of audio through Q601.

The audio demodulator is also muted, whenever the player is in the PAUSE, LOAD, RAPID ACCESS FORWARD or RAPID ACCESS REVERSE modes. However, muting is obtained a bit differently. This time the NOT SQUELCH input, pin 8 of U601, is pulled LO. This prevents noise being introduced into the audio circuits whenever the stylus is removed from the disc.

System control

Overall operation of the RCA videodisc player is supervised by a microprocessor. It is powered by a 5 VDC supply and runs at a 1.53-MHz clock frequency. It sequences all operations of the videodisc player and controls various discrete circuits within the player though its several output ports. The audio muting discussed just a few paragraphs ago is one example.

Some of the functions that the microprocessor controls include:

1. Not Audio Mute
2. Not Stylus Kick
3. Forward
4. Motor Stop
5. Stylus Up
6. Not Defect Exit

In addition, the microprocessor controls the sequence of events when the player is first turned on. For example, when the power is first turned on, timing components allow enough time for all of the power supplies to stabilize. The microcomputer also resets to insure that all output lines are in a predetermined status following the initial application of power.

In this initial state the microcomputer stays in its LOAD state until it has detected that the user has inserted a disc into the player.

Then the microcomputer switches to the RAPID ACCESS mode for two seconds. This insures that the pickup arm is at the beginning of the disc program. After an additional 4-second delay that gives the turntable a total of six seconds to come to full speed, the microcomputer orders the stylus lowered onto the disc. The pickup arm assembly now begins sensing the recorded information which is processed by the signal processing circuits. Until a "good" signal is detected, all the customer controls except for the PAUSE button are held disabled.

Once normal operation is established the customer controls can be used. These include PAUSE, which will raise the stylus from the disc and place the player in the pause mode; VISUAL SEARCH in either the FORWARD or REVERSE modes, which allows the program material to be viewed at 16 times normal speed; and RAPID ACCESS FORWARD and REVERSE, which scans the video disc at a high rate of speed to rapidly access a particular segment. During RAPID ACCESS the video display is blanked and the audio is muted.

That completes our coverage of the RCA videodisc player. There's a lot more to know about the machine. And if you're interested we suggest that you purchase a complete manual for the player from RCA. Write to Frank McCann, RCA, 600 North Sherman Drive, Indianapolis, Indiana 46201. **R-E**

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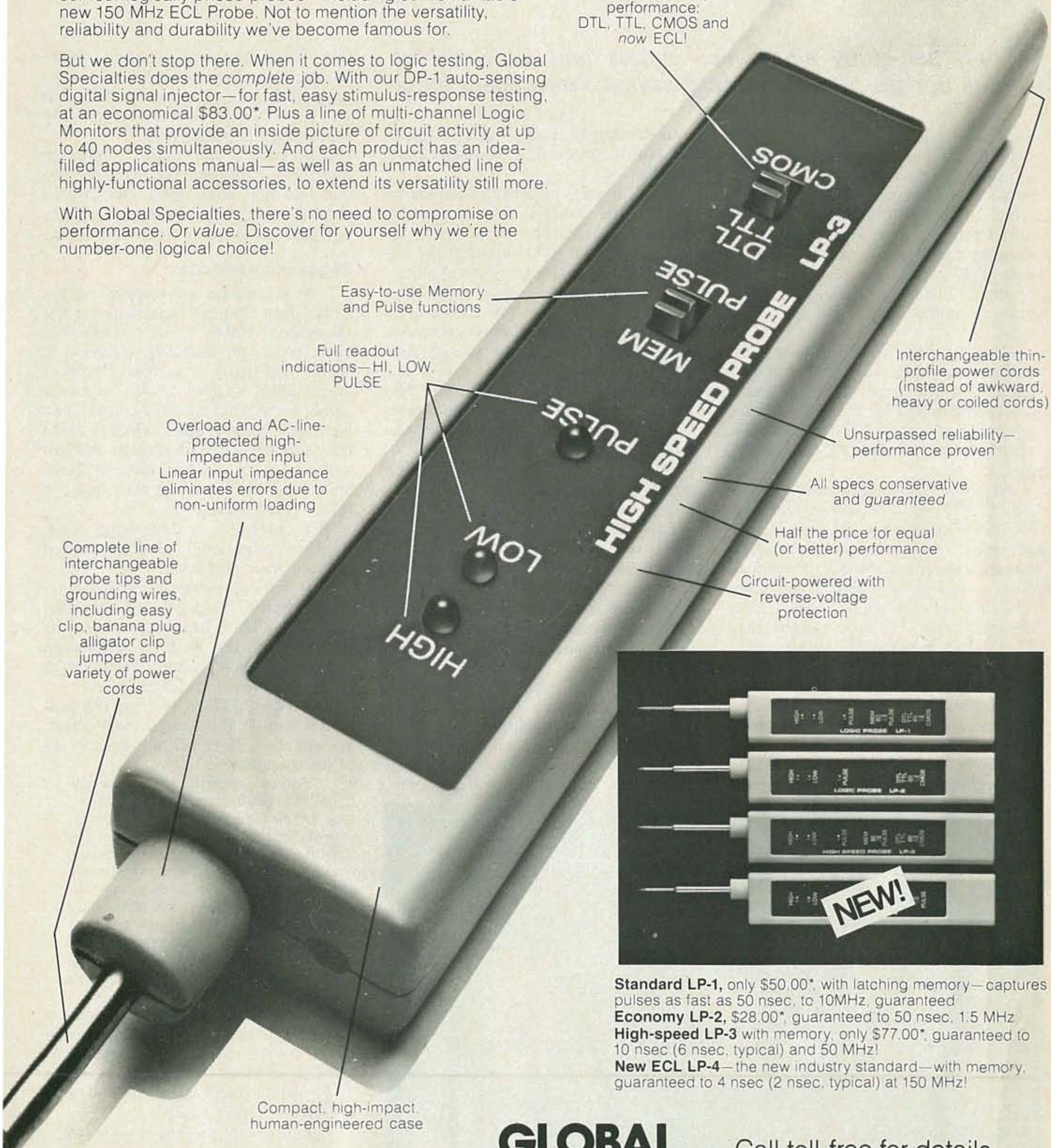

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hobby corner

A new self-study electronics course and a do-nothing circuit update.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

FROM TIME TO TIME WE HAVE DISCUSSED ways to acquire a basic and/or advanced education in electronics. Every hobbyist needs a good general background on which to build. Without it, he may construct projects from magazines or kits without really understanding why or how they work. He remains a "kit builder"—unable to design circuits or even to modify his "cookbook" projects.

Recently, I had an opportunity to examine a new self-study course in electronics. If you need such a course, I can recommend *Electronics for Hobbyists,* catalog number EE-3140 from The Heath Company, Benton Harbor, MI 49022.

Electronics for Hobbyists consists of almost 900 pages of text in two large loose-leaf notebooks and a kit of components. The components include resistors, capacitors, diodes, transistors, LED's, integrated circuits, and coils. Also included are wire, solder, and an alignment tool. They are used to carry out the experiments in the program.

The course content is quite broad. It is divided into seven units: direct current, alternating current, active devices, electronic circuits, digital electronics, digital computers, and a survey of electronics hobbies. Each unit is divided into sections. Those sections are usually introduction, objectives, activity guide, text-study material, experiments, and self-test.

There is only one word of caution regarding the course. The introduction states "...to perform the experiments in this program, you will need the *ET-3100* Electronic Design Experimenter... a volt-ohm meter, and an oscilloscope..." The *ET-3100* contains a solderless breadboard, pulse generator, and power supply. If you have (or have access to) those items, fine. If not, I suggest that you get an *ET-3100*. Not only will it be most helpful in the course, but it will be very useful long after you have finished the program.

The other two "requirements" are a different matter. Certainly, you already have a volt-ohm meter. You just can't get along in electronics without one. It doesn't have to be expensive or fancy—even a simple analog meter will do fine. On the other hand, an oscilloscope is helpful but not essential to the course. Perhaps, though, you can borrow one for a short time when you need it for the experiments.

As you can see, *Electronics for Hobbyists* is a very thorough course. The author and publisher have done about all they can to make it valuable. The rest is up to you. If you simply read through the course, you will get something (but not much) from it. Study without the experiments will give you a great deal more. The maximum benefit will go to those who conscientiously follow the full program.

If you are a "kit builder" only, get into this (or another good) course. You will find that your effort will produce great dividends in increased competence and pleasure as you pursue your hobby.

Seeds of imagination

I do appreciate your entries in the "Idiot Box Contest" mentioned in the December "Hobby Corner" (December 1980 issue of **Radio-Electronics**). It seems that many of you have built or are building, an idiot box (by whatever name) for your children or others. You have sent in some great circuits and I have already started building a modern version of my old box for my grandchild. (By the time you read this, I'll have *two* of them!)

The contest is still running. First, send me your circuit; then get started on your own idiot box.

You will appreciate this observation from Michael Lacefield of Metairie, LA: "The Idiot Box will contain the soil in which the seeds of imagination can grow." Now, what greater reason could you want for building one?

Phil Albro of Gary, NC sent this neat circuit (Fig. 1). It is low-cost and simple, yet effective. Here is Phil's description of its operation:

> "You will recognize IC2 as a typical 555 astable multivibrator driving a small speaker. IC1 alternately switches capacitor C1—in parallel with C2—into and out of the circuit, causing the tone from the speaker to warble. IC3, set up as a timed interrupter by holding pin four of IC2 high for about 12 seconds and then low for about the same length of time, causes the warbling tone to be on for 12 seconds and off for 12 seconds alternately."

Phil points out that you can jazz up this little device by replacing any or all of the starred resistors with potentiometers. That gives the double advantage of providing sound variations and more controls to "play with."

Thanks for sharing the circuit, Phil. I can see why your four children enjoy it.

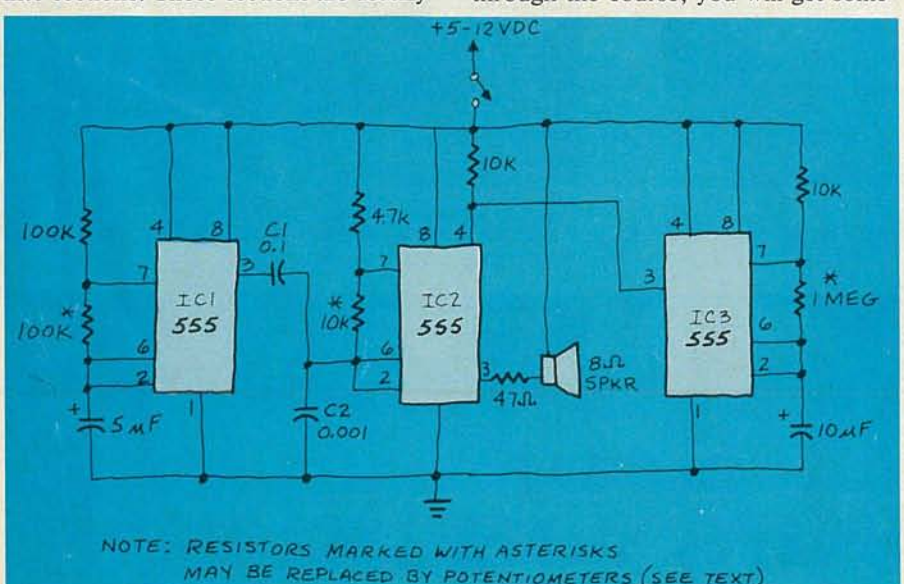

FIG. 1

Model airplanes, anyone?

Gary Wedge of Riverside, CA sent a nice letter asking for your help. He flies

model airplanes and needs a circuit to supply power to the engine glow plug on start-up.

Apparently, the common practice is to use a resistor to drop the commonly available 12-volts DC to 1.5-volts DC for the plug. I agree that the resistor approach is wasteful. Surely, there is a better way—perhaps a heavy-duty switching circuit to give the heating equivalent of 1.5-volts DC.

I don't know what current is required by the plug. Gary indicates that it is 4 amperes maximum. That may be, but I can't believe that tiny plug takes anywhere near 4 amps. Those of you who use them can fill us in on that. There is one additional circuit requirement: it must be short-circuit protected for those times when the clip slips off the plug.

Let's hear from you model flyers. We need some help for Gary and some know-how for the rest of us.

New board holder

PanaVise, the makers of that terrific line of vises and circuit-board holders, has done it again. Their new *model 333* is called a "rapid-assembly circuit-board holder." The business end of the *model 333* has the familiar spring-loaded adjustable holder arms that work so well. The new thing here is the way it is mounted (see Fig. 2).

FIG. 2

The holder itself is supported on a heavy cast-iron base. The mount features both rotating and vertical adjustments with a wide variety of locking positions. Because both adjustments are spring loaded, you can change the board position very quickly with one hand and keep right on soldering.

If you are still looking for a PCB holder or are looking for a better one, check the *model 333*. See your local distributor/dealer or contact PanaVise, 2850 29th Street, Long Beach, CA 90806. **R-E**

$60 MODEM

continued on page 42

stall these jumpers: D to I and B to J. This option makes E6 the RX DATA output and E7 the TX DATA input.

The microphone should be connected using shielded cable. Solder the shield to the microphone case. Do not install the microphone or speaker in the enclosure until testing is finished. When you solder the center conductor to the positive terminal of the microphone, use extreme care. The microphones are easily damaged. Do not dent the front shield or twist the positive-terminal solder pad. On the board end, the center conductor is connected to E2; the shield to ground. Finish by jumpering E1 to ground and install the crystal.

Connect the speaker—one end to ground and the other to E3. Referring to Fig. 10, install a DPDT switch, S1, so that it switches as shown. That connection will be changed after testing to match the schematic. If you use a slide switch, be certain that it does not momentarily short both positions during switching. Attach leads to the power supply pads to allow testing. None of the IC's should have been installed yet.

