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SEPTEMBER 1981 Vol. 52 No. 9

ON THE COVER

A reverberation system adds a sense of realism to any hi-fi system by duplicating the echoes associated with large concert halls. The reverberation device described in this issue is based on analog bucket-brigade IC's and it expands your listening room into a full-sized concert hall. The construction details start on page 43.

LISTENING TO A SCANNER receiver is becoming a popular pastime. This month we look at programmable scanners starting on page 53.

3D TELEVISION is just one of the amazing products that we describe. All are close to commercial introduction. Take a close look at this and other products starting on page 49.

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VIDEO ENTERTAINMENT

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

DIGITS AND BROADCASTING

It probably will be a long time before home television goes digital, but everything in the broadcast chain except transmission to the home could be digitized sooner than you might think. Digital VTR's already are practical, and their commercialization awaits the establishment of standards. For worldwide networking of programs, international standards committees are very close to a single standard that would make all the world's color-TV systems compatible so far as "trunk" transmission by satellite is concerned.

The preoccupation with digital television stems largely from the fact that the quality of the picture would not deteriorate with repeated taping, transmission for long distances, and other signal processing during the pre-broadcast chain of events. CBS engineers have embarked on a major program to digitize the television picture from original production virtually to the transmitter, coverting it to a standard analog picture just before its transmission to homes. One of the major tasks before inter-city digital transmission becomes practical is to reduce the bandwidth required. CBS has already sliced the number of digital elements in the TV picture from 144 to 29 megabits with little sacrifice in picture and sound quality, and is working towards further reduction. CBS believes that television production in the studio can be digitized in as little as two years. It also forecasts that theatrical movies will be made with high-definition electronic digital techniques in four to five years, with a high-definition direct satellite-to-home broadcast system possible before the end of the decade.

REVOLUTIONS IN SOUND

While CBS is working towards digital TV, it's not nearly so optimistic about digital phonograph records, despite the fact that the Philips-Sony Compact Disc laser optical digital sound system is scheduled to reach the American market in 1983. CBS officials feel that digital turntables and discs will be far too expensive for the foreseeable future—perhaps 10 or 15 years—to make them mass-market products. Instead, CBS is pushing its CX (for "compatible expansion") noise-reduction system for records. CBS claims CX is completely compatible—that is, records made with the CX technique can be played satisfactorily on standard equipment, and there is an 85-dB signal-to-noise ratio when the record is played through a CX decoder. A-B comparisons with digital tape give the CX system extremely high grades, many experts being unable to tell which was which.

At press time, CBS was already releasing CX-encoded discs, and Warner Records had agreed also to use the process. Five small manufacturers were preparing to market decoders for about $100, and CBS expects most major Japanese amplifier manufacturers to announce amplifiers with built-in decoders next January.

At the same time, many manufacturers are preparing to market the Compact Disc (CD) digital turntables. Sony, Philips, Pioneer, Matsushita (Panasonic, Quasar, Technics), Nippon Columbia (Denon), Sanyo and Mitsubishi have indicated they expect to have players on the market. Although European and Japanese record makers say they'll produce the 4.7-inch hour-per-side discs, no American record manufacturers had been heard from at press time. Turntables initially may sell for as much as $800; discs will be priced in the high-premium area.

STEREO TV

Stereo is also the wave of the future for television. The 1982 lines in both large-screen direct-view and projection sets show an increasing preoccupation with stereo. Several brands have added stereo amplifiers and dual-speaker systems with input jacks for stereo videodiscs or TV-FM simulcasts. Those new sets, of course, will be the natural companions for the new stereo VCR's. In the next two years, we'll see increasing emphasis on television sets with stereo sound capability. While they'll be suited for stereo VCR's and stereo videodiscs (RCA will add a stereo disc player model next spring), they're actually anticipating the advent of stereo-sound telecasting here. Currently in the field-test stage, stereo TV could be approved by the FCC as early as next year. The new stereo-sound sets will require adaptors to receive stereocasts, of course—but more important to the set makers is the ability to add minor circuitry or an IC to those models and be ready when stereo TV actually starts. R-E

WHAT'S NEWS

Indiana appellate court O.K.'s radar detectors

An Indiana appeals court has ruled that the State's portable police radio law does not apply to radar detectors. Enforcement of the law has been said to have been erratic over the past two years, and some motorists' radar detectors have been confiscated by the police.

The appellate decision called the law "unconstitutionally vague," and ruled that "a law forbidding or requiring conduct in terms so vague that persons of common intelligence must necessarily guess at its meaning and differ as to its application violates due process of law."

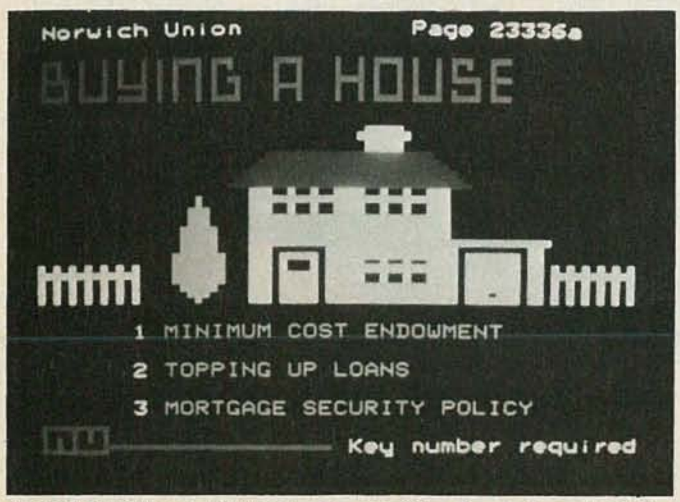
It is expected that the Indiana decision will be cited in several other state courts where police radar and scanner laws are being applied to radar detectors, even though the laws were passed before police radar existed.

British teletext group files proposal with FCC

The United Kingdom Teletext Industry Group has requested the FCC to begin a rule-making procedure to allow use of the British "defined format" teletext system in the United States. That system, widely used in Europe, is said to have two critical advantages over the rival variable-format approach. The decoders are inherently simpler and less costly, and the defined format is more resistant to disruption by multipath transmission and interference. The system proposed by the British group is also compatible with the Canadian Telidon system and with line-21 captioning for the deaf.

Teletext will allow the viewer to use his TV receiver as a newspaper, shopping guide, or educational tool.

The British group put on an extensive display of their system and equipment at the National Association of Broadcasters convention in Las Vegas last April.



A PAGE OF BRITISH TELETEXT guides television viewers through details of home loan plans.

Remedial reading programs available for the *TRS-80*

The Radio Shack Division of Tandy Corp. has entered an agreement with the Philadelphia School District to convert to the *TRS-80* microcomputer two minicomputer-based reading programs developed by the Philadelphia schools for students with reading difficulties. Radio Shack will distribute the programs, known as Computer Assisted Reading Development (CARD) and Systems Approach to Basic Reading Education (SABRE).

The Philadelphia reading programs are designed to provide individualized, self-paced reading instruction, and are based on established Computer Assisted Instruction (CAI) techniques for using computers to supplement and reinforce regular classroom instruction. They are intended to encourage positive attitudes toward learning, language, and reading in students, and to provide non-threatening, positive reinforcement in private sessions taken at the computer.

The Philadelphia system was originally developed about 10 years ago, for selected students who were reading below grade level. The programs have been improved and revised continuously since then, and researchers have recorded consistent gains as a result of their use.

The new *TRS-80* reading series is expected to be available by September 1981.

"Cottage industries"

"Louise Priester," states a recent article in the New York Times "used to key-punch insurance claims into a computer in the office of Blue Cross-Blue Shield of South Carolina. Now, she does the same thing from a bedroom in her home, using a terminal connected to the office computer by the telephone line."

Thus the Times points out a new possibility for employment that can open the way for many who because of physical handicaps, young children, an invalid in the house who requires constant care, or other reasons, cannot readily leave the home. Mrs. Priester is an example: she had to stay home to take better care of her elderly mother.

One problem for employers is to control out-of-sight employees—to make sure they put in a full day's work. The very nature of the work, however, often makes it possible to operate on a piecework basis, as in the old cottage industries. Blue Shield of South Carolina says its four "cottage keyers" process claims at a lower cost than office keyers.

While requiring workers to be in the office during the day, the FMC Corp of Chicago has installed terminals in the homes of four programmers who are on call at night to handle problems. "They used to get a phone call," says FMC manager R. M. Copella, "hop in the car, drive 45 minutes to the office, solve the problem in 15 minutes, than take 45 minutes to drive home. Now they can handle most of the problems in their pajamas."

Japan to invade U.S. microcomputer market

Japan will "undoubtedly" repeat in the microcomputer market what it has done in the U.S. automobile and consumer electronics markets. Consequently, it is "inevitable" that Japanese microcomputers will be appearing in significant numbers in 1981, and that the superior Japanese quality will ultimately hurt the American manufacturers considerably more than Japanese cost-cutting.

Thus states a report, *Retailing Personal Computers*, produced and sold (for $950.00 a copy) by Strategic Inc. of San Jose, CA.

At present, the report states, the Japanese feel that the main reason their products are not reaching the United States sooner is that FCC regulations will require that they retool to make products that meet U.S. standards (There are no RFI standards in Japan).

Hand-held models are expected to be an important new product. Tandy was first to sell this type (made by Sharp in Japan) at $250, but Strategic Inc. expects to see Sharp, Quasar, and Panasonic models by the middle of 1981.

Incidentally, Apple, Commodore, and Radio Shack products, are all being sold in Japan. Their market is decreasing, however, because of high prices and because the Japanese microsystems offer printers with Japanese as well as English characters, something the Americans do not supply.

Tronics 2000 established in ten metropolitan markets

Ten metropolitan areas in the United States are now under development by Tronics 2000, according to R. W. Lay, Tronics' Director of Internal Operations. Tronics 2000 is a new franchising corporation that aims at giving the independent electronic-ser-

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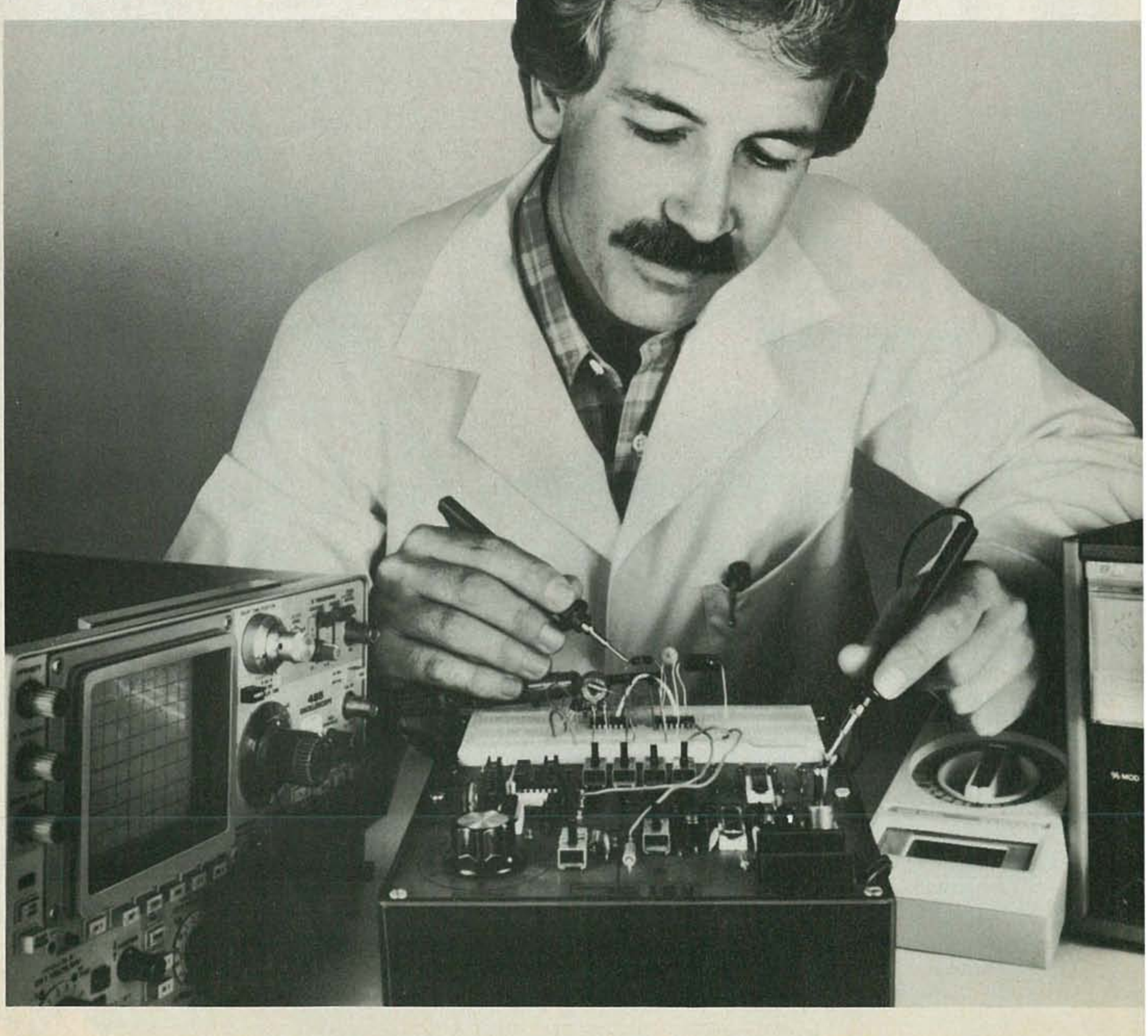

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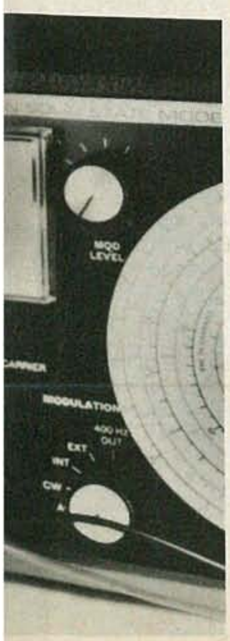

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WHAT'S NEWS

continued from page 6

vice-shop owner the prestige that small business proprietors in other fields have achieved through national franchise organizations. (See the March 1981 ("What's News") and April 1981 issues of **Radio-Electronics.)**

The areas now under development include a population of roughly nine million persons. They are Dallas, Minneapolis/St. Paul, sections of Chicago, Cleveland, Cincinnati, Louisville, Tampa/St. Petersburg, Orlando, Sarasota, and Daytona Beach. Those areas could support approximately 100 service centers, Mr. Lay believes.

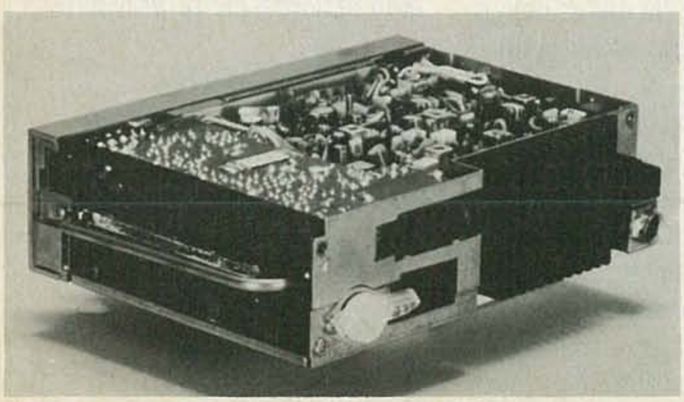
Newest car stereo has liquid cooling system

"An auto stereo system that's so hot it has to be water cooled," says Toyota of its new stereo radio for compact cars. The company further claims that the new radio's sound is "just short of a live rock concert or symphony orchestra."

The new system is standard on 1981 Cressida models and optional on Coronas. It is the industry's first use of a "heat-pump" cooling system, similar to an engine's radiator. Fluid moves through tubes surrounding the radio and four separate amplifiers. Each amplifier drives one of four speaker channels, at a rate of 10 watts per channel.

"The heat pump was found only on the finest home stereo sets until this automotive unit was developed," reports a Toyota spokesman. "The added cooling allows increased power and vastly improved sound on a chassis small enough to fit in a subcompact car."

Along with the heat-pump cooling system, the radio has several other features normally found only on home receivers. A quartz synthesizer locks directly onto broadcast frequency channels. Tuner transistors adjust for constantly changing automotive reception conditions. Other circuits suppress radio interference noise. Touch-tuning also is used.



TOYOTA'S NEW LIQUID-COOLED CAR STEREO SYSTEM.

1,125-line video system is developed by Sony

A new high-standard video recording and playback system was demonstrated recently in Tokyo by Sony Corp. Its 1,125-line, 60-field system, with a bandwidth of about 30 MHz, can handle more than five times as much information as the present standard NTSC system, with its 525 lines and bandwidth of 4.2 MHz.

The high-definition video system (HDVS) has three channels, processing the red, blue, and green signals separately from camera input to video output. The bandwidth is about 30 MHz for each of the three color channels.

The 1,125-line system consists of a high-definition 3-tube TV camera, using the new 1-inch Saticon pickup tube developed and patented by the Japan Broadcasting Corp (NHK); a 1-inch wideband RGB videotape recorder, using a new high-density recording format, and a wideband digital time-base corrector, using a new wideband analog-to-digital converter.

The high-definition system, which produces quality at least equal to that of 35-mm movie film, is expected to change the production and distribution of motion pictures dramatically in the near future, much as high-quality sound tape changed the technology of phonograph disc recording. It has the same advantages of repetitive recording and playback for on-the-spot preview and trial editing. That will reduce production time, film consumption, developing, and other costs greatly.

Not only is a revolution in film production expected, but the system has applications in film distribution, satellite broadcasting, cable TV, and optical fiber transmission.

Utah approves police radar—also "fuzz detectors"

In their Spring 1981 session, Utah legislators defeated both a bill seeking to curtial the use of police radar on the highways, and one to prohibit Utah motorists from equipping their cars with radar detectors. Thus in the same session of the Legislature they gave tacit approval to highway radar and to attempts to neutralize it.

The bill to prohibit radar detectors was defeated 45 to 21, on the basis of probable unconstitutionality. The Communications Act of 1934 prohibits states from legislating in the area of radio reception, and thus covers radar detectors, which are receivers. Difficulty of enforcement was another factor that contributed to the defeat of the radar-detector bill.

The bill intended to curtail the use of police highway radar was defeated in the Utah Senate, with a vote of 18 to 9.

Visual-display terminals pose no radiation problem

Visual-display terminals (VDT's) are safe, the president of the Computer and Business Equipment Manufacturers Association told a Congressional committee.

The president, Vico E. Henriques, pointed out to the subcommittee on Investigation and Oversight of the House Committee on Science and Technology that a recent Food and Drug Administration report shows that radiation from VDT's is well within the existing international, federal, and state guidelines.

His industry, said Mr. Henriques, has been sensitive for years to the need of keeping RF radiation extremely low. Not only does human health and safety require it, but many of the association's products are used close to equipment which is also highly sensitive to RF. He mentioned communications equipment as an example, and also mentioned that some display terminals are used in militarily secure areas where RF radiation could reveal the presence of an installation to enemy forces or espionage agents. Designing safeguards against those problems, he said, resulted in RF radiation levels so low that no significant biological effects are anticipated.

Ray-O-Vac now making lithium batteries

Under the terms of an agreement with Matsushita Electric Industrial Co., Ray-O-Vac Corp is granted a non-exclusive license to make, use and sell lithium batteries produced under the Matsushita patents on carbon monofluoride lithium cells. The 10-year agreement also includes technical collaboration between the two companies.

Ray-O-Vac has also announced its introduction of three coin-size lithium-carbon-monofluoride batteries—BR2016, BR2320, and BR2325. They have a nominal voltage of 3.0 and an energy density five times (in some cases ten times) higher than conventional units of similar weight.

The high energy density of these batteries makes them an ideally suited power source for electronic watches, calculators, measuring instruments, and computer memory back-up power, as well. R-E

EDITORIAL

How Do You Stay Number 1?

The most important part of staying on top of the electronics industry is to be the first to know about new events that will shape the future of electronics. That's an easy rule to make, but it's not nearly as easy to make it work. It is, however, the kind of rule that we live by and it has made it possible for **Radio-Electronics** to bring its readers the first TV Typewriter in September, 1973; the first Build Your Own Computer in July, 1974; the first Build Your Own Satellite TV Receiver in February, 1980; and the first Build Your Own Robot in August, 1980.

What's next? That's our secret. To find out you must read every issue of **Radio-Electronics** or you're going to have to travel along with us, in person, as we tour the world in search of the latest developments in the electronics industry.

For example, in October we are taking a trip that will encompass the Japan Electronics Show in Osaka; the Korea Electronics Show in Seoul; the Taiwan Electronics Show in Taipei; and the Hong Kong Consumer Electronics Show. We've already been to both Consumer Electronics Shows in the United States (they were held in Las Vegas in January and Chicago in June). We've also attended the Electronic Distribution Show in Atlanta; Electro-81 in New York; numerous computer shows and Hamfests in various locations throughout the country and we will be showing up at Wescon in San Francisco this month.

These are the places we go to see what will be next in electronics. These are the places where we get the input we need to decide what kinds of articles we are going to bring you next year. These are the places we meet the authors who are going to present those articles. These are the places we go to stay on the top of the heap.

What's next in electronics? More than we both can imagine! There's digital audio on a miniature disc scanned by a solid-state laser, Teletext/Teleview, flat-screen TV (shirt-pocket size), wrist computers, two-way TV, 3D TV, an entire TV set on a single IC, direct satellite-to-home TV reception and who knows what else.

But when that story breaks, we will be there. We will learn everything there is to find out and bring it to you as quickly and as accurately as possible. That's our job and we believe we do it best. We made **Radio-Electronics** must reading. We intend to continue doing just that!

Art Kleiman

ART KLEIMAN
Managing Editor

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LETTERS

WRONG ADDRESS

The address given for Design Specialty in the Lumitron-4 Light Sequencer article in the June 1981 issue of **Radio-Electronics** is wrong.

The correct address is: Design Specialty, 15802 Springdale St., Suite 80, Huntington Beach, CA 92649.
DAVID L. HOLMES

OOOOOOOPS!

I believe that there are several errors and inconsistencies in the article, "$60 Modem" (**Radio-Electronics,** June 1981). It appears as if changes were made to the parts list and parts-placement diagram, but those changes were not carried through to the other diagrams.

The parts-placement diagram lists no less than three R39 resistors: one within the dotted-line box at the lower left (call that one A); one between pins six and seven of IC2 (call that one B), and the last one hangs off pin one of IC2 (call that one C).

From the circuit diagram (Fig. 3), R39-C clearly should be R25; that's supported by the fact that R25 is entirely missing from the parts-placement diagram.

The other two R39's are both described in the parts list. Let us allow one (my R39-B) to remain R39 at 22K ohms. That leaves the last one, R39-A, which is described correctly as 10K. Let R39-A become R40, and I believe that our problems are solved.

To correct the other diagrams: in Fig. 2, the input from the answer filter should read "FROM-R40," and note that R25 is correct as output from the first stage of the originate filter. In Fig. 3, R39 in the upper left should be R40 (input to answer filter) and the R39 in the lower left is correct. R39 in Fig. 9 should also read R40.

Please continue to present us with the fine and useful articles that you have published in the past. An occasional typographical error will get by you—no one's perfect—but you have a lot of people out here willing to make final corrections. And sometimes, as with my own experience with this "modem" article, I find that I have benefitted more than had it been 100% correct.
MICHAEL D. HOFER,
Hicksville, NY

ANTI-RADAR WEAPON

The ever-increasing pollution of our highways with police radars, and the numerous local court decisions against American motorists who are ignorant of the workings of such devices, threaten to lead to the same state of lawlessness that our historical West became so famous for. As in old times, vigilantes have begun to organize, and have already found a famous scientist as their mentor: *Heinrich* Hertz. His celebrated, spark-excited wideband microwave source is the ideal ECM

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LETTERS

continued from page 16

tool against the shiny, over-expensive, tax-financed fetish of our much-underutilized police forces.

Today, Uncle Heinrich would take an old coffee can and cut it into two halves along its axis. He would mount into one of them, as a lamda-half dipole, two small nails (the more rusty, the better), and power that beam-forming contraption with an ignition coil from a junked car. Throw the switch and—victory! The ultimate anti-radar weapon in the battle on the roads is in full operation!

If Uncle Heinrich were to enter a state that outlaws such devices, he would simply say that he was re-checking his discovery.

Radio-engineers, amateurs, tinkerers—where has your pioneering spirit been in all these years since the first highway radar toys appeared?
REINHOLD GERHARZ,
Fort Belvoir, VA

Z-80 TRAINERS

In the article, "Learning About Microprocessors," by Jorma Hyypia (**Radio-Electronics,** May 1981), the author states that there are no Z-80 trainers on the market. I think that is wrong.

SD Systems makes a very good microprocessor trainer and development system, called the Z-80 Starter System. It contains a hexadecimal keyboard; Z-80 microprocessor; Z-80 parallel interface; Z-80 counter-timer circuit; tape interface; two S-100 sockets; wire-wrap area, and an EPROM programmer.

Please let your readers know that they *can* have the best microprocessor on the market in a trainer that not only trains but lets them do it with style.
ROBERT SMITH,
Michigan City, IN

UNICORN-1 ROBOT

Here's a picture of the Unicorn-Robot 1 that I am building. It's a close-up of the manipulator I designed and built. The "fingers" of this end effector are parallel, and open or close by moving toward or away from each other. This type of end

effector gives my robot a better grip than those originally described.

I think your magazine is fantastic, and I look forward to it every month.
MALCOLM P. STOCKINGER,
Ypsilanti, MI

If you're building the Unicorn-One robot (or any other) I have a suggestion about assembling the upper arm.

On the first crossbar rod, where the threaded rod fits, don't drill the hole all the way through. Instead, drill it to a depth of about $^5/_{16}$ inch. File the end of the threaded rod smooth and, before inserting it, drop a small steel ball in the hole. Be sure to leave a $^1/_{32}$-inch or so space between the gear and the crossbar rod. Then, when the assembly is pulled down by the weight of that lower arm, the rod will spin much more easily, and will take considerable strain off the motor, as the steel ball will act as a bearing.

That's a lot less trouble than trying to fit a regular ball bearing on the crossbars and much better than a plain hole.
A.M. FALCETANO,
APO NY 09026

NEW COMPUTER CLUB

My name is Scott Summer. This letter is to inform your readers of a new computer club that I am forming in Rhode Island. Our club publication will be titled The National Apple Newsletter and it will be for owners and users of *Apple II* or *Apple II Plus* computer systems.

The newsletter will print anything that

continued on page 26

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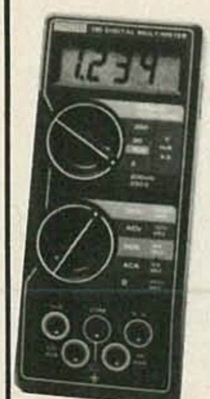

$125.

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

CALL US FOR OUR LABOR DAY SPECIALS!

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our members demand, from Pascal programs to home-control, computerized alarm systems, and other practical applications.

We hope to hold meetings monthly at members' homes. Club dues have not been set as yet, as we must find our first how many people are interested in the club. We need ambitious, eager people and welcome all inquiries.

SCOTT SUMMER,
The National Apple Newsletter,
27 Leicester Way,
Pawtucket, RI

RADAR DETECTORS

I would like to reply to the letter in the June 1981 **Radio-Electronics** by Mr. Delton T. Horn. Your magazine is quite excellent, and has no reason to apologize for anything he has commented upon. (1) Computerized ticketing—Big Brother would love that one—its sounds like something that Hilter would have produced. (2) Radar detectors—they have not been shown to be foolproof, and are indeed subject to errors and abuse. Police, being all to human, are all too capable of using radar for harrassment, speed traps, etc. Since the courts tend to view radar evidence as gospel, our only defense is offense: radar detectors. Also: a receiver is still a receiver, whether it provides communication or not. (3) Pay-TV decoders. Since they are still legal, **Radio-Electronics** has every right to publish anything about them.

I, too, am a concerned electronics technician. My concern is with the government taking more and more control over my life. The "irresponsibility" lies in too much big government.

MARK A. RECOB,
Madison, WI

I agree with your comments. However, pay-TV decoders have been ruled to be illegal devices by several courts. Thus, to make the situation worse, decoders are legal in some states and illegal in others.—Editor

SUPER TWIN LEAD

In reference to Mr. Dennis C. Brown's informative article, "How to Improve UHF Reception," in the July 1981 **Radio-Electronics,** is it possible that neither he nor the Georgia Tech group know of a type of twin lead made by Belden (Belden type 8235), which is rated at 2.2 dB losses per 100 feet at 400 MHz? I believe that the loss is less than 4 dB at 800 MHz. It is 1-kilowatt transmitting lead made primarily for hams, but the cost is about that of shielded UHF lead. I have used it for years and receive 100-mile distant stations on a VHF-UHF antenna. Best of all, it is not affected by rain!

PRESTON C. RICE,
Birmingham, AL

AUDIO-SIGNAL RESTORATION UNIT

After consultation with Mr. Joseph Gorin about his article, "Audio-Signal Restoration Unit" (**Radio-Electronics,** April 1981), I would like to alert those who are building the unit from their own parts stock (as opposed to the prepackaged kits): The unit will *not* work when 4739 preamplifier IC's are substituted for the 739 units required. Many retailers are shipping 4739 IC's from Exar or Raytheon when 739's are requested. Fairchild is the only manufacturer making the 739 at the present time. Using the 4739 will elicit correct operation of the noise-filter part of the circuit—but only silence from the expander!

ALAN J. FRIDLUND,
Martinez, CA

ROBOT-BUILDERS' CLUB

I am hoping to start a club in northern New Jersey/New York City/Long Island for anyone interested in building robots or working with them. I would like to make a list of all the people in those areas who are interested in joining such a club.

Even if you are too far away to attend a meeting, please get in touch with me. At a later time, there might be a club in your area to which I could steer you.

For the presently proposed club, there is as yet no meeting time or place, but we shall probably choose a location in New York City and meet on a week night.

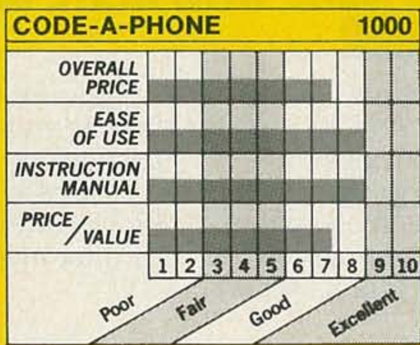
If you have any questions or problems with robots, please write to me; I might be able to help.

DAVID SMITH
4505 Kennedy Blvd.,
North Bergen, NJ

R-E

EQUIPMENT REPORTS

Ford Industries Code-A-Phone 1000 Telephone-Answering Machine



FOR YEARS TELEPHONE-ANSWERING MACHINES were used only by businessses, and usually leased from local phone companies. Now privately-owned telephone-answering devices are becoming more common every day.

Certainly among the most easy-to-install—and use—telephone-answering machines is the *Code-A-Phone 1000*, from Ford Industries, Inc. (5001 S.E. Johnson Creek Blvd., Portland, OR 97222). Although the *Code-A-Phone 1000* is their bottom-of-the-line unit, with a suggested retail price of $139.95, it has features not found on more expensive units made by other manufacturers.

The *Code-A-Phone 1000* operates on AC power (it uses a UL-approved wall-plug transformer), so you don't need to worry about dead batteries. It uses a modular plug to connect to the phone line (the connection is FCC-approved). If you have the older 4-prong jacks, adapters are available from Ford Industries or your local electronics store.

The beige plastic *Code-A-Phone 1000* case has brown trim and silver knobs. The entire unit weighs only five pounds, and measures 12 × 9 × 3½ inches. All controls are "human-engineered" for very simple use. Both the wall-plug transformer and the modular phone plug are at the ends of cables that are longer than six feet each, so you should have no difficulty in finding a suitable location for the unit.

Among the unexpected features for a low-price telephone-answering machine are a call-counter, ring selection, built-in microphone, variable announcement length, selective mes-

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EQUIPMENT AND TRAINING NO OTHER SCHOOL CAN MATCH.

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Simulated TV Reception

4.

3.

EQUIPMENT REPORTS

continued from page 27

sage erase, auto-stop, fast-forward, and a monitor. Let's discuss those in turn.

Most answering machines in the low-price range don't have a call-counter, although some indicate when the unit has received at least one message, using a "flag" or a light. The *Code-A-Phone 1000* has a window at the top of the unit through which you see a number (0–20). If you've received four calls, for example, the number shown is 4. The counter also tells you which call you're listening to on playback.

The ring-select feature allows you to choose which ring activates the device, from the first to the fourth, using a simple screwdriver adjustment located at the bottom of the unit. This feature lets you leave the *Code-A-Phone 1000* on most of the time, with the option of answering personally if it is convenient. To do that, set it to answer on the third or fourth ring. On the other hand, if you'll only be using the unit when you're away, set it to answer on the first or second ring.

The built-in condenser microphone makes it easy to change your outgoing message, and eliminates another plug and cord as well as the danger of losing the microphone.

Since it is so easy to change, the *Code-A-Phone 1000* allows you to set the length (in seconds) of the outgoing message. That eliminates having to "fill" a predetermined time period, or to have a long silence after your outgoing message before the tone signals the caller to start talking. The *Code-A-Phone 1000* outgoing announcement can be set for 5, 10, 15, or 20 seconds with a well-marked lever control, and is easily reviewed using the CHECK function on the main selector knob.

A source of confusion on many answering machines is the "old" messages. New messages, of course, automatically erase old ones as they record. But if previously you had, say, seven old messages, but only three new ones this time, the last four of the old messages are still on the tape. As you play back your messages, you can hear a message that was recorded days or weeks before and not realize it's an old message, since people rarely identify the time or date of their call. With the *Code-A-Phone 1000*, you can hold down the REWIND and MESSAGE ERASE key-type pushbuttons at the same time, erasing all messages back from that point on the tape. You can also erase while in the fast-forward mode.

Most answering machines have a fast-forward control, so that on playback of your messages you can quickly move ahead past short messages or calls where people hung-up without leaving any message. A nice feature of the *Code-A-Phone 1000* push-button FAST-FORWARD switch is that it only needs to be pressed and released. It latches, moves ahead to the next message, and resumes normal speed automatically. If you wish, you can hold it down and move forward to whatever message you wish by watching the counter advance.

To monitor incoming calls, just turn up the volume control and you can hear the caller speaking. If you wish to speak directly to the caller, just pick up your telephone handset; it is not necessary to turn off the *Code-A-Phone 1000*. The *Code-A-Phone 1000* will record both sides of the conversation until it shuts off. (Incoming message length is fixed at 30 seconds, for 20 messages total.) Your caller will have no trouble hearing you (although your voice's volume level will be a little below normal). When the *Code-A-Phone 1000* turns off, continue your conversation normally.

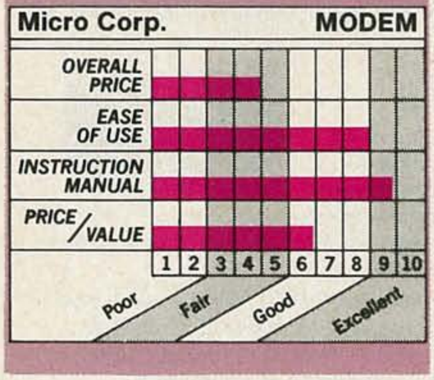
Using the *Code-A-Phone 1000* is easier than using any answering machine I've owned previously, and I've had several. When you leave the house, just move the main control knob to ANSWER—that's all! When you return, if the counter has not advanced, just turn the main control knob to OFF. If the counter *has* advanced, move the control to PLAYBACK, press the REWIND key until the counter is back to where it was when you left (usually at zero) and press the START button. Unlike some machines, only the incoming message is heard; you do not have to listen to your outgoing message over and over. Since the *Code-A-Phone 1000* has automatic level control on record, you do not need to adjust the volume control when you leave.

The booklet that accompanies the *1000* is very easy to follow, with large well-labeled photos and step-by-step instructions.

The only suggestion I could make to improve the *Code-A-Phone 1000* would be to add a small light to show when the unit is in the standby condition (answer or playback). That condition is easy to overlook, since the round control knob has only a short pointer line to indicate position, and the line is not visable from a distance. I added an LED to mine, and now I can tell from across the room when the unit is on. However, be aware that if you make this change yourself, you could void the 90-day labor and 1-year parts warranty on your *Code-A-Phone 1000*. **R-E**

The Microperipheral Corporation Microconnection Modem

CIRCLE 102 ON FREE INFORMATION CARD



A WHOLE NEW AREA OF INTEREST IS OPENing in the personal computing field—telecommunications, the transfer of computer data over telephone circuits. With a terminal or computer and a modem to interface it to a telephone line, you can transmit electronic mail in the form of letters or messages using computerized community bulletin boards and acquire material from time-sharing services. You can have access to computerized data bases, up-to-date news from the wire services, financial information, and stock market data. You can, in effect, have your computer talk to another computer!

If you have a Radio Shack *TRS-80* you would normally need an expansion interface with an RS-232 serial interface and a modem to join the telecommunications world. That would cost almost $600. (And a lot more if you add a disk and more memory!) However, for about $250 you can purchase the *Microconnection*, a 300-baud modem with an RS-232 interface and several additional features as well.

The *Microconnection* is an FCC-approved "direct-connect" modem. It plugs into both your phone line and the *TRS-80* keyboard. No expansion interface is required, and the *Microconnection* has six screw-terminals and an RS-232 output connector on the back for a multitude of uses. No modification of any kind to the *TRS-80* is required. No power is drawn from the *TRS-80*, since the *Microconnection* has its own power supply fed by a wall-plug transformer. The necessary software—a "dumb terminal" machine-language program (S80)—is supplied on cassette. Extensive optional software is available to make your *TRS-80* a "smart-terminal," allowing the transfer of programs and offering some of the power of disk-based systems.

The *Microconnection* measures just 7½ × 4 × 2 inches and weighs less than two pounds. Two large circuit boards are housed in a two-piece black wrinkle-finish metal case. White silk-screened lettering identifies the two red LED's that protrude from the top and shows the settings for the two front-mounted push-switches. There are two switches, and they are the only controls. One is set for SIMPLEX (one-way) or DUPLEX (two-way) communication; the other is placed in the VOICE position for normal telephone use, or DATA for modem use. One LED is a POWER ON indicator. The other LED lights only when the CARRIER (signal) is being transmitted.

Installation is simple. With your *TRS-80* off, you push the connector (at the end of a 12-inch ribbon-cable) onto the card-edge at the back of the keyboard unit. If you have an expansion interface, the connector pushes onto the card-edge of the screen printer port. The *Microconnection* now plugs into the phone line using the modular plug (at the end of a six-foot telephone cord that extends from the rear of the *Microconnection*). That plug mates with the standard telephone RJ-11 modular jack, using a duplex jack (such as Radio Shack 279-357). Other adapters may be required if you have older 4-prong telephone plugs.

The RS-232, DB-25 female connector on the back of the *Microconnection* can be used for a serial printer, plotter, graphic display, another computer, or any other RS-232 driven device.

The excellent, detailed manual (that includes several photos, which is unusual in documentation for low-priced peripherals) guides you through the connection procedure, as well as the loading and operation of the software program. You'll need to learn a few new commands using UP-ARROW and SHIFT keys. There

continued on page 36

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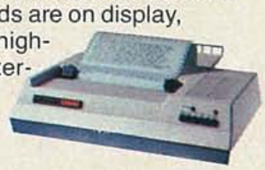

3. Software

Word processing, includes reliable, easy-to-use Zenith Electronic Typing and powerful, full-featured WORDSTAR.

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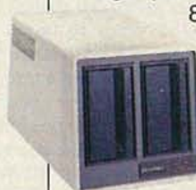

The 5¼-inch 87 Dual Disk System adds 200K bytes of storage to your 89. Both disk systems feature read/write protection and easy plug-in adaptability.

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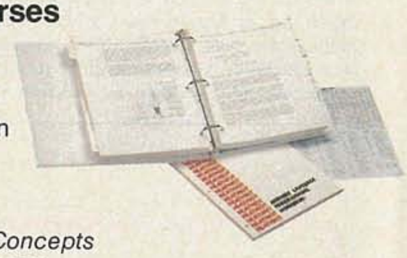

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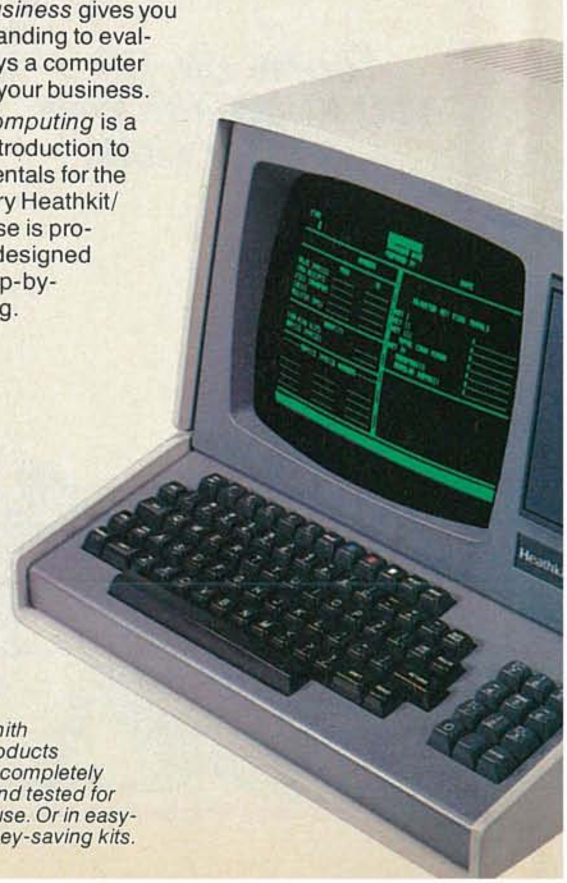

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Prices and specifications subject to change without notice.

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EQUIPMENT REPORTS

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are about 200 free "community bulletin board systems" (CBBS) around the country, with more popping up all the time. Although those CBBS's use various home computers (*TRS-80, Apple, PET,* OSI, Heath, and others) the 300-baud ASCII communication standard lets you "microspond" with any of them! Each contains "HELP" commands to document their own operation. Unfortunately, although a transmission standard (Bell System 103 compatible) exists, individual CBBS's may use different *operational* commands. A "G" on one means "goodbye", while another uses a "T" (for "terminate"). Worse yet, the *same* command letter can mean entirely different things on different CBBS's ("E" can mean "EDIT" or "EXIT", for example). After getting acquainted with the *Microconnection* and CBBS operations, you're ready for the "big time" with *THE SOURCE* or *MicroNET*, both of which are huge time-sharing systems available by subscription.

I found CompuServe's *MicroNET* an entire world of its own! It's like a gigantic cavern with bunches of caves in any direction—but that's a whole article in itself. *MicroNET* is very well documented with a 70-page two-color manual describing the commands, your own personal 125K file area, the bulletin board, games, and various services and directories. *MicroNET* now also offers a stock-quoting service, electronic mail, and news that comes right off the wire services. Radio Shack stores sell memberships to *MicroNET* for $29.95, including the software and one hour of free connect time (which is regularly $5 an hour). The same membership is available from The Microperipheral Corporation.

But communications using the *Microconnection* are not limited to the phone lines. If you are a ham radio operator, you can transmit over the air in ASCII code to another station similarly equipped. The *Microconnection* manual describes the connections (including automatic transmitter turn-on with the push-to-talk line) using four of the six screw terminals on the back of the device.

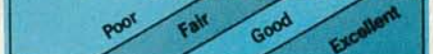
Also, since ASCII is the "universal" code of computers, it's possible to record programs on cassette tape. Three of the rear screw-terminals are used to connect to your cassette recorder for recording and playback of ASCII tapes at 300 baud.

After several weeks of using the *Microconnection* on several CBBS's and *MicroNET*, I feel I've only begun to exercise its potential. The *Microconnection* has operated flawlessly, dutifully obeying all my commands (even the wrong ones) as I aimlessly wandered in awe through various *MicroNET* services (and various bulletin boards within *MicroNET*).

Technical specifications for the *Microconnection* are available from the manufacturer, The Microperipheral Corporation, P.O. Box 529, Mercer Island, WA 98040. The *Microconnection* for the *TRS-80* computer sells for $249.00. **R-E**

Grove Enterprises Shortwave/Longwave Tuner

CIRCLE 103 ON FREE INFORMATION CARD



WHILE A NUMBER OF RECEIVER PRESELECTORS and tuners are on the market, the Grove Enterprises *Shortwave/Longwave Tuner* is the first to tune the entire 10 kHz—30 MHz frequency range.

A multi-position rotary switch selects a resonant inductor that is placed in series with a tuning capacitor (TUNE control). That circuit optimizes coupling between the antenna and the receiver at the desired frequency. Two buttons are used to connect one of two antennas to one of two receivers. That lets you select

continued on page 81

Light-torque rotary switches make the LM-3.5A DMM as easy to operate as it is to carry.

On a benchtop or a belt, over a shoulder or in a tool kit, the LM 3.5A DMM, and its LCD counterpart, the LM-350, are ready to go when you are.

