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Solid-state sounder applications

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Build your own wipeout videogame

Inside VHS recorder circuits

New packaging system for projects

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MODULAR PLUG-IN REMOTE CONTROL
How it works

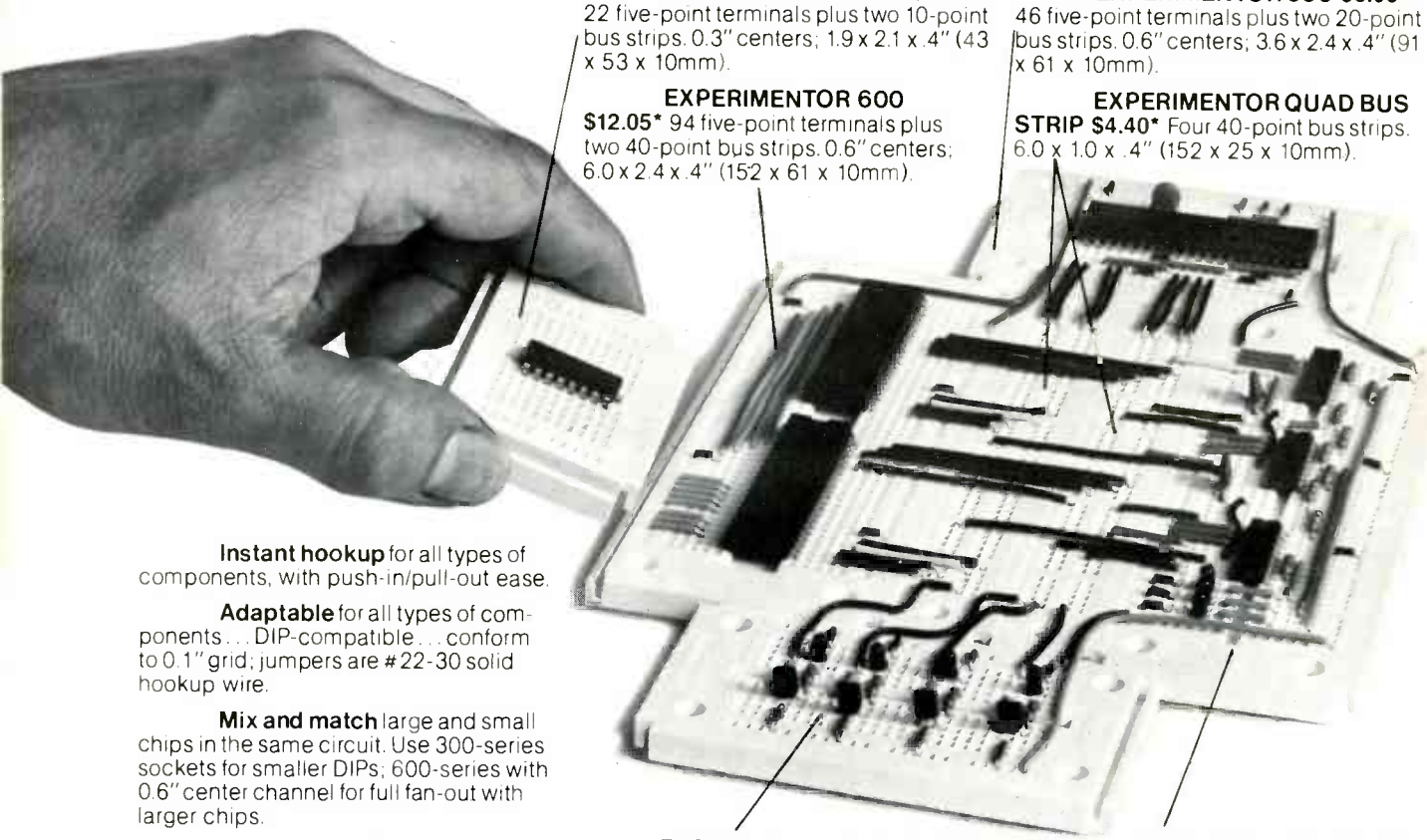
A breadboard as big as your ideas.

EXPERIMENTOR 325 $3.05*
22 five-point terminals plus two 10-point bus strips. 0.3" centers; 1.9 x 2.1 x .4" (43 x 53 x 10mm).

EXPERIMENTOR 650 $6.90*
46 five-point terminals plus two 20-point bus strips. 0.6" centers; 3.6 x 2.4 x .4" (91 x 61 x 10mm).

EXPERIMENTOR 600 $12.05* 94 five-point terminals plus two 40-point bus strips. 0.6" centers; 6.0 x 2.4 x .4" (152 x 61 x 10mm).

EXPERIMENTOR QUAD BUS STRIP $4.40* Four 40-point bus strips. 6.0 x 1.0 x .4" (152 x 25 x 10mm).



Instant hookup for all types of components, with push-in/pull-out ease.

Adaptable for all types of components . . . DIP-compatible . . . conform to 0.1" grid; jumpers are #22-30 solid hookup wire.

Mix and match large and small chips in the same circuit. Use 300-series sockets for smaller DIPs; 600-series with 0.6" center channel for full fan-out with larger chips.

Infinite flexibility lets you expand and modify circuits vertically and horizontally, simply by snapping sockets together.

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EXPERIMENTOR 350 $6.05*
46 five-point terminals plus two 20-point bus strips. 0.3" centers; 3.6 x 2.1 x .4" (91 x 53 x 10mm).

Marked tie-points simplify translation from breadboards to PC boards or wiring tables.

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EXPERIMENTOR 300 $10.95*
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Quick construction of microprocessors and other circuits—each EXP-4B gives you four bus lines, with 8-, 12-, and 16-line address and data buses easily created by combining Bus Strips.

It's hard to believe how much faster and easier building circuits can be . . . until you try our Experimentor™ solderless breadboarding sockets. From the largest DIP to the smallest resistor, components plug in and out instantly, without special hardware or jumper cables. So you save time and money by eliminating soldering and component damage. Start small and expand in any direction your thinking takes you, by snapping sockets together vertically or horizontally. With no limit to your ideas. Get started today, for as little as $3.05*!

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CIRCLE 39 ON FREE INFORMATION CARD

Bone Fone™

A new concept in sound technology may revolutionize the way we listen to stereo music.

The Bone Fone surrounds your entire body with a sound almost impossible to imagine.

You're standing in an open field. Suddenly there's music from all directions. Your bones resonate as if you're listening to beautiful stereo music in front of a powerful home stereo system.

But there's no radio in sight and nobody else hears what you do. It's an unbelievable experience that will send chills through your body when you first hear it.

AROUND YOU

And nobody will know you're listening to a stereo. The entire sound system is actually draped around you like a scarf and can be hidden under a jacket or worn over clothes.

The Bone Fone is actually an AM/FM stereo multiplex radio with its speakers located near your ears. When you tune in a stereo station, you get the same stereo separation you'd expect from earphones but without the bulk and inconvenience. And you also get something you won't expect.

INNER EAR BONES

The sound will also resonate through your bones—all the way to the sensitive bones of your inner ear. It's like feeling the vibrations of a powerful stereo system or sitting in the first row listening to a symphony orchestra—it's breathtaking.

Now you can listen to beautiful stereo music everywhere—not just in your living room. Imagine walking your dog to beautiful stereo music or roller skating to a strong disco beat.

You can ride a bicycle or motorcycle, jog and even do headstands—the Bone Fone stays on no matter what the activity. The Bone Fone stereo brings beautiful music and convenience to every indoor and outdoor activity without disturbing those around you and without anything covering your ear.

SKI INVENTION

The Bone Fone was invented by an engineer who liked to ski. Every time he took a long lift ride, he noticed other skiers carrying transistor radios and cassette players and wondered if there was a better way to keep your hands free and listen to stereo music.

So he invented the Bone Fone stereo. When he put it around his neck, he couldn't believe his ears. He was not only hearing the music and stereo separation, but the sound was resonating through his bones giving him the sensation of standing in front of a powerful stereo system.

AWARDED PATENT

The inventor took his invention to a friend who also tried it on. His friend couldn't believe what he heard and at first thought someone was playing a trick on him.

The inventor was awarded a patent for his idea and brought it to JS&A. We took the idea and our engineers produced a very sensitive yet powerful AM/FM multiplex radio called the Bone Fone.

The entire battery-powered system is self-contained and uses four integrated circuits and two ceramic filters for high station selectivity. The Bone Fone weighs only 15 ounces, so when worn over your shoulders, the weight is not even a factor.

BUILT TO TAKE IT

The Bone Fone was built to take abuse. The large 70 millimeter speakers are protected in flexible water and crush resistant cases. The case that houses the radio itself is made of rugged ABS plastic with a special reinforcement system. We knew that the Bone Fone stereo may take a great deal of abuse so we designed it with the quality needed to withstand the worst treatment.