Next month we'll show you how to test and troubleshoot the modem. We'll also show you an enclosure for the unit that includes an acoustic coupler that is made from some very common materials. **R-E**

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	IBM Compatible (128 B/S, 26 sectors)	3060	2.19	SFD-111110	473071	53426	CM-F11	800506	2305830	40013	FD1-128	FD-1	740-0	S/A 100	15002	FD34-1000	F111111X	7870-K	421602
Flexible Disc 1s	IBM Compatible (128 B/S, 26 sectors) w/ W.P.N.	3062	2.24	–	–	–	–	–	–	–	–	–	740-0	–	–	–	–	–	–
	IBM Compatible (128 B/S, 26 sectors) w/ W.P.N. & Hub ring	3064	2.55	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Single Headed Drives	IBM Compatible (128 B/S, 26 sectors) REVERSIBLE	1729	3.35	SFD-113110	473072	54431	–	–	–	40015	–	FD-2	740/2-0	–	15150	FF34-2000	F171111X	7860-K	–
Single Density Media	IBM System 6 Compatible	3066	2.19	–	473077	54561	–	800509	1669959	40014	–	–	740-0 058	–	15003	FD60-1000	F116111X	–	–
	IBM Compatible (256 B/S, 15 sectors)	3109	2.19	SFD-111210	473073	–	–	800584	2305845	40040	–	–	740-3600	–	15006	FD36-1000	F112111X	7861-K	–
	IBM Compatible (512 B/S, 8 sectors)	3110	2.19	–	473074	–	–	800585	1669954	40044	–	–	–	–	15004	FD60-1000	F113111X	7869-K	–
	Shugart Compatible, 32 hard sector	3015	2.19	SFD-211010	470901	53802	CM-F21	101/1	–	40016	FH1-32	FD-132	740-32	S/A-101	15025	FD32-1000	–	7890-K	421322
	Shugart Compatible, 32 hard sector REVERSIBLE	3025	3.35	SFD-213010	–	–	–	–	–	40017	–	–	740/2-32	–	15151	FF32-2000	–	7880-K	–
	Wang Compatible, 32 hard sector w/Hub ring	3087	2.50	–	–	54491	–	–	–	–	–	–	740-32RM	–	–	–	F37A411X	–	–
	CPT 8000 Compatible	3045	2.79	–	–	–	–	–	–	–	–	–	–	–	15226	–	–	–	–
Flexible Disc 1d	IBM Compatible (128 B/S, 26 sectors)	3090	2.95	SFD-121010	474071	54568	–	3740/1D	–	40047	FD1-128/M2100	FD-1D	741-0	–	–	FD34-8000	F131111X	7857-K	423002
	Soft Sector (128 B/S, 26 sectors) REVERSIBLE	3093	3.99	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Single Headed Drives	Shugart Compatible, 32 hard sector	3091	2.95	SFD-221010	470801	54596	–	101/1D	–	40024	FH1-32D	–	741-32	S/A-103	15075	FD32-8000	F33A410X	7887-K	423322
Double Density Media	Shugart Compatible, 32 hard sector REVERSIBLE	3094	3.99	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Wang Compatible, 32 hard sector w/Hub ring	3088	3.20	–	–	–	–	–	–	–	–	–	–	–	–	–	F22A411X	–	–
Flexible Disc 2s	Soft Sector (Unformatted)	3101	3.84	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Soft Sector (128 B/S, 26 sectors)	3113	3.84	–	–	54429	–	800814	1766870	–	–	–	–	S/A-150	15153	FD10-4026	F121111X	–	–
Double Headed Drives	Soft Sector (256 B/S, 15 sectors)	3106	3.84	–	473477	54226	–	800815	2736700	40043	FD2-256D	–	742-0	–	15154	FD10-4015	F122111X	7856-K	424612
Single Density Media	32 Hard Sector	3108	3.84	–	–	–	–	–	–	–	FH2-32	–	–	–	–	–	–	–	–
Flexible Disc 2d	Soft Sector (Unformatted)	3102	3.49	–	473485	–	–	DY150	–	40028	FD2-XDM	FD-2D	743-0	–	15103	DD34-4001	–	–	425002
	Soft Sector (128 B/S, 26 sectors)	3115	3.49	–	–	–	–	–	–	–	–	–	–	S/A-150	–	–	–	–	–
Double Headed Drives	Soft Sector (256 B/S, 26 sectors)	3103	3.49	–	473471	54325	–	800817	1766872	40019	FD2-256D	–	743-0/256	–	15101	DD34-4026	F144111X	7858-K	425602
Double Density Media	Soft Sector (512 B/S, 15 sectors)	3114	3.49	–	473472	54479	–	800818	1669044	40039	–	–	743-0/512	–	15100	DD34-4015	F145111X	–	425612
	Soft Sector (1024 B/S, 8 sectors)	3104	3.49	–	473473	54485	–	800819	1669045	40020	–	–	743-0/1024	–	15102	DD34-4008	F147111X	7859-K	425622
	32 Hard Sector	3105	3.49	SFD-321010	470851	–	–	101/2D	–	40021	FH2-32D	–	743-32	S/A-151	15125	DD32-4000	F34A411X	7881-K	425322
	Burroughs B-80 Compatible 32 Hard Sector	3092	3.49	–	–	–	–	–	–	–	–	–	–	–	–	–	F34A611X	–	–
	Soft Sector (1024 B/S, 8 sectors) w/ Hub Ring	3116	3.75	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flexible Disc FD Memorex 651 or Equiv. Drive Compatible	FD VI (Vinyl Jacket)	30712003	2.95	–	470651	–	CM-F31	FDIV	–	40002	–	FD-165	511-0	–	15026	FD65-1000	F61A111X	7910	–
Mini Flexible Disc 1s	Soft Sector (Unformatted)	3401	1.99	–	475001	54256	–	104/1	–	40500	MD1	MD 1	744-0	S/A-104	15300	MD525-01	M11A211X	7897	441002
5¼" Single Headed Drives	10 Hard Sector	3403	1.99	–	475010	54257	–	107/1	–	40501	–	MD 110	744-10	S/A-107	15325	MD525-10	M41A211X	7898	441102
Single Density Media	16 Hard Sector	3405	1.99	–	475016	54258	–	105/1	–	40502	MH1	MD 116	744-16	S/A-105	15326	MD525-16	M51A211X	7899	441162
	Soft Sector (Unformatted) W/Hub Ring	3431	2.19	–	–	–	–	–	–	–	–	–	–	–	–	MD525-01	–	–	–
	10 Hard Sector, w/Hub Ring	3433	2.19	–	–	–	–	–	–	–	–	–	–	–	–	MD525-10	–	–	–
	16 Hard Sector, w/Hub Ring	3435	2.19	–	–	–	–	–	–	–	–	–	–	–	–	MD525-16	–	–	–
Mini Flexible Disc 1d	Soft Sector	3417	2.24	–	–	54646	–	104/1D	–	–	–	–	–	–	–	MD540-01	–	–	–
5¼" Single Headed Drives	10 Hard Sector	3418	2.24	–	–	54649	–	107/1D	–	–	–	–	–	–	–	MD540-10	–	–	–
Double Density Media	16 Hard Sector	3419	2.24	–	–	54652	–	105/1D	–	–	–	–	–	–	–	MD540-16	–	–	–
Mini Flexible Disc 2d	Soft Sector	3421	2.74	–	–	54624	–	104/2D	–	–	MD2-D	–	745-0	S/A-154	–	MD550-01	–	–	–
5¼" Double Headed Drives	10 Hard Sector	3423	2.74	–	–	54627	–	107/2D	–	–	–	–	745-10	S/A-157	–	MD550-10	–	–	–
Double Density Media	16 Hard Sector	3425	2.74	–	–	54630	–	105/2D	–	–	MH2-D	–	745-16	S/A-155	–	MD550-16	–	–	–

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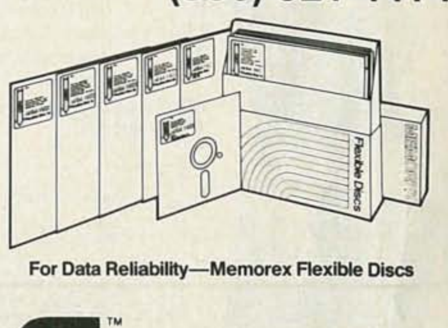

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new products

OSCILLOSCOPE ACCESSORY, the *Expand-A-Scope,* allows the user to match and identify "unknown" component values quickly with "known" reference standards by a visual "curve-trace" comparison on the CRT.

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The *Expand-A-Scope* connects to the horizontal and vertical inputs of an oscilloscope, and provides nine reference standards, against which the traces of unidentified resistors, capacitors, diodes, Zener diodes, emitter-base junctions, and short and open circuit conditions can be tested. Externally-connected components, circuit boards, and finished electronic assemblies can also be comparison-tested. An audible tone is provided for tracing circuits. A safe current-limited (5 mA maximum) test voltage is applied when testing, comparing, and "curve-tracing" components and circuits.

The *Expand-A-Scope* is priced at $250.00—**Daltec Systems, Inc.,** PO Box 157, Onondaga Branch, Syracuse, NY 13215.

AUDIO MULTIMETER, the *Bulgin Soundex,* is a multi-purpose instrument suitable for line-testing and listening, peak-program metering, amplifying microphone signals, calibrating peak-program monitors, bench testing, and various other audio functions.

It combines a switched gain amplifer with 400-volt instrumentation input and a full-specification peak program meter, capable of audio program-level measurements down to − 72 dB with 0.1 dB accuracy at center scale, as far as −50 dB. Amplifer input is fully protected to 400 volts, isolated and balanced to prevent grounding when

CIRCLE 152 ON FREE INFORMATION CARD

connected to a multiple-jack device. The 50-ohm impedance has sufficient power to drive headphones. Gain-settings are achieved by eight pushbuttons on the front panel.

Power is supplied by internal rechargeable batteries, with a built-in AC converter/charger for bench use. The instrument measures 7 × 8½ × 2½ inches and is enclosed in a tough plastic case, with an optional carrying case available for field use. The *Bulgin Soundex* Audio Multimeter is priced at $490.00.—**H. R. Kirkland Company,** 8 King Street, Morristown, NJ 07960.

ENERGY-MANAGEMENT SYSTEMS REGULATORS, *models 5700* and *1600* are master-control systems that save energy in the home or in business. The unit plugs into a wall outlet and transmits command signals to remote-control modules. A pressure-sensitive touch pad, plus a set of switches, allows the user to control any light or appliance in the house from the comfort of one's desk, bed, favorite chair, or whatever.

The regulator can turn off the water heater during the night or when the house is unoccupied, prepare hot coffee, dim lamps to 55%, 30%, or 5% brightness, and turn off TV's or lights accidently left on. As a security measure, it can stand guard by turning lights on or off, even playing the stereo and TV. Weekend commands can be scheduled different from weekdays, to further confuse potential intruders. If an intrusion is attempted when the owner is at home, the user need only flip a switch to turn all the lights on, sound sirens, or turn on the TV.

The *model 5700* controls up to 100 lights and appliances per house code. It has a 57 time-command capability, and is fully programmable for daily, weekday, or weekend cycles. Features include: all-module control, digital clock, auto/standby switch, audible tone messages, normal/alert switch that controls lamp and appliances modules, and normal/program switch.

CIRCLE 153 ON FREE INFORMATION CARD

The *model 1600* controls up to 100 lights and appliances per house code. Its features include: auto/standby switch, digital clock, program review, and alert switch to turn on all lamps instantly. It has manual or automatic operation, and 16 time commands.

The *model 5700* is priced at $299.95; the *model 1600* costs $149.95.—**Regency Electronics,** 7707 Records Street, Indianapolis, IN 46226.

DISTRIBUTION AMPLIFIERS, *models 10G501, 10G502* are high-quality, high-output devices for small- to medium-size master-antenna TV installations. Applications include motel, apartment, hospital, school, store display, and deluxe home installations. The units distribute strong, high-quality, low-noise TV signals to up to 50 multiple receivers, depending upon local conditions.

CIRCLE 154 ON FREE INFORMATION CARD

The *model 10G501* covers frequency ranges of 54-88 MHz/174-216 MHz VHF, and 470-890 MHz UHF with a minimum gain of 15 dB VHF and 16 dB UHF. The output per channel is 46 dBmV UHF.

The *model 10G502* covers frequency ranges of 54-88 MHz/120-280 MHz VHF and 470-810 MHz UHF with a minimum gain of 25 dB VHF and UHF. Output per channel is 49 dBmV VHF and 46 dBmV UHF. This model includes the CATV mid-band and superband channels.

Both units are compact—6 × 5½ × 2 inches—and can be used with an existing RCA preamplifier to provide greater gain for fringe areas; both are supplied with 75 ohm (F-connector) single input and single output.

The *model 10G501* is priced at $65.00; the *model 10G502* costs $98.00. **RCA,** Distributor and Special Products Division, 2000 Clements Bridge Road, Deptford, NJ 08096. **R-E**

communications corner

Here's a closer look at how those popular cordless telephones work. **HERB FRIEDMAN,** COMMUNICATIONS EDITOR

IN KEEPING WITH THE GREAT CLICHES OF our time, such as "You can't tell the players without a score card," there is also "You can't fix it if you don't know how it works." So this month we'll take an even closer look at cordless telephones because they pack a lot of sophisticated hardware in what appears to be a rather mundane consumer device In fact, the cordless telephone contains much that is borrowed from other areas of radio communications.

To refresh your memory, the cordless phone consists of two pieces: a *transponder* and a portable wireless *handset*. The transponder answers the telephone call, or processes an outgoing call, and is connected directly to the telephone line. The transponder transmits to the handset on a frequency that is nominally 1.6 MHz (the high end of the broadcast band) by feeding RF into the AC power line. The handset receives the signal through a Ferrite bar or loop antenna built into the handset. The handset transmits to the transponder on the new radio control band at 49 MHz. The modulation is NBFM (*N*arrow *B*and *FM*), that provides essentially noise-free reception both ways over the (approximately) 300-foot operating range.

The power line transmitting system is exactly the same as used by many colleges for their carrier-current AM radio stations that "broadcast" to the resident dorms and instructional facilities. (Most of the college carrier-current radio stations are organized and managed just like any commercial AM radio station, the difference being that reception is limited to the area near the power lines.)

If you're not familiar with carrier-current broadcasting, you may be wondering at this point how you can pump RF into the power line without have it shorted by the nearest refrigerator, transformer, or lightbulb. A look at the transponder transmitter of the Radio Shack *ET-300,* shown in Fig. 1, will illustrate how it's done.

The basic transmitter is made up of transistors Q21, Q22, and Q23. The oscillator (Q23) is FM-modulated by variable-capacitance diode D17. Transistor Q22 is a buffer amplifier. The output amplifier, Q21, is coupled to the power line by the secondary of tank-circuit inductor L12.