LM-3.5A at a glance.

DC Volts	1 to 1,000, 4 ranges
AC Volts	1 to 750, 4 ranges
Kilohms	1 to 10000, 5 ranges
AC/DC Current	1 mA to 1A, 4 ranges
Polarity Selection	Automatic
Readout	0.3" Red LED
Size	1.9" H x 2.7" W x 4.0" D
Weight	9.2 oz (batteries installed)
Power	3 type AA rechargeable Nicad batteries and charger
Price	$165.85

Convenience. That's the key to Non-Linear Systems' best-selling LM-3.5A. A high-performance, competitively-priced, all-purpose mini DMM. Convenience from light-torque rotary switches. So operation's a cinch. Convenience from bold, bright LEDs. For instant, accurate, numeric answers. Unlike some competitive meters, the LM-3.5A features both vertical and horizontal readings. And an optional leather carrying case with belt loops and shoulder strap assures hands-free operation.

At 9.2 oz., the LM-3.5A is portability at its best. There's more. The LM-3.5A is a 3½-digit DMM. Features 2,000 counts per range—100% over-ranging. Result? Increased accuracy and resolution between readings of 999-2,000. It also reduces the amount of range shifting when measuring near 1,000.

Troubleshooters swear by it. Repairmen find the LM-3.5A works wonders on tvs, business machines, even cameras. Checks all quiescent AC and DC voltage values. Spots current drains. Measures the resistance of suspect components. Quickly and precisely.

Other DMMs to match your needs. The LM-3.5A is just one in a full series of 3 to 4-digit DMMs. If you need LCD convenience for measurements outdoors, we market the LM-350, among others. You don't pay for true RMS capabilities you don't need. But if you do need true RMS readings, Non-Linear Systems can oblige.

FM-7. The bantam frequency meter. Portability teams with performance in the FM-7. The smallest, 7-digit, 60-MHz, battery or AC line-operated instrument available.

Operator convenience is the key to our line of frequency and temperature meters, too. Pictured left to right, SC-5 prescaler, FM-7 frequency meter, LED format LT-3 digital temp meter, and its LCD cousin, the LT-31. Top, the MLB-1 digital logic probe.

Hobbyists, radio and tv studios, phone companies and the military all depend on the versatile FM-7. Whether the job calls for calibrating fixed, variable frequency or voltage-controlled oscillators, checking flowmeters, high-speed photocell counters, or setting the IF or heterodyne frequency in communications equipment, the FM-7 is a standout performer.

SC-5 Prescaler. Top range booster. This 512-MHz, battery or AC line-operated prescaler was developed to extend the frequency range of the FM-7 from 60 to 512 MHz. Adapts to most other frequency meters, too.

LT-3 Digital Temp Meter. Featuring 0.1° resolution and high accuracy, the 3½-digit, 2,000 count full scale LT-3 is indispensable for home or industry. Checks everything from thermostats to appliances. Even monitors critical operations like photoprocessing and electroplating.

The LT-3 can be supplied with any of eight thermistor and RTD temp sensors to read ranges of 0-100°C, 32-199.9°F, or 0-199°C or F.

Work outdoors? Then the LT-31 (LCD format) is the ticket.

Get the word on us. We offer a full lineup of convenient, competitively-priced products. From DMMs, frequency and temp meters to miniscopes and DPMs.

For further technical information or the names of your nearest distributors, contact Non-Linear Systems Inc., 533 Stevens Ave., Solana Beach, CA 92705. Telephone (714) 755-1134. TWX 910-322-1132.

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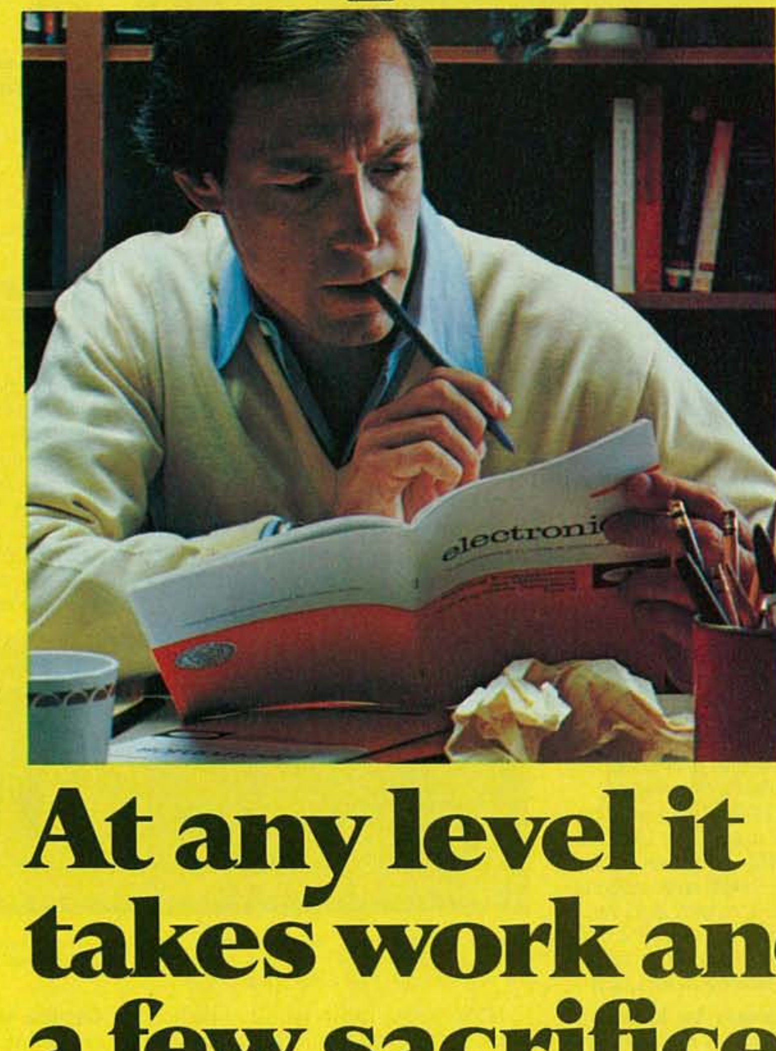
Learning electronics is no picnic.



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Whoever said, "The best things in life are free," was writing a song, not living a life. Life is not just a bowl of cherries, and we all know it.

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Why CIE? CIE is the largest independent home study school that specializes exclusively in electronics. Nothing else. CIE has the electronics course that's right for you.

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That's exactly what happens with CIE's Auto-Programmed® Lessons. Each lesson uses famous "programmed learning" methods to teach you important principles. You explore them, master them completely, before you start to apply them. You thoroughly understand each step before you go on to the next. You learn at your own pace.

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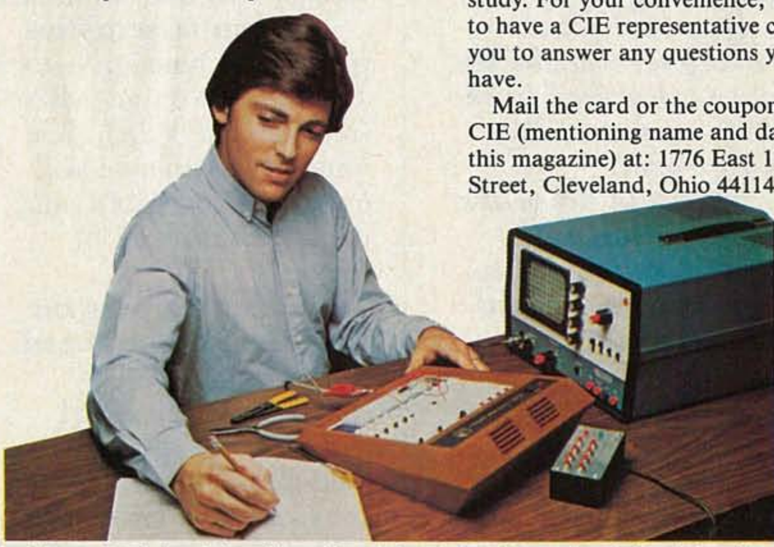

Pattern shown on oscilloscope screen is simulated.

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MAIL TODAY! RE-20

ANALOG REVERB FOR YOUR HI-FI

CARL SAWTELL*

While nothing may sound quite as good as music performed live in a concert hall, this system will add that "concert hall' feeling to your home sound system.

THE USE OF DELAY LINES IN AUDIO REproduction is an increasingly popular way to add a sense of realism to recorded music. By simulating the reverberation charactistics of a large room or hall electronically, and feeding that information to loudspeakers, the sensation of a large listening area is created. State-of-the-art systems using digital storage and microprocessors are capable of producing a complex, realistic simulation of large concert halls in a typical living room. Simpler systems, using either mechanical or electronic (digital or analog) delay schemes can produce a significant improvement in the audible performance of a music system, particularly if they can avoid the artificial quality that is associated with electronic reverberation.

Ideally, it would be desirable to simulate the natural reverberance of a concert hall. When a sound is produced on stage, a small fraction of the sound reaches a listener in the audience directly. This direct (*first arrival*) sound determines the direction and pitch of the source. Shortly thereafter, echos (*reflections*) reach the listener by the shortest path from a wall. More reflections occur as the sound bounces off other walls, the ceiling, the floor, and objects in the hall. Because there are, in essence, an infinite number of paths for the reflections to follow, the reverberation is not a series of individual echoes, but a continuous flow of sound. It builds up in a short period of time (typically a few milliseconds) and may take several seconds to die away. The reverberation time of a hall is defined as the time required for the sound level to decrease by 60 dB.

Electronic reverberation

Unfortunately, using either digital or analog delay lines, this sort of reverberation is difficult to simulate. The typical scheme for producing reverberation electronically is shown in Fig. 1. When a signal is applied to the input, it is delayed before it appears at the output. The delayed signal is fed back to the input after being reduced in level, so that it is delayed again. That feedback arrangement allows the reverberation quality to be changed, either by increasing the delay time or by changing the amount of delayed signal fed back to the input.

A system of this type does, however, have several drawbacks. First, the

*Signetics Corp., Sunnyvale, CA

R-E TESTS IT

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

THE ANALOG REVERBERATION SYSTEM IS AN audio add-on unit that simulates the ambience and acoustic environment of large listening spaces such as concert halls, night clubs, auditoriums, and even cathedrals. An audio delay is introduced by using charge-coupled devices (CCD's), commonly referred to as bucket-brigade systems, instead of the A/D and D/A converters and digital signal-storage used by some other time delay/reverberation units. In use, program signals are taken from the main stereo system (using a TAPE OUT jack-pair) and connected to the two inputs on the reverberation unit. Some delayed and, if desired, reverberated, signals are fed from the output of the reverberation system to a secondary amplifier and, in turn, to one or more speakers positioned behind or to the sides of the listener. A single speaker, without an amplifier, can also be used.

As is true of all time-delay units of this type, the longer the time delay introduced, the narrower the bandwidth or pass-band of the time-delay system. The time delay available on this reverberation system varied from ap-

Continued

proximately 5 to 50 milliseconds. Those delay times are illustrated in the oscilloscope traces shown in Figs. 1 and 2. The upper trace in Fig. 1 is a tone burst. That tone burst was used as the input signal to the analog reverb system. With its DELAY control at minimum (fully *clockwise*) the output signal (the lower trace in Fig. 1) was displaced by approximately 5 milliseconds (the sweep rate is 5 ms per division in both Figs. 1 and 2). Figure 2 shows the maximum time-displacement between the input (upper trace) and output (lower trace)—about 50 milliseconds.

Two frequency-response curves are shown in Fig. 3. The upper curve, which has a rolloff of 3 dB (at the output of the device) at 3.5 kHz, shows the response obtained with the *minimum* time delay; the lower curve, in which response is already down by some 13.5 dB at the same 3.5 kHz test frequency, shows the response obtained with the DELAY control set to maximum.

While those response curves may appear to be anything but "high fidelity", you must understand that reflected sounds (which the delayed sounds are intended to simulate) also have their high frequencies highly attenuated. Highs are more easily absorbed by walls, floors, ceilings, and other surfaces, while mid-frequencies and lows tend to bounce back with little, or no loss. Thus, the tendency of the analog reverberation system to increasingly attenuate high frequencies as the delay time is increased is desirable, and is not an unwanted side-effect of this, or any other time delay/reverb system.

We measured the total harmonic-distortion of the reverberation system for a mid-frequency (1 kHz) and for a relatively low frequency, with 1 volt applied to the inputs. With delay time set to minimum, the total harmonic distortion was 1.6% at 1.0 kHz and 3.1% at 100 Hz. Turning the delay control to its opposite extreme, we measured a total harmonic distortion of 1.3% at 1 kHz and 1.55% at 100 Hz. Again, while these levels may seem a bit on the high side to audio buffs, it must be remembered that the total contribution of sound energy by the delayed channel is but a fraction of the total sound reaching the listeners' ears. That's because in an ideal setup of this kind, the listener adjusts the rear-channel (delayed) sound so that he or she is not consciously aware that there is a separate source at the rear of the listening room. Thus, if the contribution of the delayed channel is even just 3 dB lower than that of each of the primary channels, the total harmonic distortion added by the rear channel is only one-third as great as the numbers would imply.

Figure 4 shows what happens when the reverberation control is advanced, while the basic time delay is kept at its minimum and the FEEDBACK DELAY control is set to one extreme. Note the appearance of additional, delayed signals of decreasing intensity. Those extra signals have a decay characteristic similar to what would be found in a large hall with its own natural reverberant decay-time. Additional reverberation effects can be obtained by altering the setting of the FEEDBACK DELAY control, as can be seen in Fig. 5. In that figure the FEEDBACK DELAY control was set to its opposite extreme.

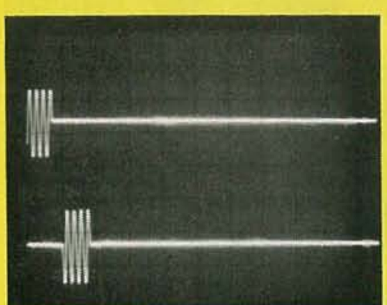


FIG. 1

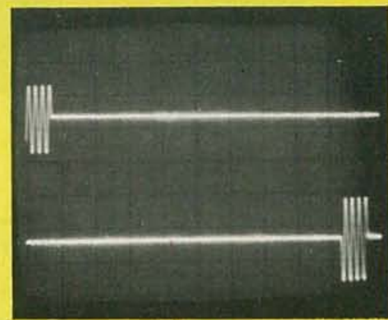


FIG. 2

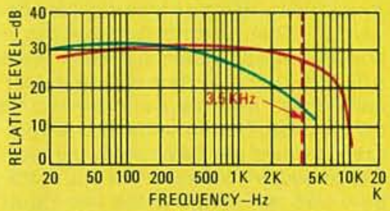


FIG. 3

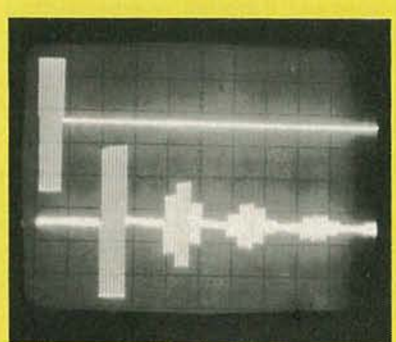


FIG. 4

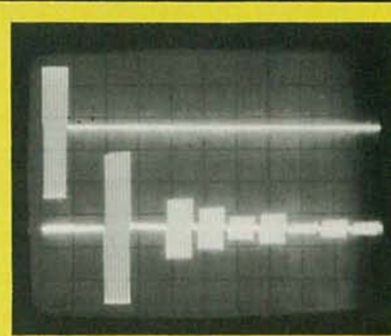


FIG. 5

Listening tests

In addition to the measurements and observations just described, we hooked up the analog reverberation system to our own sound system and to an extra amplifier (in the "mono" mode) and pair of speakers. We played a variety of musical material through this system, alternately switching in and switching out the reverberation unit. The unit, once properly adjusted for the type of program material (and that is very important), added a sense of space to our modestly proportioned listening room. We found that the reverberation control should be used in moderation. If used to excess, it gave a false quality—almost a ringing or oscillatory characteristic—to the music. That was not the case with the DELAY control however. When that control was varied, the apparent size of the listening room simply seemed to change. **R-E**

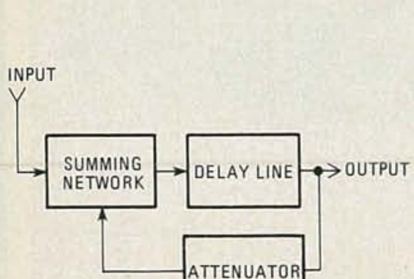


FIG. 1—ELEMENTS OF A REVERBERATION SYSTEM. Part of the output-signal is attenuated and fed back to the input to the delay line to generate a slow decay.

echoes are not random. If the delay time is 10 ms, for example, the second echo appears after 20 ms, the third at 30 ms, and so forth, as shown in Fig. 2. If the delay time is long, those echoes may be heard individually and a "flutter" echo is produced. A natural echo contains many separate random echoes that (in a well designed hall) cannot be heard individually.

A second problem with this simple reverberation system is that it produces a "comb-filter" effect. If we again assume a 10-ms delay, then the input

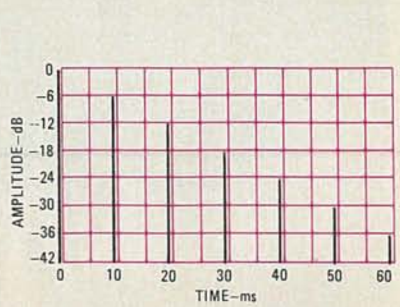


FIG. 2—THE RESPONSE OF A SIMPLE REVERBERATOR to a short pulse. If the delay time is long, the echoes can be heard individually producing a flutter effect.

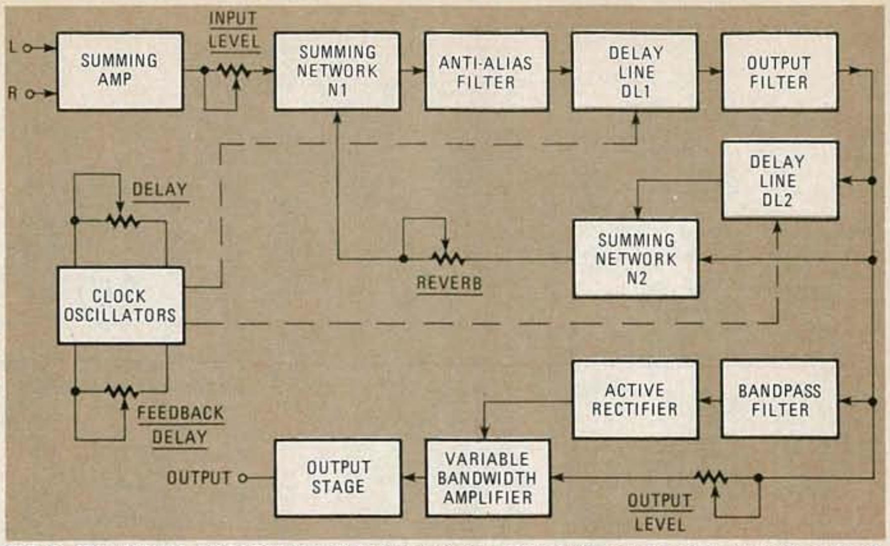


FIG. 6—THE SIGNAL-PROCESSING PATH of the analog reverberation system shows how the original signal is recirculated at ever-decreasing levels.

and the delayed signal are 180 degrees out of phase at 50 Hz. (The period of a 50-Hz signal is 20 ms.) When added together, the sum is the *difference* of the two, and the result is a decrease in output level. At 100 Hz, the input and output are in phase (360-degree phase shift), and add together. Under those conditions, dips in the response would also occur at 150 Hz, 250 Hz, 350 Hz, and so forth. Likewise, peaks in the response would occur at every 100-Hz interval. Figure 3 illustrates that response. Over a 10-kHz range, there would be 100 of those peaks and dips. And as the amount of feedback is increased, the height of the peaks and the depth of the dips also increases.

These problems are actually quite similar to those encountered in a room of poor acoustical design. A large tiled shower is a good example. The hard, reflective walls and the boxiness of the room's shape will create the same sort of flutter echoes. The room's dimensions will also set up "standing waves"

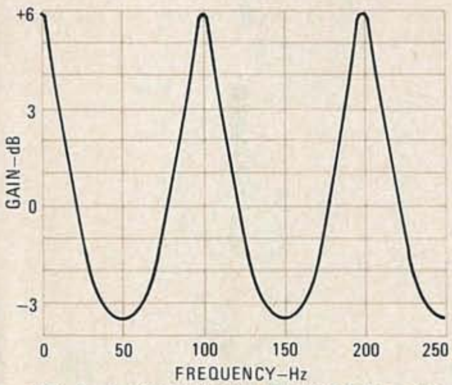


FIG. 3—A COMB-FILTER EFFECT takes place when the input and delayed signals are 180° out of phase, causing a decrease in the overall output-level.

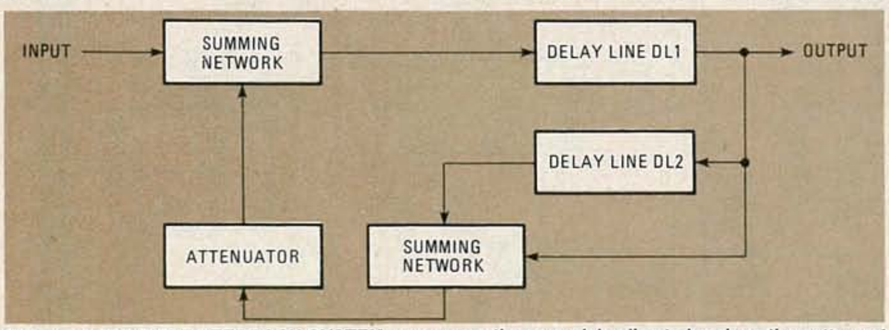


FIG. 4—A MULTIPLE-FEEDBACK SYSTEM uses more than one delay line to break up the pattern of regular echoes.

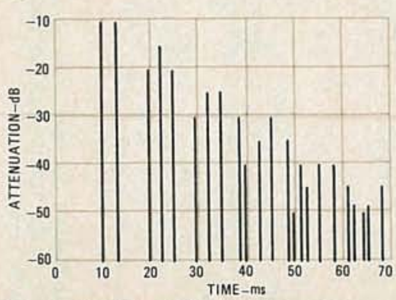


FIG. 5—THE NUMBER OF ECHOES increases with time in a multiple-feedback system, just as it would in an actual concert hall.

that will simulate the "comb-filter" effect described earlier.

Fortunately, the physical solutions to the problem of poor room-acoustics can be carried over into the design of an artificial-reverberation device. Instead of changing the dimensions of the room to give more echoes of different lengths, we can provide delay lines of different lengths in the device. Instead of breaking up the standing waves with objects or acoustical treatment, we can inject delays into the electronic feedback to break up the pattern. A block diagram of the simple system to do that is shown in Fig. 4.

The multiple-feedback reverberation technique is still not a close simulation of actual concert hall reverberation, with its complex combination of delays. This technique does, however eliminate or reduce the most objectionable artifical aspects of electronic reverberation. If delay line DL1 is 10 ms as before, and delay line DL2 is 3 ms, then the resultant echoes will be as shown in Fig. 5. Note that not only do more echoes appear, but that the number of echoes increases with time, just as it would in a natural environment.

The frequency response of a multiple-feedback reverberation device is complex. The peaks and dips remain, but are irregular. The large peaks occur only if the delayed input, the output, and the delayed output are all in phase, which makes the number of large peaks decrease; however, that situation is unlikely to occur. The number of deep dips in the response tends to be reduced similarly. There are still many ripples present, but they are not deep.

A block diagram of the complete reverberation system is shown in Fig. 6. The stereo signal from a receiver or preamp is converted into a monaural signal by a summing amplifier. The INPUT-LEVEL control allows the signal level to be adjusted for the optimum signal-to-noise ratio. The signal is then filtered through a five-pole "anti-aliasing" filter to minimize intermodulation distortion. *Aliasing* is a phenomenon that occurs in sampling systems. Our delay lines use bucket-brigade IC's. Essentially, those IC's are sampling devices with the sampling rate being determined by the clocking frequency of the IC's. If the input signal being sampled contains components that are higher in frequency than can be handled by the sampling rate, aliasing occurs. Then, the high-frequency components are "read" as *low-frequency* components and appear at the output of the sampling device along with the low-frequency components of the input signal. The low-frequency components mix together and intermodulation distortion results. To prevent aliasing from occurring, the input signal is filtered before it reaches the sampling device by either a low pass or bandpass filter to eliminate the signal components that are too high in frequency for the sampling rate to handle. A filter of that sort is commonly referred to as an *anti-aliasing filter.*

The main delay line in Fig. 6 is DL1. Its output is filtered by a seven-pole active filter to eliminate switching waveforms, ultrasonic signals, and to reduce the likelihood of creating beat frequencies from the high-frequency signals present in the system. The de-

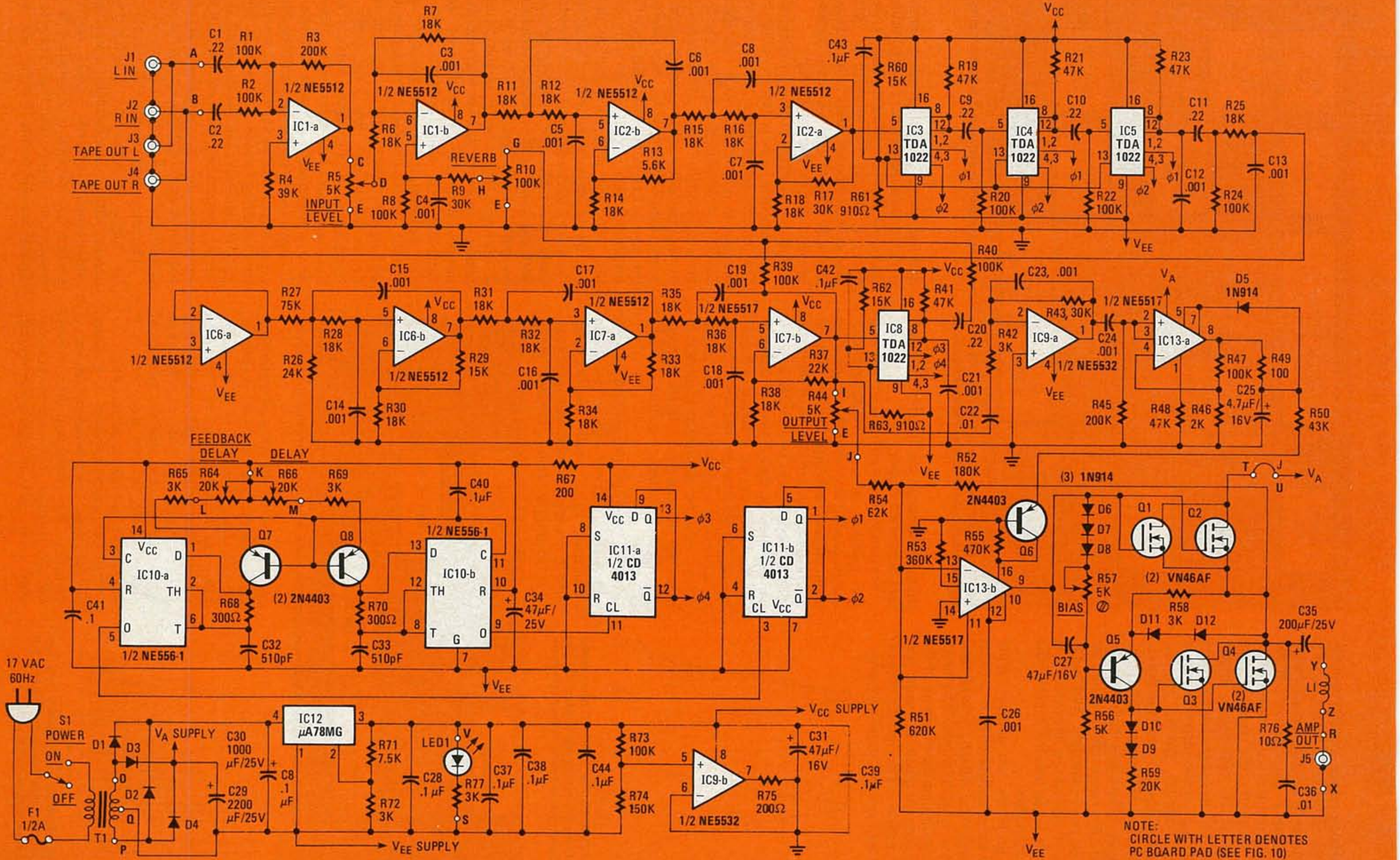


FIG. 7—SCHEMATIC DIAGRAM of the analog reverberation system. The delay required by the system is provided by IC3, IC4, IC5, and IC8—four TDA1022 "bucket-brigade" IC's (how they work is discussed in the text).

DIGITAL DELAY VS. BUCKET BRIGADES

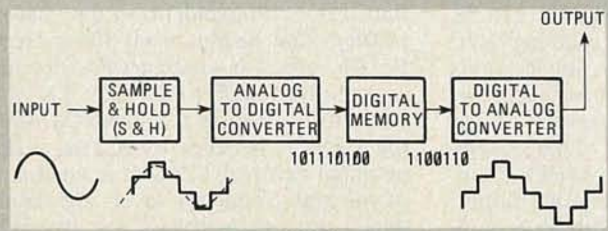


FIG. 1

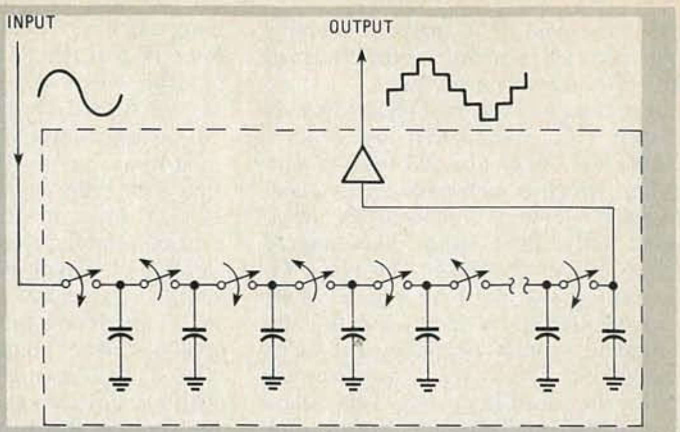


FIG. 2

TWO ELECTRONIC APPROACHES ARE CURrently used to delay analog signals. The one that has received the most attention lately is digital delay, shown in Fig. 1. In that system, the signal is measured at regular intervals (*sampled*) and the sampled voltage is converted to a number (*quantized*). The sampling operation is done by a sample-and-hold circuit that uses a capacitor to store a voltage representing the instantaneous signal-level. The voltage stored by the capacitor is temporarily held constant, making it possible for an analog-to-digital converter to derive a digital value for it. (Not all A/D systems require sample-and-hold circuits, but those commonly used for audio produce significant errors if the input voltage changes during the conversion process.) A number representing the signal can be stored in digital memory and, after the desired delay-time, be reconverted to an analog voltage. The output of the D/A converter may also contain a sample-and-hold circuit to store the output voltage during the next conversion.

The second method is the bucket-brigade delay line (BBD), a single-IC delay system that is, in effect, an analog shift register (see Fig. 2). Like the digital delay-line, the bucket brigade is a sampled system, but no digitizing is involved. Manufactured as a long string of MOSFET switches and capacitors, the BBD acts like a long string of sample-and-hold devices. At the beginning of a clock cycle, the input signal is stored by the first capacitor. During the second half of the clock cycle, that voltage is transferred to a second capacitor, and the input capacitor is ready to store a new voltage. During the next clock cycle, the original input signal is transferred from the second to the fourth capacitor, and so on. After 256 clock pulses, the original input-voltage appears at the 512th storage capacitor, which is the output of the TDA1022. The length of time it takes to transfer a signal (the delay) depends on the frequency of the clock used. **R-E**

layed signal is fed back to the input of the anti-aliasing filter through summing network N2. It is also fed to a second delay line to provide the second feedback path. The level of the delayed signals is controlled by an attenuator (REVERB control) and then combined with the input signal by summing network N1.

The output-filter signal, which consists of the input-filter signal plus all of the delayed signals, is first attenuated by the OUTPUT-LEVEL control and then fed to a variable-bandwidth filter. The control signal for this filter is derived by a bandpass filter and active rectifier. Those three blocks make up a noise-reduction circuit that minimizes the level of audible hiss in the output signal.

The final block in the signal-processing chain is an amplifier. This amplifier provides an output of approximately one watt to an 8-ohm speaker. The amplifier is also quite capable of driving a 4-ohm speaker. Although this output is minute when compared to that of the main amplifier in a hi-fi system, it is more than adequate when the reverberation system is properly set up.

In practice, the output from the reverberation unit drives a third speaker at the rear of the listening room. The output-level control is adjusted so that the listener is not consciously aware of the third speaker. In fact, the third speaker should be barely audible over the two main speakers.

How the circuit works

Figure 7 shows a complete schematic of the reverbation system. The input is taken from the tape-monitor outputs of your hi-fi system. Because the input signal will typically come from the tape output of a preamp or receiver, the inclusion of a second set of jacks (J3 and J4) allows for the connection of a tape deck. The input impedance of the reverberation unit is 100 kilohms and it should not load down your hi-fi's tape-monitor circuit significantly.

Capacitors C1 and C2 couple the input signal into summing amplifier IC1-a. The gain of this stage is 6 dB and can be modified by changing the value of R3. You may want to alter the gain if the unit is to be used in applications with particularly low-level signals, such as those from a microphone or electric guitar, or with high-level ones like the output of a power amplifier. Since the INPUT-LEVEL control, R5, follows this first stage of amplification, it is important that the signal applied to it not be too large, or overload will result. (As designed, the inputs will safely handle a 2-volt input level, more than sufficient for line-level inputs from a receiver.)

Op-amp IC1-b serves two purposes. First, it provides unity-gain inversion of the signal from the input-level control with capacitor C3 limiting the bandwidth of the signal to 9 kHz. Its second purpose is to sum the input signal with the delayed (feedback) signal. The level of this feedback signal is controlled by the REVERB control, R10. The R-C network connecting R10 to the positive input of IC1-b serves to reduce the feedback at high frequencies. This simulates the natural tendency for acoustically-reflective materials to absorb high-frequency sound, giving more reverberation at low frequencies.

Op-amps IC2-a and IC2-b form an active low-pass filter with a cutoff frequency of 9 kHz. Together with the filtering action of summing amplifier IC1-b, they form a five-pole anti-aliasing filter that rolls off the input signal at a rate of 30-dB per octave. This filter reduces noise and distortion in the system by reducing the potential for intermodulation distortion (aliasing) in the delay lines. The slew rate of the input signal is also reduced by this filter. Too high a slew rate causes distortion in the op-amps. (This is not to imply that this would be a significant problem. The NE5512 op-amp specified can produce full output at 20 kHz without reaching its slew-rate limit.)

Philips TDA1022 bucket-brigade delay IC's are used for the main delay line. These are called out as IC3, IC4, and IC5 in Fig. 7. Although identical to other commercially available bucket-brigade IC's in most respects, the TDA1022 is unusual in that it uses p-channel MOSFET's. The three delay-IC's are driven by a common clock and are cascaded to give three times the delay of a single IC. Capacitive coupling between stages minimizes the effects of DC offsets in the delay line.

The output of the third bucket-brigade device, IC5, is filtered by another 9-kHz R-C filter and fed into op-amp IC6-a, which is connected as a voltage follower. This is followed by three more active-filter stages consisting of IC6-b, IC7-a, and IC7-b. This active filter provides a 36-dB-per-octave rolloff above 9 kHz and is designed so that the complete system—including the input and output filters—has a flat response below the cutoff frequency. This means that neither the input filter nor the output filter has a flat response, but the minor ripples in the responses tend to cancel and give a flat frequency-response below 9 kHz followed by a 72-dB-per-octave rolloff.

The output of the filter is fed to a fourth bucket-brigade device, IC8, which was shown as DL2 in Fig. 6. Both the filter-output and the output of IC8 are fed to the REVERB control and combined with the input signal by summing amplifier IC1-b. The output of the filter is also fed to the OUTPUT LEVEL control, which is the primary volume control for the system.

The signal from the OUTPUT LEVEL control is fed to IC13-b. Two major functions are provided by op-amp IC13-b. First, it supplies drive for the output-amplifier stages. Although certainly not a high-power amplifier, its output is adequate for most purposes, and it eliminates the expense of having to add a power amplifier to the system. This IC also acts as the variable-bandwidth filter in a noise-reduction circuit. By making the bandwidth vary as a function of the signal level, the noise in the output signal is reduced.

A transconductance amplifier, the NE5517, was selected for IC13. This IC contains two independent transconductance-amplifiers in one package. By varying the current applied to pins 1 and 16, the gains of the two sections can be controlled independently.

To minimize audible side-effects of the noise-reduction circuit, the bandwidth of IC13-b is made a function of the high-frequency content of the input signal. The high-frequency content is sensed by a bandpass filter composed of IC9-a and its feedback network. The input to this filter is taken from a point ahead of the OUTPUT LEVEL control so that it is not dependent on the volume setting. The output from IC9-a feeds IC13-a, which is configured to operate as an active rectifier. The gain of IC13-a is set to 51 by bias resistor R48. After the signal is rectified by IC13-a, a DC potential exists on C25 that is a measure of the high-frequency level, and determines the bandwidth of the dynamic filter.

The variable-bandwidth output filter works by varying the gain of IC13-b. Compensation for the amplifier is provided by capacitor C26, which sets the gain-bandwidth product. If the gain of the amplifier is varied by changing the bias current applied to pin 16, the bandwidth is also varied. To accomplish this, the control voltage from C25 is fed to pin 16 of IC13-b through a network consisting of R50, R55, and Q6 which develops a current proportional to the rectifier output. This causes the bandwidth of the amplifier to be proportional to the high-frequency level detected by the rectifier circuit.

The power amplifier's output stage uses four VMOS power transistors (Q1-Q4) in a push-pull configuration. Transistors Q1 and Q2 act as a source follower to drive the load directly. Transistors Q3 and Q4 are driven by Q5, a small-signal PNP-type, which senses the gate drive-voltage on Q1 and Q2 through diode-string D6-D8. When the gate drive-voltage is low (Q1 and Q2 beginning to turn off), Q5 provides drive for the gates of Q3 and Q4, which supply drive current for the negative portion of the cycle. Although Q1 and Q2 will turn off completely on large negative swings with a low-impedance (speaker) load, for most purposes the amplifier operates class A. The operating current is set by trim pot R57. In the case of high current-loads, D11 and D12 prevent the gates of Q1 and Q2 from being pulled negative with respect to the source, an undesirable condition for the VMOS transistor.

The amplifier is coupled to the speaker through capacitor C25. The R-L-C network at the amplifier's output decouples the loudspeaker from the feedback loop to improve stability. Although this amplifier has a limited power-output (due primarily to power-supply limitations), it can safely be used with 4-ohm loads. Transistors Q1 and Q2, and Q3 and Q4, are connected in parallel for this purpose. No current-hogging or thermal instability results from connecting VMOS devices in parallel (as

continued on page 104

PARTS LIST

Resistors ¼ watt, 5%, unless otherwise noted
R1, R2, R8, R20, R22, R24, R39, R40, R47, R73, R74—100,000 ohms
R3, R45—200,000 ohms
R4—39,000 ohms
R5, R44—5000 ohms, potentiometer, audio taper
R6, R7, R11, R12, R14-R16, R18, R25, R31-R36, R38—18,000 ohms
R9, R17, R30, R43—30,000 ohms
R10—100,000 ohms, potentiometer, linear taper
R13—5600 ohms
R19, R21, R23, R41, R48—47,000 ohms
R26—24,000 ohms
R27—75,000 ohms
R28—27,000 ohms
R29, R60, R62—15,000 ohms
R37—22,000 ohms
R42, R58, R65, R69, R72, R77—3000 ohms
R46—2000 ohms
R49—100 ohms
R50—43,000 ohms
R51—620,000 ohms
R52—180,000 ohms
R53—360,000 ohms
R54—62,000 ohms
R55—470,000 ohms
R56—5000 ohms
R57—5000 ohms, trimmer potentiometer
R59—20,000 ohms
R61, R63—910 ohms
R64, R66—20,000 ohms, potentiometer, linear taper
R67, R75—200 ohms
R68, R70—300 ohms
R71—7500 ohms
R76—10 ohms
Capacitors
C1, C2, C9-C11, C20—.22 μF, 100 VDC, Mylar
C3-C8, C12-C19, C21, C23, C24, C26—.001 μF, polystyrene
C22—.01 μF, polystyrene
C25, C27, C31, C34—4.7 μF, 16 VDC, electrolytic
C28, C37-C44—.1 μF, ceramic disc
C29, C35—2,200 μF, 25 VDC, electrolytic
C30—1000 μF, 25 VDC, electrolytic
C32, C33—510 pF, ceramic disc
C36—.01 μF, 400 VDC, electrolytic
Semiconductors
D1-D4—1N4002, 100 PIV, 1 amp
D5-D12—1N914
LED1—jumbo red LED
Q1-Q4—VN46QF VMOS transistor (Siliconix)
Q5-Q8—2N4403 PNP transistor
IC1, IC2, IC6, IC7—NE5512 low-noise dual op-amp (Signetics)
IC3-IC5, IC8—TDA1022, 512-stage bucket-brigade device (Philips)
IC9—NE5532 low-noise dual op-amp (Signetics)
IC10—NE556-1 dual timer (Signetics)
IC11—CD4013 dual D flip-flop (RCA)
IC12—μA78MG adjustable voltage regulator (Fairchild)
IC13—NE5517 TCA (Signetics)
L1—10 turns of No. 22 wire wound around C35
T1—36 VCT, 300 mA
Miscellaneous: PC board (double-sided with plated-through holes), case, hardware, etc.

NOTE: The following are available from Advanced Analog Systems, Inc., 790 Lucerne Dr., Sunnyvale, CA 94086 (Tel. 408-730-9786): ARS-911—complete kit including case, $149.95; PC-911—PC board only, $24.00; IC-911—IC1-IC13 and Q1-Q8 only $49.95. Visa and Mastercard welcome. California residents please add sales tax. Prices include shipping (within continental U.S. only).

Home Electronics

WHAT THE FUTURE WILL BRING

LEN FELDMAN
CONTRIBUTING EDITOR

We're always interested in knowing what the future holds. The most recent Consumer Electronics Show gave us a look at that future—as it exists today.

THE FOUNDER OF THIS MAGAZINE, HUGO Gernsback, was one of the true prophets of the electronics industry of his time. Many readers of **Radio-Electronics** will recall issues of this magazine which were devoted to predictions, by Hugo Gernsback, of "electronics miracles" still to come. Amazingly, many of his predictions that might then have seemed far-fetched have indeed come true and exist today in the form of readily available consumer electronic products.

At the most recent Consumer Electronics Show in Chicago, held in early summer, 1981, one of the largest electronics manufacturing and research companies in Japan—Matsushita Electric Industrial Co.—exhibited more than 190 electronics products in a 12,000-square-foot exhibition that was in much the same tradition as the prophetic early editions of **Radio-Electronics** but with one major difference: All of the products were in the form of working models, with many of them already scheduled for early production and distribution throughout the world. Of particular interest to readers of **Radio-Electronics** were the latest in video and audio products, communication equipment, and component technology. Matsushita's exhibit also included products for the business and industrial fields as well as medical-electronics products.

We can only highlight a few of the items we saw, but from our description of these innovative products, you should get some idea of the diversity of the exhibit and of what the electronics-based home of the future is likely to contain.

High-definition color TV

It has been said that the U.S. pays the penalty for "being first" by ending up with inferior-technology systems, while countries that are content to wait benefit from our early mistakes. Nowhere is that more true than in the case of TV standards and, in particular, those for color TV.

Many experts feel that the PAL and SECAM systems used in other parts of the world deliver better pictures than does our NTSC system, (which is also used in Japan). Bypassing all three of those systems, Matsushita (whose trade names Panasonic, Technics, and Quasar are probably more familiar to American consumers than is the more-difficult-to-pronounce name of the parent company) has developed, and showed, an SHF (*S*uper *H*igh *F*requency) DBS (*D*irect *B*roadcasting *S*atellite) system combined with a high-definition, wide-screen, TV camera and receiver. The elements of the entire system are shown in Fig. 1. The SHF satellite-TV system is considered by many to be one of the most promising new concepts in broadcasting because of its ability to improve poor reception in remote areas and to eliminate the problem of "ghosts" in other problem-reception areas such as densely populated cities. The SHF band extends from 3 GHz to 30 GHz and the current lack of crowding in that band would permit the establishment of channel bandwidths that are wide enough to support the high-definition standards which Matsushita—along with others, such as CBS in this country—has proposed.

The high-definition TV system would produce better images than those obtained with 35 mm film, using 1125 scanning lines as opposed to the existing NTSC system which uses only 525 scanning lines. Among the newly developed elements and components that make the system practical are a low-noise SHF/RF converter, an easy-to-install dish antenna, an 1125-line high-resolution color picture tube, a high-resolution color TV camera with a 30-MHz-bandwidth amplifier and edge-enhancer, and a high-definition TV-signal transmission system using fiber optics technology.