The Bone Fone stereo is covered with a sleeve made of Lycra Spandex—the same material used to make expensive swim suits, so it's easily washable. You simply remove the sleeve, dip it in soapy water, rinse and let the sleeve dry. It's just that easy. The entire system is also protected against damage from moisture and sweat making it ideal for jogging or bicycling.

The sleeve comes in brilliant Bone Fone blue—a color designed especially for the system. An optional set of four sleeves in orange, red, green and black is also available for $10. You can design your own sleeve using the pattern supplied free with the optional kit.

YOUR OWN SPACE

Several people could be in a car, each tuned to his own program or bring the Bone Fone to a ball game for the play by play. Cyclists, joggers, roller skaters, sports fans, golfers, housewives, executives—everybody can find a use for the Bone Fone. It's the perfect gift.

Why not order one on our free trial program and let your entire family try it out? Use it outdoors, while you drive, at ball games or while you golf, jog or walk the dog. But most important—compare the Bone Fone with your expensive home stereo system. Only then will you fully appreciate the major breakthrough this product represents.

GET ONE SOON

To order your Bone Fone, simply send your check or money order for **$69.95** plus $2.50 postage and handling to the address shown below. (Illinois residents add 6% sales tax.) Credit card buyers may call our toll-free number below. Add $10 if you wish to also receive the accessory pack of four additional sleeves.

We'll send you the entire Bone Fone stereo complete with four AA cell batteries, instructions, and 90-day limited warranty including our prompt service-by-mail address.

When you receive your unit, use it for two weeks. Take it with you to work, or wear it in your car. Take walks with it, ride your bicycle or roller skate with it. Let your friends try it out. If after our two-week free trial, you do not feel that the Bone Fone is the incredible stereo experience we've described, return it for a prompt and courteous refund, including your $2.50 postage and handling. You can't lose and you'll be the first to discover the greatest new space-age audio product of the year.

Discover the freedom, enjoyment, and quality of the first major breakthrough in portable entertainment since the transistor radio. Order a Bone Fone stereo at no obligation, today.

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ELECTRONIC BREAKTHROUGH!

Awesome Fingertip Power!

- CASIO C-80 DIGITAL QUARTZ CHRONOGRAPH/CALCULATOR
- THE OLIVETTI WORLD'S SMALLEST PRINTING CALCULATOR/LCD CLOCK

The two wonders on this page are among the best, most wanted, and most useful everyday electronic products in the world.

Each one brings you state-of-the-art function and design and places awesome calculating power at your fingertips. Let's examine these breakthroughs one at a time.

ANATOMY OF YOUR FINGERTIP

The Casio C-80 Chronographic Calculator is the first wrist instrument whose numeric and function command keys are designed so you can operate them with your fingertip. No need to carry a special stylus or look for a pencil with a sharp point whenever you want to calculate something.

The Casio C-80 has an 8-digit read-out. It adds, subtracts, multiplies, divides, and performs chain calculations. Floating decimal tool.

It tells you the time digitally in two zones (accurate within ± 15 seconds a month), and it tells month and date. It's also a stopwatch in hundredths of seconds, with capacity up to 23 hrs., 59 min. 59.99 secs. It gives you both lap and net times as well.

The C-80 weighs much less than metal calculator watches. The case and band are space-age unbreakable plastic, and the LCD face is protected by hard mineral glass.

So far as we know, only one or two stores in New York City have been able to get the C-80. And we've seen it advertised as high as $75.00 – and that only lets you reserve it, with a long wait for delivery.

You can call our toll-free number for immediate delivery, and charge just $69.95 (plus $2.50 insured shipping) to your credit card. Thirty day money-back guarantee, one-year parts and labor warranty.

Just three more points: the battery's included. There's a tiny light to illuminate the display at night. In fact, it's bright enough to help you find your keys if you drop them in the dark. And when you receive your Casio C-80, resist the temptation to press the keys with your fingernail. Not necessary. Just use your fingertips.

WORLDS SMALLEST PRINTING CALCULATOR!

Besides all the calculating functions you expect, the Olivetti Logos 9 offers you these added features, plus more, thanks to some new technological breakthroughs.

- Measures only 1 inch by 2½ inches by 4 5/8 inches, with full 12 digit liquid crystal display, with floating or fixed position decimal.
- Exclusive paper cartridge system, simply slide up the calculator top and behold the smallest printing system you've ever seen.
- Clear crisp entries on Olivetti's special cartridge paper. Each cartridge lasts for up to 1,300 entries. (Thirty two rolls...good for three years of use, only $18.00).
- Incredibly fast printing speed of two lines per second, with print recall. Should your entries exceed unit speed, the Logos 9 will still print each entry.
- Rechargable batteries (up to 500 recharges per battery).
- Printing head labels all numerical entries with letters. You'll never forget your entries purpose.
- Accumulating memory, plus fully independent memory.
- Digital clock, a totally accurate timepiece.
- Ideal for people who employ, discounts, gross margins, and percentage markups.
- Automatic average: The Logos 9 will automatically compute the average of a group of entries.
- Complete memory recall and display.
- Battery charging and 90 day limited warranty.
- Easy Olivetti service by mail.

Try this amazing pocket calculator today, we're sure that you will agree that the Logos 9 is the most convenient and advanced pocket calculator you've ever seen. If after thirty days, you are not satisfied, return the unit for a prompt refund.

The Olivetti Logos 9 was awarded at the International Consumer Electronic Show 1980 the distinguished position of being the "Most Innovative Product of the Year", and is the best selling pocket calculator in the world.

Try it today.

HERE'S HOW TO ORDER AND SAVE

The C-80 Chronograph/Calculator is $69.95. The Printing Calculator is $89.95. That adds up to $159.90. If you order both for yourself (and don't forget gift possibilities) pay only **$144.95** for a savings of **$15.00.**

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When you order, you're protected by our 30-day money back guarantee policy. And each item is additionally covered by a one-year parts and labor warranty. All units come with instructions, and batteries are included.

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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

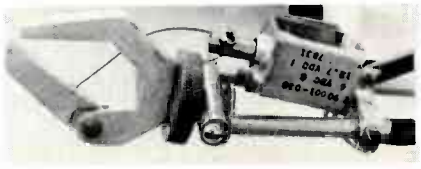
Electronics publishers since 1908

SEPTEMBER 1980 Vol. 51 No. 9

ON THE COVER

You can turn on and off lamps and appliances without ever leaving your armchair with BSR's System X-10. To install the system, you simply plug the various modules into existing AC wall outlets. The system features a hand-held ultrasonic remote control unit and a programmable timer. For a look at the circuitry and how the system works, turn to page 47.

NEW NOISE REDUCTION SYSTEM for tape recorders provides 18-dB more noise reduction than Dolby B. For the complete details, turn to page 61.



HANDS FOR THE UNICORN-1 ROBOT are solenoid activated. For details on how to assemble the manipulator arms and hands, turn to page 55.

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looking ahead

A 3-disc race: General Electric threw the already complex videodisc race into pandemonium by embracing a third system—VHD (*V*ideo *H*igh *D*ensity), developed by the Japan Victor Company (JVC). The VHD system uses a 10-inch grooveless disc to play two hours (one hour per side) of color and stereo-sound information by reading out capacitance variations in the disc material. The disc revolves at 900 rpm, and has features in common with both other consumer systems. Like the RCA CED (*C*apacitance *E*lectronic *D*isc) system, the stylus and disc form the plates of what, in effect, is a variable capacitor; but the RCA system uses grooves to guide the stylus, while VHD employs pilot frequencies that differ between adjacent tracks. Like the Philips-MCA optical system, it's grooveless and is capable of certain special effects, such as fast, slow, and reverse motion. The CED disc revolves at 450 rpm and plays one hour per side. The optical disc spins at 1,800 rpm (30 minutes per side) in the special-effects mode and at a speed varying from 600 to 1,800 in the so-called "constant linear velocity mode" (60 minutes per side). The three systems are totally—and hopelessly—incompatible with each other.

GE's espousal of the VHD system came in talks (nearing completion at press time) to establish three jointly owned companies: 1. With Matsushita (Panasonic and Quasar) and JVC to manufacture players in the United States. 2. With those companies and Thorn EMI of England to press discs here. 3. With the same three companies to acquire rights and develop disc programming. VHD starts up far behind its competitors as a true dark horse. Players for the optical system are already being marketed by Magnavox and Pioneer; discs are being sold by MCA DiscoVision. RCA plans a nationwide launch for the SelectaVision CED system early in 1981; Zenith will also sell CED players and both RCA and CBS will press discs. JVC says that the VHD system can be on the American market by the end of 1981 at a price "competitive" to RCA's $500 target (the Magnavox and Pioneer players are $775 and $749, respectively).