Let's follow the RF output from the secondary. It flows through loading coil L11 and is coupled to the power line by capacitors C201 and C202. The capacitors allow the RF to pass from the transmitter to the power line but, because of the high reactance of the capacitors at 60 Hz, they keep the 120-volts of the power line from reaching L11 and L12. Choke T202 will pass audio frequencies, but not RF. That keeps the transmitter's signal out of the power transformer and insures that RF will not be "floating" inside the transponder, causing RF feedback. The signal goes out into the power line through the line cord. That section of the circuit is shielded, as indicated by the dashed line in Fig. 1.

It's not surprising if you think about it: Washing machines, refrigerators, light bulbs, etc., do not short circuit the RF because they appear as a high impedance to the 1.6-MHz RF. Though there are losses, the power line itself appears as a very low impedance to the transmitter, and the connected equipment appears as a moderately high impedance so that a lot of the signal gets out. The effects of line variations due to changing loads are minimized by tuning-coil L11, which matches the transmitter output to the low-impedance power line antenna. (Ordinary line cord has a nominal RF impedance of 70 ohms.)

As you might well imagine, the RF radiates from the power line. If the power line is shielded (BX cable or conduit) radiation takes place only from the unshielded sections: the line cords from the wall receptacle to the consumer equipment. Actually, BX cable shield and conduit often "float" a few ohms above true ground and some

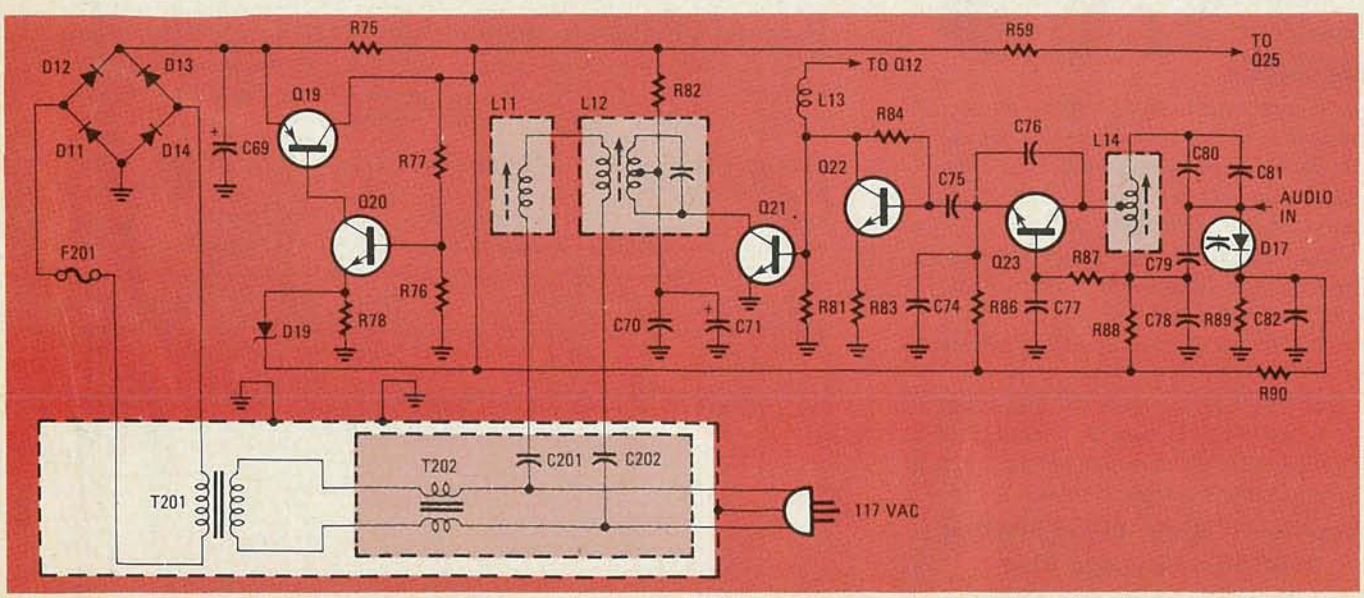


FIG. 1

radiation does take place through the metallic shield.

The signal cannot jump the line; that is, if the location is supplied with 3-phase 208 volts, or 240 volts (120 volts either side of ground) the RF will stay on its own 120-volt side or circuit. While that is no problem for the cordless phones it *is* a problem for carrier-current broadcasting because the power line side with the RF signal might branch at the distribution box, and half a building might well wind up without the RF signal. That is handled by conneting RF coupling capacitors from one side of the power line to the other. (By the way—for many years carrier-current was the RF communications system for electric utility companies, and some still use it.)

Anyway, now we have the RF from the transponder radiating from the power lines. To any receiver near the power line the RF appears to be like any other broadcast signal. So all we need is a broadcast-band receiver capable of receiving FM. And that's exactly

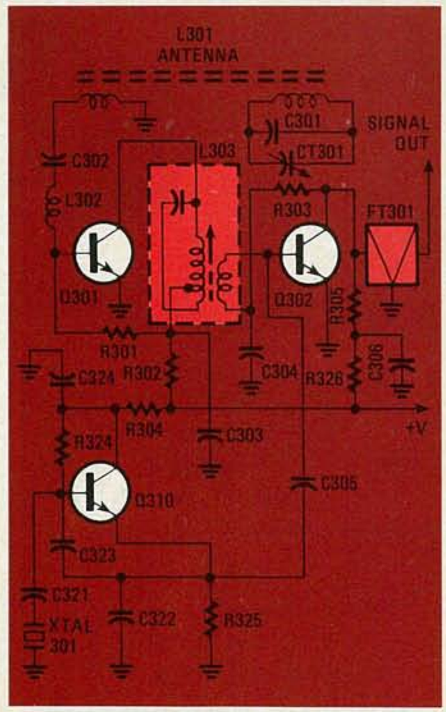


FIG. 2

what's inside the cordless handset. Figure 2 shows the front end of the handset receiver.

Antenna L301, which is located inside the cabinet, is a standard Ferrite bar antenna that picks up the RF signal radiated from the power line. From the bar antenna the signal is processed through a single-conversion receiver with a ceramic IF filter, FT301.

In a sense, the modern cordless telephone—which would be almost impossible without solid-state devices—uses a technology that is some 45 years old, and which has been in common use for all those years. **R-E**

stereo products

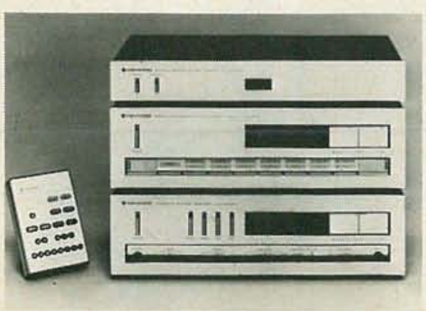
More information on stereo products is available. Use the Free Information Card inside the back cover.

PORTABLE AIR GUN, *Dust-Off,* is a simple, safe, non-contact method of getting dust and lint off valuable records, stylus tips, and other delicate hi-fi components. Air pressure is continuously variable. To get into difficult-to-reach spots, a 2-foot extension nozzle is available as an accessory. *Dust-Off* is available in 12 oz., 6 oz. and 3 oz. sizes. Retail prices are $18.95 (including a chrome valve-assembly), $3.95, and $1.98 respectively.—**Falcon Safety Products,** 1065 Bristol Road, Mountainside, NJ 07092.

CIRCLE 130 ON FREE INFORMATION CARD

COMPACT AMPLIFIER/TUNER SYSTEM, *models KA-500, KT-500* and *model RC-500.* The model KA-500 (bottom) is an integrated amplifier that uses no rotary controls. Power on/off, phono, tuner, auxiliary and tape switches are controlled by feather-touch bars, with a color-coded LED display above each bar to indicate the mode. The volume control uses two large push bars, one that lowers and one that raises the volume, and a horizontal bar graph of LED's show the power level. Other controls are loudness and muting switches, and linear slide potentiometers for bass, treble and balance. The unit has a power rating of 43 watts-per-channel minimum RMS, driven into 8 ohms from 20 to 20,000 Hz.

The *model KT-500* (middle), an AM/FM stereo tuner, also has no rotary controls and uses a quartz/PLL frequency synthesizer with digital display. Two tuning bars control automatic scan tuning and a digital computer responds to the stepping commands and also stores in its memory the digital codes for 12 preset stations—six AM and six FM.



CIRCLE 131 ON FREE INFORMATION CARD

The *model RC-500* (top) consists of a Remote Control Center and a hand-held, wireless Remote Controller. The *models KA-500* and *KT-500* are connected to the three-inch-high control center that is linked to the Remote Controller. The controller operates on/off, volume, function selection, preset and scan tuning selection, and a turntable up to 21 feet away. Prices: *model KA-500* is $275; *model KT-500* is $275; and the *model RC-500* is $235. —**Kenwood Electronics, Inc.,** 1315 E. Watsoncenter Rd., Carson, CA 90745.

SPEAKERS, a line of six high-end speakers designed for car stereo has been added to the *Hi-Comp* line. The *model HCS-10* is a 4-inch round speaker with a 7-ounce strontium-ferrite magnet, a power rating of 20 watts maximum and a frequency response of 120 to 16,000 Hz. The *model HCS-15* is a 5-in. coaxial system and has a 1-in. samarium-cobalt horn tweeter, $1\frac{1}{4}$-inch shallow-depth design, a built-in crossover network and a large 1-inch heat-proof voice coil. The *model HCS-59* (shown) is a $5\frac{1}{4}$ inch three-way speaker system with a 20-ounce barium-ferrite magnet, and a $1\frac{3}{4}$-inch high-temp aluminum voice coil. The *model HCS-342* is a 4-inch × 10 inch three-way system that offers 60 watts RMS maximum, 25 watts RMS nominal, and has a frequency response of 75 to 17,000 Hz, and a 8-ohm impedance. The *model HCS-362* is a 6-inch × 9-inch three-way system with a frequency response of 50 to 18,000 Hz. The *model HCS-90* is a two-way surface-mount enclosure system with a 4-in. butyl-edge woofer, an 8-ounce wet-type ferrite magnet and a $2\frac{1}{4}$-inch super-cone tweeter. Prices: *model HCS-10* is $36; *HCS-15* is $52; *HCS-59* is $100; *HCS-342* is $116; *HCS-362* is $116; and *HCS-90* is $190. —**Audiovox Corp.,** 150 Marcus Blvd., Hauppauge, NY 11787.

CIRCLE 132 ON FREE INFORMATION CARD

RECEIVERS, *models DA-R20, DA-R10* and *DA-R7,* are the first of a line of new receivers from Mitsubishi Audio. The *DA-R20* (shown) has a front-panel pushbutton that lets the user select either moving magnet or moving coil phono inputs directly without the need for an external transformer. It has touch-sensitive lock tuning that combines AFC lock tuning with switching that automatically turns off the AFC when tuning and turns it back on when tuning is finished. Other features are pilot signal cancellation, high blend, fluorescent digital display, and switchable IF selectivity, with a narrow band for reception in

CIRCLE 133 ON FREE INFORMATION CARD

urban areas and a wide position using linear phase ceramic filters for low distortion. The amplifier section has a DC power amp, low and high cut filters, tone defeat, and ten-position loudness control.

The *Model DA-R20* delivers 60 watts-per-channel minimum RMS power at 8 ohms from 20 to 20,000 Hz at 0.02% THD. The *DA-R10* offers 45 watts-per-channel and the *DA-R7* has 25 watts-per-channel. Prices: *model DA-R20* is $560; model *DA-R10* is $390 and model *DA-R7* is $290. **—Melco Sales, Inc.,** 3030 E. Victoria St., Compton, CA 90221.

CASSETTE DECKS, *models K-950, K-850* and *K-350,* all feature metal-tape capability, *Sendust* record/play heads, and a double-gap ferrite erase head. The *model K-950* (shown) has a wow-and-flutter of 0.028% WRMS as the result of its independent two-motor drive. Frequency response is 30 to 22,000 Hz ±3 dB with metal tape. Other features include fluorescent bar-graph peak meter, IC logic controls, timer recording switch, Dolby noise reduction, and a focus switch to extend high-end frequency response. It is enclosed in a black case where the frequently used controls are exposed, and the less used ones hidden.

The *model K-850,* is a slim silver deck that has a frequency response of 30 to 19,000 Hz ±3 dB. The wow-and-flutter is rated at 0.04% WRMS. The *model K-850* features automatic operation using one switch which permits timer operation (recording) when used with an out-boarded timer, auto repeat, auto rewind, and auto recording standby.

The *model K-350* has a signal-to-noise ratio of 57 dB, a frequency response of 40 to 18,000 Hz ±3 dB and a wow-and-flutter of 0.06% WRMS. It also features auto shut-off, direct tape loading with flip-up head, and direct switching between drive modes. Suggested retail prices are: *model K-950,* $490; *model K-850,* $360; and *model K-350,* $240.**—Yamaha Int'l Corp.,** 6600 Orangethorpe Ave., Buena Park, CA 90620.

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CAR STEREO SPEAKERS, *model BP 3500,* are 3½-inch units designed to produce the sound quality of a larger speaker in a smaller size, especially for smaller/compact-sized cars. The *model BP 3500* comes in an attractive package that includes two speakers for in-dash or rear-deck installation. Features include a 3 oz. ceramic magnet, a power rating of 10 watts and compatibility with 4- and 8-ohm tape units. Suggested retail price is $19.95. **—BP Electronics,** 855 Conklin St., Farmingdale, NY 11735.

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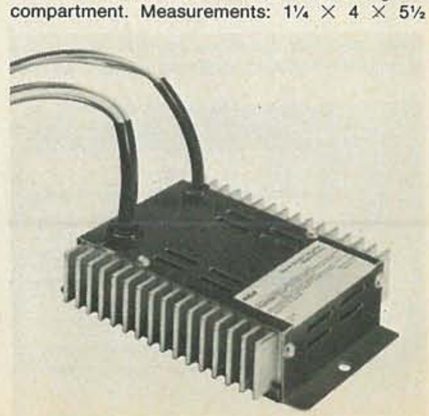
POWER AMPLIFIERS/BOOSTERS, *Custom models 20C655* and *20C656,* and *Universal model #12R906,* are designed for car-stereo systems. According to the manufacturer, the units provide a high volume and a low distortion output of 20 watts-per-channel, for a total of 40 watts. The models are useable with most car radios and tape players. The amplifier requires no switching and has a built-in protection circuit to prevent damage. The differences among the models are in the radio and speaker leads. The *model 20C655* has GM-type connectors, *model 20C656* has bullet connectors and *model 12R906* has unterminated connectors that use wire nuts provided with the unit. Small and lightweight, the amplifiers can mount behind dash or in the glove compartment. Measurements: 1¼ × 4 × 5½



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inches. Suggested retail price for *model 12R906* is $44.75; the two Custom models have open-list prices.—**RCA Distributor & Special Products Div.,** Sales Promotion Services, Deptford, NJ 08096.