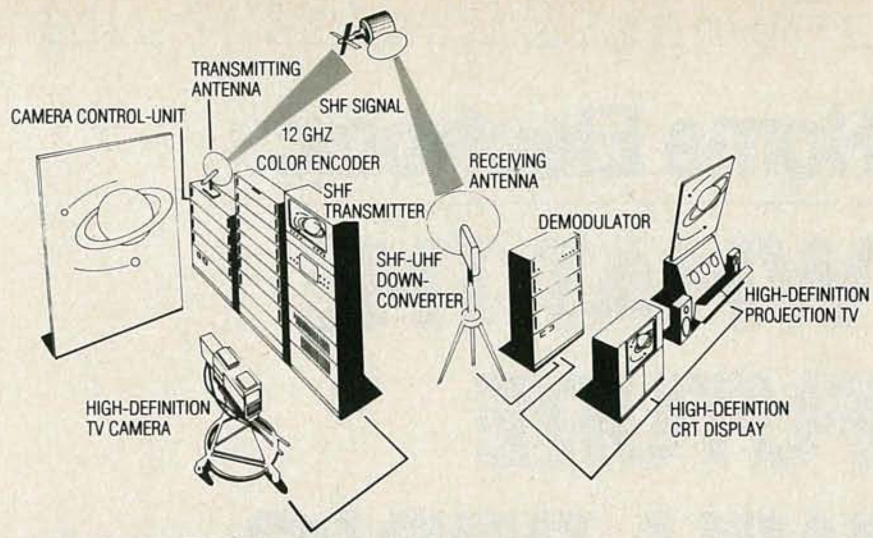


FIG. 1—THE SHF DBS SYSTEM, combined with high-definition equipment can offer high-quality video with more than twice the resolution and clarity of existing systems.

3-D television

One of the most frequently made predictions about electronic products of the future has concerned three-dimensional television. Some have even imagined a holographic display-system to create what appear to be live, moving, three-dimensional images in your living room. At the Matsushita exhibition, a much more straightforward approach was used; one which, in fact, can be used with existing VCR's and conventional TV sets or monitors. It is expected to find wide application in the field of entertainment, education, and training and industrial applications, including computer displays.

FIG. 2—TWO VIDEO CAMERAS, one for the right-eye image, and one for the left-eye image, are required for 3-D television.

The 3-D system consists of a specially designed camera, signal-processing circuitry and eye glasses with electronic lens-shutters. The 3-D TV camera (see Fig. 2) consists of two video cameras, positioned slightly apart, but focusing on the same image—working in much the same way as a pair of human eyes. The video signals from the right and left camera are fed *alternately* to the TV set or video recorder, a field at a time. The alternating fields are viewed through special glasses equipped with operated shutters synchronized with the changing left-eye and right-eye images. The mind combines the two images and the viewer sees a three dimensional one.

A videodisc with record capability

Business journals and the general press have been reporting of late that the sales of videodisc players are not meeting the original expectations of their manufacturers. One reason given for that is the notion held by uninitiated shoppers that videodisc machines can record as well as play back. Once they learn that this is not the case, prospective customers frequently opt for a videotape recorder instead. That may soon change.

One of the products at the Matsushita exhibit was a compact disc-type still-video (single-frame) record/playback system. Using semiconductor-laser technology, the unit can record 15,000 individual frames of information on a 200 mm disc with access to any given frame in 0.5 second. The new system uses a single semiconductor-laser as an optical source and a disc with 15,000 concentric grooves coated by a thin film of highly sensitive recording material. The disc is made of a plastic substrate on which a recording layer of sensitive tellurium suboxide film is coated. The recording layer is a vapor deposit of 15,000 concentric grooves of 2.5 micron pitch. Each groove is 0.8 micron wide and contains an address signal that guides the laser beam for stable recording and playback. While the new material is sensitive enough to permit the use of a semiconductor laser, it also resists temperature and humidity variations. Unlike conventional optical-disc recording systems, the laser does not make any holes on the disc surface. Rather, the recording is made by changing the optical characteristics of the disc.

The video signals are modulated by varying the intensity of the laser beam. The optical recording material on the disc absorbs the laser-beam energy and its optical characteristics are changed by the heat. The irradiated regions have different reflectivity compared with that of the non-laser-irradiated regions. The signal for a single still picture is recorded in a single groove on the disc. During playback, the laser beam, this time using less power than during recording, is reflected from the disc and reconverted into the original video signal.

To retrieve a single picture, a linear motor drives an optical head for a rough search, and then the head pinpoints the desired single frame using an electronic tracking-system. Both mechanisms are controlled by a microcomputer that permits fast image retrieval within 0.5 seconds. Some 95 patents are being applied for in Japan for this new device, with 9 more patents being applied for elsewhere.

High-speed videotape duplicator

The relatively high cost of pre-corded videotapes is caused at least in part by the fact that duplication of tapes is a real-time process. A two-hour movie master-tape takes two hours to copy and, while many "slave" copiers can be fed from a single master-tape player, the process is still quite time-consuming and expensive. Now, the high-speed videotape printer shown in Fig. 3 can duplicate two or four-hour VHS video cassettes in less than four minutes. The printer is fully automatic and features a built-in 15-cassette feeding system for continuous, unattended tape duplication.

The tape-duplicating system consists of a master-tape recorder and a separate high-speed printer. The master-tape recorder records mirror-image signal patterns on a master tape in the usual real-time. The master tape is then transferred to the printer, which produces copies at high speed by transferring the signal patterns from the master tape onto the blank "slave" tape. The recording unit uses a direct-drive cylinder and capstan for highest possible tape-motion accuracy.

The duplication method is known as "video anhysteretic-transfer contact-printing by bifilar tape-winding." In it, the specially formulated, and very-highly-magnetized, master tape is brought into contact with the blank "slave" tape, both of which are moving at extremely high speed. The master actually imprints an image of itself on the "slave" by magnetizing it directly with the video and control signals. The audio information is transferred by a recording head when the tape is rewound after the video and control signals have been imprinted. The system promises to lower the cost of pre-recorded VCR tapes in the future, and just what effect that will have on public acceptance of video *disc* formats (one of whose chief arguments has been the lower cost of software) is difficult to predict.

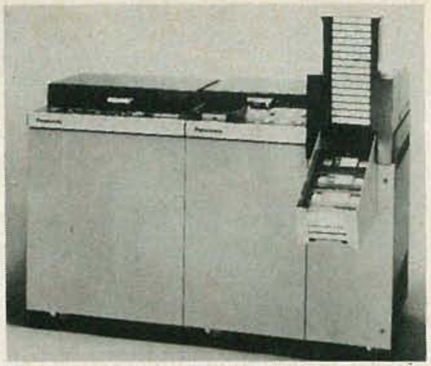


FIG. 3—THIS HIGH-SPEED videotape printer can duplicate a two or four-hour VHS video cassette in less than four minutes.

FIG. 4—INTEGRATED CAMERA/VCR unit weighs just 4.2 pounds. The cassette is about the same size as a standard audio cassette.

Micro video systems

Nearly a year ago, Sony Corporation demonstrated a mini-sized color video camera that incorporated a tape-transport and all the electronics needed for a single-piece, lightweight home videotaping system. At that time, officials of the corporation estimated that the new videotaping format would not be available before 1985. In typical one-upmanship not uncharacteristic of Japanese electronic firms, a combination color video-camera/recorder claimed to be the smallest, lightest, and lowest in power consumption of "any previously proposed format" was demonstrated at the Matsushita exhibit.

The system, shown in Fig. 4, uses a solid state micro-video system in which the camera portion uses a newly developed single-chip CPD (*C*harge *P*riming *D*evice) image sensor which is said to combine features of both MOS and CCD image sensors; namely wide dynamic range and low noise. Maximum recording time would be two hours using a new high-density "metal evaporated" magnetic tape that is just 7 mm wide and is housed in a cassette package that is a bit smaller than an ordinary audio cassette. The unit is extremely compact, measuring 7.8 by 4.7 by 2.6-inches and weighs only 4.2 pounds. Power consumption is just 4.2 watts.

This system, obviously a step ahead of the Technicolor videotape format that has been marketed for more than a year, brings to at least six the number of home videotape formats that are likely to coexist in the near future (Beta, VHS, Philips, Technicolor, Sony's future all-in-one, and now, Matsushita's single-piece camera/tape-mechanism entry). Whether all of them can survive is highly questionable, though at present both Beta and VHS seem to be having no difficulty in the marketplace and we are told that Sony, for one, is having a tough time turning out enough Betamax machines to meet worldwide demand, even though the Beta format is outsold by first-place VHS machines by about seven-to-three!

How would I look as a blonde?

...Or with a moustache, or beard, or wearing horn-rimmed glasses, or with a radically different hair style or...yes... even with a hairpiece? If you have ever wondered about those or other matters of style and appearance, imagine being able to walk into a store, standing in front of a video camera and watching yourself being transformed by a new hairstyle, a pair of glasses, or other cosmetic changes.

Actually, Matsushita's new "Style-setter" TV system, far from being an item in our future, is already is use in beauty parlors in Japan. The system works by taking a video picture of the customer, freezing the image on a TV monitor, and then superimposing various hair styles, glasses, etc. over the stationary image. The unit consists of a compact video camera, a magnetic-sheet-memory recorder, and a video image-synthesizer—the unit that superimposes the changes over the original image. The image recorded on the sheet-memory recorder does not have to match a predetermined posture since the synthesizer adjusts superimposed images to the recorded image by means of a joystick-type control. The size and shape, and even the color, of the changes can be adjusted to fit the contours of the subject's face.

Another use for the synthesizer has been to provide police departments with a more accurate means for creating identification pictures of crime suspects. Police artists can modify standard identification-kit models to fit witnesses' descriptions and create highly accurate likenesses of suspects.

Largest projection-TV yet

Projection-TV screens have been growing steadily larger as better and brighter high-intensity CRT's are developed, but unless you attend the Summer '81 CES and the Matsushita "show-within-the-show" you've probably never seen anything as large as their new high-brightness picture projected on an 11¼ by 8½-foot screen. The system, designed for institutional use, can be adapted for either front or rear projection and includes a projector featuring a new 13-inch cathode-ray tube. The system provides superb resolution as well as a light output of 300 lumens. The unit is contained in a floor or ceiling-mountable box measuring about 42 inches wide by 34 inches deep by 23 inches high and weighing 230 pounds. Depending upon the image-size desired, projection distance can be as little as 3.8 yards (2.7 yards behind the screen if a mirror is used) or as much as 5.4 yards.

Three 13-inch monochromatic CRT's (red, green and blue) combine a newly introduced bipotential-field electron gun with a large main-focus lens, and a decelerating-potential-field-type pre-focusing lens. The system projects its images through a magnifying lens onto a flat plastic screen.

In tests, the system has been used at hotels and in school auditoriums, with a viewing angle as wide as that for normal motion-picture viewing. Some uses envisioned for the system include projection of surgical operations for medical classes, display of real-time data to business or government executives, and presentation of special events to large audiences. The company has indicated that it plans to introduce the system commercially into the United States by late 1982.

The ultimte sketch pad

Remember the little slate with the lift-up plastic sheet that we all played with and drew on when we were kids? I was reminded of that toy when I saw Matsushita's *Compu-Cassette* audio/visual communication system which uses conventional stereo audio-cassette tapes for recording sound and digitally processed graphic information.

FIG. 5—COMPUTER-GENERATED GRAPHICS can be combined with single video frames on this terminal. An ordinary cassette tape is used to store the finished color images along with a sound track.

Video information is recorded digitally on the right channel while analog audio information is recorded on the left channel. A one-hour cassette tape can store approximately 200 pictures with sound. The system includes a video signal-processor, stereo cassette-deck, light pen and color monitor, with a keyboard, remote control, and printer as options. The video signal processor, shown in Fig. 5, includes a controller, memory, interfaces, and a video-display generator. Figures and illustrations are shot sequentially by a monochrome camera with three color-filters. The video-image data is converted to digital form and stored on a floppy disk for editing and arranging. The system is also capable of generating eight-color graphics displays.

With the development of the appropriate software it should find application as an information center, learning aid, home amusement-center, or even as an electronic magazine or textbook.

While the products in Matsushita's "Technology Today" exhibit that we have discussed were largely in the video and TV fields, you should know that there were equally impressive products in such categories as audio, business products, home appliances (even a microwave oven that talks to its user), component technology, medicine, and manufacturing. Many of the products of the future already exist in today's technology. **R-E**

What's News

Sears catalog on videodisc

The Sears Summer 1981 catalog has been put on videodisc for viewing in selected Sears stores and catalog-sales offices in the Washington, DC and Cincinnati areas, as well as in about 1,000 homes that have compatible videodisc players hooked to their TV sets.

SEARS SUMMER '81 CATALOG, electronic style. It supplies all the information of the printed catalog—plus the added excitement of motion and sound.

The experiment is an early part of a study of electronic technology in catalog selling. The viewer has the ordinary catalog display, plus action and sound. Shopping electronically is like playing a TV game. The viewer is given an index, and can select the desired departments or items by pushbutton. Most of the merchandise sections begin with a series of "browsing" frames that quickly show all the products offered in a given line. The viewer can scan the assortment in seconds, then reverse for a closer look at any item.

Ordering is the same as ordering from a catalog. The viewer taks down the ordering information displayed on the screen and the videodisc catalog number, then phones it in or takes it to the catalog-order desk.

Universal external interface of DiscoVision players

SSM Microcomputer Products has developed a microprocessor interface to read-only video discs, which, with appropriate supporting equipment, can give the user possession of a vast library of information. This Universal External Interface (UEI) is being made exclusively for DiscoVision Associates, a joint project of IBM and MCA. DiscoVision markets laser-based videodisc playback units.

In its "constant angular velocity" mode, the DiscoVision player, has 54,000 tracks, with one complete video frame stored per track. The theoretical digital data storage capacity is 50,000 megabytes per side. That means that each side of a disc could hold the equivalent of about 180 300-page books. When the player's "constant linear velocity" mode is used, the capacity is nearly double.

A typical setup would include the Universal External Interface, a microcomputer complete with keyboard and video terminal, the DiscoVision player, and a TV monitor. That setup could offer facilities equal to thoe that would be found in an immense library, accessible within seconds by microcomputer control. For example, a doctor could refer immediately to an amount of information equal to that in the finest medical library. A student could have all of the text and reference works that he or she could possibly require for eight years of undergraduate and graduate studies on a single disc. The videodisc, tied to a personal computer, could be a significant competitor to the broadcast and wired network services in the distribution of inexpensive mass information. It could also be the ultimate system for computer-assisted instruction and reference, since sound, video, and digital data can be mixed on a single disc.

Computer-originated mail system

RCA's Government Communications Systems unit has been awarded a contract by the U.S. Postal Service to develop and install an electronic computer-originated mail system (E-COM).

The system will offer mailers high-speed delivery of notices, statements, and other computer-originated items. Computer-generated messages will be transmitted from the mailers by domestic common carriers to some 25 serving post offices around the nation. The system, scheduled to be in operation by early next year, will deliver a message anywhere in the continental United States within two days of its transmission to the appropriate E-COM serving post office.

RCA will install equipment, develop computer programs, train postal employees, and provide initial maintenance. Cost of the contract is being negotiated. **R-E**

All About SCANNERS

Have you ever wondered what makes scanning.receivers so popular? Sophisticated electronics and, perhaps more important, exciting listening are two good reasons.

ROBERT B. GROVE

IN THE MID 1960'S, TUNEABLE AND CRYSTAL VHF receivers were quite common. Some general-coverage shortwave receivers covered the lower portion of the VHF band as well. But in 1968, the picture changed. An engineer named Al Lovell had an idea: What if a series of separate crystals could be switched automatically allowing the receiver to look for active channels? That idea lead to the creation of the scanning receiver.

The first scanners

The basic scanner patents were assigned to Lovell's new company, Bearcat. Electra, Bearcat's parent company, is understandably proud of the role it has played in the industry since those early days.

But its scanners are not the only products on the market. Many early entries, from such firms as Tennelec, JIL, SBE, and others have come and gone. Today, Regency and Radio Shack are the two major contenders in the race with Electra for scanner sales. As we went to press, another company, ComRadar Corporation, announced its entry into the scanner market. All four companies offer quality products.

How scanners work

Early crystal-controlled scanners were relatively simple. Since their frequency ranges were limited, the factory or the user merely peaked the receiver's performance near the center of the range to be monitored. Naturally, the receiver's sensitivity dropped off slightly at the edges of those ranges, but the units were still quite acceptable for local listening.

The same technology is still used in low-cost crystal scanners (see Fig. 1).

The first frequency-synthesized scanner was developed by the Teaberry Company. Its scanner, originally scheduled for introduction in 1972, never was released because of numerous problems with the device. In the Teaberry scheme, a single crystal-controlled master oscillator was used for all allowable frequencies. That master oscillator was a combination of frequency dividers, mixers, and multipliers (see Fig. 2). That is the same technique that is used today. The master oscillator can generate an almost infinite number of frequencies, each spaced to match the incremental frequency assignments throughout the VHF/UHF spectrum. In today's scanners the actual frequency generated at any instant is determined by a microprocessor.

But the microprocessor does more than determine the listening frequency; it also peaks the RF stages of the scanner automatically so that it will be properly tuned no matter where the receiver is listening. In the Bearcat *Track Tuning* scheme, the peaking is done by voltage-variable capacitors, also known as varactors (see Fig. 3). The capacitance of a variable-voltage capacitor is controlled by the voltage across it. To change the capacitance in the tuned circuit, a microprocessor regulates the voltage across the variable-voltage capacitor, peaking the tuned circuit that the capacitor is in.

Three years after the Teaberry scanner was to have been introduced another manufacturer, Tennelec, actually released a programmable synthesized scanner. The *MemoryScan* was a premature product, and did not last long. Neither did the scanner entries from SBE/Linear Systems *(Optiscan)* or JIL *(model*

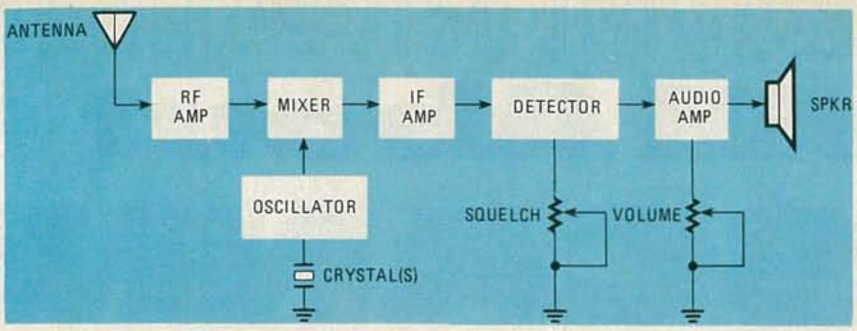


FIG. 1—SIMPLIFIED BLOCK DIAGRAM of a crystal-controlled receiver. The operating frequency is determined by the resonant frequency of a replaceable quartz crystal.

FREQUENCY LISTS AND SCANNER CLUBS

Owning a scanner is the first step. Knowing where to listen is the next. Hobby-radio stores are excellent sources for local frequency lists. For more extensive listings, several excellent publications are available.

For hobbyists who enjoy listening primarily to public safety communications, Gene Hughes' *Police Call Radio Directory* is hard to beat. It is regionalized by state and costs $5.95 from Radio Shack, or is available directly from the publisher, Hollins Radio Data, P.O. Box 35002, Los Angeles, CA 90035.

Handler Enterprises offers the *Radio Communications Guide*, concentrating on shortwave frequencies but featuring VHF/UHF listings as well. It costs $6.95 and is available from Handler Enterprises, P.O. Box 48, Deerfield, IL 60015.

Tom Kneitel's *Top Secret Registry of U.S. Government Radio Frequencies* is available for $4.95 from CRB Research, P.O. Box 56, Commack, NY 11725. Only VHF and UHF frequencies are listed.

The new *Betty Bearcat Frequency Directory* is available in two editions: Eastern and Western United States. Either costs $12.95. It lists public safety, government, and transportation frequencies. It's available from the Scanner Association of North America, Suite 1212, 101 East Wacker Drive, Chicago, IL 60601.

Among hobby scanner clubs, two organizations stand out. The Radio Communications Monitoring Association is a truly professional organization, and its monthly magazine shows it. Send for a free sample copy by writing: RCMA, P.O. Box 4563, Anaheim, CA 92803.

A hobby-scanner users club, SCAN, publishes Scanning Today. Loosely sponsored by the Electra Company, its magazine is published bi-monthly and features articles of interest to scanner listeners. For more information, write to: Scanner Association of North America, Suite 1212, 101 East Wacker Drive., Chicago, IL 60601.

SX-100).

Regency's first programmable scanner, the *Whamo-10*, proved to be awkward to use with its frequency combs, and bulky when combined with its accessory control unit. It was also very expensive.

The first programmable scanner to enjoy widespread acceptance was Electra's *Bearcat 101*, even though initial units had problems like overheating, and sometimes "lost" programmed channels stored in memory. But the rapid introduction of competitive receivers from Radio Shack, Regency, and even Electra itself, reduced the *Bearcat 101's* lead.

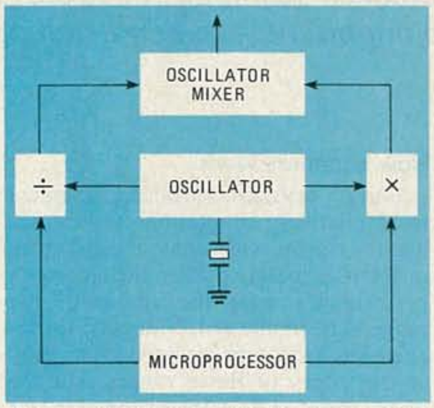


FIG. 2—THE MASTER OSCILLATOR, a combination of frequency dividers, multipliers, and mixers operating under microprocessor control, can generate a wide range of frequencies.

State of the art

Modern scanners have come a long way since the early days. Regency's first real programmable, the *model ACT-T-16K Touch*, has been replaced by the *model K-100, model K-400, model K-500* (shown in Fig. 4), *Digital Flight Scan*, and *model M-100*.

Radio Shack has replaced their classic *PRO-2001* with two newer models, the *PRO-2002* and *PRO-2008* (shown in Fig. 5).

The largest selection of new programmables has come from Electra. The *Bearcat 250, Bearcat 211, Bearcat 220, Bearcat 300*, and *Bearcar 160* have all appeared on the market within three years. Electra recently introduced a fully synthesized, hand-held scanner, the *Bearcat 100*.

The *Bearcat 300* is the most expensive scanner presently on the market. It features Service Search, a specially preprogrammed memory that searches the spectrum by service (marine, fire, police, etc.). A total of eleven factory-programmed SERVICE buttons allow instant selection of hundreds of scanning channels for a particular service without having to program discrete frequencies manually into the scanner. The Regency *model K-400* has a similar feature.

A new entry in the frequency-synthesized scanner field is the *Fox BMP 10/60* from ComRadar Corporation (Fig. 7). That receiver can be used as a portable or mobile unit, or as a base station.

Frequency ranges

Typically, scanners cover frequency ranges of 30-50, 144-174, and 420-512 MHz. Some of the newer models also cover the 118-136 MHz aircraft band and aircraft tower OMNI and VOR transmissions. The Bearcat *5/800* crystal scanner covers the 800 MHz "microwave mobile" band.

Antennas

While scanner manufacturers normally include a small plug-in antenna, that type of antenna is not suitable for receiving distant stations; an outdoor antenna is recommended. But, because large antennas also capture large amounts of local signal, some problems may result. One of those problems is intermodulation, the appearance of the same signal at several places within the tuning range of the scanner. That problem is different from image interference, which will always be heard at a fre-

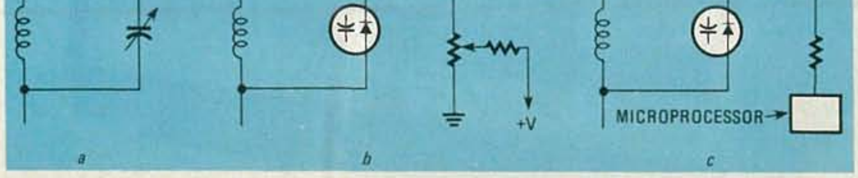


FIG. 3—A TUNED CIRCUIT (shown in *a*) can be voltage-tuned using voltage-variable capacitors (varactors) as shown in *b*. In today's synthesized scanners, the varactors are controlled by a microprocessor (c).

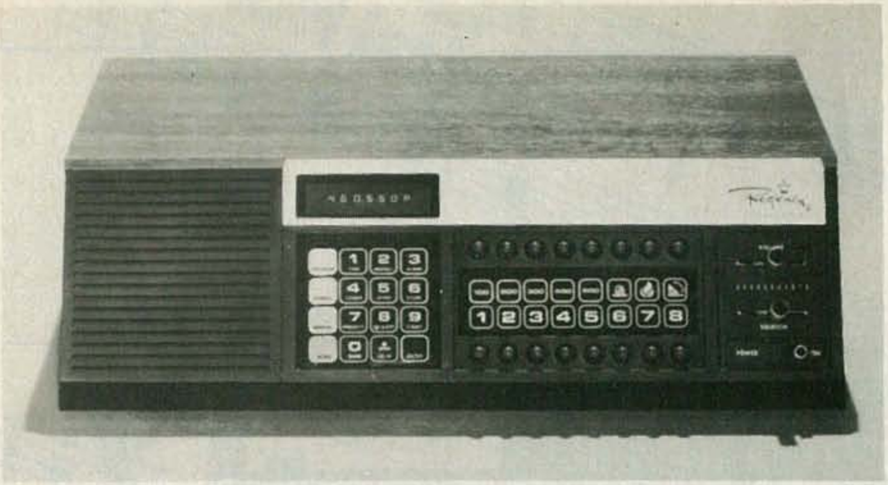


FIG. 4—THE *TOUCH K500* from Regency uses a touch-sensitive keypad instead of conventional pushbuttons.

FIG. 5—REALISTIC *MODEL PRO-2008* is a six-band, frequency synthesized, programmable scanner.

FIG. 6—THIS COMPACT SCANNER, for the Fox BMP 10/60 from ComRadar Corporation, features 60 pre-programmed frequencies.

quency that is twice the intermediate frequency of the receiver away from the carrier frequency. This sounds confusing at first, but it is easy to calculate. For example, Regency and Radio Shack receivers typically have an IF of 10.7 MHz; twice that is 21.4 MHz. If a very strong mobile telephone signal is heard at 152.54 MHz, chances are a weaker image signal will also be present at 173.94 MHz (152.54 + 21.4 = 173.94).

Image interference can sometimes be used to receive frequencies that are below the normal range of the scanner; the signals will be much weaker, but they will be there nonetheless. For example, some early programmables would not tune all the way down to 144 MHz, the low end of the two-meter amateur band, but images of two meter signals could be copied near 165-166 MHz if the signals were strong enough.

In some cases intermodulation may be reduced by turning a directional beam antenna *away* from the interfering signal.

Scrambled transmissions

Many law enforcement agencies are very concerned about the number of people who are eavesdropping on their sensitive messages. While the vast majority of listeners are merely curious, there are some who use scanners to elude the law while committing a crime. For that reason, some agencies use scramblers to encode their transmissions. A few manufacturers sell decoders that defeat the most common form of scrambling: speech inversion. Advertisements for the decoders frequently appear in various hobby radio magazines.

Because of the ready availability of those decoders, some agencies have switched to more sophisticated voice-encoding techniques. One of those, Motorola's DVP (*D*igital *V*oice *P*rotection) is said by the manufacturer to be virtually unbreakable. Will consumer technology eventually break the unbreakable code? Only time will tell.

Where to listen

A great deal of exciting listening is waiting for you out there; all you need to know is where to look! Low band (30-50 MHz) is used primarily for wide-area coverage. Military training exercises, National Guard units, State Police systems, and construction and freight companies are among the things that can be heard in this portion of the spectrum.

High band (151-174 MHz) is the most congested part of the VHF/UHF spectrum. Mobile telephone, business, and public safety communications dominate the first 11 MHz, while 162-174 MHz is used almost exclusively by the Federal Government.

The UHF band (450-512 MHz) is used mostly in metropolitan areas where high-band congestion poses a problem to new radio systems. Assignments in the UHF band are very systematic. Repeaters, high-powered transmitters that rebroadcast weak signals received from mobile and portable units, are found either 5 MHz lower than the original signal (between 450-470 MHz), or 3 MHz lower (between 470-512 MHz).

Table 1 is a listing of services and the frequency ranges (in MHz) in which you're most likely to find them. You should note that the ranges given are approximate.

In addition to the frequency ranges given in the table, police, fire, and medical assignments are shared throughout the following UHF frequency ranges: 470.3-471.2, 473.3-474.2, 488.3-489.2, 491.3-492.2, and 494.3-494.4 MHz.

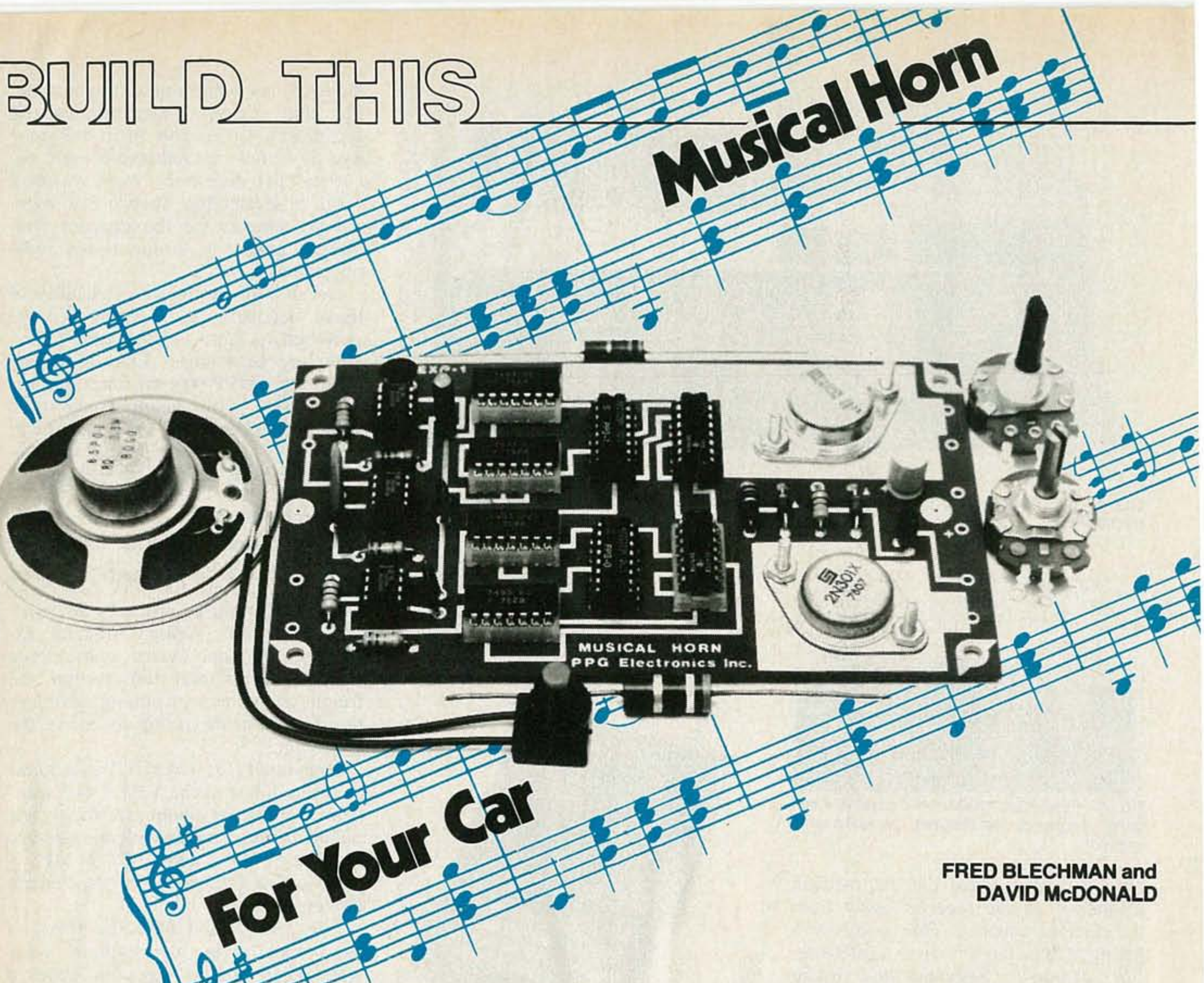
In conclusion

The scanner is a fascinating instrument. It features electronic sophistication hardly dreamed of ten years ago. Advances made possible by the space program, and the CB boom let home hobbyists tune in to a world of excitement. What does the future hold in store? We can only guess, but until then, take your pick from some of the finest consumer technology available. **R-E**

TABLE 1
(Frequencies in MHz)

Police	Fire	Medical	Fed. Gov't.	Marine	Mobile Tel.	Ham
37.02-37.42	33.42-34.0	33.0-33.1	30.0-30.56	156.25-157.4	35.26-35.7	144-148
39.0-39.98	46.08-46.5	37.9-38.0	32.0-33.0	161.6-162.0	43.26-43.7	420-450
42.0-42.94	154.0-154.5	47.0-47.65	34.0-35.0		152.0-152.2	
44.62-46.02	159.0-159.2	49.6-50.0	36.0-37.0		152.51-152.81	
154.65-156.0	453.0-454.0	151.0-151.13	38.0-39.0		158.49-158.67	
453.0-454.0	458.0-459.0	155.16-155.4	40.0-42.0		454.0-455.0	
458.0-459.0		156.0-156.25	138-144		459.0-460.0	
460.0-460.5		462.9-463.2	148.0-150.8			
465.0-465.5			162.025-173.2			
			173.4-174.0			
			406.0-420.0			

BUILD THIS Musical Horn For Your Car



FRED BLECHMAN and
DAVID McDONALD

Give your car a distinctive sound with this musical "accessory." It should take you less than an hour to assemble.

Part 2 WE WERE EXAMINING how tones were generated by the musical horn when we stopped last month. Now we'll finish up.

Whenever a match is found between the output from IC8 and the output from IC9, then IC6 and IC7 are reset at the frequency of the note called for by IC8, until the input to IC8 changes. The greater the number of counts IC6 and IC7 produce before reaching the IC8-IC9 matching-address, the longer the time period for each reset cycle, and therefore the *lower* the frequency of the note that is produced.

Let's use some actual numbers to illustrate this. Suppose IC3 is adjusted by R5 to pulse at 87560 Hz. To produce a 220-Hz musical note, "A," binary code ØØ11 (decimal 3), at address 199 of IC9, is used. Each second IC3 counts up to that memory location 440 times (87560/199=440). Each time location 199 is reached, a ØØ11 output appears at the "B" input of IC10. With the "A" input to IC10 also ØØ11, a pulse appears at IC10 output-pin 6—in this case, at the rate of 440 times per second. This is converted to a square wave with a frequency of 440/2, or 220 Hz, by flip-flop IC11-b, and this is the frequency fed to the amplifier.

Using the same IC3 pulse rate, if the musical note "E" (decimal 7) were specified by IC8, then address 133 of IC9 would contain the matching binary code (see Fig. 6) and would cause IC10 to output pulses at the rate of 658.35 per second (87560/133=658.35). That would be divided in half by IC11-b to 329.18, very close to the ideal 329.63-Hz frequency of "E-above-middle-C." Figure 6 shows all the musical notes programmed in IC9 by location, along with the decimal code notation used in Fig. 1. (Figures 1 and 6 appeared in last month's issue.)

The 7473 dual J-K flip-flop, IC11, requires a little explanation. Input K of IC11-a is connected to V_{CC}. Since J is low, Q is low. Whenever input J goes high (because of an output pulse from IC10), the next time the clock pulse from pin 3 of IC3 goes low, the Q output (pin 12) of IC11-a goes high and resets IC6 and IC7. That stretches the length of the reset pulse to equal the duration of the clock period of IC3, making it wide enough to be recognized by IC11-b. The resetting routine may occur hundreds of times per second, depending on the settings of R1 and R5, and on the note and duration called for by the song PROM.

With both J *and* K inputs tied to a positive voltage, IC11-b is used as a toggle flip-flop. Every time the Q output of IC11-a goes low, it clocks IC11-b and causes the IC11-b Q output, at pin 9, to change state. The result is a square wave output from IC11-b equal in frequency to one-half the IC10 pulse frequency. The squaring of the IC10 pulses results in a sound more closely resembling that produced by a sine wave.

Positive halves of the square wave from pin 9 of IC11-b pass through dropping resistor R8 and isolation diode D1 to bias NPN transistor Q1 into conduction. That path now provides, through R9, the forward base-bias for power transistor Q2 to conduct heavily,

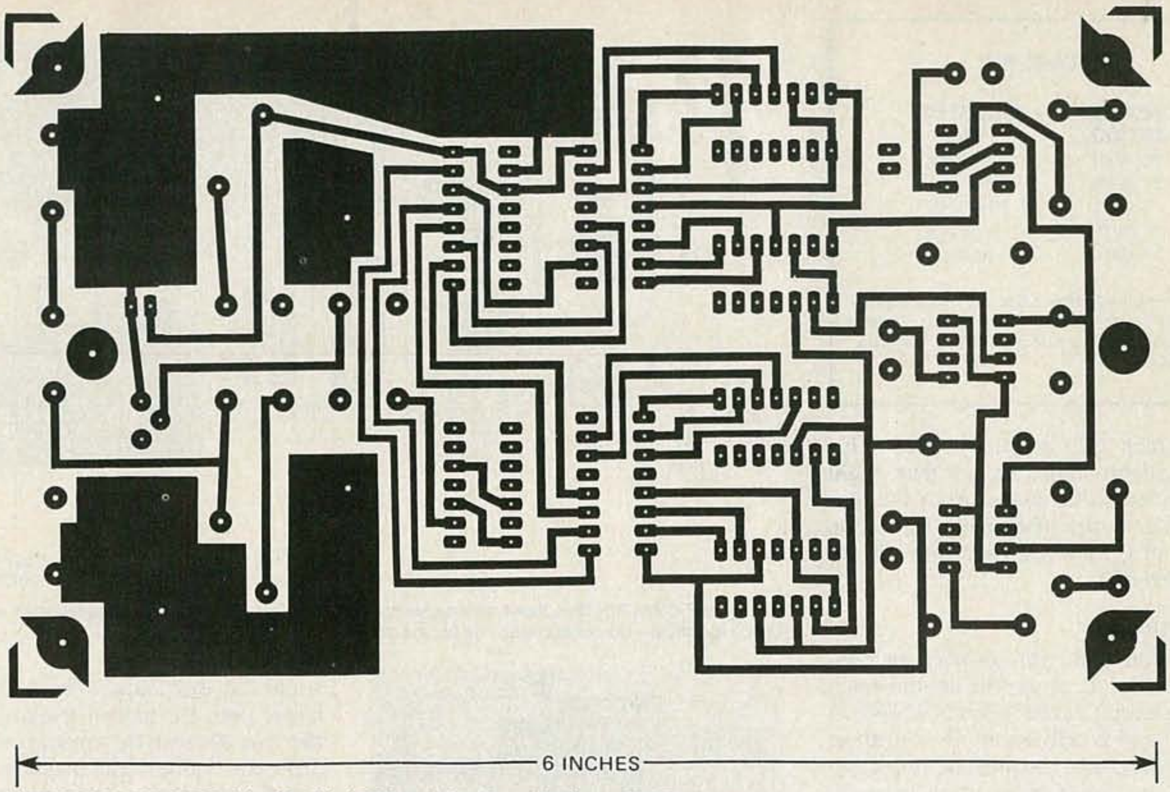


FIG. 7—PATTERN FOR FOIL SIDE of double-sided PC board. See Parts List for availability of ready-to-go boards if you don't want to make your own.

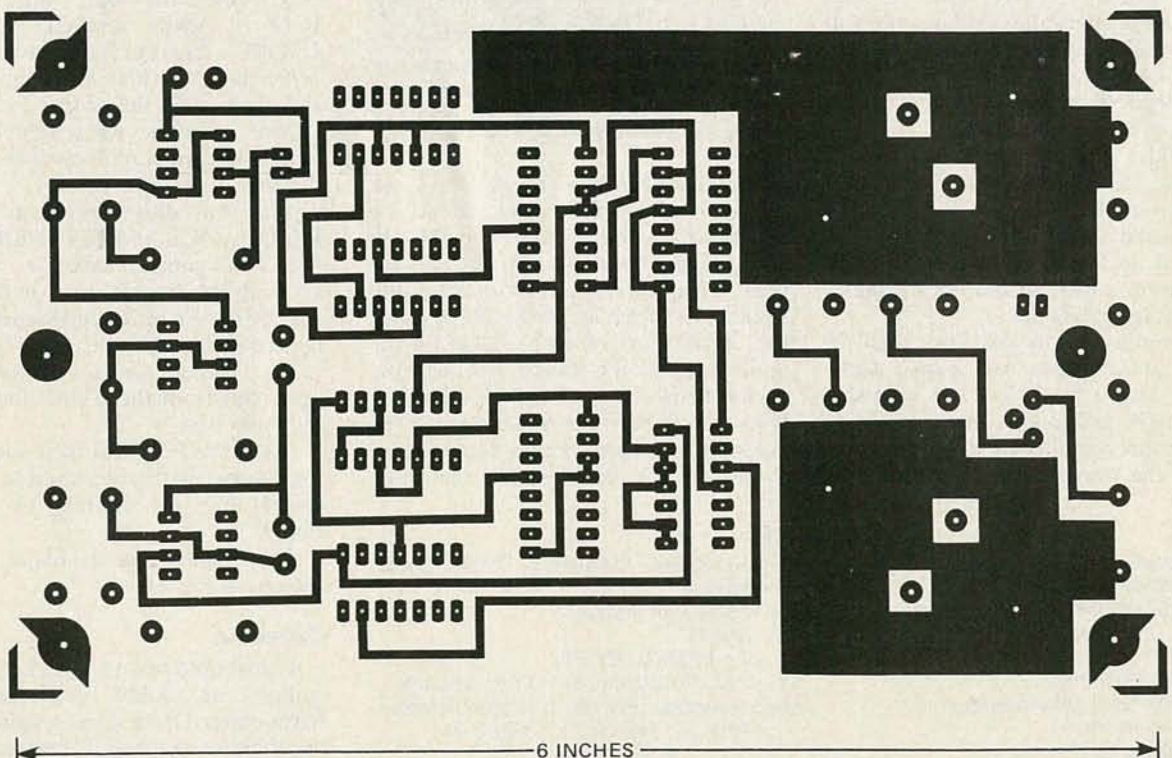


FIG. 8—COMPONENT-SIDE foil pattern. Both sides of the board must be in perfect register. Holes should be plated-through.

passing current through the speaker coil. Resistor R10 is a 2-watt series current-limiting resistor which must be used with speakers rated at less than 10 watts, as shown in Table 1.

A five-volt regulator, IC12, is protected from reverse-voltages by diode D2. Its output is filtered by C6. Switch S1 is used to operate the horn.

A song can be played in different keys as each note is not "locked-into" a specific frequency. In a musical scale each note bears a fixed mathematical relationship to every other note. You can vary the frequency of the notes as long as all the notes maintain the same relationship. PROM IC9 establishes that relationship, so you can vary song-speed with R1 and change the pitch (key) by adjusting R5.

One final note: When IC8 is programmed for "silence" (binary ØØØØ) it actually causes "matching" at an ultrasonic frequency with the first address in

SPEAKER RATING	RESISTOR (R10)
.25 watt	39 ohms
.5 watt	27 ohms
1 watt	16 ohms
5 watts	3 ohms
10 watts	none

TABLE 1

Note—If a speaker rated at less than 10 watts is used, a current-limiting 2-watt resistor must be used in series with the speaker.

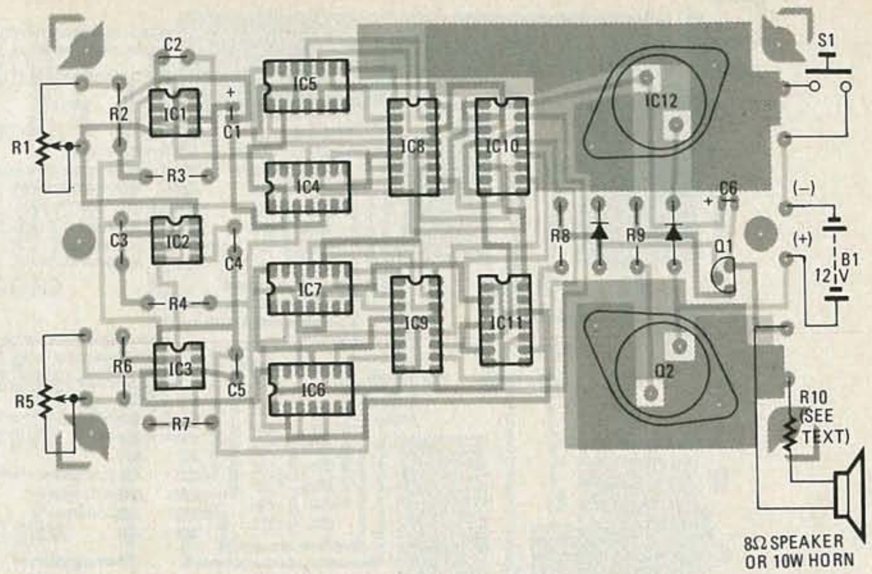


FIG. 9—BE CERTAIN that diode and capacitor polarities are correct. Packages for IC12 and Q2 are nearly identical—do not confuse one for the other.