Who's on first? RCA was the best-selling color-TV brand in the 1980 model-year (July 1979-June 1980), according to a survey by the industry newsletter *Television Digest*. That was the second consecutive model-year in which RCA was in the No. 1 spot, getting a 21% share of the market to Zenith's 20.5%. GE, with 7.5%, was No. 3 in color, followed by Sears Roebuck, also with 7.5% (but slightly lower in average ranking), Magnavox and Sony, with 7% and 6% respectively. In black-and-white, Zenith easily retained the top spot, registering 16% of the market, with RCA second at 14.85%, GE third with 10%, followed by Sears (9%) and Panasonic (6.65%).

More new VCR's: Videocassette recorders continue to sport a profusion of new features. Both VHS and Beta models under major trade names now include high-speed scan in both directions for easy program-segment selection (and for zipping through commercials) as well as noise-free still-frame, frame-by-frame advance and slow motion, all controlled by a wired remote unit. Akai has introduced the first model with dual soundtracks—a two-speed VHS portable capable of carrying stereo audio or tracks in different languages. It also is the first model to be marketed in the United States that includes Dolby noise reduction.

JVC has introduced what (at least for the moment) is the lightest and smallest portable VCR available in the United States. It weighs 11.4 pounds and can be backpacked and operated by a hand-held remote control. Meanwhile, the two longitudinal video recorders scheduled for introduction in the home market have been scratched. BASF's unit, which already was in the early stages of pilot production in a California plant, was officially withdrawn and the plant put up for sale. The Toshiba LVR will probably appear first as a data recorder, it may eventually surface again in its video form. At last June's Consumer Electronics Show, Toshiba showed a new version of the LVR that can record two programs simultaneously by using two tracks, but the official word is that until further notice, LVR is no longer a consumer product.

Telecaptions: The experts may argue long and loud over what format for teletext and viewdata should be adopted in the United States, but one form of vertical-interval message transmission is off and running and an unqualified success. This is Telecaptioning, a special service for the hard of hearing, now permitted by the FCC. Captions are prepared by the National Captioning Institute for programs submitted by ABC, NBC, and PBS. CBS chose not to participate, arguing that teletext is better suited for captioning. Sears Roebuck has the exclusive rights to sell decoders which enable TV sets to display the captions, as well as decoder-equipped TV sets, using IC's made by Texas Instruments.

In the first 11 weeks of captioning, Sears sold 17,700 caption decoders, an average of 1,600 per week, but at the end of the period (June 1), sales were running at the rate of 1,800 weekly—matching the current production rate—with a four-week order backlog. The decoders retail for $250, and a newly introduced 19-inch set with built-in decoder (in Sears' fall catalog) lists for $520. The decoders have a three-position selector switch, and captioning eventually will be offered in Spanish as well as English, along with "Infodata," a new information service being developed by National Captioning Institute. The Institute is supported by royalties from the sale of decoders.

End of an era: The grand old name in automobile radio—Motorola—has discontinued manufacture of car sound equipment for the general public. The company sold its car radio business to Texstar, which will use the Motorola name in the U.S. and Canada. Motorola also sold its Italian subsidiary Autovox, which makes TV sets, audio and car radio equipment, to a Swiss company, ending its direct involvement in consumer electronics. Its former TV-radio operation is now Quasar Electronics, a subsidiary of Matsushita. Motorola will continue to manufacture automotive electronic equipment, including radios, for sale to car manufacturers.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Facts from Fluke on low-cost DMM's

Is this any way to treat a $139 multimeter?

In the rough world of industrial electronics, even a precision test instrument can get treated like dirt. You need all the ruggedness and dependability you can get in a DMM for field use.

You'll find these qualities and more in the Fluke line of low-cost DMM's. Our DMM's have been dropped from towers, stepped on, and run over by construction equipment. And they've survived because we never cut corners on quality, even on our lowest-priced, six-function Model 8022A Troubleshooter at $139 U.S.

Take a close look at a low-cost DMM from Fluke and you'll notice tough, lightweight construction that stands up to the hard knocks of life. Sturdy internal design and high-impact, flame-retardant shells make these units practically indestructible. Right off the shelf, they meet or exceed severe military shock/vibration tests.

Even our LCD's are protected by cast-tempered plastic shields. We use rugged CMOS LSI circuitry for integrity and endurance, and devote a large number of components to protection against overloading, accidental inputs and operator errors.

We go to these lengths with all our low-cost DMM's to make sure they are genuine price/performance values. You can count on that. Because, that's what leadership is all about.

For more facts on DMM reliability and where to find it, call toll free **800-426-0361**; use the coupon below; or contact your Fluke stocking distributor, sales office or representative.

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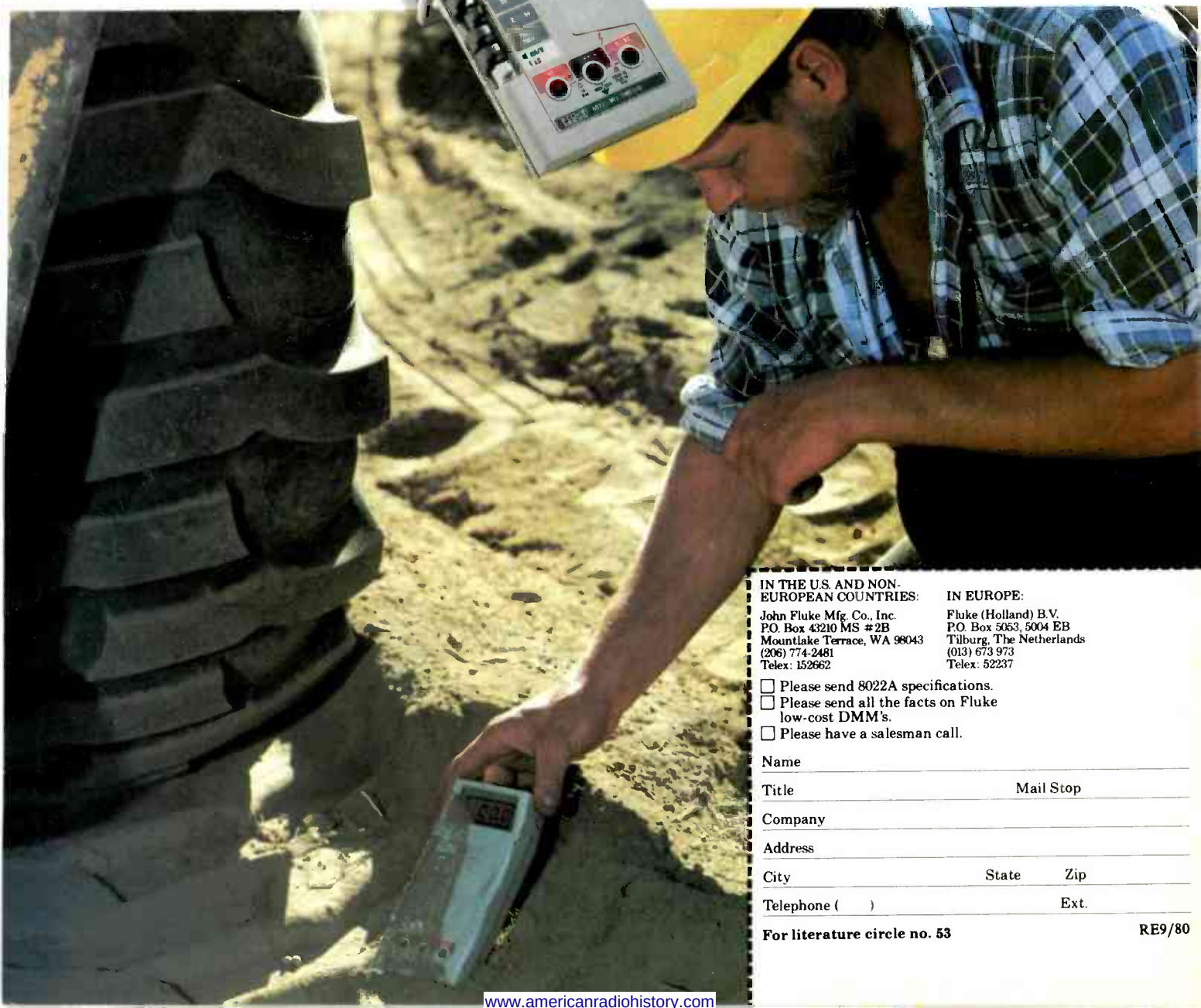
8022A Multimeter