TURNTABLE LIGHT, the *RoboLite*, is a battery-powered light that turns on automatically when the dust cover is raised. Record labels can be read easily and turntable adjustments can be made readily with the added illumination. The *RoboLite* operates from an external battery pack containing two D-size cells that is connected to the turntable light through a three-foot cable. The

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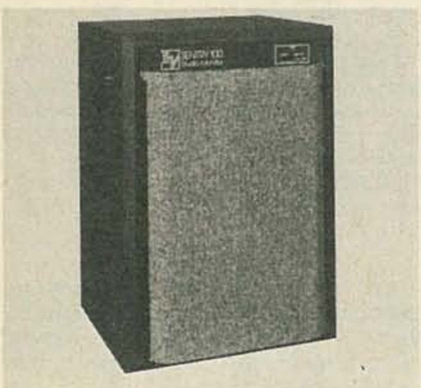
turntable light snaps onto the bottom edge of the dust cover and the battery pack can be placed on a shelf or drawer out of the way. A built-in mercury switch turns on the light when the cover is raised. When the cover is lowered, the light goes off automatically. User can swivel the bulb housing to direct light to the desired area. Suggested retail price is $21, without batteries.—**Robins Industries Corp.,** 75 Austin Blvd., Commack, NY 11725.

STUDIO MONITOR, the *Sentry 100*, is a highly efficient speaker that not only features low distortion, but can produce the sound-pressure levels of comparable units with far less amplifier power.



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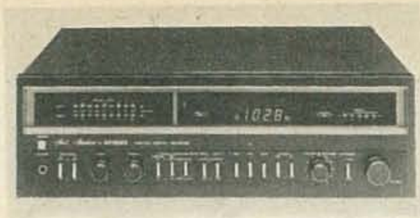
It also delivers the sonic accuracy required in critical monitoring. A hardware kit for rack and wall mounting is also available. Suggested retail price for the *Sentry 100* is $200. —**Electro-Voice, Inc.,** 600 Cecil St., Buchanan, MI 49107.

AM/FM STEREO RECEIVER, *model RS250*. According to the manufacturer, this receiver features a Class A-II DC amplifier circuit that combines the efficiency of Class B operation with the low distortion of Class A operation. Features include a digital frequency display, dual-gate MOSFET RF stage, linear-phase IF filters, double-tuned quadrature detector, and PLL MPX decoder. Other features are a built-in moving-coil cartridge preamp, full tape/source monitoring, bar-graph LED signal-strength indication, and dual LED bar-graph power meters.

The *RS250* also has push bars instead of knobs, four-position speaker selector and detented volume control. Specifications are 50 watts-per-channel minimum RMS power into 8



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ohms, a frequency range from 20 Hz to 20 kHz, and a total harmonic distortion of less than 0.02%. Available in brushed aluminum or black finish. Suggested price is $449.95.—**Fisher Corp.,** 21314 Lassen St., Chatsworth, CA 91311.

METAL TAPE DECK, *model RT-10BK*, in ebony, is designed to match the *ST/SM-1122* Pro Series tuner and amplifier. The *RT-10BK* features LED peak-level display meters, Dolby, soft-eject cassette holder, full auto-stop and an electronic-controlled DC motor. Manufacturer's specifications

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include a frequency response of 40 to 14,000 Hz ± 3 dB using metal tape, a wow-and-flutter of 0.09% WRMS and a signal-to-noise ratio of 62 dB. Suggested retail price is $129.95.—**Sharp Electronics Corp.,** 10 Keystone Pl., P.O. Box 588, Paramus, NJ 07652. **R-E**

LETTERS

continued from page 24

Tesla the extra support he needed, so that his ultimate plan of a worldwide wireless system of power and light was never achieved.

Hugo Gernsback was a good friend of Tesla's.

MARC SEIFER,
Kingston, RI

ON NIKOLA TESLA

I just had to compliment you on your article on Nikola Tesla (February issue). I just wish that you could do a series on him, because what most people do not realize is that he is the least appreciated of all the great electrical discoverers. (I use the term "discoverers" because Tesla always said that he would never invent a device; he would "... produce original work or none at all ...") It would take about three or more pages to list all his discoveries.

Anybody reading this might ask, "But what about Edison? Thomas Alva Edison had over 1200 patents to his name; how could Tesla outrank him?" But the number of patents isn't relevant, though Tesla did have 212 of them. Edison made discoveries, true, but he was far more concerned with devices, where Tesla had no interest in them.

Some of Tesla's discoveries were resonance (electrically-tuned circuits), various forms of gaseous lighting (neon, fluorescent, and others), the ancestor of the cyclotron, the carbon-button lamp, arc lamps, and many others. He also made the first alternating current motor, using his discovery of the "rotating magnetic field." Yet, about the only thing most people know about him is his famous Tesla Coil.

I would like to ask fellow readers of **Radio-Electronics** something. If anyone living in New Jersey has done extensive research on Nikola Tesla, would that person please write to me? I would like to enter correspondence and see if we can learn anything from each other. I will answer every serious inquiry.

VINCE MARASCO,
619 E. Blancke St.,
Linden, NJ 07036

THE BSR SYSTEM X10

In reference to the BSR System X10 (**Radio-Electronics,** March 1981, "Letters" section): I have had the same problem; some remotes did not work in some areas of my house.

I solved it by connecting a .022 1000-volt Mylar capacitor across the terminals of a 220-volt plug, which I plugged into an unused 220-volt outlet. It has been working fine for over a year now.

ELEMER DUBROVAY,
Redmond, WA

CABLE TV

Your editorial on cable TV in the February **Radio-Electronics** isn't exactly all wet, but it's pretty damp. In Manhattan, our cable company puts old movies and other shows on a vacant channel (10) that we get at no extra cost, and they run ads between the movies, without interrupting them. A few of the movies are very interesting, and your proposal to ban that service is a lousy one.

The proposal to keep the companies from supplying the TV set is a bad one, too. First, the independent sector won't be wiped out—just decimated the way that the movie-theater business was when TV became important. Second, if the cable companies can supply the TV set, they can break the NTSC barrier to high-resolution pictures. Otherwise, wideband signals won't be sent out until someone can receive them, and nobody's going to buy a high-resolution receiver until someone is transmitting those signals.

The movie industry tried to keep their products off TV in the 1950's, but (except in Britain) they failed as badly as your proposal to keep old TV shows off cable will fail. Why shouldn't the cable companies be allowed to re-run "I Love Lucy" or "Gunsmoke?" Just because they were once on "free" TV is no reason to freeze out the few fanatics who are willing to pay to see them.

As a heavy TV watcher, I think that your proposals will do no good, and may do some harm.

JAMES E. HENDERSON,
Manhattan, NY

DMM ACCESSORY

The article, "DMM Accessory for Ultra-Low Ohms," in the February 1981 **Radio-Electronics,** was very interesting.

May I call your attention to a basic error in the clip leads to the unknown resistance R_X? Each dual cable terminated in a *single* alligator clip. That will result in the contact resistance R_C between each clip and R_X being added to the actual value of R_X:

R_X (measured) $= R_X + R_{C+} + R_{C-}$

That can be avoided by having *four* clip leads: two for the current, and two for the voltmeter. The latter must be clipped *inside* the current leads with the clips not touching each other.

FRANK G. DUNNINGTON,
Port Richey, FL

SCHEMATIC ERROR

I just received the March issue of **Radio-Electronics** with my article, "The State-of-the-Art of Doing Nothing." It looks good, but an error did creep into the schematic (Fig. 4, page 62).

Pin 14 of IC4 should be connected to *pin 22,* regardless of which EPROM is used; the diagram shows it connected to pin 19.

The * note is correct, except for the last part. It should read "... +5V; for 2716 connect pin 19 of IC5 to pin *15* of IC4."

The other note should read: "Use pin *15* of IC4 if a 2758 is used; use pin *1* of IC4 if a 2716 is used."

Pin 22 of the EPROM is the A9 line and pin 19 is the A10 line. As drawn, the schematic will only display portions of the EPROMS' programs and will not reset until after several program repeats.

There's a minor error in column two on page 62: reset occurs when IC4 reaches either 1024 or 2048. The figure 512 was for the 74S PROM.

Otherwise, it looks great.

NOEL NYMAN **R-E**

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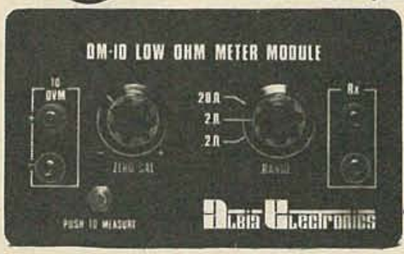

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- BNC Input Cable Accessory (Model PSA-2 add $14.95)

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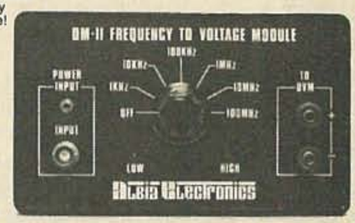

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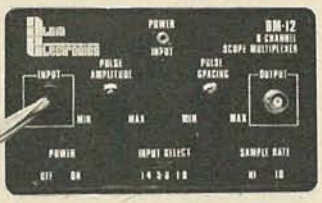

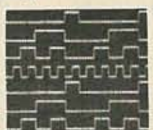

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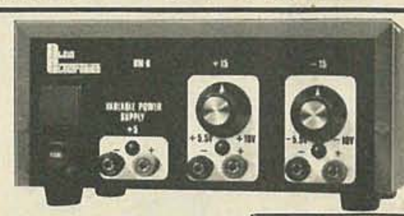

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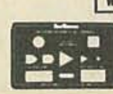

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CIRCLE 27 ON FREE INFORMATION CARD

service clinic

An open mind is one of the most important tools in fault analysis.

JACK DARR, SERVICE EDITOR

ONE OF THE LAST LETTERS IN A BIG batch of Clinic mail was a simple one. A young man in Virginia had a Sanyo with what seemed to be two obvious faults. The trouble was that he didn't recognize them! I answered the letter, giving him what seemed to be the most likely causes, and suggesting some test methods. After I got through though, I began to get mad!

Not at the young reader. He had located the key symptoms, but he did not know what caused them. I get a lot of letters just like that; the writers already have the keys but they don't know it. That's what made me angry; not at them but at the *training* they had received. Either the school they went to, the person who wrote the correspondence course, or someone else, had failed to give them the one important technique they needed: fault analysis! So, due to this gap in their education they were unable to complete the troubleshooting process.

Let's go over the actual case. The reader from Virginia said: "I've got a Sanyo 91C78 with power-supply problems. All the DC voltages from the flyback are missing, and the +120-volt source reads about +160 volts. What's causing this?"

Ever since the first article I ever wrote (in 1947) I've preached one thing: "Check the DC power supply *first*!" If that is bad, nothing else can work.

This set has the customary regulated DC power supply, supplying about +155 volts from a half-wave rectifier (see Fig. 1). Pass transistor Q901 drops that voltage to +120 volts and it's controlled by the usual error amp and driver (Q002 and Q001). If the B+ voltage is the full supply value, the pass transistor is either dead-shorted or turned on so hard that it is saturated. The most common problem is a shorted transistor. I told him to check this stage first, and find out why it wasn't working.

With the DC power supply at that level, it seemed to be running with no load at all. That usually blows up the horizontal-output transistor. From the no-load symptom, I suspected that it had been blown open. A shorted transistor would have loaded the DC-power supply down and possibly blown the line fuse. I suggested he take the horizontal-output transistor out (which would make it easier to test anyhow), and leave it out until he could get the DC power supply working. For safety's sake, I recommended that he plug the set into a variable-voltage line transformer, and bring the line voltage up slowly, monitoring the +120-volt source.

There's one and, as far as I know, just one practical way to attack problems like this. Note the symptoms, take some test voltage readings (he did that) and sit back and think about it. Look at the symptoms, figure out what could have caused them, and then check those things out. If your initial idea was right, great! If not, simply say to yourself: "Well, that eliminates those parts. Now, what else could be doing that?" Keep checking and thinking until you find the source of your problem. That takes far less time than it sounds. The one indispensable tool you must have, and *use* is a completely open mind! Do not make up your mind in advance that the fault has to be one particular thing. If you do, you'll spend your precious testing time trying to prove that you're right and not trying to find out what's really wrong. What's wrong makes no difference; your job is to find the problem and fix it.

It isn't easy! I can assure you of that after many years' experience of doing things the hard way. However, if you will give it a fair try, you'll find that things go a lot more smoothly.

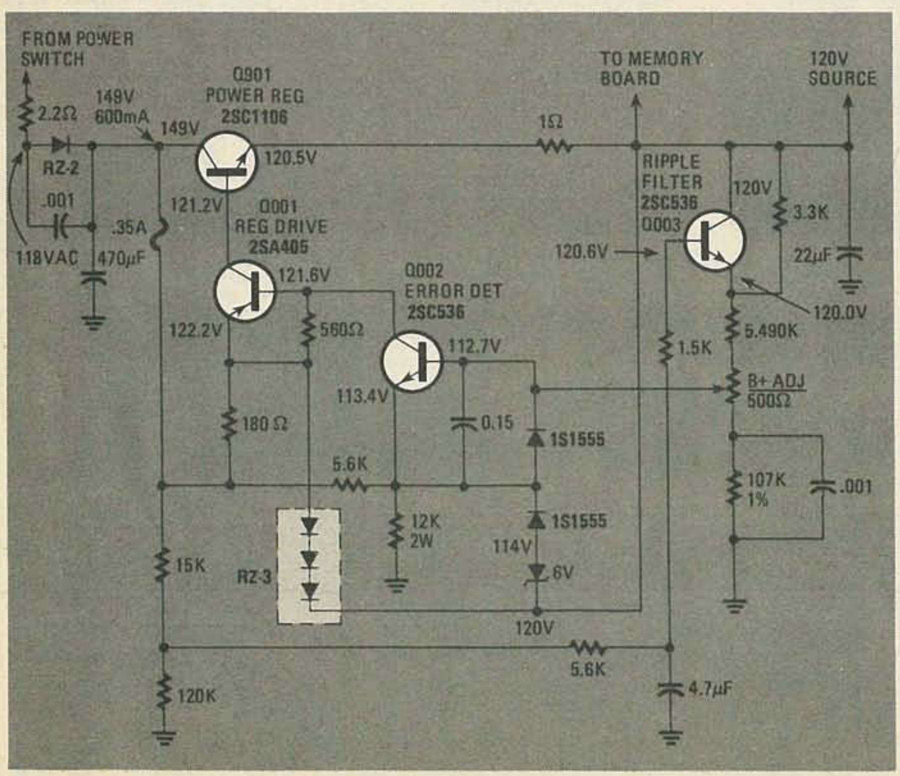

FIG. 1

More on Zenith 19EC45 vertical problem

In the February Service Questions (**Radio-Electronics**, February 1981) we had a query dealing with a repeated vertical problem on a Zenith 19EC45.