IC9, which also is binary ØØØØ. This causes slightly more current than might beexpected to be drawn from the battery, due to the high-speed saturation effects of Q1 and Q2 (fast turn-on and slow turn-off).

Construction

You can build this project on construction board, or use the double-sided printed circuit board layouts shown in Figs. 7 and 8. However, if you make your own boards you must be very careful to have good registration between the top and bottom surfaces. Furthermore, unless you are able to plate through the holes after drilling, you will have to solder each component on *both* sides of the board, since many circuit paths depend on continuity through the board!

Frankly, the double-sided, plated-through PC board offered for this project (see Parts List in last month's issue) is the most practical way to go. A parts kit, including sockets for all IC's and the tone PROM, but not including case, is also available.

Assembly should take less than an hour, and requires no special techniques. Use a small-tip 25-45 watt soldering iron and good rosin-core solder. All parts are mounted on the component side of the board. Insert and solder all the resistors first; be very careful to get the right values in the proper locations, as shown in the parts-placement diagram (Figure 9). Install all the IC sockets next, being careful not to install 14-pin sockets in 16-pin locations! Bend down the corner pins of each socket on the underside of the board to hold the socket firmly in place before soldering. Now install the two diodes (watch the polarity—the banded ends should point toward IC12). Next install the three small flat disc capacitors and then the larger one. Be careful when you install the two electrolytic capacitors; they are different values andalsomust be oriented correctly.

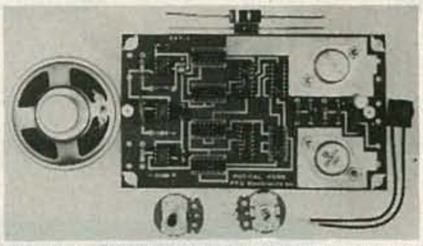


FIG. 10—COMPONENTS SURROUNDING BOARD can be mounted along with it in plastic case under the dashboard. The speaker or horn, of course, is located behind car's front grille.

Transistor Q2 and voltage regulator IC12 look alike—don't mix them up! IC12 is clearly marked "LM309 or LM340", but Q2 may have numbers *other* than "2N301" (such as SP-2540.) Put each onein the proper location and secure it to the printed-circuit board with 6-32 hardware. Now insert and solder the small transistor, Q1.

You can either program the two PROM's, IC8 and IC9 (N82S129's or 74S287's) yourself (see the "Inexpensive PROM Programmer" in the February 1981 issue of **Radio-Electronics**), using the information provided last month in Figs. 3 and 6, or obtain them pre-programmed from the source indicated in the Parts List.

Insert the IC's into their sockets, being careful that the notched or indented (pin-1) ends are oriented as shown in Fig. 9.

The finished board should look like the one in Fig. 10.

PARTS LIST

Resistors ¼-watt, 5% unless otherwise specified
R1—100,000 ohms, potentiometer
R2, R7—10,000 ohms
R3—1000 ohms
R4—100,000 ohms
R5—500 ohms, potentiometer
R6, R9—100 ohms
R8—330 ohms
R10—see Table 1

Capacitors
C1—1 μF, electrolytic
C2, C4, C5—0.01 μF, ceramic disc
C3—0.1 μF, ceramic disc
C6—10 μF, electrolytic

Semiconductors
IC1-IC3—555 timer
IC4-IC7—7493 4-bit binary counter
IC8, IC9—N82S129 or equivalent 256 × 4-bit PROM (see below)
IC10—7485 4-bit magnitude comparator
IC11—7473 dual JK master/slave flip-flop
IC12—LM309K, LM340K or 7805K 5-volt regulator
Q1—2N3904 or similar
Q2—2N301
D1, D2—1N4003, 200 PIV
S1—N.O. momentary pushbutton switch

Miscellaneous: PC board, 8-ohm speaker or horn, IC sockets, hardware, etc.

NOTE: The following are available from PPG Electronics, Dept. RE, 14663 Lanark St., Van Nuys, CA 91402: Complete kit including PC board and all parts except case and IC8 (No. 1082), $39.95; PC board only (No. 782), $11.95; IC9 tone PROM (PPG-0), $6.95; IC8 song PROM ("Cucaracha": PPG-1, "Dixie": PPG-2, "Charge": PPG-3), $6.95 each; 2N301 output transistor, $1.99. Add $2.00 shipping & handling for orders within U.S. CA residents please add 6% tax.

Checkout

You should test the unit before packaging it up. Solder short leads (bare wires clipped from resistors after soldering them to the board, for example) to the PC-board pads that will connect to the two potentiometers, the switch, the power supply, and the speaker. Use alligator-clip leads to make the test connections from them to the outboard components. When connecting the potentiometers, the center and left terminals (looking at the front of the potentiometers) are the active ones. The right terminal can be left unconnected or wired to the center terminal, as you wish—it makes no difference electrically. The

continued on page 100

SATELLITE TV ANTENNA

In this part, we'll complete the assembly of the basic 8-Ball antenna and begin to get it ready for mounting.

H.D. McCULLOUGH

Part 2 ALTHOUGH YOUR 8-Ball antenna is starting to look like the finished product, we'll finish the lattice and install the screen.

Before installing the adjustment bolts in the ends of the two outermost vertical strips, cut a piece of $^3/_4 \times 2$-inch strip long enough to reach across the corner adjustment bolts. Drill a hole at each end to match the position and size of the adjustment bolts and install as shown in Fig. 10.

Cut another piece of $^3/_4 \times 2$-inch strip to fit cross the corner in between the vertical strips and install it across the corner between the vertical strips. It must be on top of the first diagonal-corner strip and underneath the horizontal strips as shown in Fig. 11. Finish across the corners and down the sides with $^3/_4 \times 2$-inch filler strips cut from scrap and installed as shown in Figs. 12 and 13 respectively. Those filler strips are necessary in order to do a good job of stretching the screen. Attach all short pieces with brass wood screws. Trim off the excess ends of the strips with a saw and tighten **all** of the adjustment bolts. That completes the frame and lattice, and the assembly should look like Fig. 4.

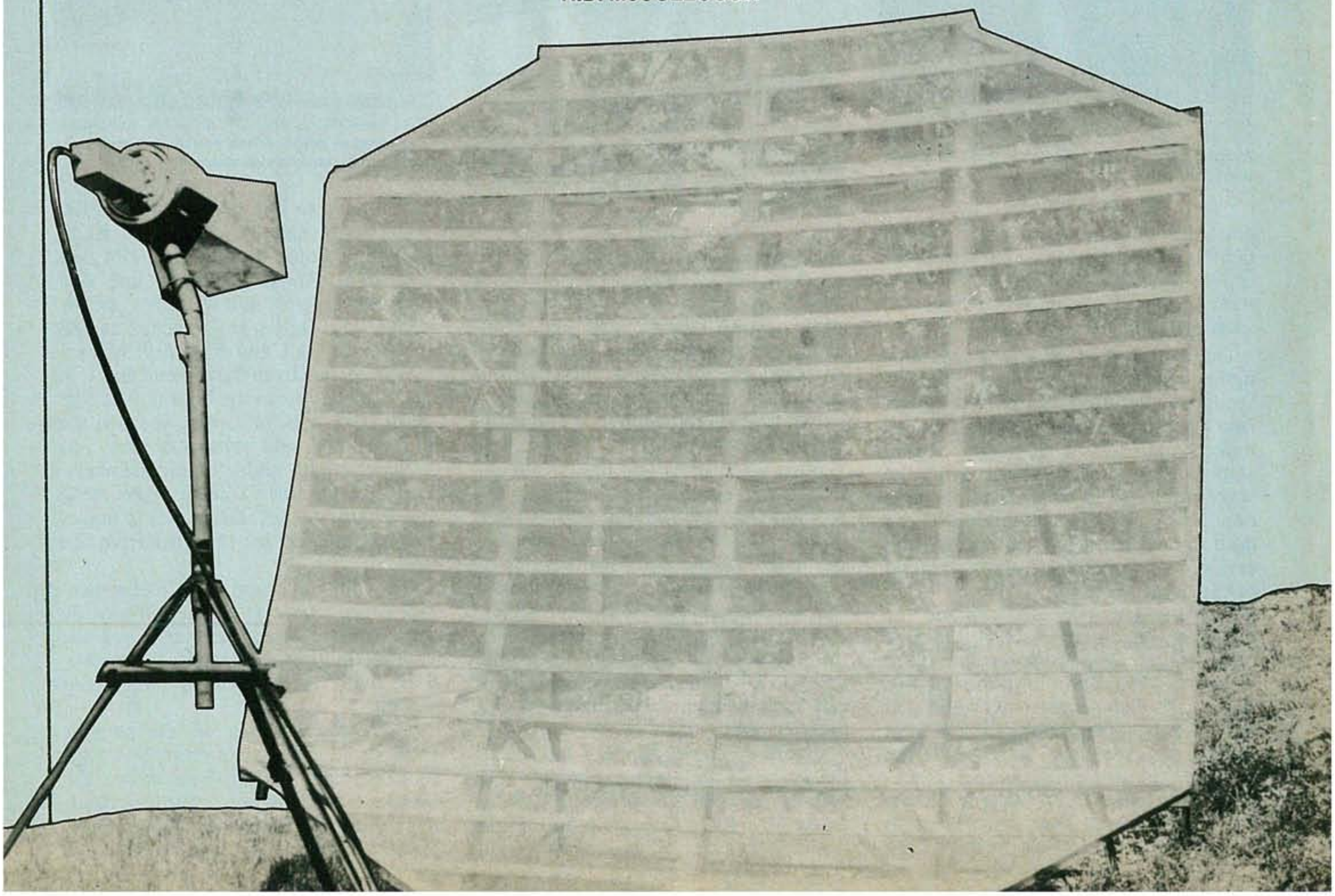
Installing the screen

Study the assembled frame from all angles, making sure that its curves are uniform. Be sure that all adjustment bolts are secure.

Up to now, we have not needed to do any precision assembly. However, the screen **must** be installed properly (meaning good and tight). If possible, move the antenna close to the spot where it will be located before beginning.

Start rolling out the first run of screen so one edge is on the middle horizontal strip of the lattice (Fig. 14). The screen is 26 inches wide. That allows for a good overlap as the screen runs repeat every 24 inches. There are six runs of 12 feet each—requiring a total of 72 feet of material.

Align the screen so that one overlap falls on the middle horizontal strip and another overlap falls on the third strip up (all overlaps should be equal). Leave equal overhangs at the ends. Use $^1/_4$-inch or $^3/_8$-inch long rustproof staples—whichever works best in your staple gun. The staples should drive into the wood far enough to hold the screen snugly—without going in far enough to cut the screen. Start with four or five staples in the center of the antenna at



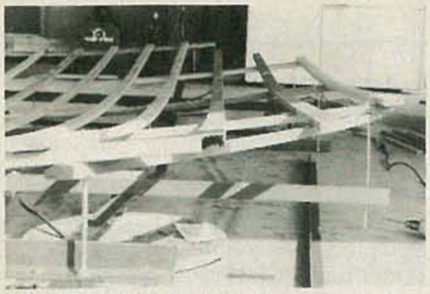


FIG. 10—A PIECE of ¾×2-inch stock, long enough to reach across the corner bolts, is installed in each corner as shown.

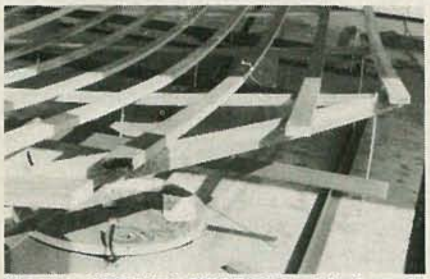


FIG. 11—ANOTHER PIECE OF ¾×2-inch stock, cut to fit between the vertical strips, is installed on top of the first so it is even with the vertical strips.

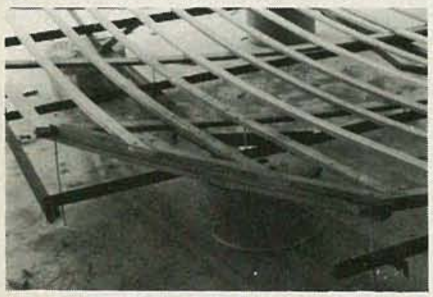


FIG. 12—MITERED STRIPS, cut from ¾×2 scrap, are fitted between the ends of the horizontal strips so that the frame edge is level for attaching the screen.

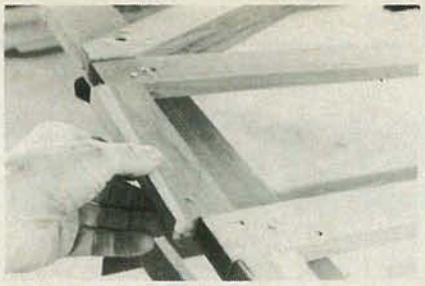


FIG. 13—SHORT PIECES of ¾×2 are cut to fit between the ends of the horizontal ribs in the lattice. They also provide an even surface for attaching the reflector screen. Brass screws hold each piece in place.

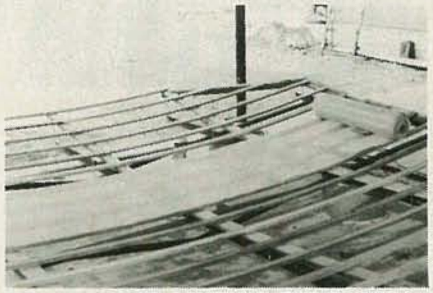


FIG. 14—START COVERING THE FRAME by rolling out the screen in a strip with one edge overlapping the center horizontal lattice strip.

FIG. 15—KEEP TENSION ON THE SCREEN as you place the staples until you have tacked all around the edges. When working with the first strip of mesh you will have to stand between slats in the lattice.

FIG. 16—AFTER STAPLING ONE EDGE, keep the screen taut and staple the point directly across from the first.

FIG. 17—PULL THE ENDS tight enough to keep the screen straight from center to edge. But, don't pull too tight—the screen may pucker in the middle.

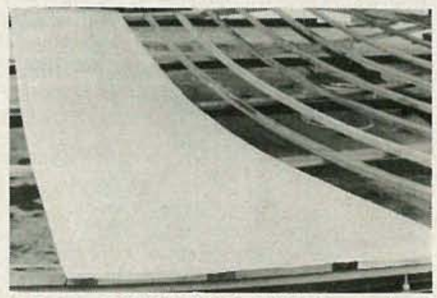


FIG. 18—ONE STRIP OF SCREEN completely anchored in place. When you've finished there will be one staple about every three inches.

one edge of the screen (Fig. 15). Pull tightly **straight** across and staple the other side as shown in Fig. 16. Now, put three or four staples into each of the two strips in between.

Go to one end of the screen and pull it tight enough to cause it to "stretch" straight across from center to the edge. **Don't pull the screen too tight**—that will make it pucker near the middle! Again, staple one edge first, then stretch the screen tightly and staple the other corner. Now, pull the screen toward you hard enough so it has uniform tension and add several staples across the end of the screen (see Fig. 17).

Halfway between one end and the middle of the screen run, pull the far side of the screen away from you a bit (¼ to ⅜-inch is OK), and put in four or five staples. Pull the screen tight and add four or five staples directly across from those you just put in. Now, staple the screen to the strips in between.

Move to a point halfway between two previously stapled points, put a staple in one edge, and then pull the screen directly across from that staple and add another staple. Continue until the entire run of the screen has been stapled in place. Don't skimp, use one staple every three inches near each side of each wood strip. Figure 18 shows one run of screen firmly stapled in place.

Install the remaining five runs of screen the same way.

Next we'll show you how to cut and install the rear legs and braces. We recommend that you don't do that part of the construction at this time since the length of the rear legs depends on your location relative to the location of the satellite(s) you wish to receive. (Complete information on how to aim the antenna will be given next month and you'll be able to proceed then.) For now, put the antenna up on blocks so it doesn't warp.

Figure 19 shows the legs and braces that support the antenna. Prepare rear legs RL1 and RL2 by attaching rear-leg extensions RLX to get the desired tilt angle. If you are not working with a kit, you'll have to drill holes in VR2, VR4, RL1, RL2, and leg extensions RLX. Drill four holes in VR2 and VR4 (see Fig. 20-a). Above the center line, drill holes at 4 inches and 48 inches. Below center, drill holes at 48 inches and 68 inches. In RL1 and RL2 drill holes 1 and 48 inches from the top end and 1, 3, and 5 inches from the bottom (see Fig. 20-b). Use special care in spotting the holes drilled and remember that you will have right- and left-hand members. Drill ¼-inch holes 2 inches apart along the length of RLX. Drill holes in braces B6 ¼ inch apart for 12 inches from one end.

The tilt angle and base pad dimensions (see Table 1) are determined by your longitude and latitude, and the satellite(s) that you want to receive. That will be covered in detail next month.

Move the antenna off the support blocks and place two short 2×4's (or blocks) under the BF base across the bottom of the antenna to prevent bending the bottom row of adjustment bolts. Raise the top of the antenna three or

HOW THE 8-BALL GOT ITS SHAPE

The reflector most often used in TVRO (*TV Receive-Only*) antennas is shaped like a parabola as shown in Fig. 1. Its design is based on the

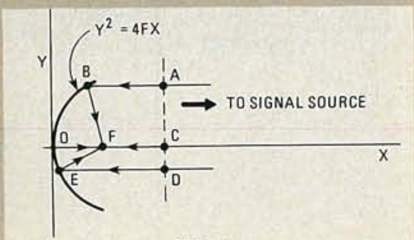


FIG. 1

equation $y^2=4fx$ where f is the distance from the center of the antenna to the focal point. A characteristic of the parabolic shape is that all signals from far away will be reflected to the focal point. This assumes that the antenna is pointed exactly toward (bore-sighted at) the signal source.

A second characteristic of the parabola is that the distance traveled from point A to point B to point F is the same as the distance from C to O to F and from D to E to F; with points A, C, and D lying on a line parallel to the Y axis. In that case, all signals reaching the focal point are in phase with each other and add together, no matter what part of the dish they are reflected from.

A horn is generally used to couple the signal at the focal point to the LNA waveguide. Its size is selected to match the F/D ratio (focal length: diameter) of the reflector. Most TVRO antennas have a F/D ratio in the range of 0.3 to 0.5. A 12-foot parabola with a 0.4 F/D ratio would be about 22½ inches deep.

The reflector surface of the 8-Ball is *spherical* rather than parabolic. It is like a 12-foot-square section cut from the surface of a sphere (ball) 60 feet in diameter (see Fig. 2). The

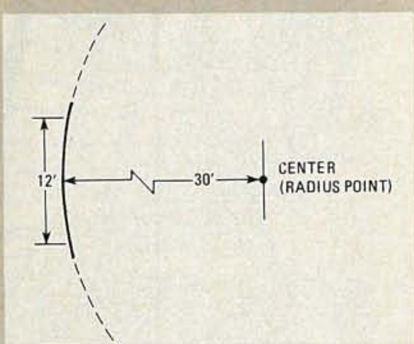


FIG. 2

depth of the 8-Ball reflector is about 7¼ inches (7.27347 inches, to be exact). On the other hand, if a 12-foot parabolic antenna were built with a 15-foot focal length, it would be 7.2 inches deep. Thus, the difference between the surface of the spherical antenna and a true parabolic antenna is only about ¼ inch (about 0.025 wavelength at 4GHz), and that much difference only occurs at the extreme edges of the antenna. The difference is much less at most points on the reflector surface.

There are, however, several practical advantages to the spherical reflector. One is that it can be easily checked for accuracy using a simple 30-foot radius-wire. Remember **all** points on the surface are the same distance from the radius point. Another advantage is that, being spherical, the curve is the same all over the dish. That means, that for the amount of curvature in the 8-Ball, it will function with good efficiency even if it is aimed to a point as much as 15 degrees either side of the exact location of the satellite (or up to 20 degrees in most areas of the U.S.). Thus the spherical dish can be used to receive signals from more than one satellite at a time, so long as the difference between the look-angles of the two (or more) satellites is less than about 30 degrees—although the difference in look-angles can be as much as 40 degrees in areas with strong signal levels.

A very useful advantage of this antenna is the fact that the reflector can be mounted in a fixed position and all satellites with look angles up to 15-20 degrees on either side of the bore-sight direction can be received simply by moving the feed horn to the proper focus point. This is shown in Fig. 3. Use two or more LNA/feed horns if you would like to receive two or more satellites simultaneously.

Still another advantage of the spherical reflector is that for elevation look angles of 30° or less, if you tilt the 8-Ball back from the vertical an amount equal to **half** the look angle, the focal point will be level with the center of the dish or about six feet off the ground (Fig. 4-a). That is a convenient height for the feed horn—particularly if you plan to shift the feed horn about to receive several satellites. (If it is necessary to have the feed horn lower than the center of the dish, you must cover the opening with something to keep the rain out because in that position, the horn is pointing up toward the center of the antenna.)

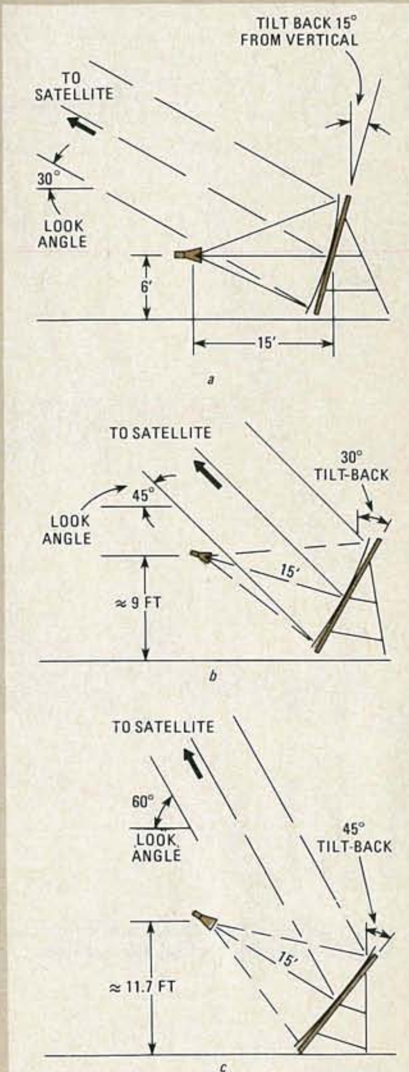


FIG. 4

For elevation-look angles of over 30 degrees, the feed horn must be mounted higher off the ground because you shouldn't have more than 15 degrees difference between the satellite look-angle and the pointing angle of the dish. Figures 4-b and 4-c show how the feed horn height must be increased as the elevation look angle increases. In those cases, the tilt-back angle is 15 degrees less than the look angle. **R-E**

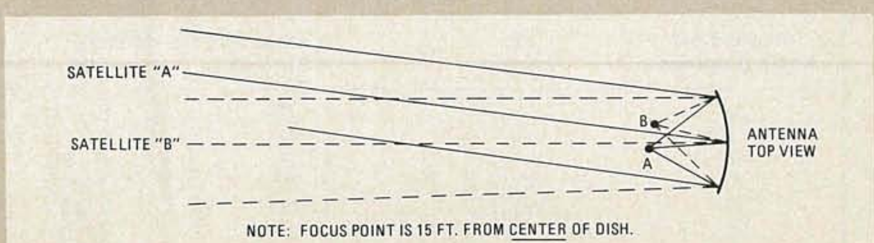


FIG. 3

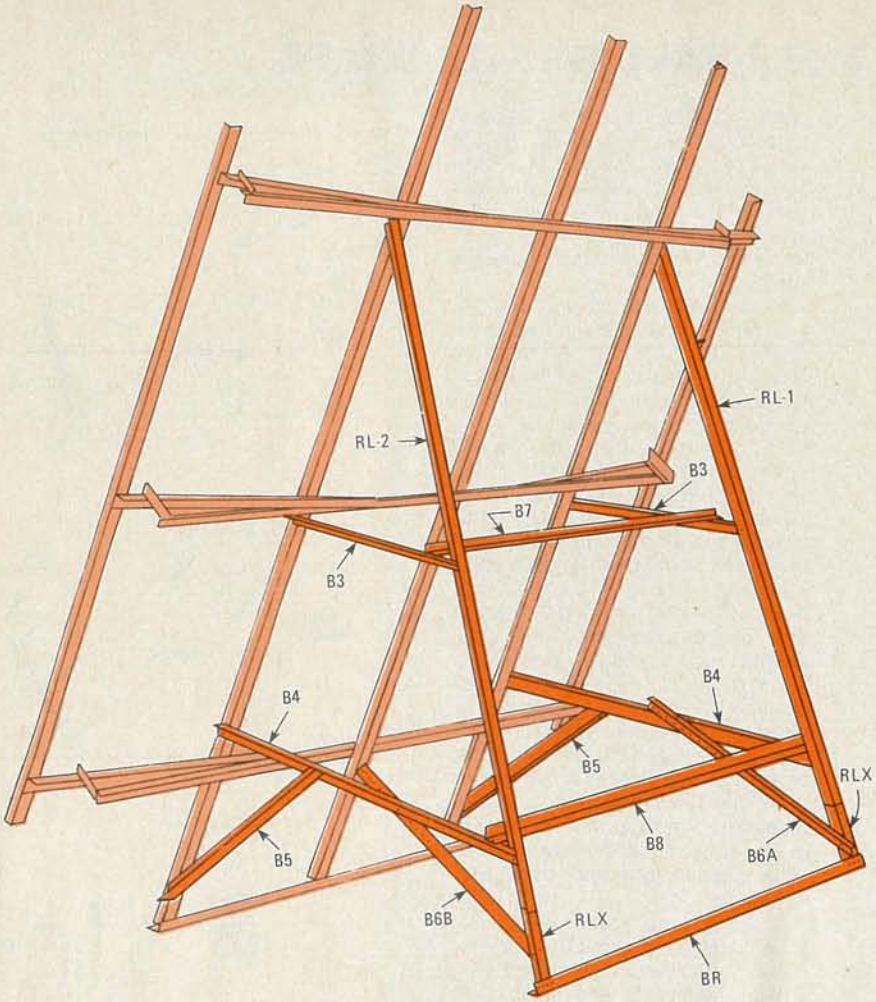


FIG. 19—THE REAR LEGS and the braces set the tilt of the reflector surface. Tilt is adjusted by lengthening or shortening the rear legs.

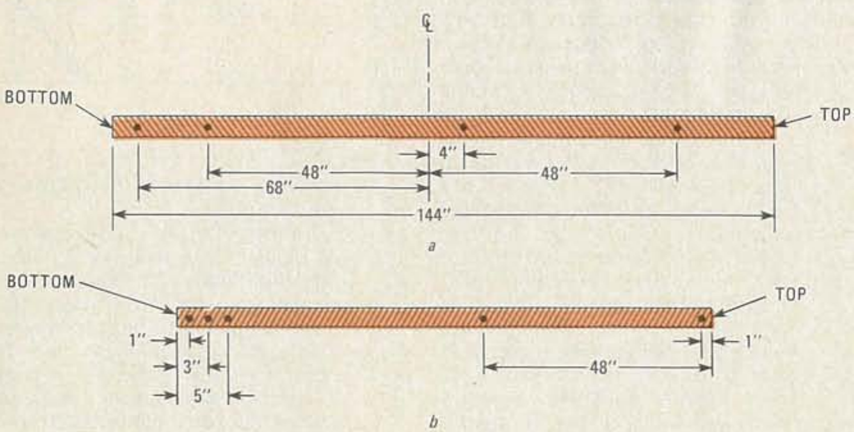


FIG. 20—DRILL HOLES in VR2 and VR4 as shown in *a*. The holes in RL1 and RL2 are drilled as shown in *b*.

TABLE 1			
Antenna Tilt Angle (Degrees)	**RL Length**	**Base Pad Dimensions (A)**	**(B)**
6	11' 7"	7' 0"	8' 2"
8	11' 4"	6' 11"	8' 1"
10	11' 1"	6' 9"	8' 0"
13	10' 7"	6' 6"	7' 11"
17	10' 1"	6' 4"	7' 10"
21	9' 7"	6' 2"	7' 9"
26	9' 1"	6' 0"	7' 8"
31	8' 7"	5' 11"	7' 6"
37	8' 0"	5' 9"	7' 4"

FIG. 21—THE TOP END OF THE ANTENNA is raised three to four feet off the ground so rear legs RL1 and RL2 can be attached. Put small blocks under the lower end to protect the corner adjustment bolts.

four feet off the ground and attach rear legs RL1 and RL2 as shown in Fig. 21.

Raise the antenna into place. The rear legs will slide into place. BE VERY CAREFUL when raising or moving the antenna until it is secured on the base pads. It can twist out of shape if one side is lifted more than the other. That can cause the screen to stretch and become loose. NEVER stand the antenna up until you are prepared to anchor it securely. It will blow over if the wind speed is 20 to 30 mph from the rear.

Install braces B3, B4, B5, B6, B7, B8, and BR in the order listed (see Figs. 19 and 22). The antenna is now complete and ready to be placed on the base pads.

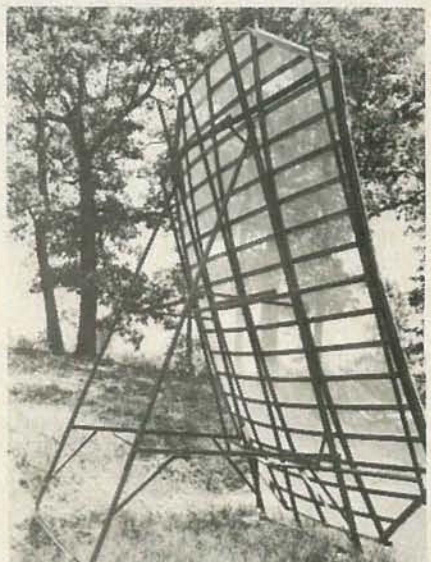
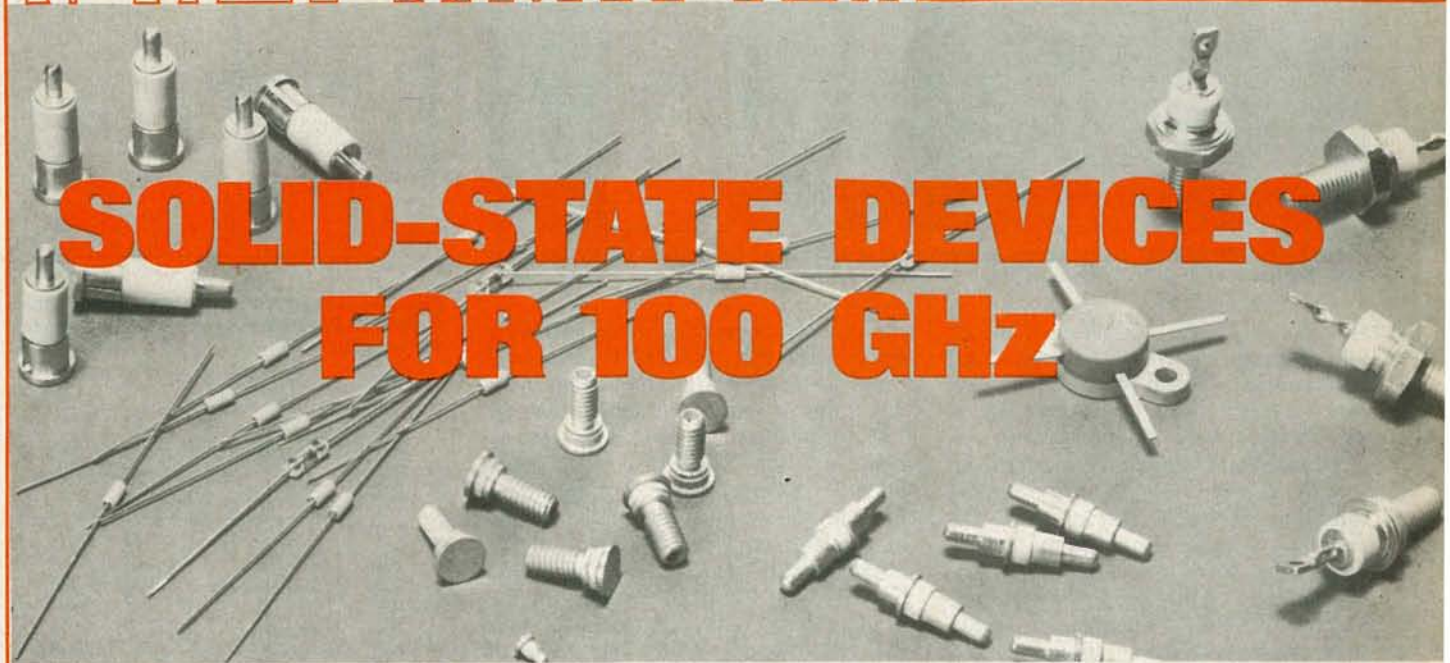


FIG. 22—REAR VIEW of the 12-foot 8-Ball antenna. All of the rear-support members are clearly visible.

That finishes the assembly of the basic 8-Ball antenna. Next month we'll show you how to find the satellites that you're interested in, pour the concrete basepads, mount the antenna, and adjust the reflector for best reception. **R-E**



SOLID-STATE DEVICES FOR 100 GHz

Higher and higher frequencies require better and more efficient microwave generators. These devices represent the current state-of-the-art.

JOSEPH J. CARR

Part 3 AS WE SAW LAST month, RCA successfully developed a higher efficiency microwave generator in 1967. But there was some disagreement on how RCA's TRAPATT worked.

Cornell University physicists offered a somewhat different explanation of the high efficiencies observed. The Cornell theory maintained that avalanche resonance pumping was the responsible mechanism, so advanced the acronym ARP. The Bell Labs view seems to have prevailed. The difficulty in determining the proper theory of operation caused a two-year delay between the first observations of the TRAPATT mode and the explanation of how it worked. Part of the problem is that TRAPATT operation is not amenable to small-signal analysis, so the correct theory had to be worked out somewhat more laboriously than would have otherwise been possible.

It has been demonstrated that ordinary PN junction diodes (silicon) can be made to oscillate in the TRAPATT mode. It is, however, rather tricky to adjust such circuits, so they do not find much application. Most commercial TRAPATT devices use the p^+-n-n^+ structure of the single-drift IMPATT. A typical TRAPATT device is shown in Fig. 16-a.

The structure of the TRAPATT device is very similar to that of the IMPATT. In fact, some TRAPATT devices will oscillate in either the TRAPATT or the IMPATT modes, depending upon the bias and other circuit conditions. It is noted that numerous TRAPATT oscillators actually start out in the IMPATT mode for a few nanoseconds after turn-on, and then convert to the TRAPATT mode when certain circuit conditions are satisfied. To make the device switch from the IMPATT to the TRAPATT mode, we need to drive it hard with a current pulse. Since the risetime of that pulse must be very short, it is usual to use the IMPATT mode to generate the pulses. (It is very difficult to obtain the risetimes needed with external circuitry.)

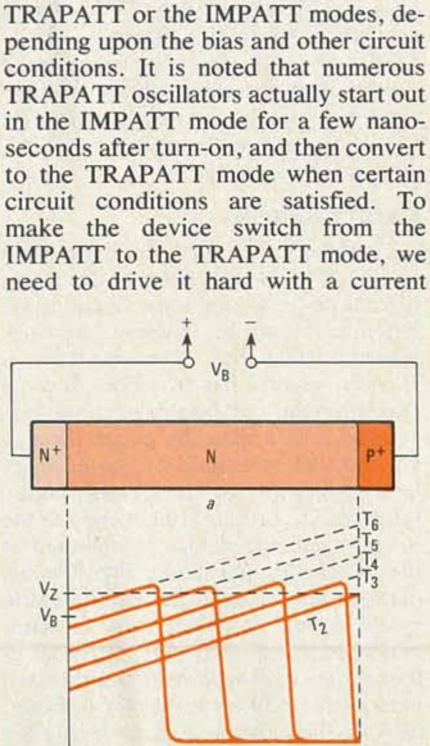


FIG. 16—TYPICAL TRAPATT device uses the p^+-n-n^+ structure of the single-drift IMPATT. Electric-field distribution in the region is shown in *b*.

What is a trapped plasma (the "TRAP" in "TRAPATT"), and how ever there is a large density of charge carriers (holes and electrons) present. If the electric field in that region is very low, then the plasma is said to be *trapped,* i.e., it takes a long time to sweep carriers out of the region under the influence of the electric field. The carrier velocity is considerably lower than the saturation velocity.

Figure 16-b shows the electric-field distribution within the n-region. The device is biased to just punch-through; i.e., the depletion zone reaches through the entire length of the n-region, but is biased at a point less than the avalanche voltage V_Z. The slope of the electric field (Fig. 16-b) is dependent upon the charge density. Because we are operating in the punch-through region, there will be no free charge-carriers present.

If we excite the TRAPATT diode with a large, fast-risetime current pulse, I_O, then we will observe a point in the constant-bias field V_B move as an avalanche shock front. We find that the velocity of that shock front can be faster than the saturated velocity of the holes and electrons, a phenomenon that

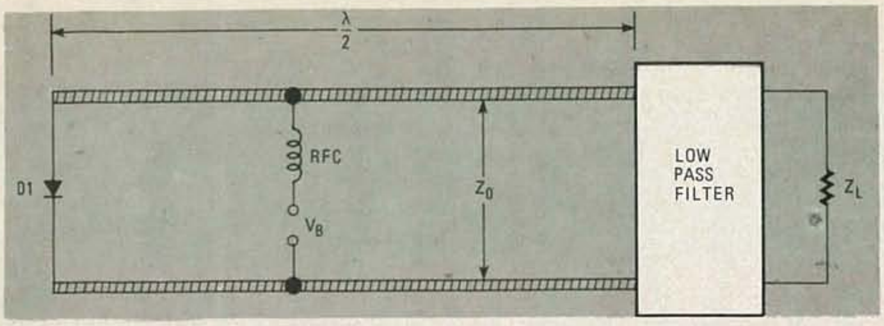


FIG. 17—A FAST-RISING, nearly square, current pulse is applied to a half-wavelength transmission line that has a TRAPATT device at its end.

is much like the behavior of water waves at the beach striking the shore at an angle. Typical times for the avalanche shock front to traverse the n-region are around 100 picoseconds.

Notice what happens to the terminal voltage in Fig. 16-b. Shortly after the initiation of each shock front, the terminal voltage drops from a very large value down to a very small value. The falltime of that drop is very rapid, so the TRAPATT operates as a very fast, low-impedance electronic switch. If we were to place the diode at one end of a half-wavelength transmission line as shown in Fig. 17, then that phenomenon would result in a pulse being applied to the transmission line. The current pulse has a fast risetime, and a waveshape that is nearly square, so it is rich in harmonics. The harmonics are taken out by a lowpass filter so that the fundamental could be applied to the load Z_L. The value of the current pulse will be $I = V_B / Z_O$, where V_B is the applied bias potential and Z_O is the characteristic impedance of the transmission line.

The description above required a current pulse to be applied to the TRAPATT diode before the TRAPATT mode could be realized. That pulse could easily be an IMPATT pulse when

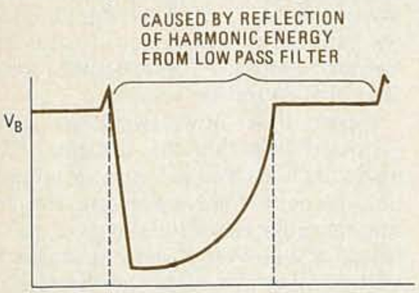


FIG. 18—HARMONICS reflected by a lowpass filter cause the TRAPATT-mode oscillators to become continuous.

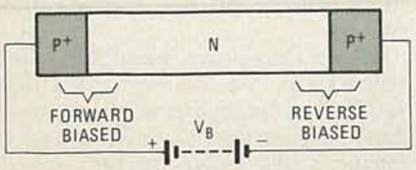


FIG. 19—BARITT DEVICE has two back-to-back p^+ junctions, one of which is slightly forward-biased while the other is slightly reversed-biased.

the device is operating in the IMPATT mode. But the TRAPATT mode will build up in a nearly exponential manner until it becomes self-sustaining. The foregoing discussion does not explain how the TRAPATT mode could become self-oscillatory. For that type of operation we must rely on the actions of the lowpass filter at the end of the resonant half-wavelength transmission line. It will transmit energy at the fundamental TRAPATT frequency, but will reflect energy at the harmonics of the fundamental frequency. Those harmonics are reflected with a phase reversal (i.e., reflection coefficient of −1 in the ideal case) so they will initiate another avalanche shock front. The small rise in the terminal voltage in Fig. 18 is caused by that returning reflection. The return pulse will, then, cause the TRAPATT-mode oscillations to be continuous. In the typical TRAPATT oscillator, the device will begin in IMPATT operation. The IMPATT-mode oscillations will build up in an exponential manner until the current becomes large enough to trigger a shock-front transit. (Hence the use of "triggered transit in" the device's acronym.)

BARITT devices

Consider the p^+-n-p^+ structure shown in Fig. 19. That device contains a pair of back-to-back junctions. One of those junctions will be slightly forward-biased, while the other junction is slightly reverse-biased. The flow of current under conditions when the bias voltage is less than the punch-through voltage will be limited by the ordinary leakage current of the reverse-biased junction. If the bias is increased to the point where the device is operated in the punch-through mode, then the depletion region exists across the entire n-region until it reaches the forward-biased junction. That will cause all of the carriers (holes) at the forward-biased junction to be swept across the n-region, causing the current to increase rapidly as shown in Fig. 20. That current can be used in a microwave oscillator provided that the field is large enough to make the holes drift across the n-region at the saturated velocity and the voltage applied is kept below the point at

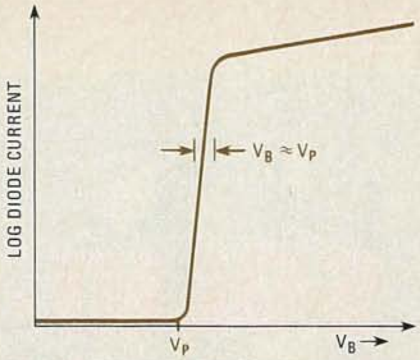


FIG. 20—CURRENT INCREASES rapidly in the BARITT device as the carriers are swept across the n-region.

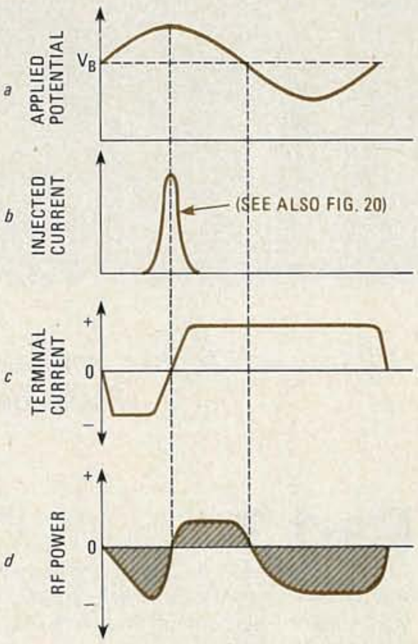


FIG. 21—IF A BARITT DEVICE is operated in parallel with a resonant tank circuit, noise pulses will ring the tank circuit and cause an RF alternating potential to appear across the diode as shown in *d*.

which avalanching will occur. Devices that use that phenomenon are called BARITT (*BAR*rier *I*njection *T*ransit *T*ime) oscillators.

Suppose that a BARITT device is biased with a DC potential close to the potential required for punch-through operation. Further suppose that the device is operated in parallel with a resonant tank circuit (as was done in our discussion of the Gunn device earlier). Noise pulses will ring the tank circuit and cause an RF alternating potential to appear across the diode that will add algebraically with the bias potential (Fig. 21-a). When the total bias exceeds the punch-through potential on positive excursions of the RF waveform, a sharp current-pulse is injected (Fig. 21-b). During the period when the injected current is peaking, the terminal current (from the DC bias) is added to it, causing a reversal of the current direction for that period (Fig.

continued on page 93

Synthesized RF Generator

This month we'll show you how to assemble the Programma-2's two main boards. When we're done, the RF generator will be nearly complete.

GARY McCLELLAN

Part 2

WITH THE THEORY OF operation of the Programma-2's control board out of the way (it's always helpful to know what you're doing) we can now start work on the board itself.

Position the board as shown in Fig. 5 and start construction by installing the 24-pin IC socket. After that, install 16-pin sockets in the IC103 and IC102 positions. In the same manner, install a 14-pin socket at IC101 and then two 8-pin sockets at IC106 and J101. Tha takes care of the IC sockets.

Install crystal XTAL101 next. Push it flush against the board and quickly solder the leads. Don't apply excessive heat, or you may crack the seal.

Now you can install the 100K resistors around IC102. Insert R108 and R107 first, then solder and clip the leads. Then install the group of four just below. Start with R104, continue with R105, and R131, and end with R106. Solder each connection and clip the leads. Then move to the right, and install another group of four resistors, beginning with R111, continuing with R110 and R109, and ending with R103. Solder and clip. Finally, move up and install the last group of four resistors in the same manner. Note that this group starts with R115 and ends with R112.