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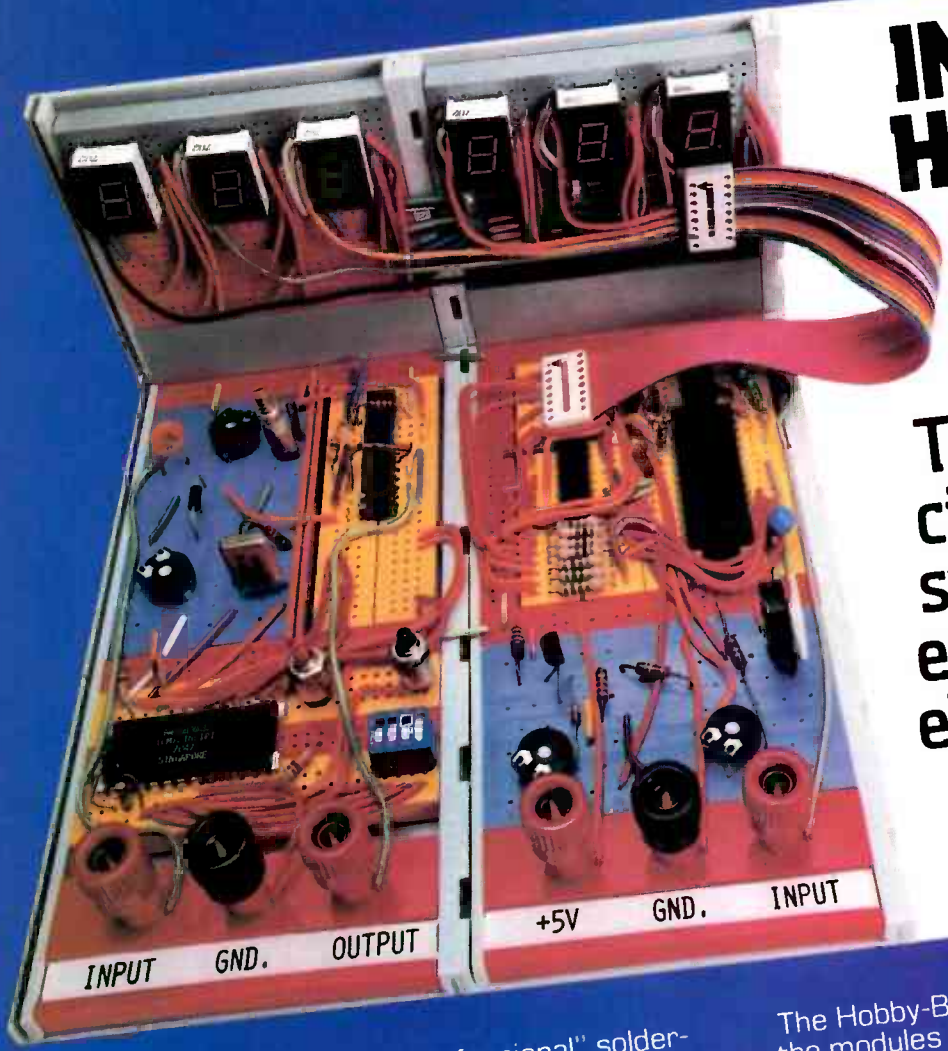

The new modular circuit building system designed especially for electronic hobbyists.

Until now, you had to buy "professional" solderless breadboards for your projects and pay "professional" prices. Now there's Hobby-Blox™, a totally new circuit-building system that's not only economically priced but offers many more advantages to the hobbyist.

At the core of the system are two expandable starter packs (priced under $7.00), one for discrete component projects, the other for integrated circuit projects. Each comes with a number of Hobby-Blox modules that fit into a tray and an illustrated project booklet. In addition, the system includes 14 separate component packs you can purchase individually — terminal, distribution and bus strips, speaker panels, binding posts, etc. — priced from $1.29 to $3.59.

The Hobby-Blox system is easy to use because the modules are color-keyed and letter/number indexed. It's time-saving, because they're solderless. It's compatible with DIP's of all sizes and a wide variety of discrete components. And you save money, because the parts can be reused again and again.

How far can you go with the Hobby-Blox system? Take a look at the example above. Then you'll know why we say, "your only limit is your own imagination!"

For a free catalog and the name of your nearest Hobby-Blox dealer call toll-free (800) 321-9668.

Patents Pending
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CIRCLE 8 ON FREE INFORMATION CARD

what's news

Weather "color" radar to get distance control

A new technique that enhances the value of airborne weather radar has been announced by RCA. In 1977 that company pioneered airborne color radar, which gives an airplane pilot information not only of the presence and position of a storm, but of the strength of the precipitation. The colors vary from green, for lightest rainfall, to red, the most intense.

Present radars give excellent information to the pilot trying to fly around a storm. But they can—and often do—underestimate the intensity of precipitation in its remoter areas. That is because signals from those areas are attenuated by the heavy rain in the nearer parts. Thus, if a radar display shows a yellow area behind a red one, it can mean either that the rain is lighter behind the intense storm or that the rain in the red area has so weakened the signal that intense precipitation behind the red area is being understated as yellow.

REACT (Rain Echo Attenuation Compensation Technique) acts as a sort of automatic gain control that compensates for attenuation by water drops in the closer parts of the storm by increasing the gain of the radar receiver for the more distant areas by an amount equal to the two-way attenuation through the nearer ones.

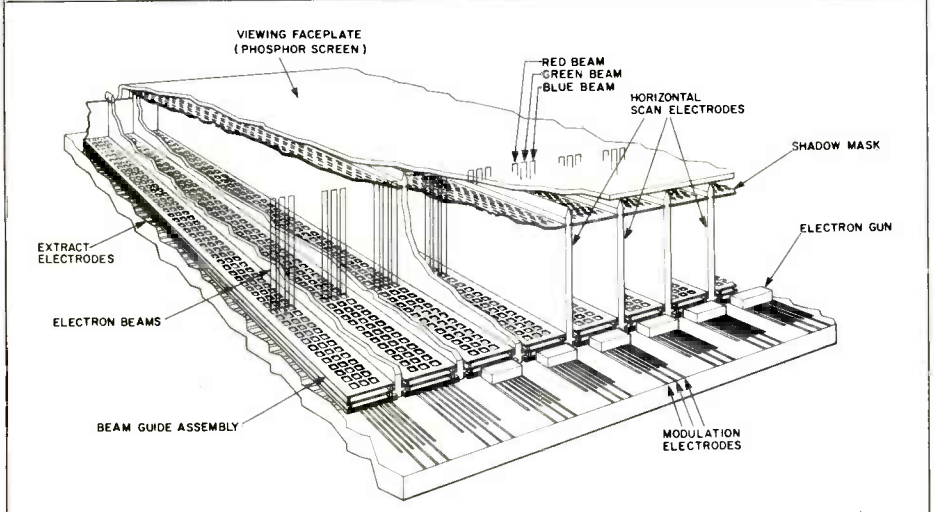
If the return signal is too weak to be seen even with REACT, the radar displays a blue, or "blind" area, which tells the pilot that the intensity of the storm in that area is unknown—it cannot be seen by the radar.

50-inch flat TV "tube" to arrive before 1990?

The concept of a 30 × 40-inch (50-inch diagonal) flat TV display was described by RCA scientists to the Society of Information Display at their recent conference in San Diego, CA. The new picture-on-the-wall "tube" will have decided advantages in brightness and picture quality over present projection equipment of similar size and will require far less space.

The display would consist of 40 modules, each 1 inch wide and 30 inches high. (Experimental displays of up to five modules have been constructed, but no complete unit has yet been made.) As in earlier concepts of a flat TV tube (**Radio-Electronics,** March 1957, page 43) the electron gun projects its beam parallel to the phosphor screen. To turn the beam (and control vertical scanning) one of a series of horizontal wires—normally held between 250 and 350 volts positive—is switched negative (50 to 100 volts). That repels the beam, "extracting" it and sending it at a right angle through mesh-like beam guides—maintained at 40-80 volts positive—to the phosphor screen, held at about 1300 volts. Vanes on each module scan the beam horizontally across the screen. Program modulation is applied through a series of vertical wires or electrodes.

As to when the new tube (or display) will be perfected, an RCA spokesman says: "While we are optimistic, we are by no means certain as to when all the problems facing us will be overcome. It will probably be close to 1990 before such a flat panel display can be manufactured at a price the home consumer will be willing to pay."



THE FLAT-PANEL TV DISPLAY would consist of 40 modules, each with its own electron gun, beam guides, and modulation electrodes, fastened side-by-side to form a 40-inch-wide and 30-inch-high display. RCA scientists hope that the new "tube" will reach the market some time before 1990.

Pocket calculator includes two-hundred-year calendar.

The Toshiba *Time Capsule* liquid crystal calculator, just announced, includes the standard four functions, square root, percent, memory and the rest. But in addition, it is programmed to give you the day of the week in which any date falls—80 years in the past and 120 years in the future. That should be particularly useful to production planners who have to know on what days week-ends and holidays fall, sometimes farther in advance than available calendars show.

THE TOSHIBA LC-840WA CALCULATOR can show, at one time, the calendar for the month, with present date flashing, the time down to the second, and the time for which the alarm has been set.

The little calculator also provides a digital clock service and a 24-hour alarm that can be preset for two times in one day or be preprogrammed up to a month in advance.

As a special feature, the *Time Capsule* can also show the entire calendar, a month at a time, with the present day flashing. The calculator measures 4.9 × 2.7 × 0.3 inches. Suggested retail price is $59.95.