John B. Richards of Aurora, CO says that "the repeated transistor failure in the vertical board of Zenith 19EC45 is a 'generic' problem! Zenith has noted that and has redesigned the board with a better heat-sink. A re-manufactured PC board from Zenith is almost a must to clear up the problem."

Thanks a lot, John. That kind of feedback from the field is a great help to all of us. **R-E**

service questions

YOKE-RETURN CAPACITOR

A Zenith H121F7 (B/W) came in with no raster. Capacitor C513 in the horizontal yoke circuit was blown. I replaced it and it worked fine, but after a few days it went out again. I put in one with a higher voltage rating and it's getting very warm! Any ideas?—D.D., Apalachicola, FL

See the Service Clinic in the February 1981 issue of **Radio-Electronics**! (It covered exactly that problem.)

Replace that capacitor only with the exact duplicate part from Zenith. The problem is a high RF current flow through the capacitor. The capacitor must have a high-RF dielectric or it won't stand up. Also, the values of these parts are critical in many sets, so use exactly the same values as the originals.

SCR TESTER

I read your paragraph about testing SCR's with an ohmmeter a while back. As you said, SCR's with a higher holding-current can't be checked easily. They won't latch up as they should.

Here's a schematic of a simple SCR tester (Fig. 1) we used to check SCR's in Army missile equipment. It's simple to make and it hasn't lied to me yet

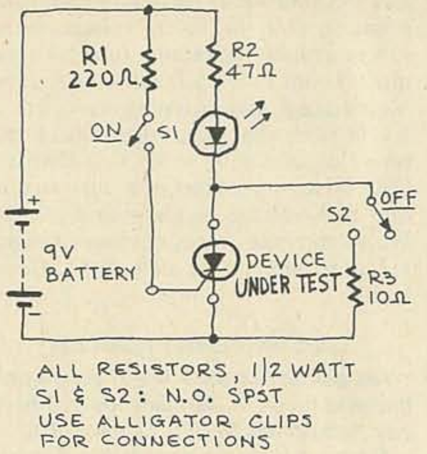

FIG. 1

even though it's been used to test quite a few of those devices. The only caution is to look out for shunt paths if you're trying to test an SCR in-circuit, especially in horizontal circuits.—Stephen P. Weinrich, APO, NY

JIG SMEAR

Do you know of anything that can be done to reduce "jig smear"? I've got some cables that are longer than usual so the jig can be up out of the way.—A.Y., Lexington, NC

Not too much can be done about it so I generally try to ignore it. You might try reducing that shunt capacitance of the cables by making up several cardboard circles about 3-4 inches in diameter. Cut slits around edges and slip the leads into those, to keep them farther apart. That can help a little. You could do that at the top section of cable and leave a piece about 12-18 inches long at the socket end so it won't be too bulky.

FOCUS PROBLEM

I've got a focus-voltage problem in a Sylvania DO-8. The maximum focus-voltage I can get is 3.8 kilovolts. The maximum high-voltage is 25 kilovolts. The boost and boosted-boost seem a bit low. The high-voltage regulator does not work too well; I have to shunt a 3.9-megohm resistor across R446 (R446 feeds the boost to the regulator grid) to get any action at all. I read that if you took the focus coil off in this circuit, the focus-voltage should go up to 5.5 kilovolts. When I unhooked this one, it went down to about 3.4 kilovolts. The tubes have been changed, and so on. The cathode current is normal. I'm lost!—T.L., Aurora, IL

I think you read about that test here; I've often mentioned it, and used it. This may be a good clue. The focus coil here loads the focus voltage down till it's at the right value. I suspect a bad focus rectifier. Those solid-state types can lose several of the little diodes and the focus voltage goes down. Try a new rectifier and see if that helps. It is also possible that the focus voltage being low is making the picture tube take too much beam current (loading down the high-voltage and dropping boost, etc.). Aside from that, you might check the boost capacitor to make sure that it's OK. Also, try some new resistors in that high-voltage regulator-grid circuit. We've had many cases of those changing value or opening up under load. Good luck!

TAPE-REVERB PROBLEM

I've got an Echoette NG-51 reverb unit that was made in Germany. Do you have any data on this?—E.R., Lynnwood, IL

Sorry, I looked through my *Electric Guitar Amplifier Handbook,* and I could not find it. However, I've seen that type before. It uses an endless loop of tape, with separate record and playback heads. The signal is first recorded on the tape and then picked up and fed back to the amp. The amount of delay can be adjusted by moving the heads closer together or farther apart.

All you really have is a tape recorder that records and plays back at the same time. Since it has tubes, it should be simple! Feed a test signal into the input and see if it gets to the record head. If so, then feed a signal to playback head and see if it gets to the output. Check the plate voltages and so on, and follow the signals. It should be fairly easy to find the problem.

HORIZONTAL YOKE TEST

Is there any simple method of checking for loss of high-voltage due to a bad yoke?—L.S., Coraopolis, PA

In tube sets, read the boost voltage and the horizontal-output tube cathode current. A shorted winding in the horizontal yoke will kill the boost and make the current go way up. To test for this, disconnect the yoke winding. (Don't forget to jumper B+ across the yoke plug; it's usually interlocked.) If the high-voltage comes back and the current drops below normal, the horizontal winding may be shorted. That can blow the horizontal output tube.

Solid-state sets usually have the horizontal yoke driven in shunt with the flyback, right off the output transistor. You can disconnect the yoke winding and if the high-voltage comes back, you'll see a bright *vertical* line on the screen. When the winding is shorted, the horizontal-output transistor is usually blown. So, for safety, always use a Variac when checking a set after transistor replacement. Solid-state yokes give you less trouble since they use bigger wire and less of it. **R-E**

new lit

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

CLOCKS AND TIMERS CATALOG, 16 pages, is a brochure covering a variety of digital clock/timers and includes photos, descriptions, specifications, and options used for each product. Products featured are digital clock thermometers, clock timers with memory, 10- and 60-minute timers, 100-minute up/down timers, and console-mount clocks and timers. The brochure also covers a time-code reader, a time-code generator, an audio-level indicator, master-clock systems, time-control systems, RAM time programmers and tape timers. Included is a price list.—**ESE,** 142 Sierra St., El Segundo, CA 90245.

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CAPACITOR CATALOG, the *Component Selector*, 96 pages, is a colorful catalog containing complete specifications and selection data on a line of DC capacitors, relays, EMI filters and AC capacitors. Product lines featured are aluminum electrolytic, film dielectric and mica capacitors, general purpose, miniature, sub-miniature and time-delay relays, all-purpose APF/EMI noise filters, and by-pass, non-PCB and "Soggy Foil" AC capacitors. Included in the catalog are product specifications, engineering data, cross-reference and selection tables.—**Cornell-Dubilier Electric,** Marketing Communications, 150 Ave. L, Newark, NJ 07101.

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CIRCLE 145 ON FREE INFORMATION CARD

CIRCUITS WITH EARS

continued from page 63

alto, tenor, soprano, etc. The spectrum's sub-band energy distribution would obviously shift slightly as the pitch of the speaker's voice shifts, and weighting factors could be introduced into the analysis to help correct for differences between speakers.

Connected speech

We have seen that time analysis of speech for today's isolated word-recognition systems requires proper framing of the word, which means recognizing its beginning and its end. But normal speech is connected speech, with the end of one word often indistinguishable from the beginning of the next.

IBM has been working on the problem of recognizing words and phrases in the midst of continuous speech. Using a large mainframe computer and some advanced techniques including spectrographic analysis, they've been able to take text derived from a 1000-word vocabulary and—with a speaker reading the text at a normal pace—transcribe the spoken text into printed copy with better than 90% accuracy.

What's here and what's coming

Speech-recognition equipment is available at every level from single boards an experimenter can connect to his computer to huge mainframe systems like those in use at Bell Labs and IBM. A great deal of attention is being given to continued developments in the sophistication and accuracy of voice-entry terminals, which accept spoken rather than keyboard-entered data.

Threshold Technology, Incorporated and Centigram Corporation are two of the leaders in speech terminals. A newcomer to that area is one of the pioneers in speech recognition for experimenters, Heuristics Incorporated.

New on the experimental end is the Cognivox by Voicetek, and the VET/1 and VET/2 from Scott Instruments.

Commercial speech-recognition systems are also made by Verbex Corporation (formerly Dialog Systems Incorporated), Scope Electronics Incorporated, and Interstate Electronics, as well as Perception Technology Incorporated. **R-E**

VOICE-RECOGNITION SYSTEMS

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SOLID STATE DEVICES

continued from page 46

is much less than G_O.

Suppose that we bias the Gunn device at some potential greater than the threshold voltage. The domain-creation phenomenon of the transit-time mode will cause several initial output pulses that serve to excite (i.e., "ring") the external tank circuit into oscillation. That action will cause a continuous RF sinewave to build up with a frequency equal to the resonant frequency of the tank circuit. The RF voltage adds algebraically with the DC bias such that the total bias is greater on positive peaks and less on negative peaks, as illustrated in Fig. 7. The value of the DC bias must be carefully adjusted so that the total bias drops below V_{TH} on negative peaks of the RF cycle, yet will remain above the minimum sustaining potential. Whenever the total bias (i.e., sum of DC and RF voltages) is less than the threshold potential the domains are quenched. If the previous domain reaches the anode while the bias is below V_{TH}, then the creation of the next domain is *delayed* until the RF cycle brings the bias back above the threshold potential. That causes the output-current pulse period to adjust to the period of the tank circuit.

We can use the frequency agility of the delayed transit-time mode to frequency-modulate the device, or make it subject to *automatic frequency control (AFC)* operation, by manipulation of the DC bias potential.

The delayed transit-time mode is considerably more efficient than the transit-time mode. The output power available in the transit-time mode is usually less than 1 watt, with efficiencies on the order of only one to five percent. The delayed transit-time mode, on the other hand, can deliver peak powers up to several hundred watts (with a duty cycle of 0.01% or less). The operating frequency of the transit-time mode is determined by the length of the active region and the velocity of the electrons. The delayed transit-time mode, however, will adjust itself to the resonant frequency of the high-Q tank circuit to which it is connected. We can often adjust the operating frequency over a range of one octave by adjusting the tank dimensions.

Next month we'll continue our discussion of Gunn devices. We'll also take a close look at some other solid-state microwave oscillators including the IMPATT, TRAPATT, and BARITT devices. **R-E**

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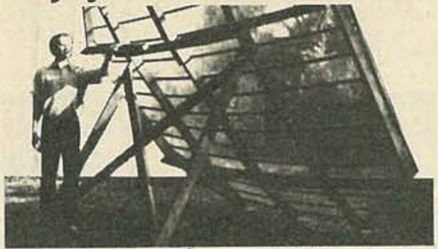

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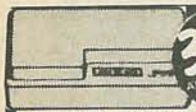

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7408N	.24	74283N	1.19	74LS85N	.89
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7412N	.38	74351N	2.20	74LS91N	.89
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7414N	.45	74366N	.69	74LS93N	.42
7416N	.36	74367AN	.69	74LS95N	.48
7417N	.36	74368AN	.69	74LS96N	.58
7420N	.29	74390N	.96	74LS107N	.38
7422N	.36	74393N	1.36	74LS109N	.38
7423N	.36			74LS112N	.38
7425N	.32	74S00N	.39	74LS122N	.48
7426N	.44	74S02N	.44	74LS123N	.64
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7430N	.22	74S05N	.56	74LS132N	.52
7432N	.56	74S08N	.56	74LS133N	1.56
7433N	.44	74S09N	.64	74LS136N	.44
7437N	.36	74S10N	.56	74LS138N	.57
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7446N	.84	74S32N	.74	74LS151N	.42
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7473N	.38	74S86N	.96	74LS161N	.69
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7485N	.66	74S134N	.69	74LS170N	1.84
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74164N	.63			74LS348N	2.65
74165N	.63	74LS00N	.17	74LS352N	1.35
74166N	.72	74LS01N	.17	74LS353N	1.65
74170N	1.98	74LS02N	.22	74LS362N	9.95
74172N	5.87	74LS03N	.22	74LS365N	.68
74173N	.79	74LS04N	.24	74LS366N	.68
74174N	.65	74LS05N	.24	74LS367N	.72
74175N	.59	74LS08N	.19	74LS368N	.72
74176N	.79	74LS09N	.24	74LS373N	1.38
74178N	1.15	74LS10N	.19	74LS374N	1.38
74179N	1.15	74LS11N	.24	74LS375N	1.98
74180N	.75	74LS12N	.24	74LS377N	1.44
74182N	.48	74LS13N	.25	74LS378N	1.19
74184N	2.95	74LS14N	.42	74LS379N	1.19
74185N	2.95	74LS20N	.18	74LS390N	1.36
74190N	.69	74LS21N	.18	74LS393N	1.25
74191N	.76	74LS26N	.39	74LS395N	1.35
74192N	.69	74LS27N	.29	74LS447N	.37
74193N	.88	74LS30N	.18	74LS490N	1.89
74194N	.88	74LS32N	.36	74LS630N	85.00
74195N	.48	74LS37N	.32	74LS669N	1.19
74196N	.78	74LS38N	.32	74LS670N	2.36
74197N	.78	74LS42N	.44		
74198N	1.56	74LS47N	.68		
74199N	1.56	74LS48N	.99		
74221N	.68	74LS51N	.21		