Continue with the rest of the resistors. Refer to Fig. 5 for details. Starting at the top left corner, install 100K resistors at R101 and R102. Then move down below IC102 and install a 100-ohm resistor at R127. Move to the right slightly and install a 150-ohm unit at R120. Keep going right and install 10K resistors at R119 and R129. After that, install a 22K resistor at R130. Stop for a moment and check your work. There should be spaces left for C104 and C103. Continue by moving to the right and installing a 47-ohm resistor at R118. On the other side of IC103, install a 10K unit at R116. Move down and install a 2.2K resistor at R117. Keep going by installing the remaining 100K units at R123 and R124. Install 33K resistors at R125 and R126. Then move up slightly and install a 68K unit at R122. Install a 1-meg resistor at R121, next XTAL101. That takes care of the resistor installation, and the board is now taking on a finished appearance.

There are five wire jumpers on this board, and they should be installed next. Use leftover resistor leads. The jumpers are identified with a "J" in Fig. 5. Install the first two as shown between IC101 and IC102. Bend the leads to fit with needle-nosed pliers, and insert them into the holes. Make sure they aren't touching, then solder and clip off the excess lead. Install the next jumper near pin 1 of IC102. Move to pin 1 of IC103, and install a jumper just below it. Finally move over to pin 1 of IC105 and install the last jumper.

Now for a few odds and ends. Start by installing C111, a 5-30 pF trimmer, by the crystal. Before installing it, turn it over and identify which pin goes to the adjusting screw. This pin must go the ground foil, and is usually wider than the other pin. Insert the trimmer so that this pin points up, and solder. Then install R128, a 5K pot. Install as shown, being sure to press it flush against the board before soldering.

Next come the transistors. Start with Q101, a 2N3906. Install it as shown next to IC103, with the flat side pointing down. Then install Q102, an MPS-A13, as indicated next to the pot. Be sure to position the case so that the flat spot points to the right. Finish up with the power-supply components. Install IC104, a 78L05 regulator, as shown, next to the crystal. Be sure the flat side of the case is pointing down. Then install D101, a 1N5229 Zener diode near the right edge of the board. Note that the banded end points toward the center of the board. Stop at that point and double check the installation of the parts. It's a good idea to correct any mistakes before going any farther!

All that's left are the capacitors. They will be installed like the resistors, from left to right in Fig. 5. Start by installing C101, a 0.001 μF disc above IC101. Then install C108, a 0.1 μF disc, on the other side of the IC. Keep going and install C104, a 22 μF tantalum type. Note that the "plus" side faces R120. After that, install 0.1 μF Mylar capacitors at C102 and C103. Continue by installing C110, a 220 μF electrolytic. Note that the "plus" side faces the edge of the board. At the other edge, install C105, a 100 μF electrolytic. Be sure the "plus" side faces the center of

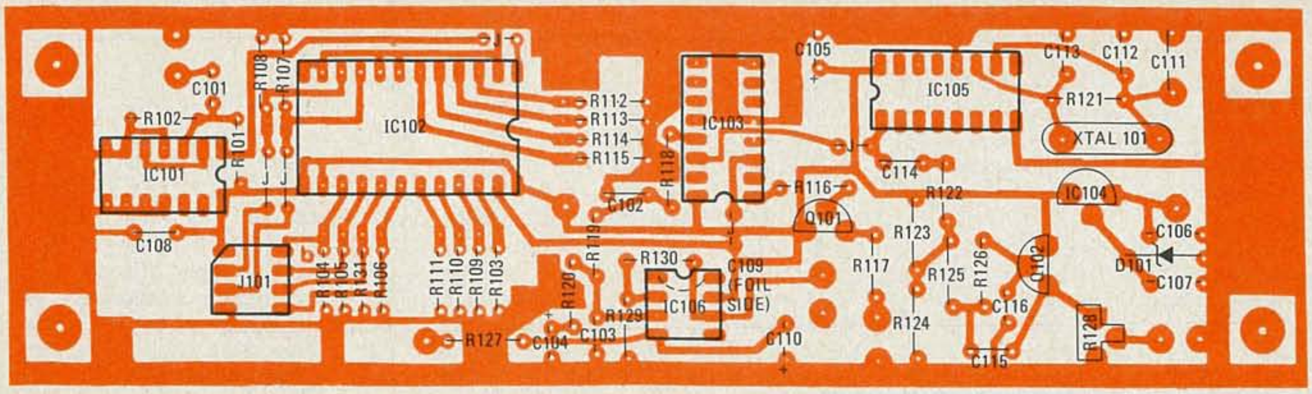


FIG. 5—STEP-BY-STEP assembly instructions are given in the text. Don't forget to install the five jumpers.

the board. Move down and install C114, a 0.1 μF disc next to IC105. Keep going down, and install C115, a 0.1 μF Mylar capacitor near the pot. Then, just above this capacitor, install C116, a 0.001 μF Mylar capacitor. At the top of the board install C113, a 68 pF mica. And right next to it, install C112, a 39 pF mica unit. Finish up by installing two 0.1 μF discs on either side of D101 at C106 and C107.

Stop at that point and check your work. Make sure the capacitors are installed in the proper places, and that the polarized ones are oriented properly. Correct any mistakes before going any farther. The board should look like the one in Fig. 6.

Turn the board over and install C109 (100 pF) on the foil side, between pins 1 and 8 of the IC106 socket. Trim the leads to about 1/4-inch first, then solder

FIG. 6—COMPLETED CONTROL BOARD. Light-colored ribbon cables around 4059 IC go to switches. Dark cables will be added later.

across the pins as shown. Bend the capacitor so that it is flush with the board. This completes the control board.

Switch connections

Now is a good time to connect the FREQUENCY-SET switches to the board, and install the IC's. Those switches, S1-S4, are the ones that mount on the front of the instrument and program the desired frequency. All wiring is done around IC102.

Refer to Figs. 7 and 8 for details as you wire the switches. It is suggested that you use short lengths of 4 conductor cable for the connections; this makes the wiring easier to follow and less messy.

The first step is to prepare the cables. Prepare four six-inch strips. Then remove two conductors from one of the strips. Separate the ends of all cables for at least 1/2-inch, then strip and tin the ends. Also cut a 6-inch piece of hookup wire and strip and tin its ends. Now you are all set for the wiring.

Look carefully at your switches' terminals. They should be marked: "C, 1, 2, 4, 8," "COM, A, B, C, D," or similarly. Run a piece of bare wire through all the "COM" lugs and solder at each. Then solder one end of the single piece of hookup wire to one of the common lugs. Now turn to the front of the switches, positioning them so you can read them. The switch position to the farthest left is S1. Connect the two-conductor cable to the "A" and

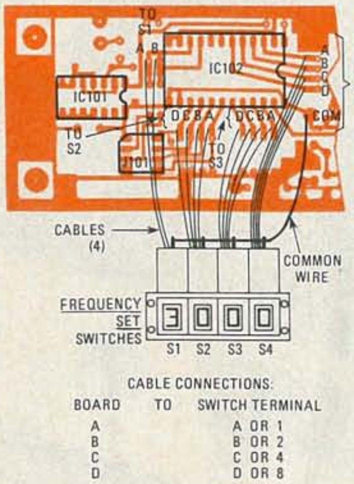


FIG. 7—DETAILS of board/switch connections. They're not difficult—just match up the letters.

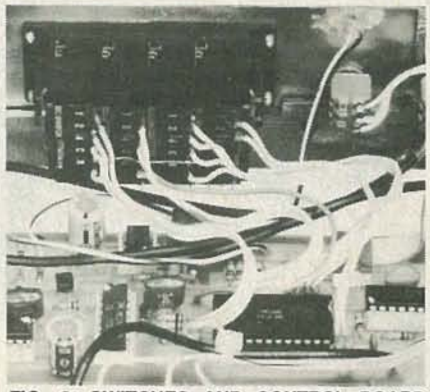


FIG. 8—SWITCHES AND CONTROL BOARD mounted in case. Usefulness of ribbon cable is obvious.

PARTS LIST
CONTROL BOARD

All resistors ¼ watt, 5%, unless otherwise noted.

R101-R115, R123, R124, R131—100,000 ohms
R116, R119—10,000 ohms
R117—2200 ohms
R118—47 ohms*
R120—150 ohms*
R121—1 megohm
R122—68,000 ohms
R125, R126—33,000 ohms
R127—100 ohms
R128—5,000 ohms, trimmer potentiometer, horizontal PC-mount

Capacitors

C101—0.001 F, ceramic disc
C102, C103, C114, C115—0.1 F, 50 volts, Mylar*
C104—22 F, 16 volts, tantalum*
C105—100 F, electrolytic, 16 volts
C106-C108—0.1 F, 16 volts, ceramic disc
C109—100 pF, ceramic disc
C110—220 F, 6.3 volts, electrolytic
C111—5-35 pF trimmer (E.F. Johnson 275-0430-005 or equivalent)
C112—39 pF, mica
C113—68 pF, mica
C116—0.001 F, 50 volts, Mylar

Semiconductors

IC101—CD4013 dual D flip-flop with set/reset
IC102—CD4059 programmable divide-by-n counter
IC103—CD4046 phase-loced loop
IC104—78L05 five-volt, 100 mA, regulator
IC105—CD4060 14-stage rippled counter
IC106—CA3130AE op amp (RCA)
Q101—2N3906 PNP
Q102—MPS-A13 Darlington, NPN
D101—1N5229 4.3-volts, 500 mW, Zener diode
XTAL101—2.048 MHz, 32 pF parallel-mode, ± 0.005%, HC-33/U case
S1-S4—BCD thumbwheel switch (C&K 332110000 or equivalent)
J101—8 pin IC socket

Miscellaneous: PC board, IC sockets, 4-conductor ribbon cable, wire, solder, etc.

"B" (or "1" and "2") lugs. The switch section next to S1 is S2. Solder the wires from a four-conductor cable to each of its terminals. If possible, match the colors to those used on S1 (and do the same for the other sections). It's easier to connect a switch, if, say, all "A" leads are green, "B" leads are blue, and so on. Wire up S3 and S4 in the same manner.

Finish up by connecting the switches to the board. Start by inserting the wire from the switches' common bus into the COM pad on the board. Solder it in place. Then match up the leads from S1 to the "B" and "A" holes below R107 and R108 on the board. Insert and solder. Match up the leads from S2 with the points on the board above the resistor group starting with R104. Note that the connections are "DCBA" reading from left to right. Insert and solder. Likewise, insert and solder the leads from S3 into the holes above the resistor-group starting with R111. Note that the connections are arranged as "DCBA" like those for S2. Finally, insert the wires from S1 through the holes by the resistor-group starting with R112. Note that R112 is the "A" connection, and that the others follow in order. That ends the switch installation.

Check over your wiring for errors, and correct any mistakes. Then finish up by installing the IC's. Refer back to Fig. 5 for placement. Install a CD4013 at IC101, a CD4059 at IC102, and a CD4046 at IC103. Make sure they are plugged in properly (watch out for bent pins) and then install a CD4060 at IC105 and a CA3130 at IC106.

That completes the control board. Next we'll cover the VCO board and start discussing final assembly.

How the VCO works

The VCO board contains three oscillators, a divider, a modulator, and an RF amplifier. Also included is some switching circuitry for both RF signals and power, and two power supplies. At this point you may want to refer to the schematic in Fig. 9 as you read about the circuitry.

The oscillators consist of IC201 through IC203, Motorola MC1648's, together with a few external components. The 10–30 MHz signals are generated by IC201, while IC202 generates the 5–10 MHz signals and IC203 handles the 3–5 MHz range. Tuning within these ranges is done by D201 through D203, Motorola MV1404 tuning diodes. Think of them as electrically controlled variable capacitors; an input voltage ranging from 0.5-volt to 9-volts will cause each oscillator to tune through its frequency range.

Since only one oscillator at a time can be operating in this device, some switching has to be done. Transistors Q204 through Q206 perform this task. The desired oscillator is turned on by grounding the base one of the transistors. This is done by the switch board, which will be described later.

The outputs of the oscillators are ECL-level (0.8 volt AC), but transistors

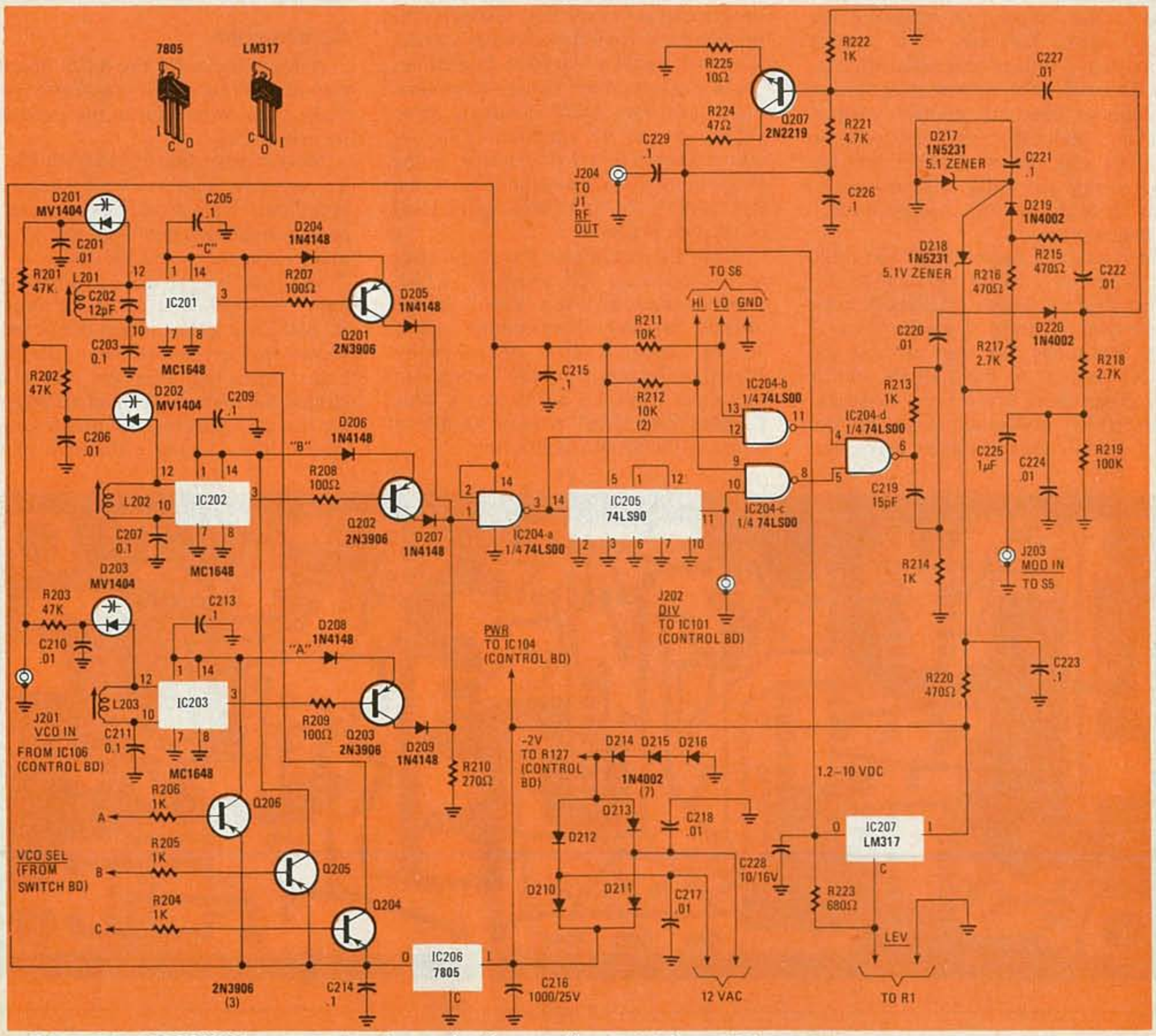


FIG. 9—THE PROGRAMMA-2 uses an ingenious method for controlling modulation and RF-out-put levels—the heart of the circuit is at diodes D219 and D220 (upper right). The scheme is described in the text.

Q201 through Q203 increase those signals to TTL levels for use by the circuitry that follows. The diodes are included for biasing and switching. Finally, IC204-a is used to buffer the signal, insuring that it is at TTL levels.

The VCO signal from the buffer is fed to both IC205, a divide-by-10 counter, and to IC204-b. That gate, together with IC204-c and IC204-d, act as an SPDT switch and select either the "direct" VCO signal or the divided-down signal from IC205. This solid-state switch is controlled by the HI/LO switch, S6, on the front panel. When the HI line from the switch is grounded, the VCO signal feeds straight through over a range of 3 to 30 MHz. When the LO line is grounded, the divided-down signal is selected (300 kHz to 3MHz). This eliminates the need for extra VCO's. The output of the divider also goes to the DIV jack, J202 , which provides the signal required for the control board's programmable-divider circuit.

The output of IC204 drives the modulator circuit. This circuit is unusual in that it uses diodes to modulate the VCO signal. Basically, it is nothing more than a voltage controlled attenuator. The amount of signal passing through it depends upon the control voltage, which is really the sine wave from the MOD IN jack. Resistor R219 sets the bias so that the signal will continue to pass through the circuit when there is no modulation.

In operation, diodes D219 and D220 are foreward biased, although to different degrees. Diode D220 tends to be more heavily biased because there is less resistance between it and the power source. At the cathode end of this diode there are several resistors. The 500-Hz modulation is also applied at this point, and the voltage across the resistors causes the current flow through the diode to vary. As the current through D220 varies, it can be greater or less than the current through D219.

At this point an interesting characteristic of diodes enters the picture—diodes can act as variable resistors; the greater the current flow through a diode, the more signal it will pass. Sometimes D219 conducts more signal—to ground, and sometimes D220 conducts more signal—to the RF amplifier. This circuit is known as a *T attenuator*. In the Programma-2 it causes the level of the RF signal to be controlled by the level of the 500-Hz tone.

From the modulator the signal goes to a broadband RF amplifier, which boosts it to useful levels. This is the job of Q207, which has a maximum gain of 5. The output level is controlled by adjusting the power supply voltage—in this case from 1.2 to 10 volts. This supplies from 10 mV to over 300 mV of signal at the RF OUT connector.

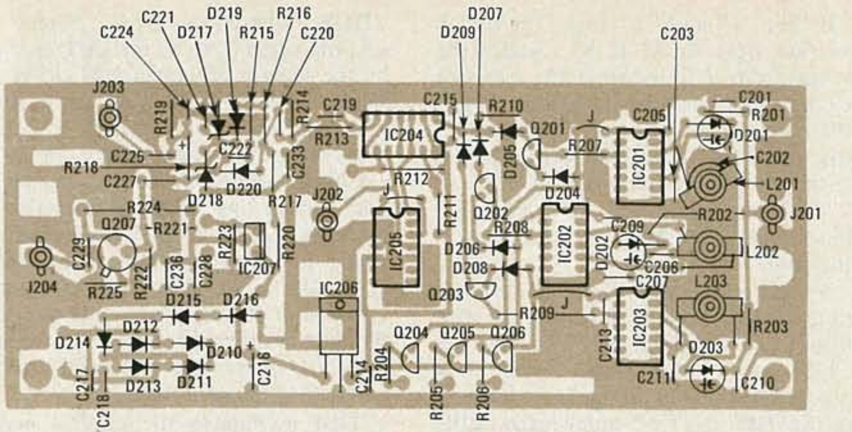


FIG. 11—CONNECTORS FROM THE COILS to the board are made using leftover capacitor leads. Capacitor C202 is soldered directly to the lugs of coil L201.

The rest of the circuitry on this board consists of power supplies. There is the usual 5-volt regulated source for the ECL and TTL devices, plus an adjustable source for the RF amplifier. An LM317-T adjustable regulator handles the latter job.

Construction

A foil pattern for the VCO board is provided in Fig. 10. If you prefer not to make your own, refer to the Parts List for a supplier.

Start construction by studying Fig. 11. To simplify matters, we'll break the board into two sections and concentrate on completing each separately; this makes construction a lot easier.

The first thing to do is to enlarge the holes for coils L201–L203. Using the IC pads as a guide, orient the board as shown in Fig. 11 and locate the three holes. Note that they are part of the ground foil that runs around the edges of the board. Using a set of progressively larger drills, increase the size of the

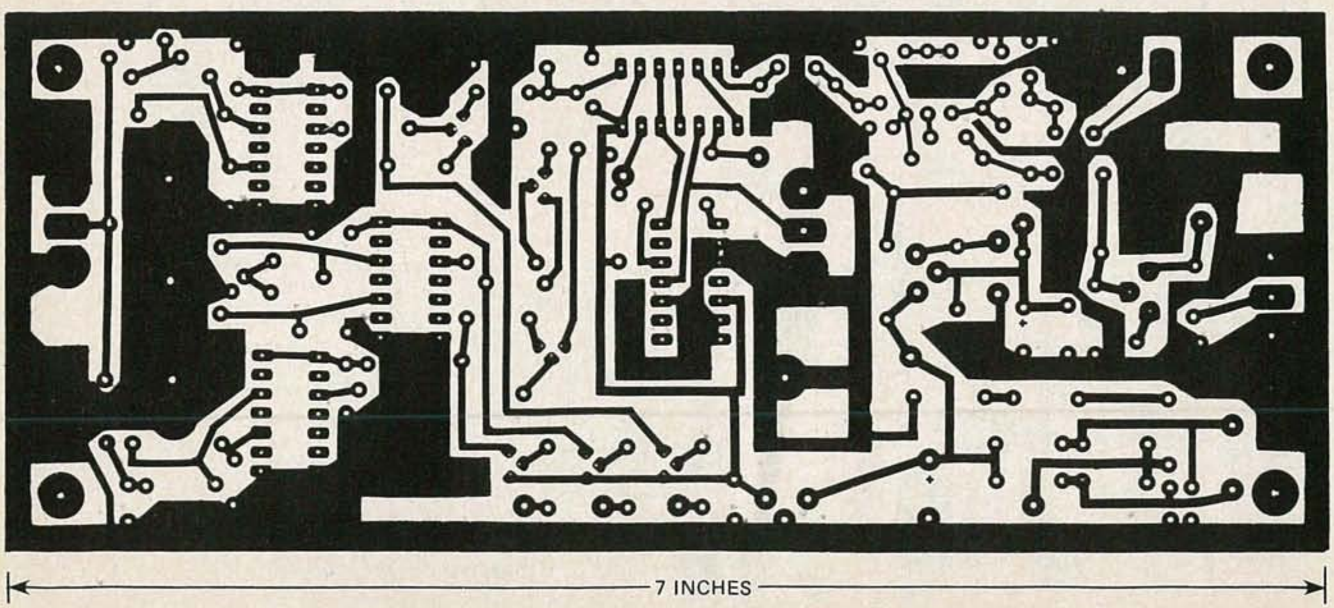


FIG. 10—THE COMPLEX VCO circuit can be built on a single-sided PC board using only three jumpers.

PARTS LIST
VCO BOARD

All resistors ¼-watt, 5% unless otherwise specified
R201-R203—47,000 ohms
R204-R206, R213, R214, R222—1000 ohms
R207-R209—100 ohms
R210—270 ohms
R211, R212—10,000 ohms
R215, R216, R220—470 ohms
R217, R218—2700 ohms
R219—100,000 ohms
R221—4700 ohms
R223—680 ohms
R224—47 ohms, 2 watts, carbon composition (see text)
R225—10 ohms

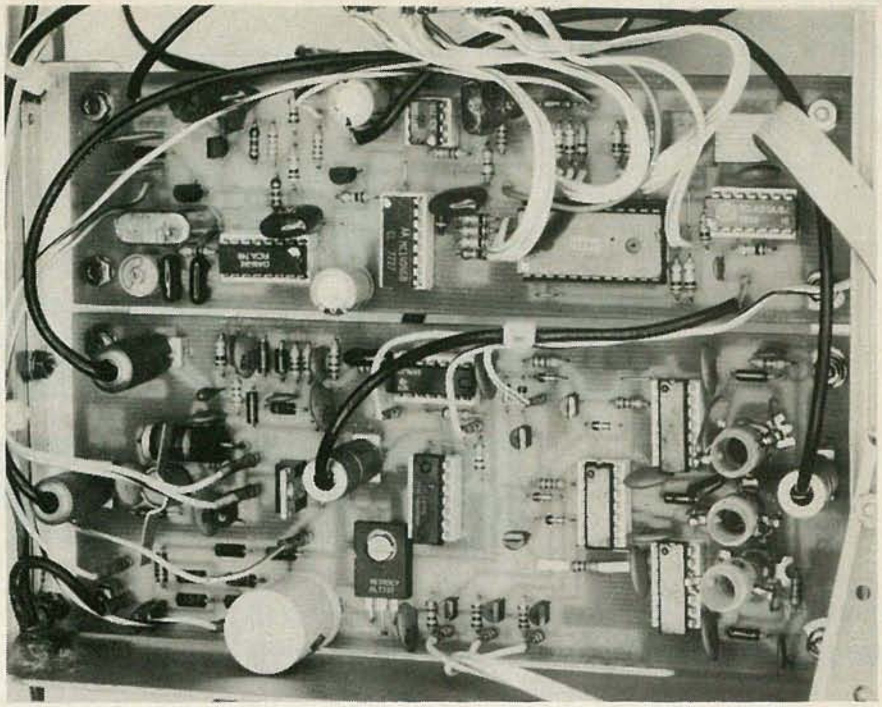
Capacitors
C201, C206, C210, C217, C218, C220, C222, C224, C227—0.01 μF, 16 volts, ceramic disc
C202—12 pF, ceramic disc or mica
C203, C205, C207, C209, C211, C213-C215, C221, C223, C226, C229—0.1 μF, 16 volts, ceramic disc
C204, C208, C212—not used
C216—1000 μF, 25 volts, PC-mount electrolytic
C219—15 pF, ceramic disc
C225—1 μF, 16 volts, electrolytic
C228—10 μF, 16 volts, electrolytic

Semiconductors
IC201-IC203—MC1648P MECL voltage-controlled oscillator (Motorola)
IC204—74LS00 quad NAND gate
IC205—74LS90 decade counter
IC206—7805 or LM340-T 5-volt regulator, TO-220 case
IC207—LM317-T adjustable voltage regulator, TO-220 case
Q201-Q206—2N3906 or equivalent
Q207—2N2219 or equivalent
D201-D203—MV1404 tuning diode (Motorola)
D204-D209—1N4148 or 1N914
D210-D216, D219, D220—1N4002, 100 PIV, 1 amp
D217, D218—1N5231 Zener, 5.1-volts, 500 mA
L201—0.3-0.58 μH coil (Miller 4201 or equivalent)
L202—2-5.5 μH coil (Miller 4203 or equivalent)
L203—10-25 μH coil (Miller 4205 or equivalent)
J201-J204—PC-mount RCA-type phono jacks

Miscellaneous: PC board, IC sockets, slip-on TO-5 heat sink for Q207, solder, etc.

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

A complete set of *parts*, excluding boards, crystal, transformer and case, is available for $112.00 ppd. from: Circuit Specialists, Inc., PO Box 3047, Scottsdale, AZ 85281. Order No. KT-5. Phone orders (800) 528-1417; all other inquiries (602) 996-0764. AZ residents please add tax.



THIS IS WHAT THE VCO BOARD looks like when it is finished and mounted in the case. The board below the VCO board is the control board.

holes to ¼-inch. Then use a reamer or small file to enlarge them farther, to ⅜ inch.

Next, install the IC sockets. Note that there are five of them, and that they are all 14-pin units. If the sockets have an identifying mark for pin 1, position them as shown.

The four RCA jacks, J201–J204, are installed next. You may have to enlarge the holes in the board so that they can be mounted.

Install the capacitors as shown. Begin with the 0.01-μF discs, and install one each at C201, C206, and C210. Note that these parts are located near the coils. Then continue with the 0.1-μF capacitors. There are quite a few. Install one at C205, C203, C209, C207, C213, and C211. Then move to the top left corner of the board and install one at C215. Move down and install one at C214. That almost takes care of the capacitors; there's one left to mount on a coil.

The coils are next. They just snap into place. Be sure to observe the positioning of the terminals before you snap them in place; this is important. Install the No. 4201 coil at L201, the No. 4203 coil at L202, and finally, the No. 4205 coil at L203. Wire the coils to the two pads below them as shown, using short lengths of solid wire. The clipped leads from the capacitors should work fine. Be sure to keep the leads as short as possible; that makes the coils more shock resistant. After the wiring is done, install a 12 pF capacitor, C202, directly across the terminals of L201.

The resistors come next. Install the 47K units first, with one at R201, R202, and R203. Note that you'll have to bend the leads of R202 so that they don't touch the coil wire. The 100-ohm units are next. Install one at R207, R208, and R209. Be careful to get them in the right places. Then come the 10K units by IC204. Install one at R211 and another at R212. After that come the 1K resistors. Install one at R204, R205, and R206 near the bottom of the board. Finish up by installing a 270-ohm resistor at R210.

The three jumpers go near IC201, above IC205, and next to IC203. Use leftover leads from the resistors for the jumpers. Install the jumper next to IC201 first, then the one below IC202, and last, the jumper above IC205.

Now for the diodes. Note that there are two kinds—MV1404 and 1N4148. The MV1404's come first. Be careful when you install them because they are rather expensive! Avoid bending the leads right at the body as this will break them. Install three MV1404 diodes at D201, D202, and D203 as shown. Note that the banded ends point to the right. Then come the 1N4148's. Install them at D205, D207, and D209 near R210. Then install the rest at D204, D206, and D208. Be sure to check your installation before going farther.

Continue with the transistors. They are all 2N3906's, which makes installation easier. Install one at Q201 and Q202. Be sure the flat in the case points to the right. Then do Q203 with the flat side pointing up. When done, move down and install the three remaining transistors at Q204, Q205, and Q206, with the flat side facing right.

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USEFUL TROUBLESHOOTING HINTS & TIPS

The best solution to any problem is often the simplest one. Here are some easy-to-use ideas that really work.

ELLIOT S. KANTER

A SHORT TIME AGO, I RECEIVED A CALL from a sales engineer who I'd helped before with certain technical problems. This time he had a serious problem that demanded an immediate resolution, as human lives hung in the balance. It seemed that around four in the afternoon each day, the telemetry units in his hospital's coronary-care unit were "clobbered" by brief but overpowering interference.

As you might suspect, the tiny radio transmitters (Fig. 1) that were attached to the patients are low-power (power output is about 1 microwatt) and they transmit in the VHF portion of the radio spectrum. Not being able to drive the 150 miles or so to the hospital, I reasoned that there was a pattern (i.e. specific time each day) and that only the telemetry equipment was being interfered with. About a week or so before, I had posed a question to my class of BMET's (*Bio*medical *E*quipment *T*echnicians), that asked them to determine a harmonic relationship between a CB transmitter and patient telemetry, and if a harmonic relationship could be identified, what specific telemetry frequencies (there are about eighty) would be affected.

I pulled out my list of calculations, and determined that the telemetry-transmitter frequency was the same as the seventh harmonic of a CB frequency. A quick call to the engineer with the suggestion that he take a walk around the area immediately surrounding the hospital resulted in both identification of the source and a cure. It appears that a nearby citizen was operating an illegal linear amplifier or "kicker." After a few words of explanation, he disconnected the linear and the interference was gone.

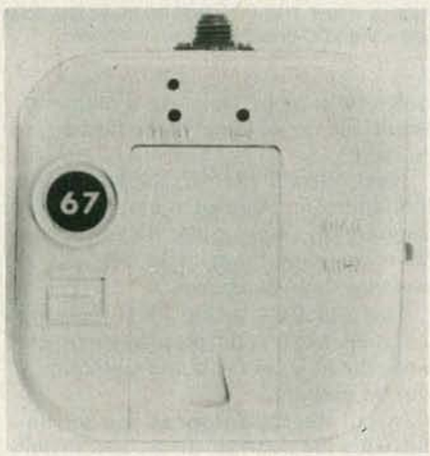


FIG. 1—MEDICAL-TELEMETRY transmitter. Some of those transmitters have power outputs on the order of a microwatt and a range of about 250 feet.

Naturally, the majority of CB users do not operate illegally, but if you do come across a problem like that one, why not stop a minute and determine what frequencies *could* (not necessarily would) have a harmonic relationship that might cause problems. Remember, it is not the properly-operated RF source that will cause the problem, but rather one improperly used or adjusted that can frequently be at the root of a problem.

Staying with low-powered RF sources for a while longer, I found that I needed an easy and cheap method of being certain that one of those small telemetry transmitters was really putting out RF. Again, I was faced with the fact that one particular model didn't even put out a full microwatt, and a frequency counter was a clear case of over-kill. What did evolve is shown in Fig. 2, a simple, cheap, and easy-to-build RF sniffer, in a shielded metal case.

If you are an "old-timer," you will recall the circuit as an add-on RF probe for use with a VTVM. It can be used with digital voltmeters as well. If you deal with devices like medical telemetry equipment, you might want to replace the probe and ground leads with either plugs or jacks to match the input (which is also the output) of the telemetry transmitter. Shielded cable is a must (RG-58/U or RG-174/U) from the probe to the VTVM. The device detects RF and displays it as a DC voltage. While that will not give you a calibrated indication of the power output, it will show you when RF output is there.

PC board component replacement

Usually, changing a resistor, capacitor, or diode on a PC board isn't too difficult or time consuming. All you have to do is unsolder the old part, re-

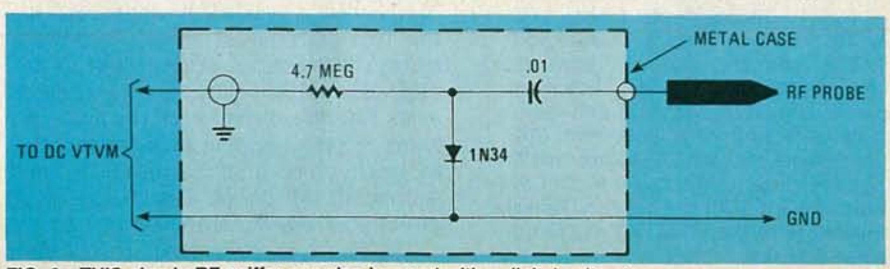
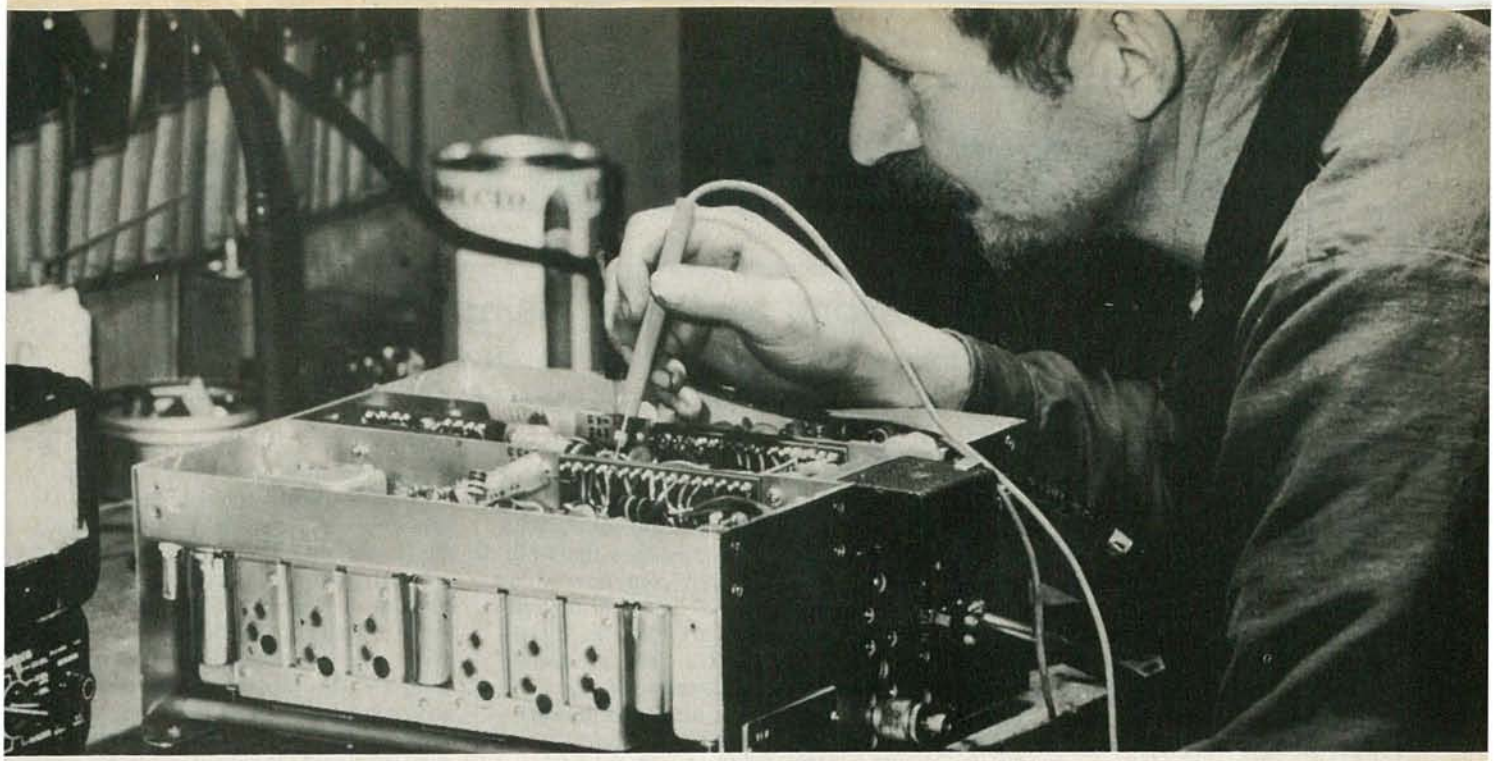


FIG. 2—THIS simple RF sniffer can also be used with a digital voltmeter.



move it, make certain the PC board holes are clear, insert the new component, resolder and clip off the excess leads. I know you are saying that's nothing new and, in fact, those five steps are just what you always do... right? ***WRONG!***

Consider a service request I had from a client: She (the head nurse) wanted all twenty of her heart-rate alarms modified for a longer delay before going off in the high-rate mode. That meant that I would have to alter a time constant determined by a resistor and capacitor on each of twenty modules. It was obvious that it would be simpler to change the 22K resistor to 39K than to match a capacitor, but I didn't especially relish all of that soldering and unsoldering. Hence the five-easy-step method illustrated in Fig. 3.

1. Take long-nose pliers and crush the resistor (or diode or capacitor). You might also need side cutters to do the job, but the object is to destroy the component, leaving only the leads.

2. Clean off the wires, and blow or brush away any residue from step one from the PC board.

3. Use your long-nose pliers and bend both of the leads upward so that they will form two posts.

4. Make a loop in each end of the replacement component (I did that before I arrived on site) and slip the replacement component over the two posts prepared in step three. Be sure to observe polarity indications.

5. Solder both connections.

Since you can pre-form the replacement components, you have cut your work at least in half and besides, you have done a neat, professional job without risking heat damage to the PC board traces, which is more than I can say for the conventional (still five steps) method of replacing components. Just be sure that you use a well-tinned iron and only enough heat and solder to do the job right.

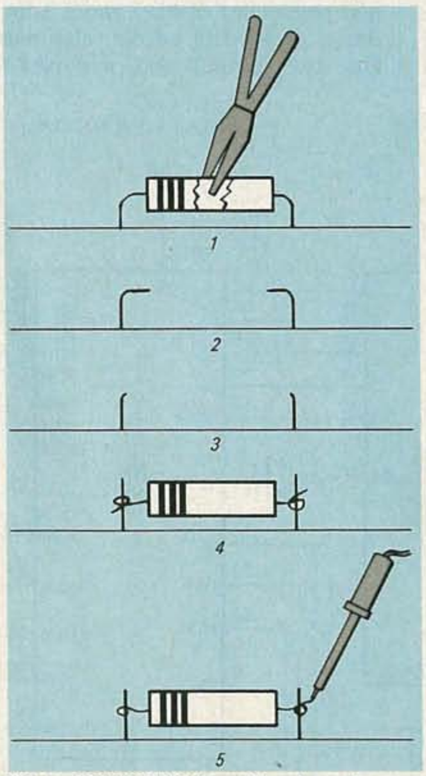


FIG. 3—FOLLOWING these five steps when you replace components on a PC board will result in less work and a neater job.

Versatile heat sink

Like most hobbyists and technicians, I build some equipment myself, either from scratch or in kit form. No matter how careful you are, that old demon—Murphy, of Murphy's Law—tends to rear his ugly head and make junk out of what should have been a lovely, neat project. Most problems seem to be heat-related and take place while following the instructions that state: "Flip the board full of components over and solder each connection."

While modern components are a great deal less heat sensitive than older transistors such as CK722's heat can, and often does, alter specifications. Besides, there nothing as upsetting as a fully loaded PC board sliding across the table top as you try to solder.

The solution is to locate an ordinary kitchen sponge slightly larger than the PC board in question. You can throw caution to the wind and purchase one or more sponges at your local hardware or discount store. For less than two dollars, you should be able to acquire a collection of assorted man-made sponges which, when damp, will serve two distinct purposes. First, they will act as a slip-resistant PC board holder and second, they will function as a heatsink. If you are a non-believer, the first sizzle you hear while soldering will make a "true-believer" out of you. A bonus is that the PC board is elevated slightly for better access. That hissing will warn you that things are getting hot and will prevent component values from "shifting" due to excessive heating.

Iron idler

There's nothing quite so frustrating as having to wait for your soldering iron to heat up from a dead start. Well, maybe there is something equally frustrating—replacing tips that have been rendered "inoperative" due to overheating. You might suggest the use of a soldering gun but remember, very few

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STATE OF SOLID STATE

From keypad to display using IC's

JOSEPH GARTMAN AND ROBERT FALKNER

LET'S TAKE A LOOK AT TWO EXCITING digital IC's from National Semiconductor; The MM74C922 16-key encoder that outputs binary code from a 4 × 4 row-column matrix of switches, and the MM74C912, a 6-digit BCD-display decoder/driver that does all the housekeeping for a 6-digit by 7-segment-plus-decimal-point display.

The MM74C922 encoder scans columns in a 4 × 4 16-key keyboard with a 2-bit counter and then reads out rows with a 4-line 2-bit encoder. A single capacitor completes the on-chip clock circuit, or an external clock can be used. When the 2-bit column clock counter, which is decoded to four discrete lines, scores a "hit" in the row encoder, a key-detect plus is sent through an on-board key-bounce eliminator and provides a strobe for the data available pin. It also latches the 4-bits (2 from the counter, 2 from the row encoding logic) of BCD data near the output. These latches are followed by on-chip Tri-state buffers that can disable or enable the data-output lines. The row encoding logic also incorporates a two-key rollover.

The MM74C912 decoder/driver accepts a 4-bit binary input (plus a decimal-point control line) and a 3-bit address, plus write enable, chip enable, and two output and multiplex-scan oscillator-enable control lines. The 3-bit digit address loads the appropriate latch of six 5-bit latches with the BCD-plus-decimal-point data strobed into the IC. An on-chip oscillator (requiring only an external capacitor) drives a count-to-6 counter. This both selects the digit that is being driven by the digit driver and multiplexes the appropriate latch's 4 data bits (the decimal point is driven separately with its own line) into a 16-line by 7-bit ROM. The ROM outputs segment information (and the decimal-point control line) to an array of NPN segment drivers that can typically output 80 mA. And, according to Na-

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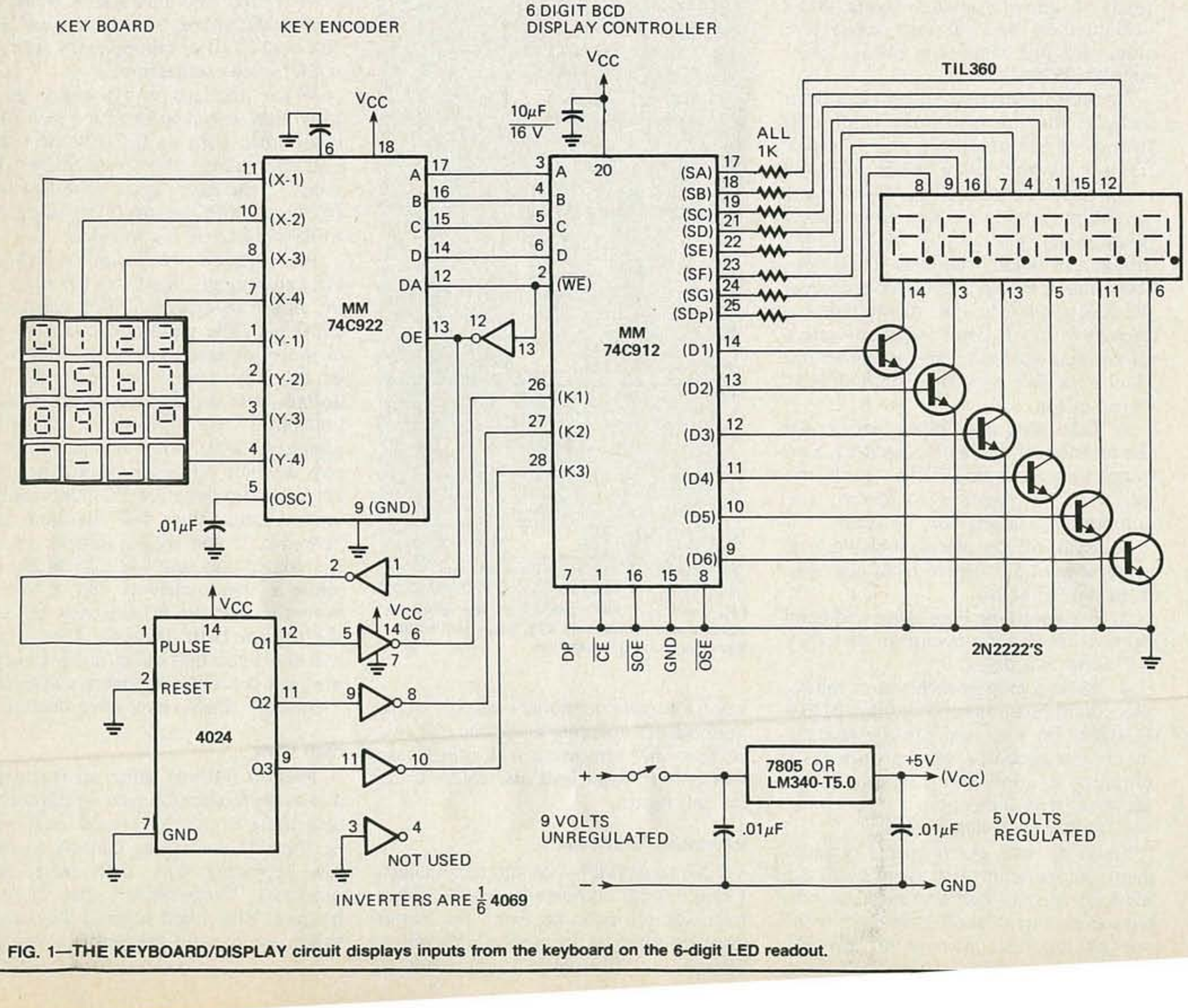


FIG. 1—THE KEYBOARD/DISPLAY circuit displays inputs from the keyboard on the 6-digit LED readout.