Magnavox will make no claims on AM stereo broadcasters

Magnavox Consumer Electronics Co. will not assert its AM Stereo broadcast patents against broadcasters or broadcast equipment manufacturers, says Magnavox president Meinken. However, "a reasonable license fee will be charged to receiver manufacturers."

The Magnavox AM Stereo system was approved by the FCC early last April. The company points out that among the advantages of the system are its pilot tone, which can be used to switch the receiver from mono to stereo automatically, at the same time turning on a light that tells the listener the program is in stereo. The pilot tone can also carry a third channel of alphanumeric data, such as call letters or a weather alert.

continued on page 13

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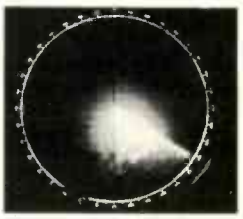

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PLS-1 LOGIC PULSER

The PLS-1 logic pulser will superimpose a dynamic pulse train (20 pps) or a single pulse onto the circuit node under test. There is no need to unsolder pins or cut printed-circuit traces even when these nodes are being clamped by digital outputs.

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what's news

continued from page 7

TV sales off in early 1980—home VTR sales on the rise

Sales of color television sets to retailers in the first 17 weeks of 1980 were 2,811,307, reports the Electric Industries Association. That is a decline of 5.7 percent from the 2,980,951 sets sold during the same period in 1979. Black-and-white sales in the same period were 1,593,733, a decrease of 12.4 percent from the 1,818,667 units sold in the first 17 weeks of last year.

Home video-tape recorder sales to retailers jumped 57.1 percent over last year—189,550 units as against 120,674 sold in the first 17 weeks of 1979.

New energy-saving light bulb

North American Philips Lighting Corporation has developed a new type of light bulb that, when compared with the conventional incandescent lamp, will last 7½ times longer and use 70% less energy. The new lamp is an 11-watt, low-pressure mercury lamp of the fluorescent type, and is similar in size and shape to conventional bulbs; it is designed to fit standard light sockets.

Low-pressure sodium lamps first appeared in Europe, during the 1930's and were about as efficient as mercury vapor lamps, which produced 40 lumens per watt. The new lamps achieve a fourfold increase in efficiency by integrating the development of rare earth fluorescent powders and radical miniaturization. The light in the new bulbs is generated by converting ultraviolet radiation to visible light by means of using fluorescent powder on the inner surface of the bulb wall. The new rare earth powders also opened up the possibility of combining good color-rendering qualities with high efficiency.

The new lamp is expected to replace standard light bulbs for both indoor and outdoor use in private homes, apartments, garages, commercial buildings, and stores. It has low glare, provides excellent contrast, and is not affected by changes in the surrounding temperature. It will be available in 240- and 120-volt versions. 120 volts is the predominant range in the United States and it will be available in the U.S. market early in 1981.

A comparison between the cost, length of life, and performance of a standard 60-watt soft-white incandescent lamp and one of the new SL-18 lamps shows the following: The incandescent lamp has a life expectancy of 1000 hours, while the new lamp has a life expectancy of 7500 hrs. The new lamp costs $12.00. To obtain the equivalent life span, 7½ incandescent lamps are required at a cost of $.85 each, for a total cost of $6.37. During the 7500-hour life span, the incandescents will consume 450 kilowatt-hours while the SL-18 consumes 135 kilowatt-hours. The savings

THE NEW SL-18 is close in size to the standard 60-watt incandescant lamp, and is designed to fit standard light sockets. It will last 7½ times longer than the oldstyle bulb and consume 70% less energy, reflecting a substantial decrease in the user's electric bills.

in the user's electric bill depend upon the unit cost per kilowatt-hour; at 2¢ per kilowatt-hour, the incandescents cost $9.00, the SL-18 $2.70 ($6.30 saved). At 4¢ per kilowatt-hour, the incandescents cost $13.50, the SL-18 $4.05 ($9.45 saved). At 6¢ per kilowatt-hour, the incandescents cost $27.00, the SL-18 $8.10 ($18.90 saved); and the savings increase where the unit price for energy is higher.

Worldwide, the lamps will immediately be available in four wattages: 11 watts, 13 watts, 18 watts, and 25 watts, as direct replacements for the standard 40-watt, 60-watt, 75-watt, and 100-watt incandescent lamps most widely used today. There can be no doubt that the reduced energy consumption, reflected in lower electric bills, and the longer life of the new bulb will more than offset the higher initial price.

Technologies of the '80's may alter our lifestyles

Westinghouse scientist George F. Mechlin described—at a Pittsburgh press briefing on "Technologies of the '80's: Myths, Facts, and Promises"—seven technologies that will have a significant impact on American society in the next decade. At the same time, he warned against the "myth" that any one of them—or all of them combined—can present a "quick fix" for our present difficulties.

The seven technologies are:

Lasers, already handling fantastic tasks, and beginning to be used to harden metals, read video discs, and separate uranium.

Optics, now able to transmit a million telephone calls for only .001 watt of laser light, and which will make information-processing a billion times faster than is remotely possible with present technology.

Microprocessors, which will invade every field of industry, transform office procedures, and have a bigger impact on our home life than the changes brought about by TV.

Robotics, to do the dangerous, heavy, hot, and monotonous jobs now handled by human beings.

Solar power, use of which will increase as and when it becomes economical.

Coal conversion, into gas, oil, gasoline or methanol, generating power without the present pollution.

Fuel cells, which will be developed intc compact, efficient, and non-polluting energy sources.

But, Dr. Mechlin warned, the very promise of technology has led to several overoptimistic myths that will lead to disillusionment. Most dangerous of those is the Myth of the Quick Fix, which leads many to hope for a near-immediate solution of many present difficulties—particularly of the energy problem.

"An alarming mistake," stated Dr. Mechlin, firmly. "No technical innovation has ever taken hold immediately. Even if a new energy source were discovered tomorrow, it would be unlikely to go 'on line' until the next century."

World's longest single-span fiber-optic video link

The longest single-span fiber-optic video service in use today was completed last April by Times Fiber Communications and is part of Vision Cable's system serving 20,000 cable-TV subscribers in 13 New Jersey communities. The new 2.4-kilometer link, that was completed in only six days, uses no repeaters and carries five channels per-fiber with studio-transmission quality, demonstrating the practicality of Fiber-optic communications.

It consists of three-conductor optical cable and electro-optical equipment manufactured by Times. One fiber-conductor serves as a final leg for televised sports events presented at Madison Square Garden and Nassau Coliseum. The fiber carries the signals from microwave receivers at the headend to the studio for signal-processing and programming. A second fiber returns the program material, along with satellite signals and other studio-originated channels, to the headend for distribution to the subscribers. A third fiber will be used for future programming.

The system is Frequency-modulated and exceeded contract performance specifications, with a measured 53-58 dB signal-to-noise level and no visible degradation of the picture. Vision Cable supplies 130,000 subscribers in the east and north, and additional fiber-optic links are planned for the future.

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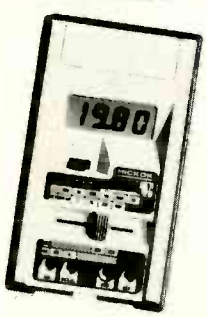

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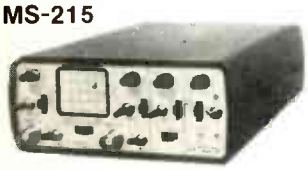

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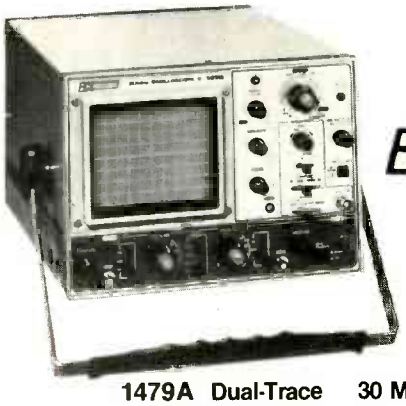

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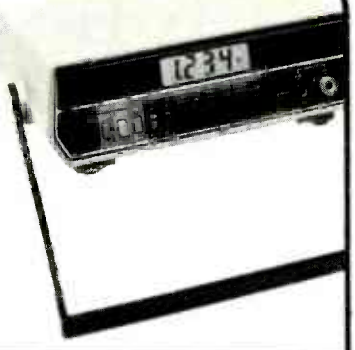

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editorial

PUBLISHER'S LETTER

Home-Study Schools Cancelled GI Bill Not Funded

That could be a minor headline in your local newspaper in the not-too-distant future. Actions now taking place in Congress could make that headline happen.

Radio-Electronics carries a good deal of Home-Study school advertising. It is important to our readers. So when an action occurs that may reduce its availability to many of our readers, we feel it is important enough to tell you the facts.

Here's the story. On June 3, 1980, the Veterans Affairs Committee reported to the budget committee of the House of Representatives and recommended that home-study and flight school instructions no longer be funded through the Veterans Administration. If that recommendation is passed by Congress, Veterans will no longer receive this important benefit.