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SN7411N	.29	SN7489N	1.75	SN74172N	4.95
SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74107N	.35	SN74184N	2.49
SN7426N	.29	SN74109N	.39	SN74185N	2.49
SN7427N	.25	SN74116N	1.95	SN74190N	1.25
SN7428N	.49	SN74121N	.39	SN74191N	1.25
SN7430N	.25	SN74122N	.55	SN74192N	.89
SN7432N	.29	SN74123N	.59	SN74193N	.89
SN7437N	.25	SN74125N	.49	SN74194N	.89
SN7438N	.40	SN74126N	.49	SN74195N	.69
SN7439N	.25	SN74132N	.75	SN74196N	.89
SN7440N	.20	SN74136N	.75	SN74197N	.89
SN7441N	.89	SN74141N	.99	SN74198N	1.49
SN7442N	.59	SN74142N	3.25	SN74199N	1.49
SN7443N	1.10	SN74143N	3.49	SN74221N	1.25
SN7444N	1.10	SN74144N	3.49	SN74251N	.99
SN7445N	.89	SN74145N	.79	SN74276N	1.95
SN7446N	.79	SN74147N	1.95	SN74279N	.79
SN7447N	.69	SN74148N	1.29	SN74283N	1.49
SN7448N	.79	SN74150N	1.25	SN74284N	3.95
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SN7451N	.20	SN74152N	.69	SN74365N	.69
SN7453N	.20	SN74153N	.79	SN74366N	.69
SN7454N	.20	SN74154N	1.25	SN74367N	.69
SN7459A	.25	SN74156N	.79	SN74368N	.69
SN7460N	.20			SN74390N	1.49
SN7470N	.29			SN74393N	1.49

74LS

74LS00	.29	74LS92	.75	74LS192	1.15
74LS01	.29	74LS93	.75	74LS193	1.15
74LS02	.29	74LS95	.99	74LS194	1.15
74LS03	.29	74LS96	1.15	74LS195	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.29	74LS112	.45	74LS240	1.95
74LS09	.35	74LS113	.49	74LS241	1.95
74LS10	.29	74LS114	.49	74LS242	1.95
74LS11	.75	74LS122	.89	74LS243	1.95
74LS12	.35	74LS123	1.25	74LS244	1.95
74LS13	.59	74LS125	.89	74LS245	2.95
74LS14	.99	74LS126	.55	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
74LS20	.29	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.49	74LS251	1.49
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.99
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.29	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	1.19	74LS273	1.95
74LS33	.59	74LS156	1.19	74LS279	.75
74LS37	.45	74LS157	.89	74LS283	1.09
74LS38	.49	74LS158	.99	74LS290	.99
74LS40	.35	74LS160	1.15	74LS293	.99
74LS42	.89	74LS161	1.15	74LS298	1.25
74LS47	.89	74LS162	1.15	74LS352	1.29
74LS48	1.15	74LS163	1.15	74LS353	1.29
74LS49	1.15	74LS164	1.25	74LS363	.75
74LS51	.29	74LS165	1.25	74LS365	.75
74LS54	.29	74LS168	1.19	74LS366	.75
74LS55	.29	74LS169	1.19	74LS367	.75
74LS73	.45	74LS170	2.49	74LS368	.75
74LS74	.45	74LS173	1.39	74LS373	1.95
74LS75	.59	74LS174	.99	74LS374	1.95
74LS76	.45	74LS175	.99	74LS375	.89
74LS78	.49	74LS181	2.95	74LS386	.69
74LS83	.89	74LS190	1.25	74LS393	2.49
74LS85	1.25	74LS191	1.25	74LS399	2.49
74LS86	.45			74LS670	2.49
74LS90	.59			81LS95	1.95
				81LS97	1.95

74S

74S00	.50	74S133	.55	74S244	3.25
74S02	.50	74S134	.69	74S251	1.45
74S03	.50	74S135	1.19	74S253	1.45
74S04	.55	74S136	1.75	74S257	1.35
74S05	.55	74S138	1.35	74S258	1.35
74S08	.50	74S139	1.35	74S260	.79
74S09	.50	74S140	1.15	74S280	2.95
74S10	.50	74S151	1.35	74S287*	4.95
74S11	.50	74S153	1.35	74S288*	4.95
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74S20	.50	74S158	1.35	74S374	3.49
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74S113	.79			74S940	3.15
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CA3013H	2.15	CA3081N	2.00	CA3089N	3.75
CA3023H	3.25	CA3082N	2.00	CA3096N	3.95
CA3039H	1.35	CA3083N	1.60	CA3130H	1.39
CA3046N	1.30	CA3086N	.85	CA3140H	1.25
CA3059N	3.25			CA3160H	1.25
CA3060N	3.25			CA3401N	.59
CA3080H	1.25			CA3600N	3.50

CD—CMOS

CD4000	.39	CD4041	1.49	CD4082	.39
CD4001	.39	CD4042	.99	CD4093	.99
CD4002	.39	CD4043	.89	CD4098	2.49
CD4006	1.19	CD4044	.89	CD4506	.75
CD4007	.25	CD4046	1.79	CD4507	.99
CD4009	.49	CD4047	2.50	CD4508	3.95
CD4010	.49	CD4048	1.35	CD4510	1.39
CD4011	.39	CD4049	.49	CD4511	1.29
CD4012	.25	CD4050	.69	CD4514	3.95
CD4013	.49	CD4051	1.19	CD4515	2.95
CD4014	1.39	CD4052	1.19	CD4516	1.49
CD4015	1.19	CD4053	1.19	CD4518	1.79
CD4016	.59	CD4056	2.95	CD4519	.89
CD4017	1.19	CD4059	9.95	CD4520	1.29
CD4018	.99	CD4060	1.49	CD4526	1.79
CD4019	.49	CD4066	.79	CD4528	1.79
CD4020	1.19	CD4068	.39	CD4529	1.95
CD4021	1.39	CD4069	.45	CD4543	2.79
CD4022	1.19	CD4070	.55	CD4562	11.95
CD4023	.29	CD4071	.49	CD4566	2.79
CD4024	.79	CD4072	.49	CD4583	2.49
CD4025	.23	CD4073	.39	CD4723	1.95
CD4026	2.95	CD4075	.39	CD4724	1.95
CD4027	.69	CD4076	1.39	MC14409	14.95
CD4028	.89	CD4078	.55	MC14410	14.95
CD4029	1.49	CD4081	.39	MC14411	14.95
CD4030	.49			MC14412	11.95
CD4035	.99			MC14419	4.95
CD4040	1.49			MC14433	13.95

A P PRODUCTS

DIP JUMPERS

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

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

Part Number	No. of contacts	Description	Wire Length	Price
924102-12	14	single end	12"	$1.51
924102-24	14	single end	24"	1.92
924102-36	14	single end	36"	2.33
924108-12	14	double end	12"	2.61
924108-24	14	double end	24"	3.02
924108-36	14	double end	36"	3.43
924112-12	16	single end	12"	1.67
924112-24	16	single end	24"	2.13
924112-36	16	single end	36"	2.58
924116-12	16	double end	12"	2.88
924116-24	16	double end	24"	3.34
924116-36	16	double end	36"	3.80
924122-12	24	single end	12"	2.60
924122-24	24	single end	24"	3.30
924122-36	24	single end	36"	4.00
924126-12	24	double end	12"	4.50
924126-24	24	double end	24"	5.20
924126-36	24	double end	36"	5.90
924132-12	40	single end	12"	4.33
924132-24	40	single end	24"	5.53
924132-36	40	single end	36"	6.71

DISCRETE LEDS

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

XC556 RED LED, METAL MTG. HDW. 2-4" LEADS.
RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

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

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

SOCKETS — RECEPTACLES

Test TEXTOOL Sockets

ZERO INSERTION FORCE

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

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

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
214-3339	14 pin	5.95	222-3343	22 pin	9.95	214-3592	14 pin	9.75	222-3596	22 pin	12.95
216-3340	16 pin	6.49	224-3344	24 pin	9.75	216-3593	16 pin	9.95	224-3597	24 pin	12.75
218-3341	18 pin	7.95	228-3345	28 pin	11.95	218-3594	18 pin	10.95	228-3598	28 pin	13.95
220-3342	20 pin	8.95	240-3346	40 pin	12.95	220-3595	20 pin	11.95	240-3599	40 pin	15.95

LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL (GOLD) STANDARD

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

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

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ASST. 1	5ea.	10 Ohm 12 Ohm 15 Ohm 18 Ohm 22 Ohm 27 Ohm 33 Ohm 39 Ohm 47 Ohm 56 Ohm	50pcs.	$1.95
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ASST. 5	5ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	50pcs.	$1.95
ASST. 6	5ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	50pcs.	$1.95
ASST. 7	5ea.	1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M	50pcs.	$1.95
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7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	28.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
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7205IPG	CMOS LED Stopwatch/Timer	12.95
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7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.50
8212CPA	Volt Ref/Indicator	2.50

* INTERSIL'S EVALUATION KITS

74C

74C00	.39	74C106	.75	74C195	1.59
74C02	.39	74C107	1.89	74C221	1.95
74C04	.39	74C151	2.95	74C240	2.25
74C08	.39	74C154	3.95	74C244	2.25
74C10	.39	74C157	2.25	74C373	2.49
74C14	.75	74C160	1.69	74C374	2.59
74C20	.39	74C161	1.60	74C901	.89
74C30	.39	74C162	1.49	74C903	1.15
74C42	1.39	74C163	1.69	74C911	10.95
74C48	1.95	74C164	1.59	74C912	10.95
74C73	.79	74C173	1.39	74C915	1.69
74C74	.79	74C174	1.39	74C917	10.95
74C85	1.95	74C175	1.39	74C922	5.49
74C86	.99	74C192	1.69	74C923	5.75
74C89	6.95	74C193	1.69	74C925	7.50
74C90	1.29			74C926	7.50
74C93	1.29			80C95	.79
74C95	1.59			80C97	.79

LINEAR

LH0002CN	6.85	LM340T-5	1.25	NE570N	4.95
LM10CLH	4.50	LM340T-12	1.25	LM702H	.79
LM11CLH	4.75	LM340T-15	1.25	LM703CN	.89
LH0070-OH	6.05	LM341P-5	.75	LM709N	.49
TL071CP	.79	LM341P-12	.75	LM710N	.79
TL072CP	1.39	LM341P-15	.75	LM711N	.79
TL074CN	2.49	LM342P-5	.69	LM723N	.69
LH0082CD	35.80	LM342P-12	.69	LM733N	1.00
TL082CP	1.19	LM342P-15	.69	LM739N	1.19
TL084CN	2.19	LM348N	1.25	LM741CN	.35
LH0094CD	35.80	LM350K	5.75	MC1741SCG	3.00
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LM301CN	.35	LF353N	1.00	LM748N	.59
LM302H	1.95	LF355N	1.10	LM1014N	2.75
LM304H	1.95	LF356N	1.10	LM1310N	1.95
LM305H	.99	LM358N	1.00	LM1458CN	.59
LM307CN	.45	LM359N	1.79	LM1488N	1.25
LM308CN	1.00	LM370N	4.49	LM1489N	1.25
LM309H	1.95	LM373N	3.25	LM1496N	1.95
LM309K	1.25	LM377N	2.95	LM1556V	1.75
LM310CN	1.75	LM380N	1.25	LM1800N	2.95
LM311H	.90	LM381N	1.95	LM1877N-9	3.25
LM312H	2.49	LM382N	1.79	LM1889N	3.20
LM317MP	1.15	LM384N	1.95	LM1896N	1.75
LM317T	1.75	LM386N-3	1.29	LM2002T	1.49
LM317K	3.95	LM387N	1.45	LM2877P	2.05
LM318CN	1.95	LM389N	1.35	LM2878P	2.25
LM319N	1.95	LM392N	.69	LM2896P-1	2.25
LM320K-5	1.35	LF398N	4.00	LM3189N	2.95
LM320K-12	1.35	LM399H	5.00	LM3900N	.69
LM320K-15	1.35	TL494CN	4.49	LM3905CN	1.25
LM320T-5	1.25	TL496CP	1.75	LM3909N	1.15
LM320T-12	1.25	NE510A	6.00	LM3914N	3.95
LM320T-15	1.25	NE529A	4.95	LM3915N	3.95
LM323K-5	5.95	NE531H	3.95	LM3916N	3.95
LM324N	.99	NE536H	6.00	RC4136N	1.25
LM329DZ	.65	NE540H	6.00	RC4151NB	3.95
LM331N	3.95	NE544N	4.95	RC4194TK	5.95
LM334Z	1.30	NE550A	1.30	RC4195TK	5.49
LM335Z	1.40	NE555V	.39	KB4428	4.25
LM336Z	1.75	LM556N	.99	KB4429	5.95
LM337T	1.95	NE564N	3.95	LM4500A	3.25
LM337MP	1.15	LM565N	1.25	ICL8038B	4.95
LM338K	6.95	LM566CN	1.95	LM13080N	1.29
LM339N	.99	LM567V	1.25	LM13600N	1.49
LM340K-5	1.35			75138N	1.95
LM340K-12	1.35			75450N	.89
LM340K-15	1.35			75451CN	.39

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

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The unique and valuable components of the MicroAce

The MicroAce is not just another personal computer. Quite apart from its exceptionally low price, the MicroAce has two uniquely advanced components: the powerful BASIC interpreter, and the simple teach yourself BASIC manual.

The unique versatile BASIC interpreter offers remarkable programming advantages:

- **Unique 'one-touch' key word entry: the MicroAce eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability — takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The MicroAce also has string input — to request a line of text when necessary. Strings do not need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

'Excellent value' indeed!

For just $149.00 (including handling charge) you get everything you need to build a personal computer at home... PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or color); everything!

Yet the MicroAce really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The MicroAce is programmed in BASIC, and you can use it to do quite literally anything, from playing chess to managing a business.

The MicroAce is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done: connect it to your TV ... link it to the mains adaptor ... and you're ready to go.

Fewer chips, compact design, volume production-more power per Dollar!

The MicroAce owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the MicroAce 1K byte RAM (expandable to 2K on board) is roughly equivalent to 4K bytes in a conventional computer — typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines.

And Benchmark tests show that the MicroAce is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.