HOBBY CORNER

An easy way to etch one-of-a-kind PC boards without a darkroom

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

WE HAVE ON SEVERAL OCCASIONS DIScussed the various methods of making printed circuit boards, especially those methods that are most suitable when you need only one or two of a given board. You are aware of my inclination to avoid the etching process, which I have always considered to be time consuming and messy.

Not long ago I told you about Bishop's copper stick-on patterns that produce a good board with no etching. Some of you have written to say that you don't mind etching all that much but inquired about how you could avoid using a darkroom.

Well, to each his own. (Wouldn't it be a boring world if we were all alike!) Here is some information for you no-darkroom etchers. This method and the associated products are from DATAK Corp. (Box 192, Sparks, NV 89431 or 65 71st Street, Guttenberg, NJ 07093).

You may be familiar with Datak's panel and equipment marking sets. Those rub-on letters, numbers, titles, and symbols have been available for years. The really neat and professional looking projects you see in **Radio-Electronics** were probably marked with Datak materials.

Their *Direct Etch* dry-transfer system consists of the standard PC patterns mounted on plastic sheets. Those sheets appear very much like black patterns made for photographic reproduction by Datak and other manufacturers but there is a significant difference. The photo patterns are printed with ink and the *Direct Etch* patterns are made of black plastic. The *Direct Etch* sheets are very clearly marked with the words ETCH RESISTANT.

In use, the *Direct Etch* dry transfer patterns are simply rubbed on copper clad boards. To insure sharp etching without undercutting, the patterns should be burnished down. When the circuit pattern is in place, as shown in Fig. 1, you are ready to etch. A clean copper board, adequate burnishing, and proper etching will assure you of a good PC board.

When the etching is completed, completely remove the *Direct Etch* material. A PC board with the *Direct Etch* partially removed is shown in Fig. 2. A finished, ready-to-drill board is shown in Fig. 3.

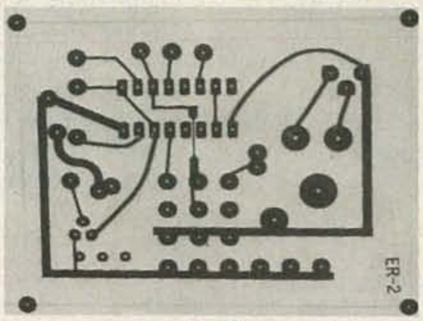


FIG. 1

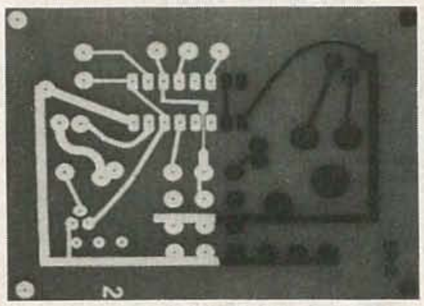


FIG. 2

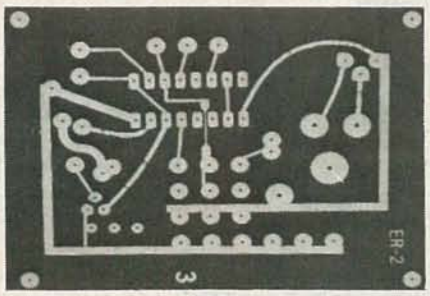


FIG. 3

That's all there is to the system. There are advantages and disadvantages, just as there are to other systems we have discussed. You should select the system you prefer, and the one that best meets your needs.

Datak *Direct Etch* dry transfer materials, including complete kits, are available through your local dealer. Either Datak office should be able to furnish you with information on that product as well as their others.

Do unto others

Just the other day I received a copy of a letter from a "Hobby Corner" reader. The original had been sent to a respected, long-established national company. It seems that this reader had ordered an item that had been mentioned in this column but he did not receive it. He did enclose a photo-copy of his cancelled check.

Now I know that there are some crooks out there in the mail-order business. But they are a very small minority and most don't stay in business very long once word gets out.

Most people that you deal with through the mail are quite honest and they do their best to serve you well. Yet, I can think of a number of reasons why they may fail to get ordered merchandise to you.

For example, they may have done their part but the carrier failed to deliver. I have had even first class mail and packages misdelivered, and on occasion lost by the US Postal Service. If that happens to first class mail, how much more frequently must it happen to third and fourth class packages?

Another reason for not receiving merchandise may be honest error. Of course, the reputable firms attempt to keep the number of errors to a minimum but one will creep in now and again. (I don't know of any organization or individual who is perfect!) It does happen sometimes that an order gets marked "Filled" when it hasn't been. Occasionally a wrong address gets placed on a label. And sometimes some very strange things happen—about two weeks ago I received a sturdily wrapped empty box!

Getting back to the reader's letter, I regret that **Radio-Electronics** and my name were mentioned in it. The writer was abusive and accused the company of dishonesty. That's not the way to go about getting a mistake corrected! If you write such a letter, you should not expect the seller to be in a big hurry to solve your problem.

When you do not receive an order, keep your cool. Let the seller know and give him a chance to correct the error whether it was his or the carrier's. Give him the benefit of the doubt—do not jump to the conclusion that he is trying to cheat you.

Of course, you deserve the merchandise that you've paid for. If you don't receive it after a reasonable notification and in a reasonable time, complain to the postal service and to the state and federal consumer protection offices. And write our advertising department in New York City, giving full details. They usually can get results.

I should also mention that you should allow ample time for your order to be filled. All kinds of things can prevent a company from getting your order out within a day or two of its receipt—illness, holidays, trouble with their suppliers, and so on. (They are required to notify you if it will take more than 30 days.) Recently I mailed a small first class package; It took two and a half WEEKS to make the 350-mile trip!

So if you have trouble with an order, remember that the other guy is most likely as concerned as you are and is really trying to serve you well. Start with reasonableness and patience.

Packrat

Perhaps I am unduly influenced by the "Be prepared" motto or perhaps I suffer from the "get-it-while-the-price-is-right" syndrome. For whatever reason, I seem to gravitate toward bargain tables.

Bargain tables are a source of unending delight to me. They may contain almost anything—discontinued merchandise, slow-moving stock, returned kits that someone goofed up—you never know. And I just can't resist. How about a communications receiver that cost $10 and required that I spend one-half to locate and replace a reversed electrolytic? Or a $5 two-way telephone amplifier with one cold solder joint?

You get the idea. I have bought hundreds of diodes, resistors, IC's, transistors, capacitors, and so on because "someday I'll need that." And in most cases, I have!

What brought all that to mind is that last week a friend lost a large gold class ring in some tall grass near his home. A diligent search proved useless. He told me a couple of days ago that he had to find a metal detector somewhere. You can imagine my response: "Let's see—I think I have one."

I did! It was a bargain kit that I picked up a couple of years ago after dropping a key that I didn't find until the snow melted. Following a little assembly time, my friend was out trying to locate his ring. He's still out there making sectional sweeps.

Now I'm going to have to get back in that storage closet. I saw some other forgotten bargains in there—an electronic thermometer, three 100-kHz calibrators, and two VOM's. I wonder what else I have packed away in that closet in the last several years.

Theatrical light control

Rod Schmidt of Mascoutah, IL is looking for some help in designing a system to control theatrical lighting in his school. He needs to control six identical circuits (independently, I assume). Each circuit carries 600 watts on 110-volt lines.

Rod has reviewed the "Hobby Corner" (**Radio Electronics,** December 1977) on SCR's and triacs. He plans to use triacs for full-range control but the final design is a bit more complex.

The dimming system must be operable from backstage and from a remote location at the back of the auditorium. It's also possible to control the triacs with a microprocessor.

I am sure that some of you have encountered lighting problems similar to those Rod is facing. How did you solve them? Let me know and I'll pass the best solution along.

Automotive microprocessor

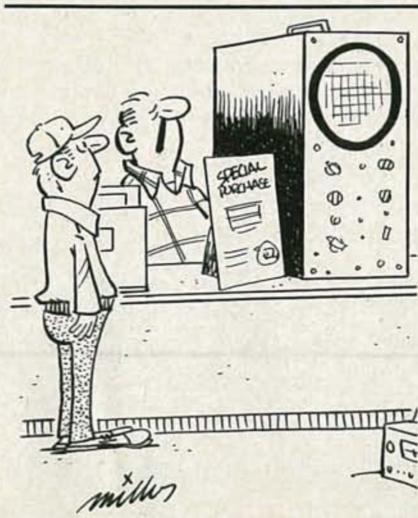
M. A. Anderson of Julian, CA has written to inquire about the Mostek 3870 IC that is billed as an "8-bit automotive microcomputer." The IC itself is inexpensive but some of the devices using it are quite costly.

Anderson feels that there must be many applications in which a hobbyist can use a 3870. I suspect that he is correct but I have not had a chance to experiment with it myself. The IC contains a programmable timer, a clock, 64×8 RAM, 2K PROM, I/O's, and other goodies. That sounds like the makings of a variety of interesting devices.

Let us know if you have used the 3870 as the basis for a project and we'll pass the information along.

Coming soon

I am sure tha you have seen ads for the 76477 sound generator IC. It makes some of the best and worst sounds you've ever heard. We'll be looking at a project using the 76477 in the near future. Stick around. **R-E**



"Their production department misread the engineering drawings by one decimal point."

COMMUNICATIONS CORNER

Speech processing can add "punch" to your signal for better DX.

HERB FRIEDMAN, COMMUNICATIONS EDITOR

THE FIRST TRANSMITTER I EVER BUILT was an AM unit with "modulation clipping"—a circuit that simply lopped off the peak of any speech waveform that would have produced more than 100% negative modulation (see Fig. 1-a). (It is carrier interruption, produced by negative peaks "below zero-volts," that causes sideband splatter.)

My latest transmitter is a store-bought appliance with a host of circuits that provide speech processing to increase the average audio level, or "talk power" of my signal. In fact, any circuit or system—regardless how simple or sophisticated—is a "speech processor" if, in any way, it modifies the original modulation so that it can convey more information.

How we increase that "talk power" depends primarily on current technology. The earliest form of speech processing was the modulation clipper I mentioned earlier. Basically, it was a high-voltage rectifier tube in the secondary of an AM plate-modulation transformer. That tube prevented modulation peaks from driving the B+ to the final RF-amplifier plate below zero-volts. When the B+ was driven to precisely zero-volts, the RF amplifier was said to be modulated 100% negative. When the B+ was driven to twice the DC value, the amplifier was modulated 100% positive. Since the positive modulation can be any level without adversely affecting adjacent frequencies, most attention was given to the negative modulation, for if it exceeds 100% the carrier is literally cut off and the RF-distortion products generate spurious signals that cause interference on adjacent frequencies. (Actually, the FCC was somewhat fussy about the positive modulation, and broadcast transmitters were limited to a maximum of 125% positive modulation.)

Early signal processing

There is a characteristic of the human ear known as "average-power sensitivity" that got technicians working on the idea that the required 100%/125% modulation-limiting could be used to increase that esoteric characteristic called "talk power." While the transmitter's modulation is determined by the modulation's instantaneous peaks, the ear senses the volume of the "average-power modulation level," which is 10 dB to 20 dB below the peak value. For reasons too complex to go into at this time, the peak-to-average ratio is assumed to be 10 dB. In practical terms that means that if the transmitter is modulated to 100% by unprocessed speech, the *effective* modulation level is approximately 30%.

Early radio technicians and engineers figured that, since the modulation peaks aren't necessary to convey intelligence (fidelity, yes; intelligence, no), if the microphone's preamplification was increased so that the modulation was driven deep into peak clipping at the modulation transformer, the average-to-peak ratio would be less than 10 dB, increasing the average modulation level. That would cause the signal to sound louder at the receiving station; in essence, a boost in "talk power." (A peak-to-average ratio of 5 dB provides 55% average modulation-depth.) Logically, with greater clipping all peaks could be eliminated; and if high volume-levels were clipped to boost low volume-levels effectively, the signal could have an almost unvarying, high, modulation-level. Heavy clipping was tried, but the trouble is that clipped waveforms produce distortion, and the greater the clipping the greater the distortion. It takes heavy filtering above 3 kHz to prevent distortion products from spilling to adjacent RF frequencies; also, beyond a reasonable limit of about 8 dB the distortion makes the signal "mushy," and actually less readable when buried under interference and static.

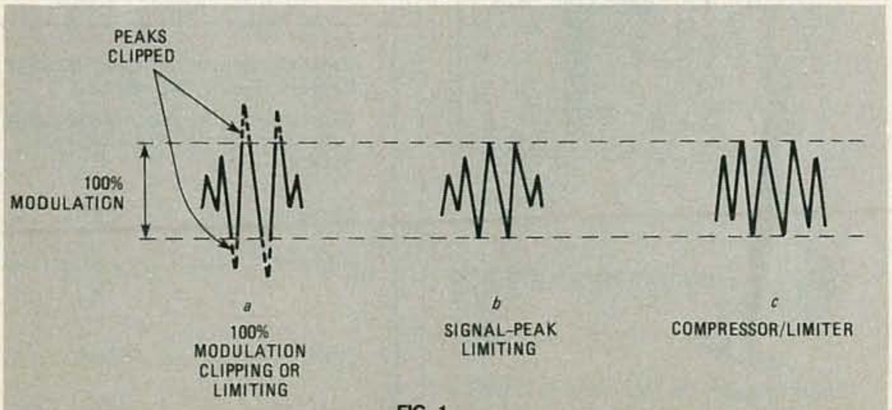


FIG. 1

Out of all this early experimentation came the observation that readability was improved if the voice's normal dynamic range was sharply reduced; that is, if the weak sounds or words could be amplified in relation to the stronger sounds. The most successful early method for transmitters was the "limiting amplifier" (not a peak limiter), a circuit used very successfully in CB transceivers because it does not produce excessive distortion products.

It works this way. The audio preamplifier works at maximum gain until it senses a predetermined input-signal level, after which it provides less than "normal" gain. As a general rule, a limiter provides a 1:2 ratio; above the limiting threshold it delivers 1-dB output for each 2-dB increase in input level. (Some limiters have a 1:3 ratio, providing a 1-dB increase in output level for each 3-dB increase in input level above the limiting threshold.)

Combined peak/volume limiters—often simply called "limiters"—actually provide almost no amplification above the threshold; a 10-dB rise in input level might result in less than 1-dB rise in output level. This type of "limiting" is extremely effective, though it produces excessively "hot" highs because the low frequencies—which are generally considerably stronger than the high frequencies—trigger the threshold, producing reduced gain for the lows and normal or "wide open" gain for the highs. The resulting waveform is shown in Fig. 1-b. This type of limiter is generally used only to protect against overmodulation (since it does not really boost the average modulation level). It's a standard limiter for broadcasting stations that don't process the sound in any other way.

Speech processing today

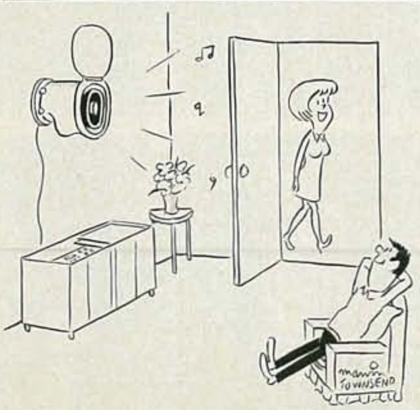
Solid-state devices really made a big difference in speech processors. Transistors, and in particular IC circuits, are very easily adapted to low-distortion filter designs. The modern speech processor first strips off the frequencies that don't convey much intelligence. Those are the frequencies below about 300 Hz and above 3kHz. The lows help us distinguish who is speaking but we don't need them to convey intelligence. Besides, they burn up a lot of power and tend to foul up limiter and gain-riding adjustments.

The frequencies above 3000 Hz also contribute little to intelligence and take up an unreasonable amount of spectrum.

Finally, we push what's left through a compression amplifier—an amplifier that provides maximum gain to weak signals, and little (or even negative) gain to very loud signals. Combined with peak limiting (fixed peak-signal threshold), what modulates the transmitter is a more or less constant "average power" signal (see Fig. 1-c)—literally a wall of audio. Whether the input signal is a scream or a whisper, it comes out as nearly 100% average "voice-power" modulation.

It would be nice to be able to assign some value and say that processed speech was 10 dB, 15 dB, or 20 dB more effective than unprocessed modulation, but there's really no way to specify a value. A loud sound into the microphone might gain only 6 dB or 10 dB, but a very low voice or a whisper might be 20 dB or even 30 dB more effective than if it were unprocessed. And this is where the advantage really lies: it is the weaker sounds that get the greatest boost through speech processing.

We've come a long way since the early AM transmitter peak-limiters. While a signal may not have the best fidelity, at least we can be certain we will hear all we need to. **R-E**



"Beautiful, Henry! How did you ever achieve such clarity and purity of tone?"

SERVICE CLINIC

The more problems, the harder they are to find.

JACK DARR, SERVICE EDITOR

I'VE OFTEN MENTIONED CASES OF DOUBLE troubles: two different problems in the same set. I have also mentioned problems due to overlooking a very significant symptom. We see it, of course, but we don't recognize it for what it means. Here are a pair of "doubles;" different in one way but alike in another.

The first case involves a Magnavox T-910-01. No vertical or horizontal sync at all. After doing some checking, I found that the horizontal oscillator circuit wouldn't "free-wheel." The capacitor across the oscillator coil (hold control) was shorted. Replacing it restored the horizontal sync with a fairly good picture, but still no vertical sync. The oscilloscope showed the vertical sync-pulse present on the coupling capacitor to the vertical oscillator input, but the pulse was very ragged. Checking the output of the video detector showed a problem.

Video *was* present, but the waveform looked like the one shown in Fig. 1, instead of the normal one. The sync is negative going at that point, as it should be, but note the amplitude of that pulse; it's at least four times too high (and the video is way too low). A bit more looking around with the oscilloscope showed that the AGC filter capacitor, C2 (see Fig. 2), was open. That allowed a number of signals to get into the AGC line, causing feedback. A little experimenting with a capacitor substitution-box showed that marginal filtering in this AGC circuit can cause a loss of picture detail before the vertical sync is affected. That fact may be worth remembering if you run into a similar problem.

That is an elegant example of how much faster you can diagnose a problem when you use a scope intelligently. In fact, in cases like that, it is about the only instrument that will give you any valid data on exactly what the circuit is doing. The key clue in this kind of analysis is to look for the presence of signals (or pulses, etc.) at points where they should *not* be. Do that at any circuit point that is filtered or bypassed.

Now we get to a much worse case, unless you're looking for a good example of how to foul up a fairly easy diagnosis! The set was a Philco hybrid (solid-state IF, etc., and tube amplifiers). When I was called in, the problem was no picture. The screen showed only a pattern of faint vertical bars with "squiggles" in them. The technician said that when the set had first come in the trouble had been a "smooth white screen"—no snow, no picture. He'd tried a tuner-subber on it but without luck. After putting the original tuner back, the symptoms changed.

So, we checked the IF stage. The DC voltages there were close to normal, though the AGC was low. A video signal from a color-bar generator was fed into the grid of the first video-amplifier tube. That signal came through and made a perfect picture on the screen. It told us that everything beyond that point was OK. This also fed some video to the AGC input from the first video-amp's plate-circuit. We found that the AGC didn't work, either.

We now had the trouble pinned down between two points. We tried overriding the AGC with a bias box but that had no effect on the pattern. We still saw the faint bars on the screen. At this point we had all the clues needed to find the trouble, but we didn't know it.

After some more fruitless checking, I had to leave but the technician kept working on it. When I came in the next day, he told me he had found the problem: The video-detector diode was shorted! The vertical bars/squiggles on the screen were due to a less-than-perfect job of hooking up the tuner IF cable to the chassis! The ground was open, and that upset the IF input.

With perfect 20/20 hindsight, we both agreed that we had overlooked two significant clues. First, the *change* in the symptoms after the tuner substitute had been tried. That should have told us that something wasn't hooked up correctly. The second was the fact that overriding the AGC had no effect at all on the symptoms. It should have; even if the IF was in oscillation, we should have been able to cut it off and get back the white screen symptom. If we had not been distracted by the tuner-hookup problem, there were a couple of tests that could have been made that would have helped. The scope would have shown nothing at all on the video-detector output. By using a crystal-detector probe on the scope, we could have coupled this loosely to the third video-IF and seen that there was a normal signal at that point. Between this and the output there was only one thing that could cause the problem—the diode.

So, let that be a lesson to you. When you're making tests, pay close attention not just to *what* you're seeing, but especially to what it *means*.

Power supply

I've just gotten some data on a DC power-supply circuit with an unusual feature. Let's have a look at it so that you'll have an idea of what's going on when you run into it. It's used in a Magnavox chassis, the *model 13C2*.

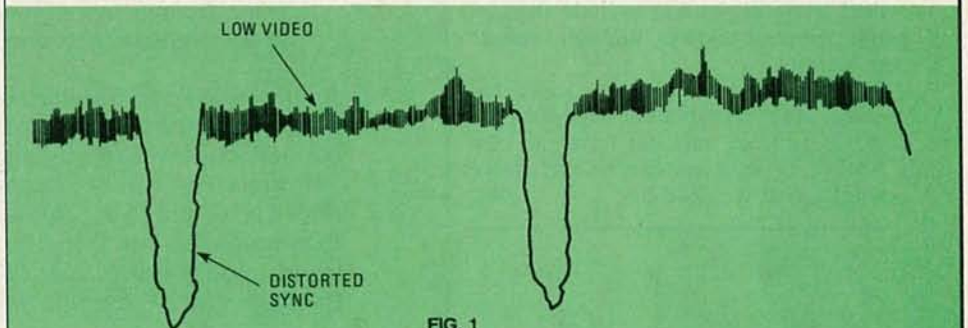


FIG. 1

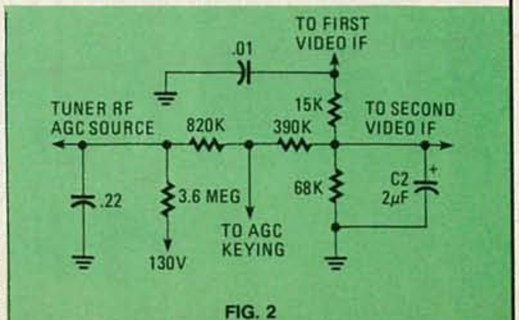


FIG. 2

That is one of those switching-regulator types that have been discussed in previous columns. A pass-transistor does the actual regulating. It is switched on or off to vary the pulse-widths, at the horizontal frequency.

The unusual thing here is that the oscillator used is in an IC on the voltage-regulator board, the 70419 module. Some similar circuits use two horizontal oscillators, one of which is the main horizontal oscillator, with the other one synced to it. Here, there is only the one, and that does it all. The IC also incorporates the phase detector and over-current, over-voltage, and under-voltage protection circuits. It even has a protection circuit to guard against any faults in the control-loop of the IC itself. If any of those circuits are faulty, the same thing happens: The DC power supply is turned off. That is done by simply turning off the pass transistor so that no current flows at all, and that stops everything.

Hope that some of this will be of help, and good luck!

SERVICE QUESTIONS

TOP LINES "TEAR"

I'm tearing my hair over this Sylvania Video Monitor. It works fine, but there's a "tearing" in the first three or four lines at the top of the picture. The rest of the raster is stable. This unit is used as a computer display terminal. The horizontal oscillator will free-wheel, and the tearing disappears in this model! Any help would be appreciated.—J. A., Richardson, TX

Here's a suggestion, and I hope it works! Since you changed the AFC diodes, this stage should be OK. Scope the *bottom* end of the diode unit. There are resistors and bypass capacitors used in this area and if one of them is open, it can create some funny problems. I had a very similar case some time back; I found some of the bypass capacitors were bad. . .after I'd already replaced two or three diode units! Incidentally, an *unbalanced* diode can have the same effect.

INTERMITTENT TURN-ON

The complaint on this Panasonic model CT-254 was intermittent turn-on. Press the switch several times and it would either start or would flicker several minutes, then it worked fine. It played on the bench for seven days in a row, then it started jittering, contracting and expanding in both directions. I changed the pass transistor in the regulator. The set played three days with no problems. I took it home; it wouldn't work!

So, back to the bench. I changed the SCR in the regulator. The set worked for a

week then started acting up again! I changed the VDR and checked the junctions on all the regulator transistors. I swapped C805 and C807 and found the sawtooth generator waveform output was a fair squarewave! The same waveform showed up in the clipper. I replaced both capacitors. Now I see a good sawtooth; the set works normally!—L. C., Mena, AR

Hooray!

ADDING A HORIZONTAL CENTERING CONTROL

John Rusinko of Little Falls, NJ sends in this interesting idea on how to add a horizontal-centering control to a chassis that does not have one.

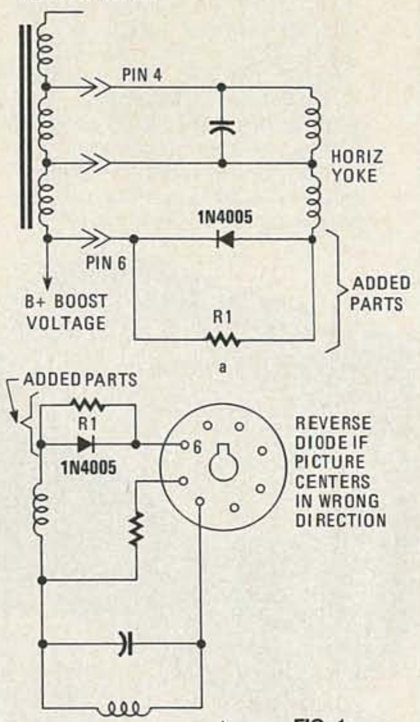


FIG. 1

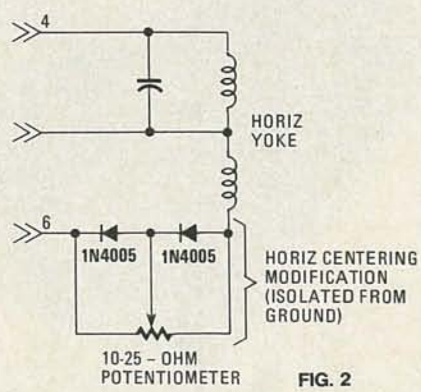


FIG. 2

Lift the lead from pin 6 of the horizontal yoke plug and place the parallel combination of 25-ohm pot and a 1N4005 diode in series with the lead. Adjust the pot until the picture is centered. Measure the value of the pot and then replace it with a fixed resistor. The diode/resistor combination is covered with heat-shrink tubing for safety. The modified circuit is shown in Fig. 1. The value of R1 will, of course, vary from set-to-set.

If you wish, a pot may be permanently installed as shown in Fig. 2, but care must be taken to isolate the pot from the chassis, because boost voltage is present.

BUZZ IN SOUND

Just serviced a Panasonic *CT-329*. Complaint was low-level buzz from the speaker when the set was turned off via the remote control. It was caused by T801, the remote-power transformer. That is mounted too close to T251, the audio-output transformer. T801 is on even with the set off and it was coupling a 60-Hz signal into the output transformer! Only one screw holds T801 and the leads are long enough to move it to another area a couple of inches away.

Thanks to Frank Ferrell of Bala-Cynwyd, PA for that one.

A 3.16 MEGOHM RESISTOR

In the "Service Questions" column (**Radio-Electronics**, November 1980) there was a question on a *CTC-27X* with no color. The stated cure was replacing a 3.16-megohm, ½-watt resistor.

"There ain't no such thing!" Checking with RCA Service Co. in Medford, MA, they said: "Go out to the open market and buy a 3.3-megohm, ½-watt resistor. That will work." I tried it and it does.

Thanks to A.W. Martell of Nick's TV, Watertown, MA and the RCA Service Co. in Medford.

INTERMITTENT GREEN SCREEN

This Panasonic model CT-91T works fine except for an intermittent all-green screen. When this happens, the voltage on the green screen jumps to +840. I changed the green-screen control and the bypass capacitor. At turn-on, the screen stays green for a few minutes, then clears up for an indefinite time. Help!—C. C., Johns Island, SC

Well, you've changed the screen control and the arc-gap capacitor across it. So, *something* is shorting across the screen control and letting the full boost voltage reach the screen grid. Here's a suggestion: Take off the screen control and examine the location *very* closely. See if there isn't a short piece of bare wire (the end of the resistor lead, clipped off, etc.) floating around behind the control. This short seems to be "thermal"; i.e., when the set is cold it shorts the control, and when the set heats up, it opens. Solder blobs can also cause these kinds of problems!

COLOR PROBLEM

This model T-995 Magnavox has a bad case of yellow fever! The color intermittently turns yellow and then clears up. Any help would be appreciated.—Q. H., Blue Springs, MO

continued on page 82

EQUIPMENT REPORTS

continued from page 36

between two antennas for different frequency ranges, and selectively feed the tuned signal into one of two separate receivers, or into the two separate antenna jacks frequently found on modern wide-coverage receivers.

Jacks and screw terminals on the rear of the cabinet let you attach antenna leads and connect the unit to the receiver(s). While coaxial cable is recommended for connecting the tuner and the receiver, for short distances insulated single-conductor wire with a separate ground lead or even shielded phone cable can be used.

The *Shortwave/Longwave Tuner* is not an antenna matchbox in the truest sense; it is not intended to provide near-perfect impedance-matching between the antenna system and the receiver. Rather, it is a preselector circuit that can be made resonant at a particular frequency, improving reception on, or near, that frequency while simultaneously rejecting out-of-band interference. That makes the device useful with modern low-cost communications receivers that feature high sensitivity but fall short in selectivity. The background clutter from intermodulation and front-end overload may be reduced or even eliminated with this tuner.

Our test

We tried the *Shortwave/Longwave Tuner* with several receivers: the Radio Shack DX–300 and 302, Kenwood R-1000, Drake R7/DR7, and the Yaesu FRG-7700. While signal improvement varied with the receiver tested, some improvement was noted with every receiver. The improvement was most noticeable on the lower frequency ranges (AM broadcast band and below).

While the manufacturers of most general-coverage receivers capable of tuning below 100 kHz usually state that frequency as a nominal cutoff point, using the *Shortwave/Longwave Tuner* extended low-frequency reception considerably. When used with a 50 to 100-foot wire antenna, reception of WWVB (60 kHz) and even Omega (12 - 15 kHz) was possible! In their literature, Grove Enterprises indicates that the low-frequency reception is best when using a 100-foot insulated wire lying on the ground as an antenna! Using that for low-frequency reception and a shortwave dipole would make an excellent antenna system.

The Grove *Shortwave/Longwave Tuner* is not perfect; in order to keep the cost competitive RF chokes, rather than a large-diameter-wire inductor, were used. As a result, there is series resistance, as well as low Q, on the lowest frequency ranges. Despite that shortcoming, the tuner gives an excellent accounting of itself when used for casual longwave reception, and provides some improvement on the higher frequencies as well.

The *Shortwave/Longwave Tuner* sells for \$59.95 plus \$1.75 shipping from Grove Enterprises, Inc., Brasstown, N.C. 28902. **R-E**

SERVICE QUESTIONS

continued from page 80

Well, the most likely thing I see in the crystal ball is that you are losing your *blue* completely. This leaves red and green, which together make yellow. So you have to start at the picture tube and eliminate the various possibilities.

Check the control grid, cathode *and* screen voltages on the blue gun. For example, if you were losing the blue screen voltage, the blue gun would cut off. There are three screen controls on the "Retrace/Screen" module; check this area for a possible hairline crack or a bad solder joint on the blue screen control.

Check the collector voltage on the blue video output transistor to see if it goes off (either up or down!) when the trouble shows up. If this transistor is intermittently opening, this lets the blue cathode voltage go more positive, which cuts off the blue gun.

LOSS OF VERTICAL SWEEP

There's an odd problem in this RCA CTC-53XP chassis. It begins losing its vertical size, forms a thin line, and then the breaker trips. I found that the vertical oscillator plate voltage drops slowly, goes clear out, which is when the breaker trips. Can you give me a clue?—A. S., McKeesport, PA

There's one good clue: This plate is fed from the +600-volt *boost*. When you check, you'll see that the *horizontal* oscillator plate is also fed from the same boost voltage. If you lose the grid drive to the 31LZ6, it draws enough current to make the breaker trip.

Try a new 17CT3 damper tube. You might just fix the problem! If this doesn't help, then check through the complete boost circuit from the flyback to the points fed from it. I doubt that this problem is caused by a leaky capacitor, since when this happens, it is usually permanent. However, tubes can short, cool off and clear up.

PICTURE PROBLEM

This Airline model 129462 (Sams 1544-2) has a picture problem. Contrast, brightness and brightness-limiter controls have no effect at all. There's a whitish raster with heavy retrace lines. When I turn up the color a funny picture comes on that looks like a film negative. I tried a new M800 video module with no help. The picture tube is good.—F. C., Gainesville, TX

The crystal ball says you've lost the video or the black-and-white signal. When this happens, turning up the color *will* give you a funny picture. Since the video module is OK, check back through the video circuits. There's another video-amplifier transistor (Q204) on the front board along with the IF's, etc.

If transistor Q204 is shorted, it will give you a negative video and a severe loss of gain. If the transistor is OK, check the video-detector diode to make sure whether it is open or shorted. There should be 6.2 volts of video signal on the Q204 collector, with the sync going negative; if there isn't, everything from here on in will be bad!

BREAKER TRIPS

After about a minute of operation, the circuit breaker trips in this Sylvania model D-14. If I disconnect the degaussing coil, the set works OK. I decided the coil was bad and replaced it. The breaker still trips! Any leads?—C. G., Amityville, NY

Since there are only two items in the degaussing circuit—the coil *and* a positive-temperature coefficient thermistor—I suspect that the thermistor is shorted. Because the symptom goes away when this circuit is open, the thermistor is the only thing left to go wrong. This part is a Sylvania No. 38-33206-1. Use only an *exact* replacement. Normal resistance is 25 ohms cold and must go up very quickly.

THICK HORIZONTAL LINE

The screen of this Zenith model 14Z33 shows a horizontal line. The 8BA11 and

10GK6 tubes test OK, but the vertical linearity and vertical size controls do nothing. Any ideas?—J. P., Brooklyn, NY

I have one: I note (from the photo you sent along) that the screen line is approximately an inch high and not very thin. This generally means that the vertical-output stage is trying to work. It picks up enough stray AC on its grid to create a thick line.

However, the vertical oscillator obviously isn't running. Using just your fingertip, touch the 8BA11 pin 9 grid, the input grid of the vertical oscillator. If this causes the vertical deflection to increase slightly, you have eliminated this tube as a cause of the symptom. The chances are that one of the parts in the *feedback loop* is open; without feedback, there's no oscillation.

MORE BROADMOOR DATA

George R. Welker, Spokane, WA sends this supplemental data on Broadmoor chassis. He says that the 6911-C chassis was made by Midland for many private labels such as Bradford, Truetone, and Coronado as well as Broadmoor! You can get parts and data from Midland International Corp., 1900 Johnson Drive at State Line Road, Shawnee Mission, KS 66205.

Thanks a lot, George! If we keep on trying, we'll get some useful data in our files on those. **R-E**

NEW IDEAS

Simple Tesla coil

I'M SURE THAT MANY READERS FOUND the article on the recreation of Tesla's original experiments by Robert Golka (see **Radio-Electronics,** February 1981 issue) very interesting. I know that I did, especially since I built a small version of a Tesla coil not too long ago (although I'm only age 14). I'd like to share the details with you.

There is one important thing to keep in mind before we even begin: The Tesla coil described here can generate 25,000 volts so, even though the output current is low, **be very careful!**

The main component of the Tesla-coil circuit is a flyback transformer. You can get one from a discarded TV.

The first thing you must do is to get rid of any excess wire or other debris that's on the transformer's core, as shown in Fig. 1. Leave the high-voltage winding alone; but if there is a capacitor at the end, it should be removed.

After that, you can start winding a new primary coil. Begin by winding 5 turns of No. 18 wire on the core. Then

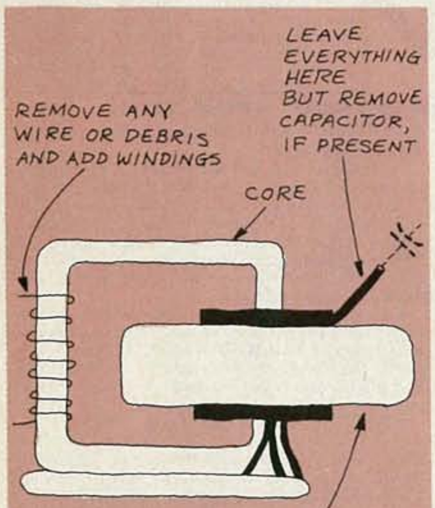


FIG. 1

twist a loop in the wire and finish by winding five more turns. Wrap with electrical tape, but leave the loop exposed.

A four-turn winding has to be wound over the ten-turn winding that you've just finished. That is done the same way. First wind two turns of No. 18 wire, then make a loop, and finish up by winding two more turns. Again, wrap the new winding with electrical tape, leaving the loop exposed.

When the windings are finished, the two loops shouldn't be more than ¼-inch apart (but take care that they do not touch). Connect a 240-ohm resistor between the two loops. The modified transformer now should look like the one shown in Fig. 2.

Connect the transformer as shown in Fig. 3. The 27-ohm resistor and the two transistors should be mounted on a heat sink and *must be insulated from it.*

The output of the high-voltage wind-

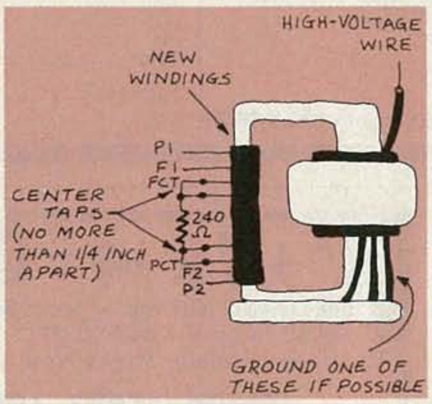


FIG. 2

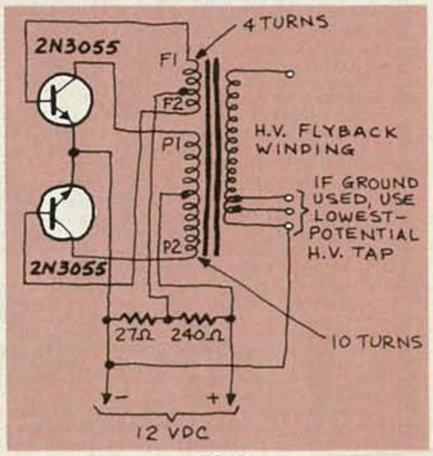


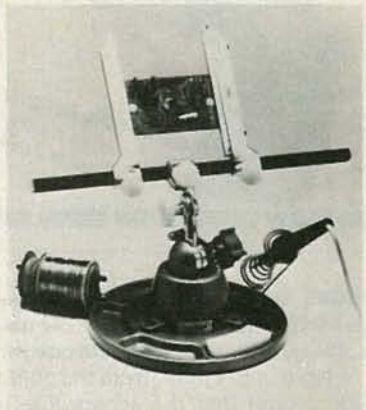
FIG. 3

ing should begin to oscillate as soon as the circuit is connected to a 12-volt DC power supply. If it does not, reverse the connections to the base leads of the transistors. In normal operation, you should be able to draw 1-inch sparks from the high-voltage lead using an **insulated** screwdriver.—*Eric Wold*

NEW IDEAS

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

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



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NEW PRODUCTS

For more details use Free Information card inside back cover.

FREQUENCY COUNTER, *model IM-2420,* is a new 512-MHz digital frequency counter that is available both in kit and fully-assembled versions.

The *model IM-2420* features four gate times and 8-digit resolution for precise readings. It does more than just measure the frequencies of input signals. A period function can give cycle time in seconds, while the frequency-ratio function provides the user with the ratio between two input frequencies.

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A standby power switch keeps the crystal oven warm for maximum frequency accuracy. The oven is proportionally-controlled to keep the internal time base within 0.1 part per million over a wide temperature range. The crystal-controlled time base provides long-term stability, with drift controlled to less than 1 ppm per year. There are also provisions for using external time-base signals.

Four gate times and a 0.43-inch-high, 8-digit LED display provide the resolution needed to measure UHF signals. Trigger-level control assures stable counting when noise is present, and provides more accurate measurement of complicated waveforms. Frequency measurements can be made by direct connection, or by using the optional *SMA-2400-1* swiveling telescopic antenna. The model *IM-2420* can be wired for either 120 or 240 VAC operation.

The *model IM-2420* is priced at $239.95 as a kit, with a complete step-by-step assembly manual; the factory-assembled and tested version, *model SM-2420,* is priced at $299.95.—**Heath Company,** Benton Harbor, MI 49022.

ASCII ENCODED KEYBOARD KIT, the *JE610,* is designed to interface with almost any computer system. It comes complete with a 62-key keyboard switch assembly, IC's, sockets, connector, and a double-sided PC board. The switches are SPST mechanical action, and 60 keys generate the 128 characters (both upper and lower case) of the ASCII set. Two user-defined keys are provided for custom applications. The unit is fully buffered and there is a "caps lock" for upper case and alpha characters. The system has a 40-pin ROM with outputs compatible with TTL/DTL or MOS logic arrays. The keyboard assembly requires +5 VDC at 150 mA and −12 VDC at 10 mA for operation. Interfacing is accomplished by a 16-pin DIP socket or an 18-pin edge card connector. Step-by-step wiring instructions and circuit diagram are also included. Suggested retail price is $79.95, less enclosure. Available in kit form only.—**Jameco Electronics,** 1355 Shoreway Rd., Belmont, CA 94002.

CIRCLE 111 ON FREE INFORMATION CARD

FM PORTABLE: Two new options are now being offered by Motorola for their *Series MT500* FM 2-way portable radios—*touch code,* and *touch-code* encoders with automatic number identification (ANI). The *MT500* series includes almost 100 different models, each specifically tailored to the customer's options.

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Those new options encode dual-tone multi-frequency (DTMF) tones which enable the user to control devices remotely, or to place telephone calls when interconnected with the proper system. The ANI feature expands the encoder option to identify the user and acknowledge valid system-entry automatically. ANI is the function of a hybrid programmable PROM that plugs into the radio front cover, thus leaving internal space for additional options.

The *touch-code* option is $200 additional: the *touch-code ANI* option is $260.00 additional.—**Motorola, Inc.,** c/o Pat Schod, Communications Group Public Relations Dept., 1301 E. Algonquin Road, Schuamburg, IL 60196.

INTEGRATED AMPLIFIER, the *Plus A75,* features a moving coil preamplifier and left- and right-channel 12-stage LED input/output peak indicators. The preamp section features a wide-band, DC-coupled Class A design. Controls include "triple-turnover" bass and treble equalizers, a sharp-cutoff switchable subsonic filter, and separate dubbing and monitoring facilities for two tape decks.

The *Plus 75* has a minimum rated power of 75 watts-per-channel into four or eight ohms. Response is from 20 Hz to 20 kHz with less than

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0.009% THD. The LED display shows not only output power but can also show input levels to aid in monitoring the output of signal sources connected to the amp. The amp section uses fully complementary DC-coupled output devices that have a slew rate of 120 volts-per-microsecond. Suggested retail price is $509.95.—**Sanyo Electric, Inc.,** Consumer Electronics Div., 1200 W. Artesia Blvd., Compton, CA 90220.