Why are we so concerned? After all the veteran could still attend a resident school and have his education paid for. There are several practical problems with this answer.

1. **There may be no resident school** in the city where the veteran lives.
2. **Even if there is a resident school** in the city where he lives, it may not be convenient for him to reach it after work.
3. **Some resident schools** do not offer the best possible training, and if a veteran can only attend a resident school, his freedom of choice is severely limited.
4. **Correspondence schools permit the student to learn** at his own pace and fit his education into his own schedule. Thousands of veterans have taken home-study school courses and made those courses an important part of their career training. Personally, I got started in electronics by taking a DeForest Technical Training course while I was in the US Army. I finished it after being discharged.
5. **Home-Study schools are much less expensive** than the equivalent resident school. Resident schools can cost from two to five times as much—so eliminating home-study can actually increase the cost of providing benefits.

Radio-Electronics has a vested interest in not losing the advertising dollars we earn each year from correspondence school advertising. But we have an even greater interest in the future of our country and the careers of its veterans. If you agree with our viewpoint, it is urgent that you contact your Congressmen immediately. Let them know that you do not want them to take this extremely important benefit away. Write a letter, a mailgram, or send a telegram right now. Tomorrow could be too late.

Larry Steckler

LARRY STECKLER
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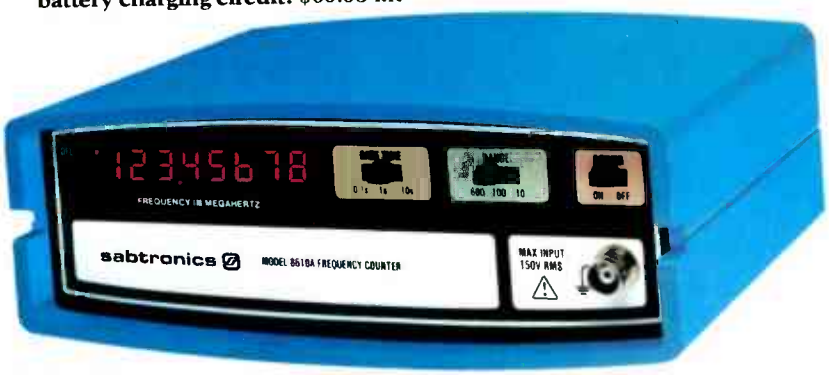
Also available Model 8110A, same as 8610A except maximum frequency is 100MHz and without battery charging circuit: $69.95 kit



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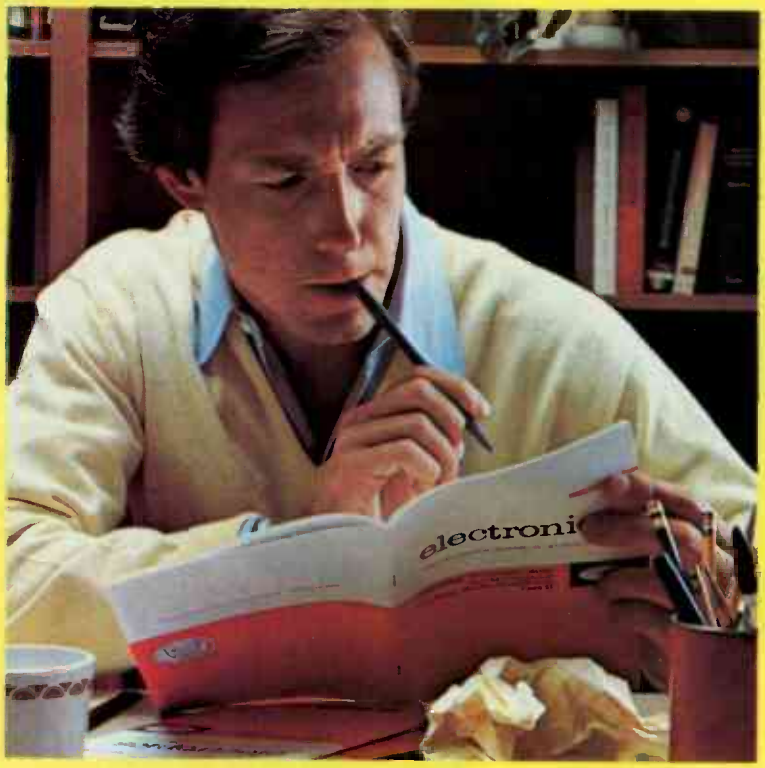

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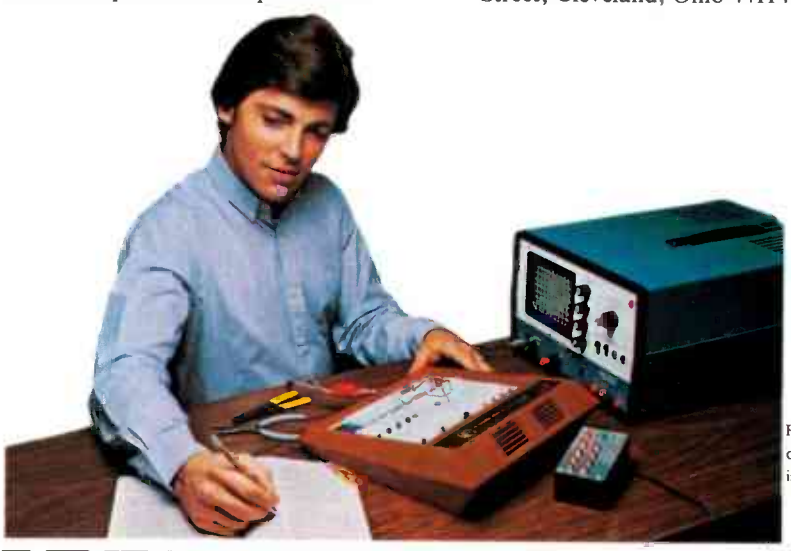

Pattern shown on oscilloscope screen is simulated.

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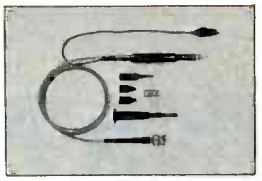

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letters

AUDIO POWER LEVEL METER

The Audio Power Level Meter (February, 1980 issue) can be modified to show about twice the dynamic range (55 dB) for those who like "dancing lights" down to background power levels. With 55 dB dynamic range, if the top LED is calibrated to indicate 100 watts, the bottom LED will indicate .003 watt! In this modification, the meter is converted to a single-channel, 20 LED meter, and thus, two are required for stereo. The modification requires replacing R20 with a 1200 ohm, 5%, resistor and R21 with a 4,870 ohm resistor (the previous value of R20), eliminating R15, R17 and the left channel inputs, and rewiring (Fig. 1).