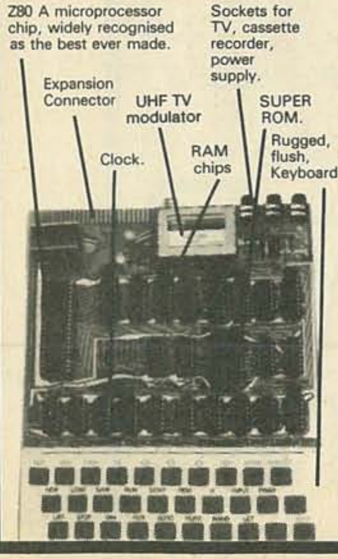
The MicroAce teach-yourself BASIC manual.

If the features of the BASIC interpreter mean little to you-don't worry. They're all explained in the specially-written book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming-from first principles to complex programs. (Available separately-purchase price refunded if you buy a MicroAce later.)

A hardware manual is also included with every kit.

The MicroAce Kit:
$149.00 with IK COMPLETE
$169.00 with 2K

Demand for the MicroAce is very high: use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. If you are unsuccessful in constructing your kit, we will repair it for a fee of $20.00, post and packing FREE. Of course, you may return your MicroAce as received within 14 days for a full refund. We want you to be satisfied beyond all doubt — and we have no doubt that you will be.



Your MicroAce kit contains...

- Printed circuit board, with IC sockets for all ICs.
- Complete components set, including all ICs-all manufactured by selected world-leading suppliers.
- New rugged keyboard, touch-sensitive, wipe-clean.
- Ready-moulded case.
- Leads and plugs for connection to domestic TV and cassette recorder. (Programs can be SAVEd and LOADed on to a portable cassette recorder.)
- Mains adaptor of 600 mA at 9VDC nominal unregulated.
- FREE course in BASIC programming and user manual.

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	MicroAce Kit 2K	$169.00	
	Manual	$10.00	
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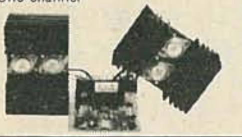
100 W CLASS A POWER AMP KIT

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

Specifications:

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



TA-1000 KIT $51.95
Power transformer $18.00 each

REGULATED VARIABLE D.C. POWER SUPPLY KIT

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

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

$59.50 per kit NEW

NEW WHISTLE ACTIVATED SWITCH BOARD

All boards are pre-assembled and tested. Your whistle to its FET condenser microphone from a distance, as far as 30 feet away (sensitivity can be easily adjusted) will turn the switch on, then latched you whistle to it again then it turns off. Ideal for remote control toys, electrical appliance such as lights, coffee pots, TV, Hi-Fi, radio or other projects. Unit works on 9V D.C.

Model 968 $4.50 each

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
9 Steps 4 Colors
LED VU

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

IN KIT FORM $18.50

2 WATT AUDIO AMP

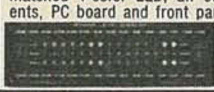
Pre assembled units. All you need is to hook up the speaker and the volume control. Supply voltage from 9~15V D.C. measures only 2" x 3½", making it good for portable or discrete applications. Comes with hook up data.

BUY 2 FOR **$4.99**

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!

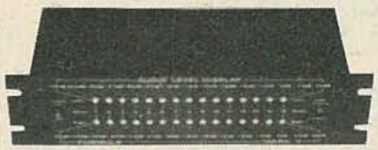
Kit includes 70 pcs. driver transistors, 38 pcs. matched 4-color LED, all other electronic components, PC board and front panel.



MARK IV KIT **$31.50**

NEW MARK V 15 STEPS LED POWER OUTPUT INDICATOR KIT

All functions same as Mark IV but this is with heavy duty aluminum front plate and case. Can be easily slot into the front panel of your auto, truck or boat. Operates on 12V DC.



$41.50 EACH KIT

BATTERY POWERED FLUORESCENT LANTERN

MODEL 888 R

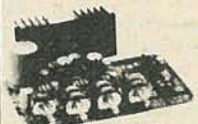
FEATURES

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

$10.50 EA

30W+30W STEREO HYBRID AMPLIFIER KIT

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



$32.50 PER KIT

5W AUDIO AMP KIT

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

TWO IN ONE PANEL METER D.C. VOLTAGE AND AMP IN ONE

D.C. Volts reads 0-50
D.C. Amp reads 0-3
Meter case made of black plastic with a white scale plate and glass window.

#ST-680 $12.50 EACH

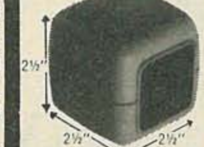
SPECIAL 0.5" LED SALE ALARM CLOCK MODULE

ASSEMBLED! NOT A KIT!

Features: • 4 digits 0.5" LED Displays • 12 hours real time format • 24 hours alarm audio output • 59 min. countdown timer • 10 min. snooze control.

ONLY **$7.00 EACH**
SPECIAL TRANSFORMER FOR CLOCK
$2.50

CUBO CLOCK CASES



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

3 Attractive Colors
(white, lime green or orange)

BUY 3 FOR ONLY $2.50

TV GAME BOARD

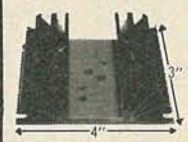
PLAYS 4 GAMES: TENNIS; HOCKEY; HANDBALL AND JAI-ALAI.

All boards complete with all parts ready to play. Requires 6C size batteries and a small speaker for sound effects. The boards were surplus from a famous game manufacturer. They will play on all US standard black and white or color TV sets.

Regular price for these games were $39.50 each
OUR PRICE ONLY $6.50 EACH

PART #57456

MULTI-FINS HEAT SINK



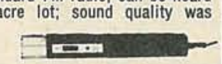
Ideal for high power output. Holes predrilled for 1 to 3 transistor. Made of aluminum with ten radiating fins.

2 FOR $4.50

PROFESSIONAL FM WIRELESS MICROPHONE

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

$16.50



FOR 'BOX' BUILDERS

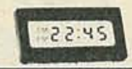
Pre-Drilled PC Board			**$17.50**
Tolriod Coils (Set of 4)			**$ 3.00**
Multi Turn Trim-Pots 10K ohm			**$ 2.50**
Trimmer Capacitor 6-35pF			**$ 0.60**
MC1358	**$ 2.50**	RC1458	**$ 1.00**
MC1350	**$ 2.00**	LM380	**$ 1.80**
MC1330	**$ 3.50**	LM340T-15	**$ 1.20**
		NE565	**$ 2.00**

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

LCD CLOCK MODULE!

• 0.5" LCD 4 digits display • X'tal controlled circuits • D.C. powered (1.5V battery) • 12 hr. or 24 hr. display • 24 hr. alarm set • 60 min. countdown timer • On board dual back-up lights • Dual time zone display • Stop watch function.

NIC1200 (12 hr) ON SALE
NIC2400 (24 hr) $16.99 EACH



SANYO UHF VARACTOR TUNER

For UHF CH 14~83

Tuning voltage + 1V~+ 28V D.C. Input impedance 75 OHM. I.F. band width 7~16 MHZ. Noise figure 11.5 dB MAX. Size 2⅝" x 1¼" x ¾". Supply voltage 15V D.C. Sound I.F. = 58.0 MHZ. Video I.F. = 62.5 MHZ

All units are brand new from Sanyo.
MODEL 115-B-405A
$35.00 EACH

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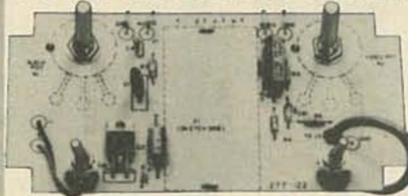

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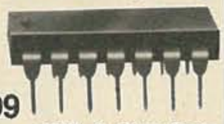

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PB-6	16.95	PB-104	54.00
PB-100	18.00	PB-203	97.00
PB-101	21.00	PB-203A	149.00
PB-102	25.00	PB-203A-Kit	129.00
PB-103	43.00		

SEMICONDUCTORS SPEAK☆☆☆☆☆☆☆

DIGITALKER™

Speech Synthesis System

The DIGITALKER is a speech synthesis system consisting of multiple N-channel MOS integrated circuits. It contains a speech processor chip (SPC) and speech ROM and when used with external filter, amplifier, and speaker, produces a system which generates high quality speech including the natural inflection and emphasis of the original speech. Male, female, and children's voices can be synthesized.

- Completely independent system, not requiring a processor controller
- Designed to be easily interfaced to most popular microprocessors
- 256 possible addressable expressions
- Male, female, and children's voices
- Natural inflection and emphasis of original speech
- Addresses 128k of ROM directly
- Communicates with static or clocked dynamic ROMs
- TTL compatible
- MICROBUS™ compatible

DIGITALKER™ DT1000. Self contained board that – with just a speaker and a power supply – can rattle off any desired combination of 144 words. $485.00

DIGITALKER™ DT1050. Chip set for building Digitalker into your own evaluation design. $95.00

National Semiconductor

Apple® II 48K
Apple® II Plus $1250

DISK SYSTEM SPECIAL

Apple II Plus w/48K Supermod Video Modulator
Disk II w/Controller Integer Based ROM Card.

ACP PRICE $1995.00

Hi-Speed Serial I/O	$189.00	DS65 Digi-Sector	$349.00	Integer ROM Card	$189.00
Centronics Printer I/O	180.00	Apple Graphics Tablet	675.00	Proto Card	21.95
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2 Ch. Analog Output	164.95	Business Software Pkg	625.00	Romplus +	169.00
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apple /// $3995

- Apple III Option A: Apple II 96K, Information Analyst Package, 12" B/W Monitor $3995.00
- Apple III Option B: Same as Option A Plus: Disk II for Apple III $4395.00
- Apple III Option C: Same as Option A Plus: Disk II for Apple III, Silentype Thermal Printer $4785.00
- To substitute 128K Apple III for 96K Apple III .... Add $450.00

NEW APPLE PRODUCTS

- "APPLE FAN" – Cures thermal problems from overcrowded machines designed specifically for Apple $49.95
- "BIT 3" – New 80 x 24 Video Board for Apple. Completely compatible with Pascal $329.95
- "BAR WAND" Hewlett Packard HEDS-3000 Bar Code interfaced to Apple $199.00
- "SEC APPLE A/D" – 8 Channel A/D Interface completely assembled and tested $99.50
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- "APPLE CRYPTEXT" for data encryption and security $449.00
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- "DIGISECTOR" Converts video input to Hi-Res graphics $349.95
- California Microproducts VisiCalc Keypads Numberic keypad with space, space ESC - and - keys for VisiCalc compatibility $169.00
- DOS 3.3 Upgrade Kits 23% more storage in 16-sector format $65.00
- Mountain Hardware Music Board, best yet – 16 channels $550.00
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- Pascal Revision Kit. Adds executive and chaining capabilities to Pascal environment $65.00
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- Smart Term Apple 80 x 24 Video Card $619.00
- Symtex X-10 $349.00
- Apple Silentype. With Apple Intelligent Interface Card $549.00
- NEW! California Computer Systems APPLE Clock. Only $124.95
- NEW! Z-80 Softcard for APPLE CPM 2.2 & M BASIC 5.0 $325.00
- SEC ECHO II Speech Synthesizer $249.95

NEW APPLE SOFTWARE

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2. RTR Stock Market Analysis – Hi-Res, Trend Lines, etc. $109.95
3. ASTEROIDS $29.95
4. "Both Barrels" – Hi-Res simulation of Western Gunfight and Skeet Shooting. Same author as Nasir. $29.95
5. "Apple Tax Power Package" $89.95
6. "New-DOS Tool Kit" $64.95
7. NEW! Apple Z-80 CP/M Software Call for Price

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

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

$649.00

ATARI® 800 & 400

Personal Computer System

ATARI 800 $825.00
ATARI 400 $449.00

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

Peripherals		**Education System Cassette Programs**		Spelling	35.00
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Printer	499.00	U.S. Government	35.00	Basic Algebra	35.00
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Software – ROM Cartridges		World History (Western)	35.00	Guide to BASIC Programming	18.00
Education System Master Cartridge	28.00	Basic Sociology	35.00	BASIC Game Programs	19.00
Atari BASIC	55.00	Counseling Procedures	35.00	**Add-On Memory**	
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Life	42.00	Great Classics (English)	35.00	**Diskettes**	
Super Breakout™	42.00	Business Communications	35.00	Blank Diskettes	
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Super Bug™	42.00	Effective Writing	35.00	**Accessory Controllers**	
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				Joystick Controller Pair	18.00

SINGLE BOARD COMPUTER SELECTION GUIDE

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

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99/4 PERSONAL COMPUTER

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

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

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Console only.