SPEECH CONTROLLER, the *VSC* (Variable Speech Control), offers self-paced listening. Recent studies show that comprehension and retention increase by as much as 42% when material is heard at a rate of 250 to 300 words per minute—twice as fast as most people speak. The *VSC Speech Controller* enables the user to regulate that speed.

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For studying, previewing, transcribing, reviewing, or analyzing tapes of lectures, conferences, interviews, or personal notes, the unit can play up to 2½ times faster than a normal recorder and still reproduce voices without distortion. Speech can also be slowed down without distortion.

There is a built-in microphone, 3-digit counter, record-level meter, cue-review control, 12-volt-DC adaptor jack, headphone, earphone, and remote microphone jacks. An external microphone, earphone, and stand are also available as accessories.

The *VSC Speech Controller* is priced at $259.00.—**Edmund Scientific,** 7082 Edscorp Bldg., Barrington, NJ 08007.

HI-FI PREAMPLIFIER, *Linear Preamp,* is designed to serve as the basic control/preamp unit of any stereo setup. In addition to the standard function-select controls, the unit features a sub-

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sonic filter, two tape-monitor circuits plus selection of either the left or right channel in the monaural mode and channel-reverse capability in the stereo mode. A gain switch offers 20 dB of additional gain when needed. This compact preamp is housed in an enclosure with solid walnut end

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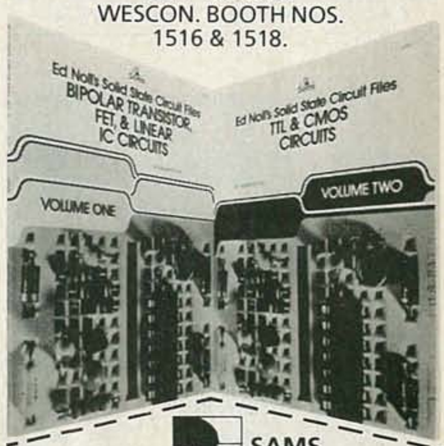

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pieces and a black anodized finish. The unit measures 1¾ × 19 × 6 inches. Suggested retail price is $330.—**MXR Innovations, Inc.,** 740 Driving Park Ave., Rochester, NY 14613.

POWER SUPPLY, the *AppleJuice model APS-3,* is a reserve power supply that provides one-hour back-up power for the *Apple II* Computer and *Apple*-powered peripherals during power flickers, prolonged outages, and brownouts. During an outage, the *AppleJuice* alerts the user visually,

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audibly, and electronically that there is a power failure, giving the user time to bring the system to an orderly shutdown with all data files intact. An interrupt feature can be used to generate an interrupt to transfer memory content automatically to disk or to operate any external device requiring less than 60 mA. Suggested retail price is $295.00. A 20-minute version is available for $249.00.—**High Technology, Inc.,** P.O. Box 14665, Oklahoma City, OK 73113.

TWO-WAY BUSINESS RADIO, *model 867L,* is a 30-watt VHF FM unit available with either one or two channels. Designed for mobile use or as a base station, it operates in the 140- to 174-MHz frequency range. There is an adavanced Hi-Q

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receiver on the front end, to insure sensitivity and selectivity of signal reception. The automatic transmitter power control maintains a steady transmission at the rated power output over a widely varying input voltage. A microstrip RF power amplifier reduces tuning time and makes for over-all easier alignment and service. Private channel (CTCSS) operation is available as an option. The *model 867L* is priced at $425.00 for the one-channel version, $446.00 for the two-channel version.—**Standard Communications Corp.,** P.O. Box 92152, Los Angeles, CA 90009.

FUNCTION GENERATOR, *model 1200A,* includes the *Waveguard* output-protection circuit that was available formerly only at extra cost. That circuit prevents damage to the generator's output stage if an external voltage is applied accidently across the generator's output terminals. The *Waveguard* circuit recovers automatically when the external voltage is removed.

The *model 1200A* provides 20-volt P-P sine, square, and triangle waveforms from 0.2 Hz to 3 MHz, and also provides 1500:1 linear up or down sweeps, with adjustable sweep durations from

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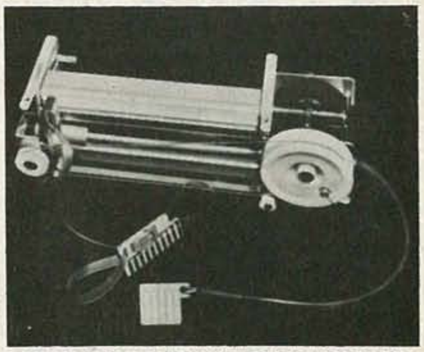
1000 seconds to 1 millisecond. There is also variable DC offset and auxiliary TTL output.

The *model 1200A* is priced at $395.00.—**Krohn-Hite Corporation,** Avon Industrial Park, Avon, MA 02332.

PRINTERS, *EUY-5E* and *EUY-5T* are miniature alphanumeric printers, that print either on electrosensitive paper *(EUY-5E)* or thermosensitive paper *(EUY-5T).* Both print 32, 40, 64, or 80 characters per line. Characters are formed by a 7 × 5 dot matrix, and are 0.11-inch high. The *EUY-5E* can print two lines per second while the *EUY-5T* prints 0.8 lines per second. Both printers measure 7.68 × 2.56 × 2.76 inches and print on 5-inch wide paper and have an expected life of 1 × 10^6 lines; that makes them suitable for applications where inexpensive hardcopy output is required, including computer peripherals, measuring instruments, analyzers and others.



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The printers come without a case, ready to be mounted and connected via their ribbon cables and PC connectors. The *EUY-5E* requires two ±24 VDC sources at 100 mA each and a +5 VDC supply at 30 mA. The *EUY-5T* requires one ±24 VDC supply at 100 mA, one ±24 VDC at 1 amp for the thermal head, and +5 VDC at 30 mA for the logic. In OEM quantities, the *EUY-5E* is priced at $145 and the *EUY-5T* is priced at $196. –**Panasonic,** Electronic Components Div., 1 Panasonic Way, Secaucus, NJ 07094.

ANTENNA TUNERS, *models 228* and *227,* feature two-inch, 47-tap toroids with silver-plated 18-gauge wire and tap selectors. Used in a wide-range "T" network with variable capacitors, the toroids permit vernier tuning for easy, accurate adjustment.

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A front-panel five-position ANTENNA SELECT switch offers a choice of dummy load, one of three different antennas, or tuner bypass for one of the antennas. Also, one antenna may be a long-wire type.

The tuners will match conventional 50-75 ohm unbalanced outputs to a variety of unbalanced or balanced load impedances. A built-in balun converts one antenna to a balanced configuration if desired (max. balanced load on 160 and 80 meters is 500 ohms). Power ratings are 200 watts RF intermittent, 100 watts continuous (ideal for any transceiver with input power up to 200 watts).

The *model 228* has a built-in SWR bridge, FORWARD/REVERSE switch, SENSITIVITY control, and a meter that indicates SWR's between 1:1 and 5:1. The size is 3⅝ × 10½ × 7¾ inches. *Model 227* is identical except that there is no SWR bridge, and the size is 3⅝ × 8½ × 7¾ inches. Both models are styled to match Ten-Tec transceivers.

The *model 228* is priced at $95.00; the *model 227* sells for $79.00.—**Ten-Tec,** Inc., Highway 411 East, Sevierville, TN 37862.

LOUDSPEAKERS, the *L112*, is a 3-way bookshelf speaker system designed in "mirror-imaged" pairs for greater stereo imaging. The *L112* features include a one-inch dome radiator, a five-inch midrange driver and a 12-inch woofer. A high-resolution dividing network provides smooth transition between the drivers. The 12-inch woofer uses a *Symmetrical Field Geometry* (SFG) flux-

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stabilized magnetic structure. The driver is equipped with a 10¼-pound magnet and a 3-inch copper-edgewound voice coil to offer high-power handling, low distortion, and good transient response. The *L112* can be driven by an amplifier with as little as 10 watts or as much as 300 watts continuous sinewave per channel. The enclosure is constructed of wood panels finished in black walnut with a three-dimensional brown grille. Measures 24½ × 14¼ × 13 inches. Suggested retail price is $450 for each speaker.—**James B. Lansing Sound, Inc.,** 8500 Balboa Blvd., Northridge, CA 91329.

UNIVERSAL COUNTER, *model 412*, is a panel-mount, 8-digit counter/timer measuring 3 × 2 × 0.5 inches in a red acrylic case that requires no panel cut-out for front mounting; only a ⅜-inch diameter hole is needed.

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The *model 412* has eight bright .35-inch LED's in addition to the LSI IC, a few discrete components, and two micro DIP switches that are accessible to the operator. Frequency, frequency ratio, time interval, period, or events are selected by one of the switches. Gating times of 0.01, 0.1, 1, and 10 seconds or external are selectable through the second switch. Frequency response of 0-10 MHz is standard in all functions except frequency ratio, where it is limited to 2 MHz. Hold and reset inputs are available as standard connections, with others on request.

The power requirements are 5-volts DC at 180 mA, or 120/240-volts AC at 50-60 Hz when the wall-mount plug-in power pack is ordered. Applications include either portable or panel-mount rate indicator, frequency monitor, process timing, period measurement, event counter, frequency comparator, and others. Sealed units with dedicated function and gating time are available for use in harsh surroundings.

The price of the *model 412* is $175.00 for the standard unit; $225.00 for the sealed unit.—**International Microtonics Corporation,** 4016 E. Tennessee Street, Tucson, AZ 85714.

REINFORCER RINGS, designed to protect flexible disks and minidisks, prevent hole tearing and help reduce coating removal and rippling damage that causes premature flexible-disk failure. Made of heavy-duty Mylar, the rings are especially rec-

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ommended for use with Wang and other drives which require reinforced flexible disks. The *Reinforcer Ring Kit* contains 50 adhesive-backed rings, an easy-to-use applicator, and instructions. Re-order packages of 50 rings are also available. Price of the kit is $9.95. Refills are $6.95.—**MISCO, Inc.,** 963 Holmdel Rd., Box 399, Holmdel, NJ 07733.

CASSETTE DECK, *model TCD-420A,* is a two-head metal-tape compatible record/playback deck. The combination of the *Actilinear* Recording System, the *DNYEQ*—the dynamic recording-

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equalization system, plus the Diamond Cut Multicore Senalloy record/playback head provides the higher saturation limit required for new metal tapes. The *TCD-420A* also features a 3-motor, servo-controlled dual-capstan transport system, dual-scale peak-reading equalized meters, plus horizontal, vertical, or wall-mount operation. Suggested retail price is $850.—**Tandberg of America, Inc.,** Labriola Ct., Armonk, NY 10504.

DIGITAL MULTIMETER, *model 274,* is a hand-held instrument with a 3½-digit liquid crystal display. It measures AC and DC volts, DC current, and resistance in 21 ranges. The *model 274* features single-chip LSI logic, automatic decimal point and overload-protection, and operates up to 200 hours from a single 9-volt transistor battery. An automatic LO-BAT indicator warns the user when the battery life is down to 20%. Accuracy is

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better than 0.8% and input impedance is 10 megohms. The *model 274* comes with 9-volt battery, deluxe test probes, spare fuse, and carrying case; it is priced at $89.95.—**EICO Electronic Instrument Co., Inc.,** 108 New South Road, Hicksville, NY 11801.

SPEAKER AMPLIFIER SWITCHER, *model MP-3,* allows up to four pairs of stereo loudspeakers to be driven from a single amplifier without overloading the amplifier's output stage. Each pair of speakers may be volume-controlled independently of the others, without changing the load impedance "seen" by the amplifer. Input switching for two separate power amplifiers is provided so that any loudspeaker pair may be driven from either of two signal sources.

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The *model MP-3* uses constant-impedance "L pads" as the control elements, instead of the variable resistors that are usually used for that purpose. Though more costly than variable resistors, the L pads provide a minimum load impedance of 4 ohms, resulting in more stable operation of the driving amplifier and allowing extension loudspeakers to be turned up, down, or off without altering the volume of the main speaker pair.

The *model MP-3* will accept power inputs from any commercially available amplifier, and will drive loudspeakers of any nominal impedance in any combination up to a level of 70 watts per speaker. It is packaged for home or office in a metal case of black painted finish and measures 9¾ × 3 × 7½ inches. It is also available in a rack-mount version, as *model MP-3R,* for professional installations, with dimensions of 19 × 3⁷⁄₁₆ × 7½ inches.

The *model MP-3* is priced at $149.95; the rack-mounted *model MP-3R* costs $159.95.—**Russound/FMP, Inc.,** Box 2369, Woburn, MA 01888. **R-E**

NEW BOOKS

For more details use free information card inside back cover

Z80 ASSEMBLY LANGUAGE PROGRAMMING, by Lance A. Leventhal. Osborne & Associates, Inc., 630 Bancroft Way, Berkeley, CA 94710. 608 pp. 5⅛ X 8 in. Softcover. $9.50.

This book provides a comprehensive discussion of the Z80 microprocessor assembly language. It assumes that the reader is already familiar with *An Introduction to Microcomputers; Vol 1—Basic Concepts* (particularly Chapters 6 and 7), and does not discuss the general features of computers, microcomputers, addressing methods, or instruction sets.

Features included in the present volume are sample programming problems (more than 80); problem solutions in source code and object code; full explanations of each Z80 instruction; complete Z80 instruction set reference tables; Z80 assembler conventions; Z80 I/O devices and interfacing methods, and comparisons of Z80 and 8080/8085 instruction sets and interrupt structure.

CIRCLE 131 ON FREE INFORMATION CARD

MICROSOFT BASIC, by Ken Knecht, dilithium Press, P.O. Box 92, Forest Grove, OR 97116. 158 pp. 5⅜ X 8⅜ in. Softcover. $9.95.

This is a book that describes the BASIC programming language. After an initial explanation of BASIC and a chapter on definitions, the author presents a complete course on programming in Microsoft BASIC. The examples given, starting with the simplest, are all workable ones.

Subjects covered include branching and loops, arithmetic in BASIC, strings, editing, arrays and files, the disk, additional useful features, and a description of the Radio Shack Level II BASIC. There are four appendices, the third of which illustrates error messages and how the computer informs the user that something is amiss.

CIRCLE 132 ON FREE INFORMATION CARD

THE PERSONAL ELECTRONICS BUYERS GUIDE, by Charles J. Sippl & Roger J. Stippl. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632, 338 pp. 6¾ X 9¼ in. Softcover. $8.95.

Covering the entire range of present electronic devices this is a definitive source of price and operating information that goes into the capabilities and limitations of each.

Personal computers, electronic games, TV devices (including those that edit out commercials), home security systems, burglar and fire detection systems, solar energy devices—all the above and more are covered in this consumers' manual which tells both what you want and need to know.

CIRCLE 133 ON FREE INFORMATION CARD

MODERN CB RADIO SERVICING, by Marvin Hobbs. Hayden Book Company, Inc., 50 Essex St., Rochelle Park, NJ 07662. 176pp. 7⅛ X 9¾ in. Hardcover. $6.95.

Japan is the source of most CB transceivers, but most CB test equipment is produced in the USA. The present book explains the considerable range of the latest service equipment that is produced to meet the requirements of technicians and CB service people. An introductory chapter deals with both first and second-generation 40-channel transceivers as well as the 80-channel SSB transceivers and transceivers for use in other countries. Also covered farther on are the newest trends in transceiver design, including the PLL and microprocessor control techniques. Circuitry of all types is described and illustrated with diagrams.

Specialized test equipment, designed to reduce the time required for repair jobs, is explained; and in the chapters dealing with troubleshooting, the techniques described are applicable to either 40-channel or 23-channel transceivers.

There is a chapter on making initial tests in troubleshooting, and another spelling out the most commonly encountered symptoms and the procedure in handling them. Another chapter is devoted to RF interference and noise elimination. The book includes an appendix with diagrams of various crystal combinations in 23-channel transceivers with multicrystal synthesizers.

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DC POWER SUPPLIES: APPLICATION AND THEORY, by Robert J. Traister. Reston Publishing Company, Inc., Reston, VA 22090. 234pp. 6 X 9¼ in. Hardcover. $16.95.

The first part of this handbook, devoted entirely to DC power supply, theory, and associated circuits, includes power supply circuitry, power supply components and ratings, dynamic regulation, electronic regulation, protective circuits, voltage multiplication, metering, and safety circuits.

Each chapter in the book ends with a set of study questions, the answers to many of which you must deduce from the text. They are not there explicitly; but figuring them out will show your level of comprehension of what you have read.

The second part discusses the actual circuits, and among the topics discussed are low voltage supply circuits, medium voltage supplies, high voltage supplies, and DC-to-DC supply curcuitry. There are over 80 schematics and drawings.

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PROBLEMS FOR COMPUTER SOLUTION, by Stephen Rogowski. Student Edition. Creative Computing, PO Box 789-M, Morristown, NJ 07960. 104pp. 8¼ X 10¾ in. Softcover. $4.95.

This is a book of exercises in computer use for high school and college students, as well as for self-learners of any age. The 90 problems presented for computer solution cover such areas as arithmetic, algebra, geometry, trigonometry, number theory, probability, statistics, calculus, science, and general problems. The student is also given an opportunity to try his or her hand at three of the famous unsolved problems in mathematics.

There are no answers to the problems given in the Student Edition; those are to be found in the Teacher's Edition. Those who want to take up the challenge this volume offers on their own will have to obtain both editions.

CIRCLE 136 ON FREE INFORMATION CARD

ALL ABOUT TELEPHONES, by Van Waterford. TAB Books, Blue Ridge Summit, PA 17214. 190pp. 5⅛ X 8⅛ in. Softcover $4.95.

It is now possible for you to own your own telephone system, rather than rent the equipment from the telephone company. After one chapter briefly relating the history of the telephone, and another on how it works, this book tells what kind of private telephone systems exist, how they work, how to build each kind, and what legally you may and may not do with them. You'll also learn what regulations apply to the telephone company and the manufacturers of private telephone systems.

The author describes an astonishing variety of new telephones and telephonic devices, including the picturephone, the electronic telephone, the speaker phone, and cordless telephones. There's also a chapter on telephone security devices, such as voice-scramblers, wire-tap debuggers, and the voice stress analyser system. There are two appendices: I: Glossary, and II: List of Suppliers. The book is well filled with diagrams and the material is presented crisply and clearly.

CIRCLE 137 ON FREE INFORMATION CARD

MORSE, MARCONI, AND YOU: UNDERSTANDING AND BUILDING TELEGRAPH, TELEPHONE AND RADIO SETS, by Irwin Math. Charles Scribner's Sons, 597 Fifth Avenue, New York, NY 10017. 79pp. 7¾ X 9⅛ in. Hardcover. $8.95.

For young hobbyists, this little book explains the basic principles of electricity clearly and shows the experimenter how to build working telegraph sets, telephones, and radios using the same materials that the great inventors of those devices used: wood, tin cans, and bell wire. Following clearly put directions, the experimenter will not only be able to build devices that work, but will learn in the process exactly *why* they work as they do. The few components that will have to be purchased can be bought cheaply.

Each construction program leads inevitably to another, slightly more complicated one. When the experimenter has done all the projects offered here, he or she will have a solid foundation in electronics as well as skill in a fascinating and constructive hobby.

CIRCLE 138 ON FREE INFORMATION CARD

THE BUGBOOK IV: MICROCOMPUTER INTERFACING USING THE 8255 PPI CHIP WITH EXPERIMENTS, by Dr. Paul Goldsbrough. Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis, IN 46268. 224pp. 5¼ X 8½ in. Softcover. $8.50.

This book details the major microcomputer input/output techniques and their implementation with the 8255 *P*rogrammable *P*eripheral *I*nterface (PPI) IC. When the techniques are mastered, the same principles can be applied to other PPI IC's. The full range of operation modes is detailed, including data transfer process, flag testing, bit testing, etc.

Experiments are presented with each chapter, and range from the simple input and output ports through the more complicated master-slave microprocessor configurations.

CIRCLE 139 ON FREE INFORMATION CARD

AUDIO AND VIDEO INTERFERENCE CURES, by Larry Kahaner, Hayden Book Company, Inc., 50 Essex Street, Rochelle Park, NJ 07662. 128pp. 5¼ x 8¼ in. Softcover $5.50.

This book provides all the information needed to deal with noise sources of all types. There are step-by-step instructions on how to find the source of interference and put it under control. Also included are schematic wiring diagrams of filters for all types of receivers and transmitters. They include simple filter diagrams to eliminate radio and TV interference caused by noisy home appliances, neon lights, and motors. For those who have an especially difficult interference problem, the final chapter supplies a list of outside resources that can be helpful. **R-E**

CIRCLE 140 ON FREE INFORMATION CARD

STATE OF SOLID STATE

continued from page 72

tional, there's enough dead time between digits to allow multiplexing gas-discharge displays.

We've breadboarded a little circuit (Fig. 1) to exercise these IC's. The circuit simply displays what is entered on the keyboard. Each time an entry is made, the display shifts one digit to the right and the new entry appears in the left-most display digit. The circuit accepts keyboard data entry, encodes it to binary, and counts digits (we cheated, the circuit accepts 8 key strokes but we only drive 6 digits; so after the 6th digit, two more key strokes are required before we reload the first digit). The circuit provides the data to the display controller, limits current to the segments, and uses 2N2222's as digit drivers. We used a 7805 (or a LM340-T5.0) to regulate the voltage at 5.0 DC from our 9-volt battery supply.

The *Digitran* 4 × 4 16-key keyboard provides a path from the row-output pin (there are four) to the column-output pin (of which there are also four) when a key at any row-column intersection is pressed. This data is encoded by the 74C922 into a 4-bit binary code. The data available strobe is used three times: first, via an inverter, to enable the output of the 74C922; second, through a second inverter, to advance the count of the three least-significant stages of 4024-type 7-stage binary counter; and third, without any inverter, to drive the write enable control of the 74C912. The 74C912 drives 6 digits of a 6-digit LED counter through 2N2222 drivers. Segment currents are limited through 1000-ohm resistors.

Note that the 4024 Q_n outputs are inverted before driving the 74C912 address lines. If they were not inverted, digits would load from right to left. Five sections of a 4069-type hex inverter are used. **R-E**

MICROWAVE DEVICES

continued from page 64

21-c). If we plot the power (i.e., product of Figs. 21-a and 21-c), then we will obtain the power-vs-time waveform of Fig. 21-d. Notice that, for substantial periods during the cyclic excursion, the power is negative—meaning that the device is oscillating and will deliver energy to the external tank circuit. There is only a brief period in which the terminal current and terminal voltage are both positive and that will limit the efficiency of the BARITT oscillator.

The BARITT device is a low-power microwave energy source, and is considered superior to the Gunn device for many applications. **R-E**

NEW LIT

For more details, use free information card inside back cover

MICROPROCESSOR PRODUCT GUIDE, *No. MPG-180C,* contains 60 pages describing all the elements needed to build a microprocessor system. It covers the complete line of IC's, support systems, and accessories that make up the *COSMAC* microprocessor family. The guide describes the *CDP1802* microprocessor and contains data for a wide variety of RAM's, ROM's, I/O and interfacing devices. Basic descriptions, characteristics, and functional and terminal diagrams for other general-purpose memory IC's are also presented. Other features of the guide are a cross-reference guide listing RCA types equivalent to other manufacturer's devices and an index to the line of manuals and application notes on the *COSMAC* system.—**RCA Solid State Div.,** Box 3200, Somerville, NJ 08876.

CIRCLE 141 ON FREE INFORMATION CARD

HIGH-VOLTAGE COMPONENTS GUIDE, is a six page two-color brochure describing components used as replacements in color television sets. It is designed to provide comprehensive product data to electronic parts distributors, service dealers, and technicians. It contains sections on high-voltage multipliers including a variety of tripler and quadrupler devices, high-voltage rectifiers and resistive divider/focus assemblies. Circuit diagrams and package outlines are also given. 31 solid-state devices are cross referenced in the brochure to 615 industry part numbers listed in alphanumeric order.—**Sylvania/Philips Electronic Components,** 1025 Westminster Dr., Williamsport, PA 17701.

CIRCLE 142 ON FREE INFORMATION CARD

WATTMETER/ANALYZER BROCHURE, *No PA4381-1179,* is a full-color 4-page guide introducing a series of multipurpose digital RF directional wattmeters. The microprocessor-based model 4381 RF Power Analyst offers measurement of several signal parameters in addition to bi-directional power from 0.5 to 2300 MHz and 0.1 to 10,000 watts. The brochure features application of VSWR, return loss, % modulation, dBm, and peak envelope power functions. Also described are a delta display and min/max memory on any of the displayed quantities. Full specifications are included.—**Bird Electronic Corp.,** 30303 Aurora Rd., Cleveland, OH 44139.

CIRCLE 143 ON FREE INFORMATION CARD

ELECTRONIC SURPLUS CATALOG, contains 40 pages of brand-name merchandise at bargain prices. Items such as AM/FM stereo car radios, AM tape-deck stereos, Hi-Fi speaker-system kits, car alarms, telephones, microwave timer boards, TV games, and computers are all offered at low prices. Other electronic items such as relays, batteries, capacitors, heat sinks, IC's, semiconductors, switches, and many more, are also included in the catalog.—**B & F Enterprises,** 119 Foster St., Peabody, MA 01960.

CIRCLE 144 ON FREE INFORMATION CARD

PRECISION TOOL CATALOG, *No. FL-979,* is a 24-page compact flier of tools designed for electronics, telecommunications, and aerospace for use in maintenance and production departments. The flier features over 500 various spring adjusters, tension and thickness gauges, burnishers, tool kits, and precision hand tools. It also shows a line of wire wrapping and unwrapping tools, and contact connector insertion and removal tools. Included is a price list of the products.—**Jonard Industries Corp.,** Precision Tools Dept., 134 Marbledale Rd., Tuckahoe, NY 10707.

CIRCLE 145 ON FREE INFORMATION CARD

MAGNETIC TAPES BOOKLET, *Sony Magnetic Tapes,* is a four-color 11-page brochure explaining different tape formulations and their recommended applications. It offers information on how the raw materials are selected and combined to create a variety of tape formulations and also explains how the tape, cassettes, reel transport mechanisms, and winding tension are prepared for final assembly. There are separate sections on each of the six types of tape which include cassettes, open reel, 8-track, microcassettes, and videotape cassettes. Complete technical information is provided for each tape, including length, bias and equalization settings, and frequency response. A selection chart is also offered.—**Sony Magnetic Tape Div., Sony Industries,** 9 W. 57th St., New York, NY 10019.

CIRCLE 146 ON FREE INFORMATION CARD

SWITCH BROCHURE, *Tini DW Multi-Switch Switches, NPB-349,* is a full-color 8-page brochure describing those subminiature switches with 10 and 15 mm centers. The brochure covers the basic-design features of the switch, plus the switching functions, material specifications, and terminations. Special features such as available pushbuttons and legends are also covered. These nonilluminated switches are used in analog and digital computers, analyzers, transmitters and receivers, and intercoms, and are available in up to 18 stations in a single row. Ordering information is included.—**Switchcraft, Inc.,** 5555 No. Elston Ave., Chicago, IL 60630.

CIRCLE 147 ON FREE INFORMATION CARD

CONNECTOR CATALOG, *Adapta-Con Catalog ACBP-6,* 18 pages, offers information on UBS and UBC series crimp contacts. The catalog contains 10 photographs and 30 drawings of the connectors and features standard information for material and finishes, mechanical features and electrical data. It also includes instructions on how to order unshrouded headers, which electrically connect rigid PC boards with UBC crimp housing or ribbon-cable socket connectors.—**ITT Cannon Electric,** 666 E. Dyer Rd., Santa Ana, CA 92702.

CIRCLE 148 ON FREE INFORMATION CARD

COMPONENTS AND TEST EQUIPMENT, *Catalog No. 21,* is a 30-page, 2-color catalog offering products from leading manufacturers. Included is a wide selection of IC's and transistors, along with a listing of their ECG equivalents. Other products offered are capacitors, tape heads, test cassettes, soldering equipment, wire and cable, lamps and fuses, LED's and crystals, power supplies, and test equipment that includes oscilloscopes, signal generators, and DMM's. Technical specifications for the products are provided along with pricing and ordering information.—**Ora Electronics,** 7241 Canby Ave., Reseda, CA 91335.

CIRCLE 149 ON FREE INFORMATION CARD

UHF & VHF RADIO MODULES CATALOG is a pocket-sized guide containing 24 pages of kits and assembled units for transmitting and receiving converters, FM receivers, receiver preamps, FM exciters, linear power amplifiers, adapters, test probes, and accessories. Photos, features, specifications, and connection diagrams are offered for the products. Pricing information and order form are included.—**Hamtronics, Inc.,** 65 Moul Rd., Hilton, NY 14468.

CIRCLE 150 ON FREE INFORMATION CARD

SHORTWAVE NEWS BULLETIN, the *DX Journal,* 32 pages, is a bi-monthly news bulletin devoted to the DX listening hobby, and contains technical and general interest articles. It includes news items from around the world and around the bands, a DX hotline, technical reviews, and equipment reports. Subscription price for one year is $7.00. Sample copy is $1.00.—**World Shortwave Listeners' Club,** 80 Hartsdale Ave., White Plains, NY 10605.

COMPUTER BOOKS CATALOG, 16 pages, is a fully illustrated catalog covering 61 titles on basic and advanced instructional books, dictionaries and reference works, plus books on language, programming and interfacing, technical circuitry, microcomputers, software debugging, computer graphics programming, and much more. Expanded descriptions are provided for these new titles—*Microcomputer Primer,* 2nd ed., the *Howard W. Sams Crash Course in Microcomputers,* and the *Computer Dictionary and Handbook.* Also included are *6502 Software Design, 8080/8085 Software Design,* and the *Computer Graphics Primer.* The catalog has alphabetical and numerical indices to the contents which helps speed its use, and also features a completely new authors' index in which 29 computer-book authors, their positions, education, and experience in the field are described.—**Howard W. Sams & Co., Inc.,** 4300 W. 62nd St., P.O. Box 558, Indianapolis, IN 46206.

CIRCLE 151 ON FREE INFORMATION CARD

COMPONENTS CATALOG, *Industrial Catalog No. 030,* 344 pages, features more than 75 product lines and provides complete descriptions, technical specifications, and pricing. Special emphasis is placed on test equipment which includes oscilloscopes, multimeters, frequency counters, generators, logic probes, VOM's, and many more. Other products covered include printed-circuit equipment, tools, transformers, semiconductors, resistors, capacitors, switches, relays, hardware, wire and cable, fuses and lamps, plus many others. The catalog also provides a 32-page technical-data handbook which includes the most frequently needed electronic tables, symbols, and formulas. Catalog is available for $2.00.—**Joseph Electronics, Inc.,** 8830 N. Milwaukee Ave., Niles, IL 60648.

THERMISTOR CATALOG, *Iso-Curve Catalog L-2B,* 16 pages, covers a line of standard Iso-Curve, R-T, Curve-Matched interchangeable thermistors. Specific technical data on the entire line is included. The catalog provides the latest thermistor state-of-the-art information on bead and glass probe interchangeable thermistors that are precision curve-matched to standard resistance temperature curves to an accuracy of within ±.25°C, ±0.5°C or ±1.0°C. Also offered are R-T tables for each standard unit, resistance tolerance vs. temperature tolerance curves, a temperature range and design configuration availability table, half-degree increment standard R-T temperature characteristic curves, a standard part number index for standard glass probes, miniprobes, standard bead, and small bead thermistors, typical *Iso-Curve* thermistor probe assemblies, and more.—**Fenwall Electronics,** Sales & Application Engineering Dept., 63 Fountain St., Framingham, MA 01701.

CIRCLE 152 ON FREE INFORMATION CARD

OSCILLOSCOPES, *Catalog No. 449-16,* is a 16-page bulletin featuring a line of portable oscilloscopes and includes instruments for a broad range of applications—from educational and service use to laboratory and digital circuit measurements. A description, photograph, and specifications are included for each instrument. Among the instruments detailed are 15-MHz dual trace and true dual-beam oscilloscopes, a 25-MHz scope with signal delay, a 30-MHz unit with variable trigger delay, and 60-MHz and 100-MHz scopes with third-channel trigger view and hold-off. Also described is the OS4000 digital-storage scope which features roll-mode viewing, T-Y and X-Y display, trigger-window control, and a 1K × 8-bit memory.—**Marketing Communications, Gould, Inc., Instruments Div.,** 3631 Perkins Ave., Cleveland, OH 44114.

CIRCLE 153 ON FREE INFORMATION CARD

TEST-EQUIPMENT CATALOG, *Electronic Measurement Instrumentation,* is an 86-page guide that offers background and technical information and selection guides for different types of test instruments including digital multimeters, electrometers, picoammeters, nanovoltmeters, voltage and current sources, milliohmmeters, and test systems. Various models in each group are described, along with photographs, main features, and technical specifications. Various accessories are also described. Included is a model number and product-description index.—**Keithley Instruments, Inc.,** 28775 Aurora Rd., Cleveland, OH 44139.

CIRCLE 154 ON FREE INFORMATION CARD

ELECTRONICS ACCESSORIES, *Catalog C-29,* is an attractive 44-page two-color guide covering a number of electronics products, along with descriptions, specifications, and illustrations. Items covered include couplers, telephone accessories, personal communications equipment, audio connectors and cables, automotive speakers, multitesters, power supplies, phono cartridges, and many more. Featured are UHF/VHF/CATV/MATV amplifiers, UHF/VHF hybrid splitters, 2- and 3-way crossover networks, electret microphones, and a 2-channel wireless FM intercom system.—**Vidaire Electronics Mfg. Corp.,** 150 Buffalo Ave., Freeport, NY 11520.

CIRCLE 155 ON FREE INFORMATION CARD

HAM ANTENNA CATALOG, *Hygain,* 24 pages, covers over 100 base and mobile antennas, towers, rotators, microphones, headphones, boom mic headsets, and accessories for the amateur radio operator. Featured are a full line of desk and hand microphones, the HDR-300 antenna rotator and a series of seven crank-up antenna towers. Illustrations and detailed specifications on all products are offered, including SWR curves on all base antennas.—**Telex Communications, Inc.,** 9600 Aldrich Ave. So., Minneapolis, MN 55420. **R-E**

CIRCLE 156 ON FREE INFORMATION CARD

CIRCLE 28 ON FREE INFORMATION CARD

CIRCLE 61 ON FREE INFORMATION CARD

RF GENERATOR

continued from page 69

Finish up this half of the board by installing the IC's. Orient them as shown in Fig. 11. Install the MC1648's first, at IC201, IC202, and IC203. Then install a 74LS00 at IC204, and a 74LS90 at IC205.

Take a breather at this point; then carefully check your work. Correct any mistakes you find before going any farther.

Now for the rest of the board. Start with the voltage regulator IC's. Install an LM317T at IC207 with the tab to the right. Then mount a 7805 (LM340T-5) at IC206. Note that this IC mounts flat against the board, and that no heatsink is required. Use 4-40 hardware to fasten it in place before you solder the leads.

Next mount the rest of the capacitors. Use extra care with them because there are quite a few, and they can wind up in the wrong places. Start by installing a 1000-μF electrolytic at C216. The "+" lead goes nearest D216. Then install two 0.01-μF capacitors at C217 and C218. Move up and install a 10-μF electrolytic at C228, and a 0.1-μF disc beside it at C226. Install another 0.1-μF capacitor at C229. Then move up a bit and install a 0.01-μF capacitor at C227. After that install a 1-μF electrolytic at C225, just above. Note that its positive side is to the right. Three 0.01-μF disc capacitors come next. Install one at C224, another at C222, and the remaining one at C220. Continue with two 0.1-μF capacitors; one goes at C221 and the other at C223. Finish up by installing a 15-pF unit at C219.

Now, more diodes. First, there are seven 1N4002 rectifiers for the power supply. Install them as indicated at D210 through D216. Then install two more 1N4002's at D219 and D220. *Be careful not to install D219 in D217's place!* Mount the two 1N5231 Zeners as indicated at D217 and D218.

The resistors come next. Install 1K resistors at R213 and R214. Next, install 470-ohm resistors at R216 and R215. Move down the board a bit and install 2.7K resistors at R217 and R218. Then install a 100K unit at R219. Continue by installing a 47-ohm, *2-watt* resistor at R224. Note that this must be a carbon composition type, and not wirewound. If you use a wirewound type the RF output will be erratic. Below R224 install a 4.7K resistor at R221, a 1K resistor at R222, and a 10-ohm resistor at R225. Finish up by installing a 680-ohm resistor at R223 near the LM317-T, and a 470-ohm one at R220.

The last component to be installed is a transistor. Install a 2N2219 at Q207 and slip a small TO-5 heatsink over it.

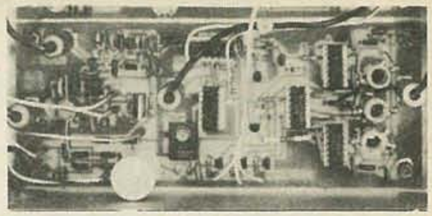

FIG. 12—A HEAT SINK must be used on Q207 (lower left). Also note that IC206 (7805) is secured to the board with 4-40 hardware.

Carefully check your work. Make sure that the diode and electrolytic capacitor polarities are right, and correct any errors you find. The assembled VCO board is shown in Fig. 12.

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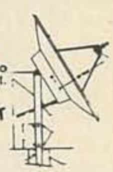

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MICROWAVE television "downconverters" under $50.00. High quality, easily assembled. Catalog: $2.00 (refundable). **NDS,** Box 12652-R, Dallas, 75225

MUSICAL HORN

continued from page 58

switch should be a normally-open type. If you use a speaker rated at less than 10 watts, see Table 1 for the series resistor to use. If you're not sure of the speaker rating, use a 39-ohm, 2-watt resistor to be safe. Bear in mind that driving a 10-watt horn speaker with no resistor provides the loudest, most directional, sound.

Be particularly careful about the power connections. Use fairly heavy leads, and make sure that the positive side of the power source is connected to the positive-input lead. The power source should be 12 volts, capable of providing over 1 ampere of current. That means a 12-volt car battery or heavy-duty power supply!

Troubleshooting

If you don't get a melody, disconnect the board from the power source and remove the song PROM, IC9. Now reapply power, press S1, and you should hear a steady tone. If not, check your connections and the polarities of the diodes and capacitors, make sure the correct components are in the correct locations, and make sure that Q1 is inserted correctly. Next verify the orientation of all IC's—and check for bent-under pins. Defective IC's are rare, but they may be checked most easily by substitution, if no other problems are found.

Packaging

This unit is intended to be used in a vehicle, drawing power from the vehicle battery. No power is drawn except when switch S1 is held down. The unit should be installed in a plastic case under your dashboard (**not** in the engine compartment) with the potentiometers, speaker jack and switch on the cover, and a power supply jack on the side, for example. Use a 3-amp fuse in the power leads, and use heavy wire for the leads and speaker connections. Mount the speaker somewhere behind the vehicle's grille. **R-E**

HINTS & TIPS

continued from page 71

guns have a small delicate tip suitable for working around IC's and other tiny components. What you really need is a soldering iron with two temperature settings: one for regular use; the other an "idle" setting that keeps the iron warm but won't allow it to overheat. No doubt there are a number of those on the market, but half the fun of doing it yourself is not to spend all that money.

The circuit shown in Fig. 4 changes any AC soldering iron into a two-setting, switch-selectable soldering "tool." All of the parts are available from your local electronics dealer, or you just may have them already in your junk-box. There's nothing really critical about the circuit or the components: a cord assembly to bring 117 volts AC in, a diode that rectifies the 117 volts. AC

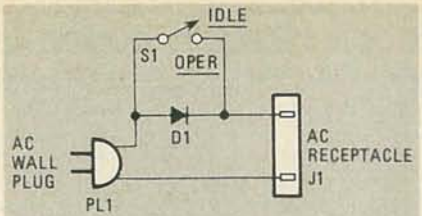

FIG. 4—ADD a STANDBY or WARM setting to almost any AC soldering iron with this circuit.

PARTS LIST—IRON IDLER

- D1—1N5404, 400 PIV, 3 amps (Radio Shack 276-1144 or equivalent)
- S1—SPST switch (Radio Shack 275-612 or equivalent)
- PL1—AC plug
- J1—AC chassis-mount socket (Radio Shack 270-642 or equivalent)

Miscellaneous: Small case, line cord, hardware, etc.

into pulsating DC at a lower effective voltage, a chassis mount AC receptacle to plug the soldering iron into, and a switch. With S1 open as shown in the schematic, pulsating DC is sent to the soldering iron, keeping it warm but not allowing it to reach full operating temperature.

When S1 is closed, the diode is bypassed and full-line voltage reaches the soldering iron, which heats up to full temperature and is ready to use in a matter of seconds. You might want to get fancy and use a leaf-switch for S1. When the iron is lying across it, the diode is in circuit, and when the iron is lifted, the diode is bypassed. No matter how simple or fancy you make that circuit, you will find it helpful in your work or hobby.

Hints, kinks, and tips are all great and useful, but in closing, I'll share a secret with you—one which has been of immeasurable assistance to me for years: KISS (*K*eep *I*t *S*imple, *S*tupid)! Don't try to reinvent the wheel; the best ideas are the simple ones. **R-E**

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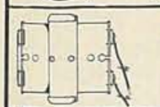

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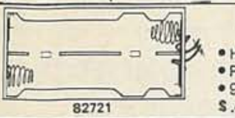

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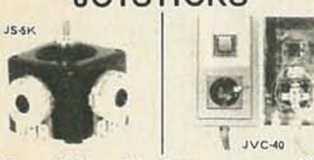

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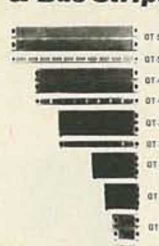
Quick Test Sockets & Bus Strips



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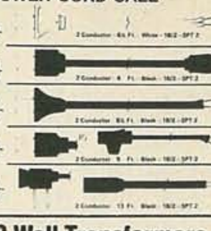

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Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
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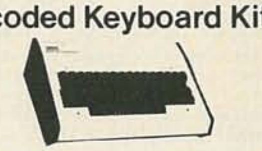
★ Documentation for Conversion

TRS-16K2 *150NS $29.95
TRS-16K4 *250NS $24.95

JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and –12V @ 10 mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14¾"W x 8¾"D

JE610/DTE-AK (After assembled as pictured above) ...$124.95
JE610 Kit 62-Key Keyboard, PC Board, & Components (no case)....$ 79.95
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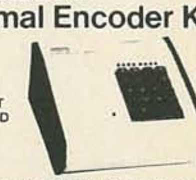
DTE-AK (case only – 3¾"Hx11"Wx8¾"D)$ 49.95

NEW! JE212 – Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT
Provides -12VDC from incoming 5VDC . . $9.95

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD



The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¾"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) $99.95
JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) . . $59.95
K19 19-Key Keyboard (Keyboard only) $14.95
DTE-HK (case only – 3½"Hx8¾"Wx8¾"D) $44.95

CIRCLE 2 ON FREE INFORMATION CARD

7400

SN7400N	.25	SN7472N	.29	SN74156N	.79
SN7401N	.20	SN7473N	.35	SN74157N	.69
SN7402N	.25	SN7474N	.35	SN74160N	.89
SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.25	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
SN7407N	.35	SN7482N	.99	SN74165N	.89
SN7408N	.29	SN7483N	.69	SN74166N	1.25
SN7409N	.29	SN7485N	.89	SN74167N	2.79
SN7410N	.25	SN7486N	.35	SN74170N	1.95
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	SN74104N	.89	SN74184N	2.49
SN7426N	.29	SN74105N	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74186N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
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SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	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	74LS196	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.35	74LS112	.45	74LS240	1.49
74LS09	.35	74LS113	.49	74LS241	1.49
74LS10	.35	74LS114	.49	74LS242	1.49
74LS11	.39	74LS122	.89	74LS243	1.49
74LS12	.35	74LS123	1.25	74LS244	1.49
74LS13	.59	74LS125	.89	74LS245	2.95
74LS14	.99	74LS126	.59	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
74LS20	.35	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.49	74LS251	.99
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.69
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.35	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	.89	74LS273	1.95
74LS33	.59	74LS156	.89	74LS279	.89
74LS37	.45	74LS157	.89	74LS283	.89
74LS38	.39	74LS158	.89	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	1.15	74LS365	.69
74LS51	.35	74LS165	1.15	74LS366	.69
74LS54	.35	74LS168	1.15	74LS367	.69
74LS55	.35	74LS169	1.19	74LS368	.69
74LS73	.45	74LS170	1.95	74LS373	1.95
74LS74	.45	74LS173	.99	74LS374	1.95
74LS75	.59	74LS174	.99	74LS375	.89
74LS76	.45	74LS175	.99	74LS386	.69
74LS78	.49	74LS181	2.95	74LS393	2.49
74LS83	.89	74LS190	1.25	74LS399	2.49
74LS85	1.25	74LS191	1.25	74LS670	2.49
74LS86	.49			81LS95	1.95
74LS90	.69			81LS97	1.95

74S

74S00	.45	74S124	3.95	74S243	3.25
74S02	.45	74S133	.55	74S244	3.25
74S03	.45	74S134	.69	74S251	1.45
74S04	.55	74S135	1.19	74S253	1.45
74S05	.55	74S136	1.75	74S257	1.35
74S08	.50	74S138	1.35	74S258	1.35
74S09	.50	74S139	1.35	74S260	.79
74S10	.45	74S140	.79	74S280	2.95
74S11	.45	74S151	1.35	74S287	3.25
74S15	.45	74S153	1.35	74S288	2.75
74S20	.45	74S157	1.35	74S373	3.49
74S22	.45	74S158	1.35	74S374	3.49
74S30	.45	74S160	2.95	74S387	2.95
74S32	.55	74S174	1.59	74S471	19.95
74S38	1.25	74S175	1.59	74S472	10.95
74S40	.50	74S188	2.95	74S473	10.95
74S51	.45	74S194	1.95	74S474	12.95
74S64	.50	74S195	1.95	74S475	12.95
74S65	.50	74S196	1.95	74S570	5.95
74S74	.75	74S240	2.95	74S571	5.95
74S86	.79	74S241	2.95	74S572	9.95
74S112	.79	74S242	3.25	74S573	9.95
74S113	.79			74S940	3.15
74S114	.79			74S941	3.15

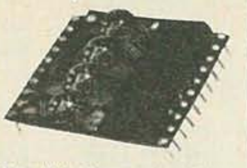
CA—LINEAR

CA3010H	.99	CA3060N	3.25	CA3089N	3.75
CA3013H	2.15	CA3080H	1.25	CA3096N	3.95
CA3023H	3.25	CA3081N	2.00	CA3130H	1.39
CA3035H	2.49	CA3082N	2.00	CA3140H	1.25
CA3039H	1.35	CA3083N	1.60	CA3160H	1.25
CA3046N	1.30	CA3086N	.85	CA3401N	.59
CA3059N	3.25			CA3600N	3.50

CD—CMOS

CD4000	.39	CD4041	1.49	CD4098	2.49
CD4001	.39	CD4042	.99	CD4506	.75
CD4002	.39	CD4043	.89	CD4507	.99
CD4006	1.19	CD4044	.89	CD4508	3.95
CD4007	.25	CD4046	1.79	CD4510	1.39
CD4009	.49	CD4047	2.50	CD4511	1.29
CD4010	.49	CD4048	1.35	CD4512	1.49
CD4011	.39	CD4049	.49	CD4514	3.95
CD4012	.25	CD4050	.69	CD4515	2.95
CD4013	.49	CD4051	1.19	CD4516	1.49
CD4014	1.39	CD4052	1.19	CD4518	1.79
CD4015	1.19	CD4053	1.19	CD4519	.89
CD4016	.59	CD4056	2.95	CD4520	1.29
CD4017	1.19	CD4059	9.95	CD4526	1.79
CD4018	.99	CD4060	1.49	CD4528	1.19
CD4019	.49	CD4066	.79	CD4529	1.95
CD4020	1.19	CD4068	.39	CD4543	2.79
CD4021	1.39	CD4069	.45	CD4562	11.95
CD4022	1.19	CD4070	.55	CD4566	2.79
CD4023	.29	CD4071	.49	CD4583	2.49
CD4024	.79	CD4072	.49	CD4584	.75
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	CD4082	.39	MC14412	11.95
CD4034	3.49	CD4093	.99	MC14419	4.95
CD4035	.99			MC14433	13.95
CD4040	1.49			MC14538	2.49
				MC14541	1.95

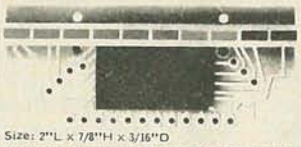
4-Digit 16 Segment Alphanumeric Intelligent Display with Memory, Recorder, Driver



End-stackable, 4-character package. High contrast, 160mil high, magnified monolithic characters. 64-Character ASCII format. Built-in memory, decoder, multiplexer and drivers. Direct access to each digit independently and asynchronously. Five volt logic, TTL compatible. Five volt power supply only. Independent cursor function. Size: 1"L x 1-3/16"H x .225"D.