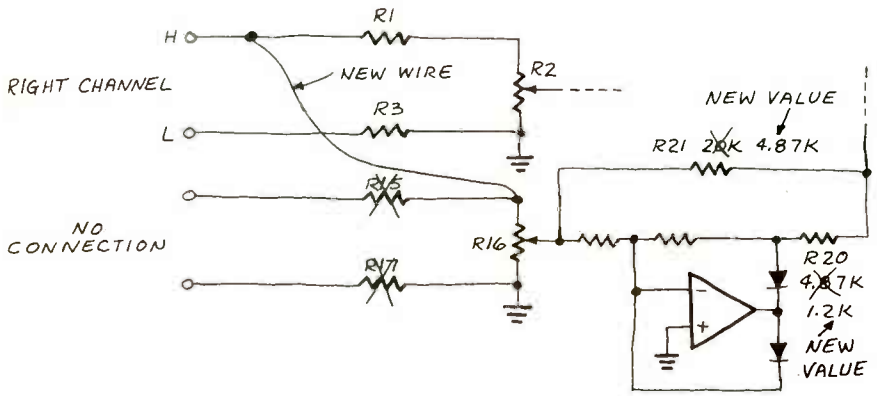


FIG. 1

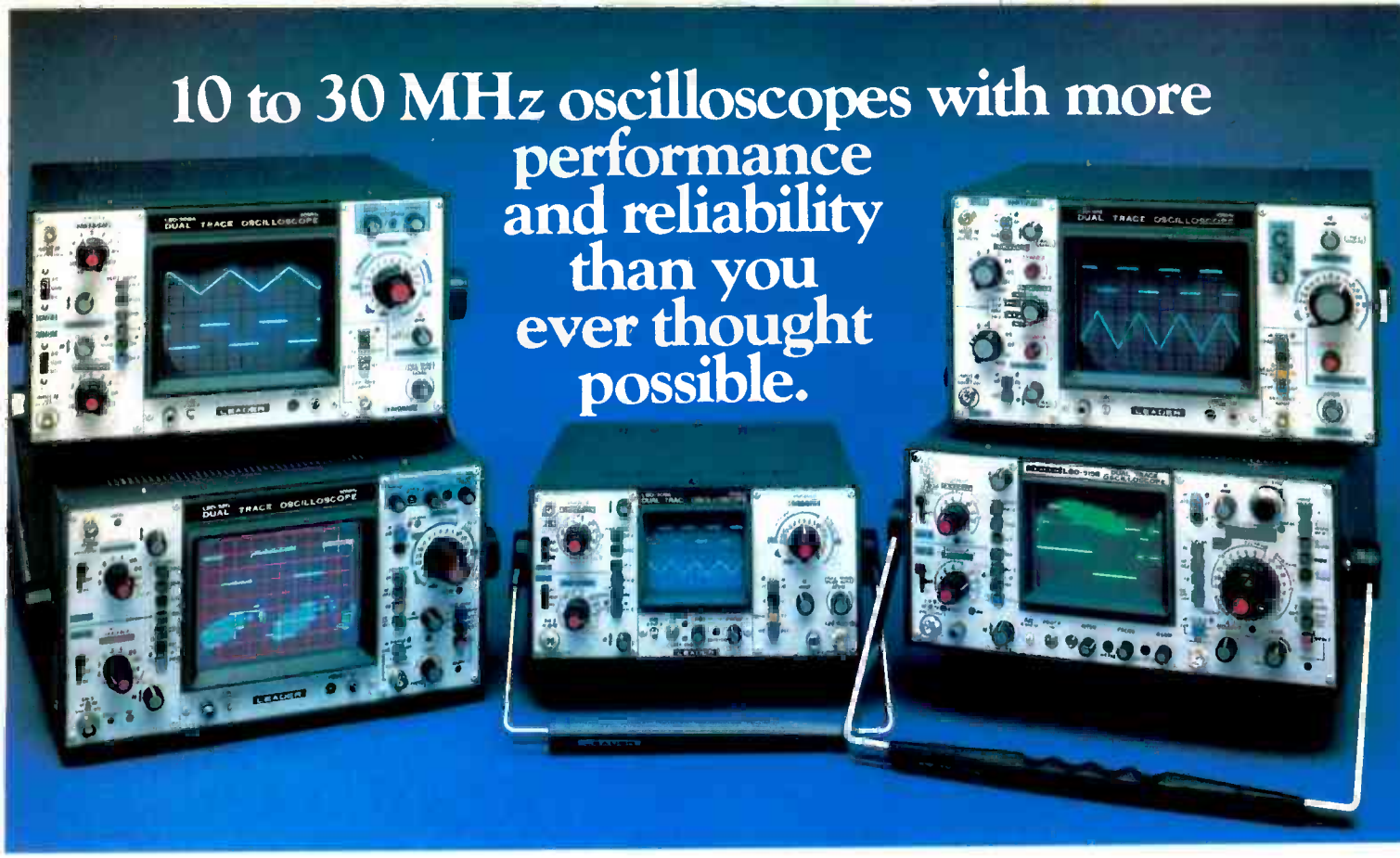
This modification should work with amplifiers capable of 40 watts or more per channel. R2 is still adjusted as described in my article. Adjust R16 by playing music that lights up between 8 and 12 of the LED's and adjusting for a smooth transition from the 10th to 11th LED. (This is hard to describe but easy to do!)

The standard PLM-1 kit can only be used with stereo amplifiers whose outputs include a common ground (virtually all commercial amplifiers). Unfortunately, the Talbot amplifier in your December, 1979 issue does not have a common ground between two output channels, and thus can only be used with two independent PLM's, such as those built with this modification. Also, with this modified monaural PLM, one can be placed on top of each speaker in a stereo system, making it easy for the listener to see.

Discussions with readers has shown me that many people don't realize that the pictures of the PLM-1 in my article were taken from underneath. When turned over, the PLM appears to be in a solid walnut case.

continued on page 32

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



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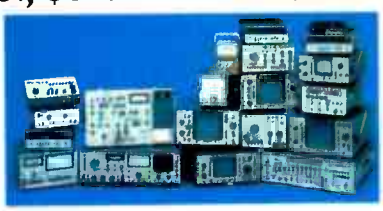

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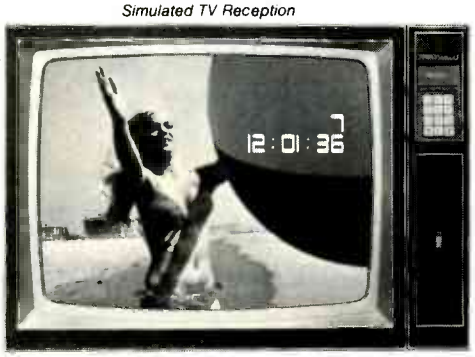

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LETTERS

continued from page 26

The PLM-1 kit is available from Symmetric Sound Systems, 1608 South Douglas Ave., Loveland, CO 80537 for $42 postpaid.
JOE GORIN
Loveland, CO

LIGHT

John W. Ecklin's letter in the March 1980 issue concerns the velocity of light and other electromagnetic radiation. His statement "the speed of light is a constant only to the source and may not be a constant to all observers" is interesting.

Consider first the Doppler explanation for spectrum shifts. That explanation was developed first to explain the changed pitch of sound from a moving source, and was based upon the fact that the relative velocity between sound and its source varies with the motion of the source. The variations caused changes in wavelength to the front and rear which in turn caused the frequency as received to change.

When light was believed to be a wave disturbance moving through an ether substance, it was reasonable to assume a similar effect upon the wavelength of light. After the failure of the Michelson-Morley experiment the wave-ether concept was abandoned. Relativity is based upon the postulate that light moves at a velocity which is an absolute constant, regardless of the motion of the source or receiver. If that is correct, the wavelength of light from a moving source must be the same as if the source were motionless, and no spectrum shift could occur. Spectrum shifts may result from a change in either wavelength or frequency as received, and neither wavelength or frequency can change under the absolute constant velocity concept.

My reasoning suggests the following: A) We cannot reconcile the Doppler explanation and the absolute velocity concept. B) We cannot return to a simple wave concept because of the failure of the Michelson-Morley experiment. Therefore the only concept which will explain both the results of the Michelson-Morley experiment and spectrum shifts is the particle-photon concept of light. Under the photon concept, we may assume that light moves in full accord with Newton's principles of motion for particles of matter. If so, the addition-of-velocity principle will explain spectrum shifts as due to changes in velocity which change the frequency of light as received. Also when the Michelson-Morley experiment is re-analysed, assuming that light moves as a particle, the failure to detect an interference pattern is in agreement with the particle concept.

Measuring the velocity of light photons is not sufficient to test this matter; what is required is an experiment which will compare, simultaneously, the speed of light from a stationary and a moving source.
M. J. IRESON
Sechelt, British Columbia, Canada

FCC CERTIFICATION

Regarding the article by Greg Grambor entitled "Servicing Communications Equipment" (May Issue). Mr. Grambor is under the assumption that there is a "required-by-law frequency and modulation certification" that must be performed yearly. What he does not realize is that on September 9, 1976 the Federal Communications Commission put into effect the deregulation proposal of Docket 20665, which eliminated required annual measurements of transmitter power, frequency and modulation. The responsibility of keeping the equipment in compliance with FCC specifications now rests entirely with the user, allowing him to decide when to check the equipment. So contrary to Mr. Grambor's statement, each radio will not generate at least one service call a year.
STEVEN L. NELSON
Webster, MN

With apologies to reader Nelson and others for my coming across a bit of stale source material, I stand corrected. However, it is important to note that, in principle, the idea of every piece of communications equipment generating at least one service call per year remains the same. In the words of Mr. Mannino, the gentleman I interviewed for the article, ". . . any good contractor will advise his customers to have a frequency and modulation check done annually, even though no longer mandated by law. It is both in the interest of the license holder, and good business for the service shop."—Greg Grambor

EINSTEINIAN IMPOSSIBILITIES

In reference to the letter by Anthony Hans Klotz on page 22 of the April 1980 issue: Mr. Klotz has expressed a very common misconception of Dr. Einstein's theory

continued on page 36

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LETTERS

continued from page 32

of Special Relativity. **Radio-Electronics**, unfortunately, has given credence to that misconception by allowing Mr. Klotz's letter to appear without comment. May I explain?

A woman stands beside a highway. A man in an auto drives past her at a constant speed. The speedometer in the auto indicates 60 mph.

The woman, looking at the auto, sees it zip past her. The man, looking out the window of the auto, sees a woman zip past him.

Which of those two observers is correct? The woman says an auto drove past her at 60 mph. The man says he looked out the window of the auto and saw a woman zip past him at 60 mph.

In everyday life, we *automatically assume* that it was the woman who was at rest and that the man in the auto was the one in motion. In our day-to-day affairs, such as assumption causes no difficulties, However, when such an assumption was extended to the realm of atomic particles, with their small masses and very high velocities and energies, the assumption rapidly caused severe problems and obvious miscalculations. What to do?