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INTELLIVISION

ACP LOW PRICE

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GAME CARTRIDGES $26.95

BASEBALL	HOCKEY	POKER/BLACKJACK
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AUTO RACE	MOTOCROSS	HORSE RACING
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GOLF	CHECKERS	ARMOR BATTLE
SOCCER	CHESS	SPACE BATTLE
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10% OFF ON $25.00
15% OFF ON $50.00

7400	$.18	7464	.30	74155	.50
7401	.18	7465	.30	74156	.64
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7403	.18	7472	.32	74158	.75
7404	.20	7474	.18	74160	.70
7405	.25	7475	.49	74161	.79
7406	.20	7576	.49	74162	.85
7407	.20	7480	.35	74163	.85
7408	.27	7482	.25	74164	.85
7409	.27	7483	.65	74166	.85
7410	.18	7485	.50	74170	1.50
7415	.29	7486	.42	74173	1.25
7416	.20	7489	1.75	74174	1.05
7417	.20	7490	.59	74175	.85
7420	.20	7491	.64	74176	.70
7425	.39	7492	.59	74177	.70
7426	.35	7493	.35	74180	.35
7427	.25	7494	.59	74181	1.85
7430	.25	7495	.35	74182	.35
7432	.20	7496	.35	74189	.50
7437	.20	74105	.48	74190	1.15
7438	.18	74107	.35	74191	1.15
7440	.18	74121	.35	74192	.50
7441	.59	74122	.39	74193	.79
7442	.35	74123	.39	74194	.85
7443	.55	74125	.50	74195	.69
7444	.60	74126	.50	74196	.80
7445	.50	74132	.75	74197	.75
7446	.59	74141	.35	74198	1.40
7448	.59	74145	.50	74199	1.25
7450	.18	74148	1.25	74S200	3.75
7451	.22	74150	1.35	74279	.65
7453	.18	74151	.50		
7454	.18	74153	.35		
7460	.18	74154	1.45		

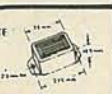
8000 (Signetics)
8263 2.95 8267 1.75 8281 .95

9000 Series
9601 .25 9602 .29

SOCKETS — LOW PROFILE, SOLDER TAIL

	ea		100
8 pin	.20	.18 pk-10	.16ea
14 pin	.25	.21 pk-10	.19
16 pin	.26	.22 pk-10	.20
18 pin	.32	.28 pk-8	.26
24 pin	.48	.45 pk-3	.38
28 pin	.65	.60 pk-3	.55
40 pin	.75	.70 pk-2	.63

MINIATURE SOLID STATE ELECTRONIC BUZZER



6V 15mA ± 1.5 4-9 VDC (OPER. V)

$1.25ea
10-24 1.00ea
25- .90ea

DIPSWITCH - 4 sw
8 pin DIP SPST

1-9 $1.65ea
10-24 1.55ea
25- 1.49ea

DIPSWITCH - 8 sw
16 pin DIP SPST
1-9 $2.10ea
10-24 1.95ea
25- 1.85ea

DIPSWITCH - 10 sw
20 pin DIP SPST
1-9 $2.20ea
10-25 2.05ea
25- 1.95ea

CERAMIC CAPACITORS

1pf 22pf 56pf 120pf 270pf .0047uf .030uf
5pf 27pf 68pf 150pf 390pf .001uf .01uf .050uf
7pf 33pf 82pf 180pf 470pf .0015uf .015uf .1uf
10pf 47pf 100pf 220pf 600pf .003uf .022uf
1pf - .050uf .1uf

Total	EA.	PK-10	PK-100	EA.	PK-10	PK-100
1-1000	$.20	$ .95	6.50	.25	1.25	9.00
1000-	.20	.85	6.00	.25	1.10	8.00

CERAMIC CAPACITOR KIT
CK-c2 5ea. of the above values $11.50
CK-c3 10ea. of the above values 20.50

POLYESTER FILM CAPACITORS - 100V ± 10%

	EA.	PK-10	PK-100		EA.	PK-10	PK-100
.001uf	$.15	.95	6.50	.033uf	$.20	1.00	10.00
.0015uf	.15	.95	7.50	.047uf	.20	1.15	10.50
.0022uf	.15	.95	7.50	.068uf	.25	1.30	12.00
.0033uf	.15	.95	7.50	.1uf	.30	1.75	13.50
.0047uf	.15	.95	7.50	.15uf	.35	2.25	14.00
.0068uf	.15	.95	7.50	.22uf	.40	2.55	20.00
.01uf	.15	.95	7.50	.33uf	.45	2.75	25.00
.015uf	.15	.95	7.50	.47uf	.50	3.50	30.00
.022uf	.15	.95	7.50				

TOTAL QTY. 1000 pcs. -10%, 5000 pcs. -15%

POLYESTER CAPACITOR KIT
5 ea of the above values $14.95

TANTALUM CAPACITORS solid dipped ± 20%

		10			10			10
.1uf/35V	.30	.25	4.7uf/16V	.38	.30	22uf/16V	.50	.40
.22uf/35V	.30	.25	4.7uf/25V	.45	.35	22uf/35V	.60	.55
.33uf/35V	.30	.25	6.8uf/6V	.35	.28	33uf/6V	.55	.45
1uf/20V	.30	.25	6.8uf/16V	.45	.39	33uf/10V	.60	.50
1.5uf/20V	.30	.25	10uf/20V	.42	.35	47uf/6V	.60	.50
2.2uf/20V	.35	.25	15uf/6V	.42	.35	47uf/15V	.65	.55
2.2uf/35V	.38	.28	15uf/20V	.50	.40	56uf/6V	.85	.75
3.3uf/35V	.40	.30						

TANTALUM CAPACITOR ASST.
5 ea. of above - $37.50

DISCRETE LED'S

JUMBO LED
.20"dia, diffused
Red, Clear or White 10/$1.00 25/$2.25 100/$8.00
Green or Yellow 7/$1.00 25/$3.25 100/$10.45
SUBMINITURE LED
.125"dia, diffused
Red or Clear 10/$1.00 25/$2.25 100/$8.00
Green or Yellow 7/$1.00 25/$3.25 100/$10.46

LED MOUNTING CLIP & RING
FOR .20" - JUMBO LED
10/$ 1.25
25/$ 2.75
100/$ 7.00

LED DISPLAYS

.4" ORANGE LED DISPLAY $1.19ea
7 segment RHD 10/$7.95
MAN4610 - common anode 25/$17.50
MAN4640 - common cathode 100/$65.00

.4" ORANGE overflow ±1 $.40ea
MAN4630 - common anode 10/$3.50

.3" RED LED DISPLAY $.99ea
7 segment RHD 10/$7.95
XAN72(MAN72 equiv) 25/$17.50
common anode 100/$65.00

.6" RED LED DISPLAY $1.25ea
7 segment LHD 10/$11.50
XAN6940 - common cathode 25/$26.50
100/$98.00

TRANSISTORS

	ea	pk/10	pk/25	pk/100	pk/1000
MPSA06	$.25	$1.65	$3.25	$12.00	$100.00
2N2222A	.45	3.50	8.00	29.00	265.00
2N3053	.55	5.00	11.75	45.00	420.00
2N3904	.25	1.65	3.25	12.00	100.00
2N3906	.25	1.65	3.25	12.00	100.00

DIODES

1N4148 (1N914) 400mw 15/$1.00 100/$5.00 1000/$40.00
1N4001 50PIV 12/$1.00 100/$7.00 1000/$60.00
1N4007 1000PIV 10/$1.25 100/$11.00 1000/$10.00

CMOS

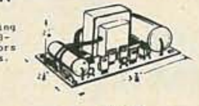
10% OFF ON $25.00
15% OFF ON $50.00

4000 Series CMOS

4000	$.25	4020	1.14	4050	.45
4001	.39	4021	.95	4051	1.15
4002	.25	4022	.95	4066	.79
4006	.95	4023	.30	4069	.39
4007	.39	4024	.75	4071	.29
4008	.95	4025	.22	4072	.39
4009	.46	4027	.59	4073	.39
4010	.45	4028	.85	4078	.39
4011	.45	4030	.49	4081	.39
4012	.25	4035	.95	4082	.30
4013	.59	4040	1.15	4518	1.25
4014	.95	4041	1.20	4528	1.50
4015	.95	4042	.95	4585	1.50
4016	.64	4043	.85	4901	.59
4017	1.08	4046	1.69		
4018	.95	4049	.45		

POWER SUPPLY KIT

+5V, +12V, +15V
A regulated power supply using a 115V/29V CT transformer, 3-LM140T and 3-LM120T regulators to supply the above voltages. Heat sink provided for +5V



PARTS INCLUDED
Transformer
6 regulators
PC board
4 diodes
Capacitor 1000 uf
Capacitor 500 f
3 Capacitors 10 uf

ea $17.50
10- 16.00
25- 15.00
+ shipping

CRYSTAL CONTROLLED TIME BASE KIT

PARTS INCLUDED
MM5369 divider
4049 buffer
2-4018 counter
3-12pf var. cap
47pf cap
.1uf cap
2-10Mohm res
1Kohm res
3.57954 mhz crystal
PC board (1 5/8" X 3")

Produces accurate 1hz, 10hz and 60hz outputs--three of the most popular frequencies for any piece of test equipment.

$15.50ea
10-24 13.75ea
25- 12.50ea

CARBON FILM RESISTORS,

CARBON FILM ±5%
1/4watt (R.Ohm R25) 1/4 & 1/2 watt
.095"dia X .250"long (body)
1/2watt (R.Ohm R50)
.146"dia X .354"long (body)

PRICING

total quantity	ea	pk-10	pk-100	pk-1000
1-999	$.10	.45	2.00	
1000-	.10	.40	1.80	15.00
5000-	.10	.30	1.70	14.50
10000-	.10	.25	1.55	13.00

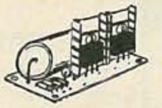
25 or more resistors - not individually packaged - mixed - specify any assortment of values $.04ea

VALUES STOCKED (ohms)

.5	3.9	16	68	300	1.2K	5.1K	22K	91K	390K	1.6M	*6.2M
1.0	4.3	18	75	330	1.3K	5.6K	24K	100K	430K	1.8M	*6.8M
1.1	4.7	20	82	360	1.5K	6.2K	27K	110K	470K	2.0M	*7.5M
1.2	5.1	22	91	390	1.6K	6.8K	30K	120K	510K	2.2M	*8.2M
1.3	5.6	24	100	430	1.8K	7.5K	33K	130K	560K	2.4M	*9.1M
1.5	6.2	27	110	470	2.0K	8.2K	36K	150K	620K	2.7M	*10M
1.6	6.8	30	120	510	2.2K	9.1K	39K	160K	680K	3.0M	*11M
1.8	7.5	33	130	560	2.4K	10K	43K	180K	750K	3.3M	*12M
2.0	8.2	36	150	620	2.7K	11K	47K	200K	820K	3.6M	*13M
2.2	9.1	39	160	680	3.0K	12K	51K	220K	910K	3.9M	*15M
2.4	10	43	180	750	3.3K	13K	56K	240K	1.0M	4.3M	(* 1/2w only)
2.7	11	47	200	820	3.6K	15K	62K	270K	1.1M	4.7M	
3.0	12	51	220	910	3.9K	16K	68K	300K	1.2M	5.1M	
3.3	13	56	240	1.0K	4.3K	18K	75K	330K	1.3M	5.6M	
3.6	15	62	270	1.1K	4.7K	20K	82K	360K	1.5M		

VOLTAGE REGULATORS

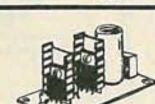
LM320T-5	Negative 5 V reg (7905)	1.19
LM320T-12	Negative 12 V reg (7912)	1.19
LM320T-15	Negative 15 V reg (7915)	1.19
LM340T-5	Positive 5 V reg (7805)	1.19
LM340T-8	Positive 8 V reg (7808)	1.19
LM340T-12	Positive 12 V reg (7812)	1.19
LM340T-15	Positive 15 V reg (7815)	1.19



REGULATED POWER SUPPLY KIT PS-2

Uses +5V and +12V TO-220 regulators Kit includes PC Board(1 11/16" X 3"), Rectifiers, 7805 & 7812 Regulators, Capacitors & Heat Sinks. Transformer not included. Fits PCB slots of Hammond Case 1591DGY.

$6.00ea
10- 5.50ea
25- 5.00ea



REGULATED POWER SUPPLY KIT PS-3

Uses +5V and +12V TO-220 Regulators. Kit includes PC Board (1 1/4" X 2 3/8"), Rectifier Bridge, 7805 & 7812 Regulators, Capacitors and Heat Sinks. Transformer not included. Fits PCB slots of Hammond Case 1591CBU

$7.50ea
10- 7.00ea
25- 6.50ea

METAL FILM RESISTORS,

METAL FILM ±1%
RN60 (R.Ohm CRB60FY) 1/4watt 1/4 watt
Low temp coef - 50ppm/°C
.138"dia X .355"long (body)
color banded

total quantity	ea	pk-10	pk-25	pk-100	pk-250
1-999	$.25	1.00	2.00	7.50	17.50
1000-	.20	.90	1.80	7.00	16.25
5000-	.20	.85	1.70	6.50	15.00
10000-	.20	.80	1.55	6.00	13.75

10 or more resistors - not individually packaged - mixed - specify any assortment of values $.15ea

VALUES STOCKED (ohms)
Standard 1% metal film values from 10 ohm to 475K ohm

10.0	12.1	14.7	17.8	22.6	27.4	33.2	40.2	48.7	59.0	71.5	86.7
10.2	12.4	15.0	18.2	23.2	28.0	34.0	41.2	49.9	60.4	73.2	90.9
10.5	12.7	15.4	18.7	23.7	28.7	34.8	42.2	51.1	61.9	75.0	93.1
10.7	13.0	15.8	19.1	24.3	29.4	35.7	43.2	52.3	63.4	76.8	95.3
11.0	13.3	16.2	19.6	24.9	30.1	36.5	44.2	53.6	64.9	80.6	97.6
11.3	13.7	16.5	20.0	25.5	30.9	37.4	45.3	54.9	66.5	82.5	
11.5	14.0	16.9	20.5	26.1	31.6	38.3	46.4	56.2	68.1	84.5	
11.8	14.3	17.4	22.1	26.7	32.4	39.7	47.5	57.6	69.8	86.6	

and multiples of 10 of the above values to 475K
i.e. 10.0 100 1.0K 10.0K 100K etc (total 448)

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LM308CN	.45	LM703CN	.39
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LM310CN	.75	LM710N	.45
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LM318CN	1.45	LM723N	.49
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LM320K-5.2	.95	LM741CN	.29
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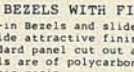

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color banded

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11.0	30.1	84.5	475	1.96K	5.49K	11.5K	21.5K	33.2K	60.4K	150K	348K
11.5	31.6	90.9	487	2.05K	5.76K	12.1K	22.1K	34.8K	64.9K	158K	374K
12.1	33.2	100	499	2.21K	6.04K	12.4K	22.6K	36.5K	68.1K	165K	402K
13.0	35.7	107	604	2.43K	6.49K	12.7K	23.2K	37.4K	69.8K	174K	432K
14.0	37.4	121	649	2.49K	6.81K	13.0K	23.7K	39.2K	75.0K	182K	453K
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15.0	43.2	137	750	2.87K	7.50K	14.0K	24.9K	41.2K	82.5K	200K	475K
16.2	45.3	150	909	3.01K	8.25K	14.7K	25.5K	43.2K	90.9K	205K	1M
17.4	47.5	165	1.00K	3.16K	8.66K	15.0K	26.1K	45.3K	95.3K	210K	
18.2	49.9	191	1.02K	3.32K	9.09K	15.4K	26.7K	46.4K	100K	221K	
19.1	54.9	200	1.10K	3.57K	9.53K	16.2K	27.4K	47.5K	105K	232K	
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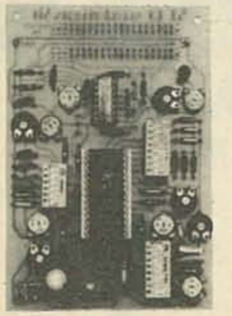

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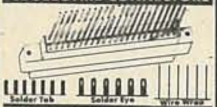

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