DL-1416 Alphanumeric Display **$19.95 ea.**

10-Segment Bargraph Displays
(with On-Board Driver IC-Chip)



Size: 2"L x 7/8"H x 3/16"D

Bar or dot display mode externally selectable by user. Packages are end-stackable for expanded displays. Can be cascaded to 10 arrays (100 bargraph elements). LED current programmable from 2mA to 30mA. Stable internal voltage reference for full scale analog inputs from 1.2 to 12V. Each LED output of driver IC with external access. Size: 2"x7/8"x3/16".

NSM3914	Linear Function (10 bars red)	$5.95
NSM39146	Linear Function (6 bars green/4 red)	6.95
NSM3915	Logarithmic Function (10 bars red)	5.95
NSM39158	Logarithmic Func. (6 grn./2 yell./2 rd.)	6.95
NSM3916	VU-Meter Function (10 bars red)	5.95
NSM39168	VU-Meter Func. (6 grn./2 yell./2 rd.)	6.95

DISCRETE LEDS

XC556R	.200"	red	5/$1	MV50	.085"	red	6/$1
XC556G	.200"	green	4/$1	XC209R	.125"	red	5/$1
XC556Y	.200"	yellow	4/$1	XC209G	.125"	green	4/$1
XC556C	.200"	clear	4/$1	XC209Y	.125"	yellow	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

.200(T1¾) Red/Green

Diffused Bi-Color LED

Part No.	1-99	100+
XC5491	.79	.69

XC556 RED LED, METAL MTG. HDW. 2-4" LEADS.

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

DISPLAY LEDS

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

Type	Polarity	Ht	Price	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	.99	DL728	C.C.—red	.500	1.49
MAN 54	C.C.—green	.300	.99	DL741	C.A.—red	.600	1.25
MAN 71	C.A.—red	.300	.75	DL747	C.A.—red	.600	1.49
MAN 72	C.A.—red	.300	.75	DL750	C.C.—red	.600	1.49
MAN 74	C.C.—red	.300	1.25	DLO847	C.A.—orange	.800	1.49
MAN 82	C.A.—yellow	.300	.49	DLO850	C.C.—orange	.800	1.49
MAN 84	C.C.—yellow	.300	.99	DL33B	C.C.—red	.110	.35
MAN 3620	C.A.—orange	.300	.49	FND358	C.C. ± 1	.357	.99
MAN 3630	C.A.—orange ± 1	.300	.99	FND357	C.C.	.357	.75
MAN 3640	C.C.—orange	.300	.99	FND500	C.C. (FND503)	.500	.99
MAN 4610	C.A.—orange	.400	.99	FND507	C.A. (FND510)	.500	.99
MAN 6610	C.A.—orange—DD	.560	.99	HDSP-3401	C.A.—red	.800	1.50
MAN 6630	C.A.—orange ± 1	.560	.99	HDSP-3403	C.C.—red	.800	1.50
MAN 6640	C.C.—orange—DD	.560	.99	HDSP-3406	C.C. red ±1	.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	1.25
MAN 6710	C.A.—red—DD	.560	.99	5082-7300	4x7 Numeric (RHD)	.600	22.00
MAN 6740	C.C.—red—DD	.560	.99	5082-7302	4x7 Numeric (LHD)	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7340	4x7 Hxdcl. (0-9/A-F)	.600	22.50
DLO304	C.C.—orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.69
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

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* G.F. PSF Plastic Body
* For testing IC's

* 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

1/4 WATT RESISTOR ASSORTMENTS – 5%

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

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INTERSIL

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	24.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
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
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

74C00	.39	74C95	1.59	74C221	1.95
74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	2.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.69	74C901	.69
74C20	.39	74C161	1.60	74C903	.69
74C30	.39	74C162	1.49	74C911	10.95
74C42	1.39	74C163	1.69	74C912	10.95
74C48	1.95	74C164	1.59	74C915	1.69
74C73	.79	74C173	1.39	74C917	10.95
74C74	.79	74C174	1.39	74C922	5.49
74C85	1.95	74C175	1.19	74C923	5.75
74C86	.99	74C192	1.69	74C925	7.50
74C89	6.95	74C193	1.69	74C926	7.50
74C90	1.29	74C195	1.59	80C95	.79
74C93	1.29			80C97	.79

LINEAR

LH0002CN	6.85	LM340T-5	1.25	LM702H	.79
LM10CLH	4.50	LM340T-12	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-15	1.25	LM709N	.29
LH0070-OH	4.95	LM341P-5	.75	LM710N	.79
TL071CP	.79	LM341P-12	.75	LM711N	.79
TL072CP	1.39	LM341P-15	.75	LM723N	.69
TL074CN	2.49	LM342P-5	.69	LM733N	1.00
LH0082CD	35.80	LM342P-12	.69	LM739N	1.19
TL082CP	1.19	LM342P-15	.69	LM741CN	.35
TL084CN	2.19	LM348N	1.25	MC1741SCG	3.00
LH0094CD	36.80	LM350K	5.75	LM747N	.79
LM300H	.99	LF351N	.60	LM748N	.59
LM301CN	.35	LF353N	1.00	LM1014N	2.75
LM302H	1.95	LF355N	1.10	LM1310N	1.95
LM304H	1.95	LF356N	1.10	LM1458CN	.59
LM305H	.99	LM358N	1.00	LM1488N	1.25
LM307CN	.45	LM359N	1.79	LM1489N	1.25
LM308CN	1.00	LM370N	4.49	LM1496N	1.95
LM309H	1.95	LM373N	3.25	LM1556V	1.75
LM309K	1.25	LM377N	2.95	LM1800N	2.95
LM310CN	1.75	LM380N	1.25	LM1871N	5.49
LM311/CN	.90	LM381N	1.95	LM1872N	5.49
LM312H	2.49	LM382N	1.79	LM1877N-9	3.25
LM317MP	1.15	LM384N	1.95	LM1889N	3.20
LM317T	1.75	LM386N-3	1.29	LM1896N	1.75
LM317K	3.95	LM387N	1.45	LM2002T	1.49
LM318CN	1.95	LM389N	1.35	LM2877P	2.05
LM319N	1.95	LM392N	.69	LM2878P	2.25
LM320K-5	1.35	LF398N	4.00	LM2896P-1	2.25
LM320K-12	1.35	LM399H	5.00	LM3189N	2.95
LM320K-15	1.35	TL494CN	4.49	LM3900N	.69
LM320T-5	1.25	TL496CP	1.75	LM3905CN	1.25
LM320T-12	1.25	NE510A	6.00	LM3909N	1.15
LM320T-15	1.25	NE529A	4.95	LM3914N	3.95
LM323K	5.95	NE531H	3.95	LM3915N	3.95
LM324N	.99	NE536H	6.00	LM3916N	3.95
LM329DZ	.65	NE540H	6.00	RC4136N	1.25
LM331N	3.95	NE544N	4.95	RC4151NB	3.95
LM334Z	1.30	NE550A	1.30	RC4194TK	6.95
LM335Z	1.40	NE555V	.39	RC4195TK	5.49
LM336Z	1.75	LM556N	.99	LM4500A	3.25
LM337T	1.95	NE564N	3.95	ICL8038B	4.95
LM337MP	1.15	LM565N	1.25	LM13080N	1.29
LM338K	6.95	LM566CN	1.95	LM13600N	1.49
LM339N	.99	LM567V	1.25	75138N	1.95
LM340K-5	1.35	NE570N	4.95	75450N	.89
LM340K-12	1.35			75451CN	.39
LM340K-15	1.35			75492	.89

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

.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

.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

CIRCLE 2 ON FREE INFORMATION CARD

ANALOG REVERB

continued from page 48

might be the case if bipolar transistors were used), and this configuration serves to split the power dissipation between the transistors and increases the transconductance (gain).

The power supplies for this unit are somewhat unusual. A separate supply is used for the power amplifier. This 25-volt supply (V_A) is formed by D3, D4, and C29 in a simple full-wave rectified unregulated supply. Since this voltage may drop considerably when driving a speaker at high levels, separate rectifiers and filter capacitors are provided for the main supply (V_{CC}). This supply is regulated by IC12 to +18 volts.

It was found that using split supplies for the op-amps introduced excessive noise—any variation in the positive supply appeared at the outputs of the op-amps along with the signal. To eliminate this problem, an artificial "AC ground" was created that closely tracks V_{CC}. That artificial AC-ground serves two purposes. First, it is used as the ground reference for the input signal. Second, by connecting it to the "unused" input of the op-amps, it cancels the variations originally induced by V_{CC}.

The AC ground is generated by a resistor divider-network, R73 and R74, and applied to op-amp IC9-b. The ground is coupled closely to V_{CC} by capacitor C31. Integrated circuit IC9 is a 5532 dual op-amp, used because of its high drive-current and its high slew-rate; it reduces voltage variations much better than a voltage-regulator IC.

You should note that there is a possibility for confusing the input and output grounds. The input should be grounded to "AC ground." This provides minimum noise and is most consistent with the rest of the circuit. If the output is used to drive another amplifier or other electronic device, care must be taken because AC ground is the output of an op-amp, and only about 30 mA can be drawn from this supply.

Because of this situation, direct connection to a speaker is made to the negative supply, V_{EE}, which is 10 volts below AC ground. *The loudspeaker ground must remain isolated from the AC ground or the supply will short out!* (This will cause no damage, but *will* result in silence. The 5532 is fully protected against such abuse.)

The last circuit we will discuss is the one for clocking the bucket brigades. The NE556-1 (IC10) is a dual 555 timer configured in the astable (oscillator) mode. The clock signal for the main delay-line (IC3, IC4, and IC5) is produced by IC10-a and the clock signal for the feedback delay-line (IC8) is produced by IC10-b. The frequencies are determined by the values of capacitor C32 for IC10-a and C33 for IC10-b, and by the current available to charge them.

Instead of using resistors to develop charge-current, transistors Q7 and Q8 provide the currents directly. These currents are adjusted by potentiometers R64 (FEEDBACK DELAY) and R66 (DELAY). The outputs of the 556 are applied to IC11, a dual-D flip flop. The flip-flop converts the pulse outputs from the 556 to square waves of one-half the original frequency. The availability of both Q and Q outputs provides the out-of-phase square wave clock-signals needed for the bucket-brigade devices.

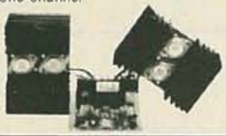
Now that you know how the Analog Reverberation Unit works, you probably want to know how to build one. We'll show you when we continue this article next month. **R-E**

100W CLASS A POWER AMP KIT

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

Specifications:

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



TA-1000 KIT $51.95
Power transformer $18.00 each

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

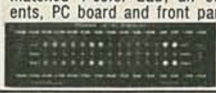
Pre assembled units. All you need is to hook up the speaker and the volume control. Supply voltage from 9~15V D.C. measures only 2" x 3½", making it good for portable or discrete applications. Comes with hook up data.

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!

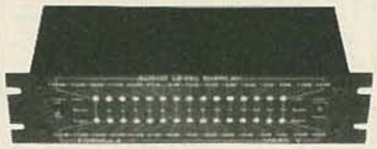
Kit includes 70 pcs. driver transistors, 38 pcs. matched 4-color LED, all other electronic components, PC board and front panel.



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

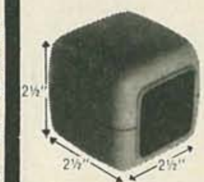
SPECIAL 0.5" LED SALE ALARM CLOCK MODULE

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)

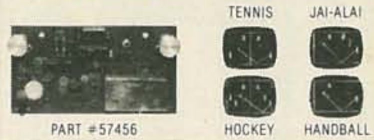
BUY 3 FOR ONLY $2.50

TV GAME BOARD

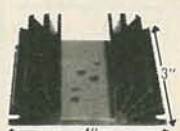
PLAYS 4 GAMES: TENNIS; HOCKEY; HANDBALL AND JAI-ALAI.

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



MULTI-FINS HEAT SINK



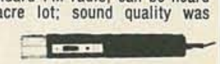
Ideal for high power output. Holes predrilled for 1 to 3 transistor. Made of aluminum with ten radiating fins.

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

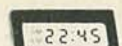
Pre-Drilled PC Board			$17.50
Tolriod Coils (Set of 4)			$ 3.00
Multi Turn Trim-Pots 10K ohm			$ 2.50
Trimmer Capacitor 6-35pF			$ 0.60
MC1358	$ 2.50	RC1458	$ 1.00
MC1350	$ 2.00	LM380	$ 1.80
MC1330	$ 3.50	LM340T-15	$ 1.20
		NE565	$ 2.00

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

CIRCLE 4 ON FREE INFORMATION CARD

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED
Lights up 8 ~ 15 Watt Fluorescent Light Tubes. Ideal for camper, outdoor, auto or boat. Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!

With Case Only $6.50 Per Kit

SUPER FM WIRELESS MIC KIT — MARK III

This new designed circuit uses high FEQ. FET transistors with 2 stages pre amp. Transmits FM Range (88-120 MHz) up to 2 blocks away and with the ultra sensitive condenser microphone that comes with the kit, allows you to pick up any sound within 15 ft. away! Kit includes all electronic parts, OSC coils, and P.C. Board. Power supply 9V D.C.

FMC-105
$11.50 PER KIT

PRESS-A-LIGHT SELF GENERATED FLASHLIGHT

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

Never worry about battery, because it has none! Easy to carry in pocket and handy to use. Ideal for emergency light. It generates its own electricity by squeezing grip lever. Put one in your car, boat, camper or home. You may need it some time!

ELECTRONIC DUAL SPEAKER PROTECTOR

Cut off when circuit is shorted or over load to protect your amplifier as well as your speakers. A must for OCL circuits.

KIT FORM
$8.75 EA.

"FISHER" 30 WATT STEREO AMP

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

Super Buy Only $18.50

SPACE WAR SOUND GENERATOR BOARD

Brand new preassembled module for a toy factory. The board gives out 6 different selectable space sound with LED light effect. Sounds include UFO take-off, space gun blast, wave, and space chime. 7 LED on the board will work with the sound. Requires 9V battery to operate. Speaker not included.
SPECIAL **$3.99** EACH SPEAKER **$1.25** EACH

ELECTRONIC PIEZO BEEP BUZZER

Unique surplus ⅞" Dia. piezo ceramic disc on circuit board gives a distinct high freq. buzz. Unit contains an I.C., 2 caps, 6 resistors and is already preassembled. Requires 9V battery to operate.
SPECIAL 2 FOR **$2.99**

2 BIT COUNTER, WARBLE PULSE ALARM BOARD

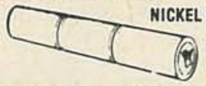
This new assembly easily converts to a counter, stop watch, warble and pulse alarm generator by adding a few components. We supply the data and typical applications. Requires 9V battery to operate.
SPECIAL 2 FOR **$1.99**

AUDIO OUTPUT dB METER

Meter made of clear plastic with a silver white face plate. Scale reads from −20 +3dB. Meter also comes with an internal dial light.
MODEL: 6F-3
$6.50 EACH

BATTERIES

PK/$10.00
2 PKS/$19.00
ILLUSTRATED LESS COVER



NICKEL CADMIUM BATTERY PACK 'D' SIZE

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

9V RECHARGEABLE NI-CD BATTERY

Replace all 006P type 9V battery
Model: GC9
BRAND NEW $4.50 EACH

NI-CD BATTERY SALE

12V Pack 450 MZ/HR Size 3" x 1" x 2"
$8.00 PER PACK
4 AA Pack 450 MA/HR
$3.50 PER PACK
All above batteries are used but late date code and we guarantee to take back all bad ones for exchange.

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

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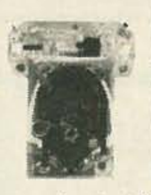
ELECTRONIC PIN BALL MACHINE



That sounds and plays like the real thing. All units are brand new but without the case Functions of the game include double flipper control, kicker control, 1-4 players, 3 speed ball control, tilt switch, automatic score, extra bonus cave and many more. All solid state with LED panel, no moving parts. Requires 9V battery to operate, speaker not included.
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Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver. All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operates by 9-12 DC. **$15.50**

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KEY 330

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

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All parts completed on a PC Board SCR will turn on relay, buzzer or trigger other circuit for 2 - 10 sec. (adjustable). Ideal for use as door alarm, sound controlled toys and many other projects. Supply voltage 4.5V 9V D.C.
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±4 30V DC 800 MA adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator I.C.

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Transmitter: FET mic for flat 30~18 KHz response extra controlled 49 MHz AM Band for drift-free performance. 100 MW output (range approx. ¼ mile) for reliable long range transmission. Powered by a 9V radio battery (included).
Receiver: Extra controlled locks on 49 MHz transmitter signal. With on panel VU meter monitors the signal strength from the microphone. Standard phone jack outlet connection to a P.A. or other phone input. 9V battery included. This professional set is ideal for on stage, in field, church, in house or outdoor use.

POWER SUPPLY KIT

0-30V D.C. REGULATED
Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts.

Transformer for Power Supply, 2 AMP 24V x 2 **$8.50**
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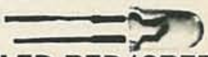

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BIPOLAR LED RED/GREEN

2 colors in one LED, green and red, changes color when reverse voltage supply. Amazing!
2 FOR $2.20

ELECTRONIC SWITCH KIT

CONDENSER TYPE
Touch On Touch Off uses 7473 I.C. and 12V relay
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Incorporates brand-new D.C. design that gives a frequency response from 0Hz — 100KHz ±0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuation!
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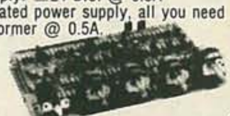
Kit comes with regulated power supply, all you need is a 48V C.T. transformer @ 0.5A.



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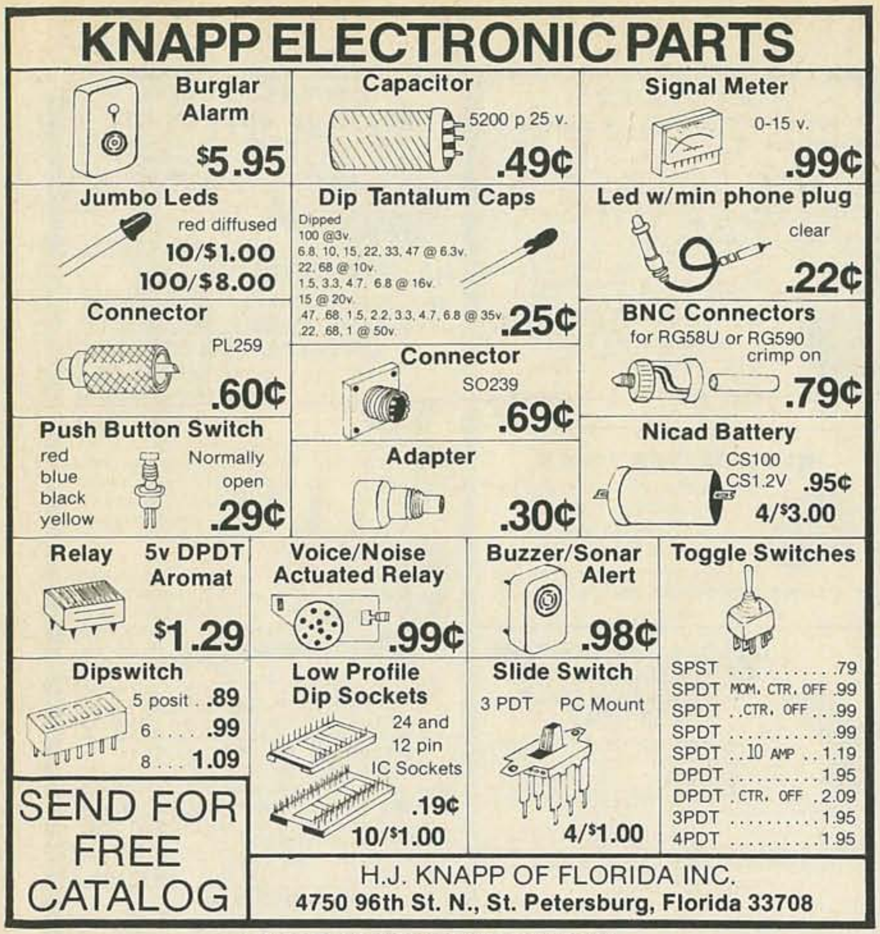

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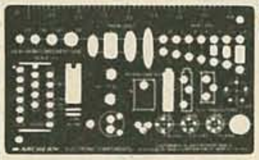

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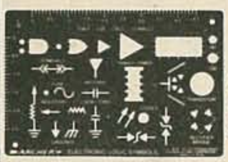
Symbols Template



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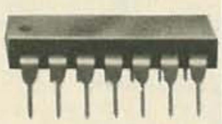

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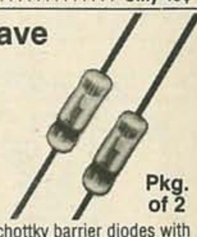
Microwave Diodes



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14	19	36	59
16	20	38	62
18	24	59	84
20	29	69	99
22	24	79	1.10
24	35	.85	1.20
28	43	1.10	1.49
36	58	1.25	1.69
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FND508	500	Red	Comm. Anode (+1)	99
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FND550	500	Orange	Comm. Cathode	149
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FND807 (810)	800	Red	Comm. Anode	175
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HP5082-7300	600	Red	4 x 7 Sgl. Digit RHD	18.95
HP5082-7731	300	Red	Comm. Anode	75
TIL305	–	Red	Array 5 x 7	795
TIL308	270	Red	Numerical Display	10.95
TIL309	270	Red	Numerical Display	9.95
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XAN3062	300	Red	Comm. Anode Left DP	125
XAN3063	300	Red	Overflow, CA, Left DP	125
XAN3064	300	Red	Comm. Cathode Right DP	125
XAN3051	300	Green	Comm. Anode Right DP	199
XAN3052	300	Green	Comm. Anode Left DP	199
XAN3053	300	Green	Overflow CA, Left DP	199
XAN3054	300	Green	Comm. Cathode, Right DP	199
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SN7416N	.29	SN74151N	.67
SN7417N	.29	SN74152N	.67
SN7420N	.22	SN74153N	.67
SN7421N	.35	SN74154N	1.19
SN7422N	.29	SN74155N	.78
SN7423N	.29	SN74156N	.78
SN7425N	.29	SN74157N	.69
SN7426N	.29	SN74158N	1.65
SN7427N	.25	SN74160N	.88
SN7429N	.45	SN74161N	.88
SN7430N	.23	SN74162N	.89
SN7432N	.29	SN74163N	.87
SN7437N	.25	SN74164N	.87
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SN7439N	.29	SN74166N	1.20
SN7440N	.19	SN74167N	1.95
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SN7442N	.57	SN74172N	4.75
SN7443N	.95	SN74173N	.79
SN7444N	.95	SN74174N	.89
SN7445N	.79	SN74175N	.85
SN7446N	.79	SN74176N	.75
SN7447N	.65	SN74177N	.75
SN7448N	.79	SN74179N	1.34
SN7450N	.19	SN74180N	.75
SN7451N	.19	SN74181N	1.75
SN7453N	.19	SN74182N	.75
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SN7472N	.29	SN74190N	1.15
SN7473N	.34	SN74191N	1.15
SN7474N	.34	SN74192N	.85
SN7475N	.38	SN74193N	.85
SN7476N	.34	SN74194N	.85
SN7479N	4.60	SN74195N	.68
SN7480N	.49	SN74196N	.85
SN7482N	.95	SN74197N	.85
SN7483N	.55	SN74198N	1.39
SN7485N	.65	SN74199N	1.39
SN7486N	.35	SN74221N	1.19
SN7489N	1.75	SN74251N	.95
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SN7492N	.45	SN74283N	1.40
SN7493N	.45	SN74284N	3.90
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SN7495N	.65	SN74290N	1.25
SN7496N	.69	SN74298N	.95
SN7497N	2.90	SN74365N	.68
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SN74107N	.32	SN74367N	.68
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CD4018	.89	CD4510	1.19
CD4019	.45	CD4511	1.19
CD4020	1.10	CD4512	1.39
CD4021	1.19	CD4515	2.75
CD4022	1.15	CD4516	1.45
CD4023	.29	CD4518	1.39
CD4024	.75	CD4520	1.25
CD4025	.25	CD4555	4.95
CD4027	.65	CD4556	.99
CD4028	.85	CD4566	2.25
CD4029	1.29	74C00	.35
CD4030	.45	74C02	.35
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CD4032	2.15	74C08	.35
CD4034	3.25	74C10	.35
CD4035	.95	74C14	.72
CD4037	1.95	74C20	.35
CD4040	1.29	74C30	.35
CD4041	1.25	74C32	.99
CD4042	.95	74C42	1.35
CD4043	.85	74C48	1.89
CD4044	.85	74C73	.75
CD4046	1.75	74C74	.75
CD4047	1.25	74C85	1.79
CD4048	.99	74C89	5.95
CD4049	.45	74C90	1.19
CD4050	.69	74C93	1.19
CD4051	1.10	74C95	1.49
CD4052	1.10	74C107	1.19
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CD4066	.75	74C163	1.65
CD4069	.35	74C164	1.55
CD4070	.49	74C173	1.35
CD4071	.35	74C174	1.35
CD4072	.35	74C175	1.35
CD4073	.35	74C192	1.65
CD4075	.35	74C193	1.65
CD4076	1.29	74C195	1.55
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74LS01N	.28	74LS165N	.89
74LS02N	.28	74LS166N	2.48
74LS03N	.28	74LS168N	1.15
74LS04N	.35	74LS169N	1.15
74LS05N	.28	74LS170N	1.99
74LS08N	.28	74LS173N	.89
74LS09N	.35	74LS174N	.89
74LS10N	.28	74LS175N	.89
74LS11N	.39	74LS181N	2.20
74LS12N	.33	74LS190N	1.15
74LS13N	.47	74LS191N	1.15
74LS14N	.95	74LS192N	.98
74LS15N	.33	74LS193N	.98
74LS20N	.26	74LS194N	1.15
74LS21N	.33	74LS195N	.95
74LS22N	.33	74LS196N	.89
74LS26N	.33	74LS197N	.89
74LS27N	.33	74LS221N	1.15
74LS28N	.33	74LS240N	1.69
74LS30N	.26	74LS241N	1.69
74LS32N	.28	74LS242N	1.69
74LS33N	.55	74LS243N	1.69
74LS37N	.45	74LS244N	1.49
74LS38N	.39	74LS245N	2.20
74LS40N	.26	74LS247N	1.10
74LS42N	.79	74LS248N	1.10
74LS47N	.79	74LS249N	1.19
74LS48N	.95	74LS251N	1.40
74LS51N	.26	74LS253N	.98
74LS54N	.29	74LS257N	.85
74LS55N	.29	74LS258N	.98
74LS73N	.45	74LS259N	2.95
74LS74N	.42	74LS260N	.65
74LS75N	.59	74LS261N	2.49
74LS76N	.45	74LS266N	.59
74LS78N	.45	74LS273N	1.75
74LS83AN	.79	74LS275N	4.40
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74LS86N	.45	74LS283N	.99
74LS90N	.57	74LS290N	.99
74LS92N	.75	74LS293N	.99
74LS93N	.75	74LS295N	1.10
74LS95N	.88	74LS298N	1.19
74LS96N	.98	74LS324N	1.75
74LS107N	.45	74LS347N	1.95
74LS109N	.45	74LS348N	1.95
74LS112N	.43	74LS352N	1.19
74LS113N	.43	74LS353N	1.19
74LS114N	.43	74LS363N	1.49
74LS122N	.55	74LS365N	.69
74LS123N	1.19	74LS366N	.69
74LS124N	1.35	74LS367N	.69
74LS125N	.89	74LS368N	.69
74LS126N	.52	74LS373N	1.89
74LS132N	.79	74LS374N	1.89
74LS136N	.49	74LS375N	.69
74LS138N	.85	74LS377N	1.95
74LS139N	.85	74LS385N	1.95
74LS145N	1.25	74LS386N	.65
74LS148N	1.49	74LS390N	1.95
74LS151N	.79	74LS393N	1.95
74LS153N	.79	74LS395N	1.70
74LS154N	1.70	74LS399N	2.35
74LS155N	1.19	74LS424N	2.95
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74LS157N	.85	74LS670N	2.29
74LS158N	.75	81LS95N	1.69
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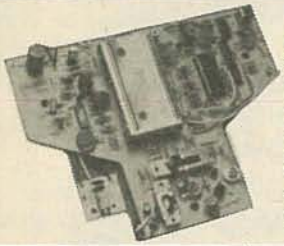

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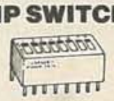

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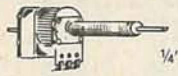

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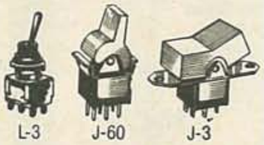

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CND-DB25P	25 PIN MALE	$ 3.00	$ 2.75	$ 2.60
CND-DB25S	25 PIN FEMALE	$ 4.00	$ 3.75	$ 3.50
CND-DB51212	1 PC. GREY HOOD	$ 1.60	$ 1.45	$ 1.30
CND-P25H	2 PC. GREY HOOD	$ 1.50	$ 1.25	$ 1.10
CND-DB51226	2 PC. BLACK HOOD	$ 1.90	$ 1.65	$ 1.45
CND-DC37P	37 PIN MALE	$ 5.80	$ 5.10	$ 4.45
CND-DC37S	37 PIN FEMALE	$ 8.70	$ 7.70	$ 6.70
CND-DC37C	37 PIN COVER	$ 1.80	$ 1.55	$ 1.30
CND-DD50P	50 PIN MALE	$ 8.75	$ 7.75	$ 6.70
CND-DD50S	50 PIN FEMALE	$11.65	$10.25	$ 8.90
CND-DD50C	50 PIN COVER	$ 2.00	$ 1.80	$ 1.60
CND-D20418	HARDWARE SET 2 PR	$ 1.00	$ 0.80	$ 0.70
CND-RS2328F	RS232, DB25P, EIA CLASS 1 CABLE 8 CON. 8 FT	$19.95	$17.95	$15.95
CND-5730360	CENT. 700 SERIES PRINTER CONNECTOR	$ 9.00	$ 7.50	$ 6.00

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450ns 8K EPROM

2716 — $11.95 EA — 8/$48.00

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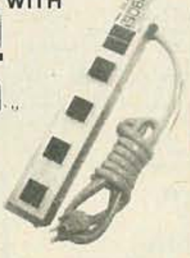

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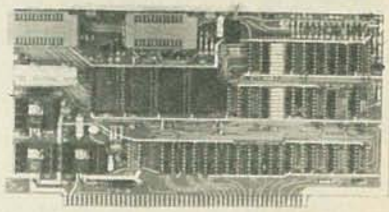

PB1 2708/2716 PROGRAMMER & 4K/8K EPROM BOARD

PB1 has two separate programming circuits so 2708 or 2716 (5v) type of EPROMs can be programmed without modifying the board. Programming voltage is generated on-board; no need for an external power supply. Programming sockets are Dip Switch addressable to any 4K boundary. And complete software is provided for programming and verifying EPROMs.

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VRB-MD557-10	Hard 10 Sector	77 Track Cert 100 TPI	2	$56.00
VRB-MD557-16	Hard 16 Sector	77 Track Cert 100 TPI	2	$56.00
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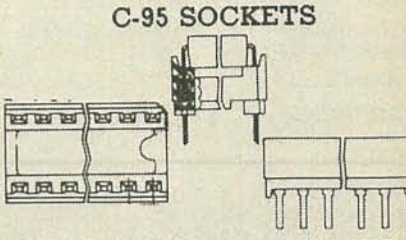

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- ____ 25-2N3904 TRANSISTORS, 100% material .... (#6370)
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28 pin ST	.40	.32
40 pin ST	.49	.39
ST = SOLDERTAIL		
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14 pin WW	.69	.52
16 pin WW	.69	.58
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4164	(200ns)	CALL	CALL

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					8pcs
1702		256 × 8	(1us)	4.95	4.50
2708		1024 × 8	(450ns)	3.95	3.50
2716	(5v)	2048 × 8	(450ns)	6.95	5.95
2758	(5v)	1024 × 8	(450ns)	9.95	8.95
2716-1	(5v)	2048 × 8	(350ns)	12.95	11.95
TMS2716		2048 × 8	(450ns)	9.95	8.95
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2732	(5v)	4096 × 8	(450ns)	17.95	16.95

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21L02-1	(LP)	(450ns)	1.29	1.15
2111		(450ns)	2.99	2.49
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TMM2016		(200ns)	CALL	CALL
MB6116		(200ns)	CALL	CALL

LP = LOW POWER

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74S04	.40	74S112	.85	74S175	1.40
74S06	.45	74S133	1.40	74S194	1.10
74S08	.40	74S135	1.50	74S257	1.50
74S10	.30	74S138	1.25	74S258	1.40
74S11	.35	74S139	1.10	74S260	1.50
74S15	.40	74S140	1.00	74S280	1.50
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4009	.45	4035	.75	4510	.85	74C90	.90
4010	.45	4040	.75	4511	.65	74C93	.90
4011	.20	4042	.55	4514	1.40	74C151	1.75
4012	.20	4043	.65	4515	1.50	74C157	1.75
4013	.30	4049	.30	4516	1.20	74C160	1.20
4014	.55	4046	.90	4518	1.25	74C161	1.15
4015	.55	4047	.90	4520	.70	74C163	1.15
4016	.30	4049	.40	4553	2.75	74C165	1.25
4017	.60	4050	.40	74C00	.27	74C173	1.30
4018	.50	4051	.80	74C08	.30	74C174	1.30
4019	.45	4052	.75	74C10	.27	74C175	1.30
4020	.70	4053	.75	74C14	1.20	74C192	1.30
4021	.55	4066	.50	74C20	.27	74C901	.50
4022	.80	4069	.30	74C32	.45	74C926	5.50
4023	.20	4071	.25	74C73	.75		
4024	.45	4072	.25				
4025	.25	4076	.65				
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600		1.80	3.60	15.00

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400	.09	.25	.65	1.50	6.50	12.00
600	.11	.30	.80	2.00	8.50	15.00
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7403	.17	7476	.40	74173	.75
7404	.24	7480	.45	74174	.65
7405	.24	7483	.50	74175	.60
7406	.33	7485	.65	74176	.75
7407	.35	7486	.42	74177	.75
7408	.27	7490	.45	74180	.75
7409	.24	7491	.45	74181	1.90
7410	.17	7492	.45	74182	.45
7411	.22	7493	.45	74190	.70
7413	.42	7494	.60	74191	.75
7414	.50	7495	.60	74192	.70
7416	.33	7496	.60	74193	.70
7417	.37	74107	.35	74194	.85
7420	.17	74121	.35	74195	.45
7425	.30	74122	.39	74196	.75
7426	.33	74123	.42	74197	.75
7427	.30	74125	.45	74279	.60
7430	.17	74126	.45	74365	.65
7432	.27	74145	.75	74367	.65
7437	.27	74150	1.10	74368	.65
7438	.27	74151	.50	74390	.90
7440	.17	74153	.40	75324	2.25
7441	.85	75154	1.10	74325	1.50
7442	.45	74155	.50	75491	1.05
7445	.70	74157	.50	75492	1.05
7446	.75	74160	.85	8T98	1.20
7447	.65	74161	.65	9312	.60
7448	.75	74162	.60	9601	.75
7450	.17	74163	.60	9602	.75
7472	.35	74164	.60		

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400	1.00	1.65	3.30
600	1.30	1.90	4.40

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74LS03	.20	74LS112	.38	74LS240	.95
74LS04	.22	74LS113	.45	74LS241	.95
74LS05	.22	74LS114	.55	74LS242	.95
74LS08	.20	74LS123	.85	74LS243	1.00
74LS09	.22	74LS125	.50	74LS244	1.35
74LS10	.20	74LS126	.50	74LS245	1.50
74LS11	.22	74LS132	.50	74LS247	.75
74LS12	.22	74LS136	.45	74LS248	1.10
74LS13	.45	74LS138	.55	74LS251	.90
74LS14	.40	74LS139	.55	74LS253	.55
74LS15	.35	74LS151	.40	74LS257	.70
74LS20	.18	74LS153	.40	74LS258	.60
74LS21	.18	74LS156	1.19	74LS259	1.50
74LS22	.25	74LS157	.55	74LS266	.45
74LS26	.35	74LS158	.50	74LS273	1.15
74LS27	.28	74LS160	.70	74LS279	.50
74LS28	.45	74LS161	.70	74LS280	1.80
74LS30	.18	74LS162	1.00	74LS283	.80
74LS32	.35	74LS163	.70	74LS290	.75
74LS37	.30	74LS164	.70	74LS293	.40
74LS38	.30	74LS168	1.25	74LS365	.65
74LS40	.40	74LS169	1.75	74LS366	.65
74LS42	.44	74LS170	1.70	74LS367	.70
74LS47	.65	74LS173	.65	74LS368	.70
74LS51	.20	74LS174	.45	74LS373	1.30
74LS54	.20	74LS175	.40	74LS374	1.35
74LS73	.35	74LS181	2.00	74LS377	1.40
74LS74	.35	74LS190	.80	74LS386	.50
74LS75	.35	74LS191	.80	74LS390	1.35
74LS76	.45	74LS192	.70	74LS393	1.25
74LS83	.75	74LS193	.90	74LS670	2.50
74LS85	.85	74LS194	1.10	81LS97	1.10
74LS86	.40	74LS195	.90	81LS98	1.10
74LS90	.45				
74LS92	.45				

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1458	.50	LM383	2.50	CA3018	1.95
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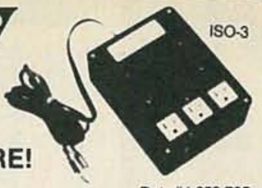

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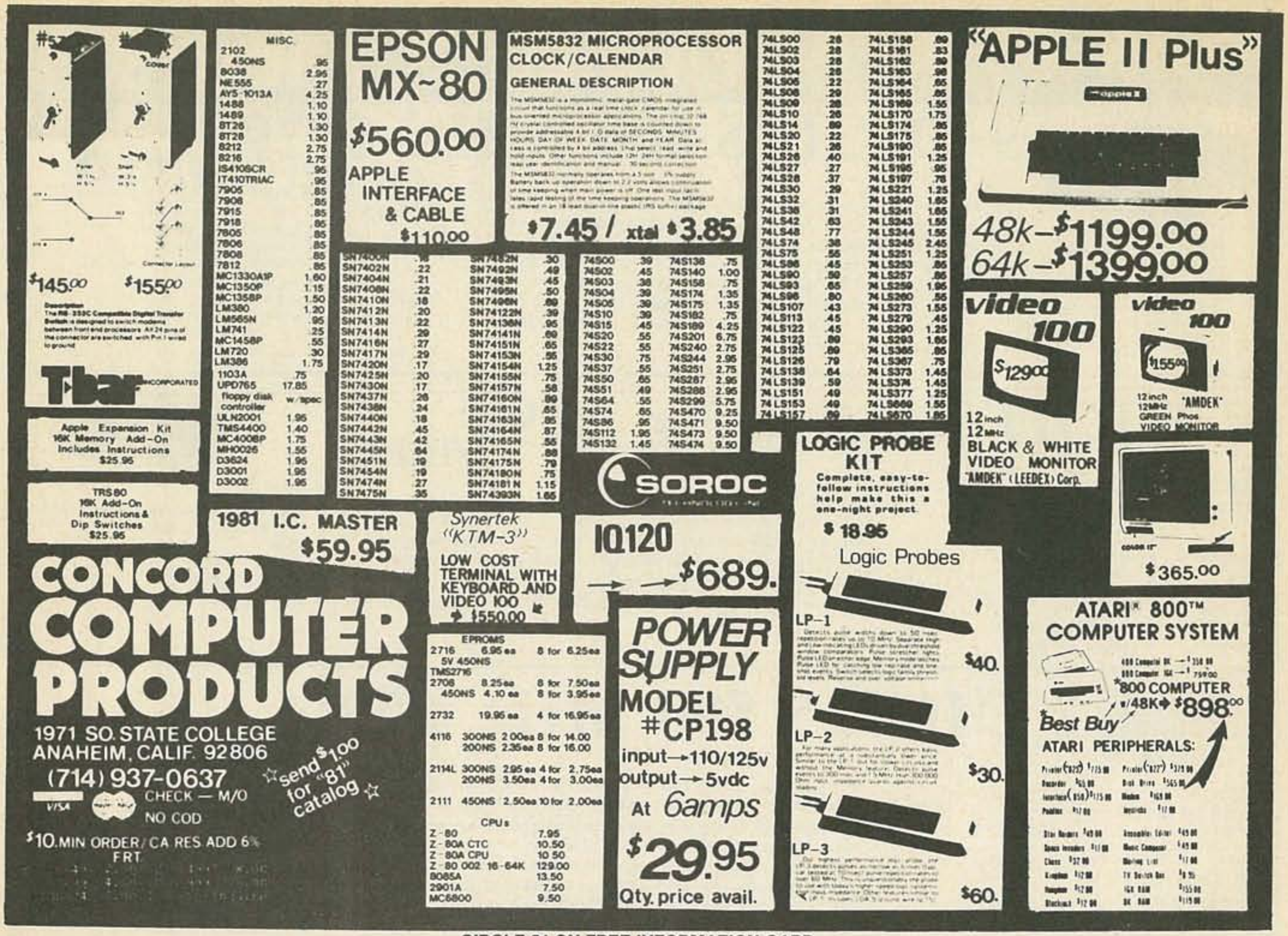

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