Dr. Einstein provided the answer. He showed with mathematical precision that *both* the man and the woman are equally correct. It is no more correct to say that the woman was still and the auto in motion than it is to say that the auto was still and the woman zipped by, unless . . .

Unless a third, *independent observer* is introduced. For example, an astronaut on the moon might look at the man and woman (imagine he has a super-telescope) and say: "Yes, the woman is standing on the earth and the man in the auto is moving over the earth's surface." Thus the motion of the man and woman must be judged *relative* to an observer. Even then, the motion is only relative to that one observer. For example, if the man and the woman were judged by a pilot flying a helicopter at 90 mph in a direction opposite to that of the auto, the pilot's observation would be quite different from that of the astronaut. (The pilot would have to say that the woman was moving past him at 90 mph, while stating that the man in the auto was passing him at 150 mph.)

Returning now to Mr. Klotz's letter, which concerns light beams moving relative to two observers, with one observer moving and the other at rest—Mr. Klotz comes to the conclusion that Dr. Einstein's logic is invalid.

But the argument is deficient in two respects. First, Mr. Klotz cannot have two moving observers (a reference frame, and M' in his notation) without an *additional observer* to whom such motion would be relative. To speak of a "moving reference frame" is self-contradictory, as the reference frame, by definition, is arbitrarily considered stationary, in order to judge the motion of the other objects. If a reference frame is indeed that, and is also assumed to be in motion, then two separate problems are being combined invalidly.

Mr. Klotz's second deficiency is in the use of lightbeams in a contradiction of simultaneity. Dr. Einstein had theorized that the speed of light is a universal constant. It is the same relative to any and all observers. In one of the most famous experiments in all physics, Dr. Albert Abraham Michelson confirmed that theory: It is an experimental fact.

To appreciate Dr. Michelson's work, assume that two spaceships are rushing toward each other at ¼ the speed of light. One of them is emitting a beam of light while the other tries to measure the speed of that beam.

Now assume that the two spaceships are rushing away from each other at ¼ the speed of light, and again one emits a beam of light while the other measures its speed. What results are obtained?

One might assume that the measuring spaceship would measure the light beam at 1¼ times the speed of light when the ships are approaching, and at ¾ the speed of light when they were retreating. Not so. The speed of light would be read exactly the same in both cases. As said, experimentally confirmed.

Perhaps the simplest way of putting it is this: When Dr. Einstein published his famous papers, it was the year 1905. The ideas he presented therein were called theories. It is still common to refer to them as "theory," though most all of them have been confirmed time and again by direct experiment. Indeed, no modern atomic particle accelerator could function unless its design took Dr. Einstein's "theory" into account.

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equipment reports

The Defender TS-1 CB Antenna Tuner/Monitor

CIRCLE 101 ON FREE INFORMATION CARD

ONE OF THE LEAST UNDERSTOOD PARTS OF A CB station may possibly be the antenna system. There seems to be a general idea that if you go out and buy a new antenna designed for operation on all 40 channels, then you should expect equal efficiency at each channel chosen for your favorite operation. Not so! In most cases an antenna can operate at its best on only one particular channel and as one moves farther and farther away from that design point, there is a loss of efficiency. That has been noticed especially in mobile units when checking for proper tuning of the antenna and you have found it difficult to get a good SWR reading across the entire band. In most cases you have had to accept a compromise adjustment.

The *Defender TS-1* is designed to allow you to squeeze every last bit of power out of your base rig. It operates by making it possible to adjust your antenna system to the point of optimum match with your transmitter. In other communication fields, that type of unit has been called by various names but it really is an antenna tuning unit. There have been some "add-on" items available for CB, but the *Defender* has built the tuner into an attractive wood-grained cabinet. In addition to the antenna tuner, the *TS-1* also contains a built-in power meter capable of operation on either 5 or 50 watts, an SWR (*S*tanding *W*ave *R*atio) bridge, a modulation meter, and a handy antenna selector switch. The *Defender* is manufactured by The Shakespeare Co., Inc., Columbia, SC 29202.

In operation, the *Defender* is connected to the CB rig through a short piece of 50-ohm coaxial cable and the station antenna is connected to either one of the two antenna connectors on the rear panel of the unit. The unused connector can be terminated in a dummy load (supplied with the *TS-1*) or to a secondary station antenna. At that point, all further adjusting or measuring is accomplished with the front panel controls. For instance, if you wish to check the power output of the transmitter quickly, all that need be done is to set the antenna switch to the position the dummy load is connected to, press the button marked POWER, and read the output power directly on the meter face. Calibration is from 0-5 watts.

By setting the antenna selector switch to the position that connects the antenna to the rig you are now ready either to check the SWR of the system or to continue communicating. Assuming that you would want to test the SWR, all that is required would be first to press the FORWARD button, and adjust the METER ADJUST control for full-scale reading on the meter while keying the transmitter. Then press the REVERSE button (still holding the transmitter in the keyed position); the meter will now indicate the SWR value. The center scale is used for that measurement and is coded in bright red when the SWR exceeds 3 to 1. Of

continued on page 40

continued from page 38

course, if you are using two (2) antennas connected to the DEFENDER then you could press the selector switch and check the SWR of the secondary antenna. The SWR reading is a good indicator of the efficiency of your antenna system.

The *Defender* will also allow you to tell at a glance just how much "talk-power" your rig is delivering. That function is accomplished by the built-in modulation checker. While keying the transmitter but not talking, press the SET button and adjust the METER ADJUST control for a reading of 100% on the meter. Now, by pressing the TEST button and speaking into the microphone, you will note that the meter will indicate a reading that should increase the louder you speak. The percentage of modulation is checked by using the bottom scale of the meter. Remember, whenever you exceed the 100% reading while speaking into the microphone, your audio quality will be degraded, and distortion will be noticeable on your signal. The *Defender* operating manual suggests that you constantly monitor the percent modulation at all times in an attempt to keep your voice at the level that will provide the best talk-power on the air.

And now, we come to the antenna-tuning capabilities of the *Defender TS-1*. To make your antenna sytem present the best load possible to the transmitter, tune your rig to the desired channel and depress the SWR REVERSE button. Set the ANTENNA MATCH switch to the IN position, key the microphone (don't speak), and adjust the TUNE control until a reduction in the SWR reading on the meter is noticed. When you have found the point of minimum reading, adjust the LOAD knob until once more the reading on the meter is at minimum. By repeating each of those two adjustments—the TUNE and the LOAD controls—until no further reduction is obtained, you may get close to a perfect 1-to-1 match. To check, measure the SWR and you may be happily surprised to find that it is much lower than that which was previously measured on that particular antenna. The match will be best *only* at the channel in use when you tuned the antenna. If you change the operating frequency (channel) then you should either place the matching switch in the OUT position, or, retune the system to the new channel. It should also be pointed out that the adjustment for one antenna will not usually be the same for another antenna. Each time the antenna is changed or there is a switch in the operating channel, to keep the system at optimum, the tuner should be readjusted.

In the model supplied, there is a toggle switch located on the rear panel which allows the *Defender* to be used to make readings up to a maximum of 50 watts of RF power. There are instructions provided for such use. However, all other measurements and checks must be made at 5 watts only.

The *Defender TS-1* is covered by a 1-year limited warranty from the manufacturer. It has specifications that include SWR measurements of 3 to 1 and over, power output measurements of 5 and 50 watts, modulation to 125% can be checked and the antenna tuner can match a 4-to-1 system to provide an SWR of 1.5 to 1 (or less).

In an actual test of the *Defender*, we were able to match two different antenna systems that initially had SWR readings of almost 3 to 1. We obtained an almost perfect match for both antennas. It should be noted that your system may vary from what we obtained. However, if the SWR in your system is reduced by even a small amount, there can be little doubt that your system is providing a more potent signal. And, isn't that really what you are attempting to do in the long run? **R-E**

IET Model RCS-500 R-C Substitution Box

ANYONE WHO HAS GONE THROUGH THE AGONY of trial-and-error component substitution by the "one-at-a-time" connect and disconnect method will appreciate the convenience of the *Model RCS-500* resistance/capacitance substituter from IET.

The *RCS-500* is actually a combination of two separate resistance and capacitance substitution boxes available as the *models RS-200* and *CS-300*.

continued on page 42

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EQUIPMENT REPORTS

continued from page 40

The substituter features thumbwheel selection of values, independently obtained from either the resistance or capacitance side of the instrument through separate terminals.

The real beauty of such an instrument is, of course, the capability of dialing in virtually any resistance or capacitance imaginable.

The resistance portion of the box is accurate to 1%. All resistive components are ½-watt units, serially tied, allowing for a selection in 1-ohm increments from 1 to 9,999,999 ohms. Residual circuit resistance is 0.4 ohms.

The resistance thumbwheels are conveniently separated and labelled as ohms, kilohms, and megohms. Thus, no mental gymnastics are necessary—merely dial it up and read it!

The capacitor portion of the substituter is just as simple to use. The thumbwheel switches on that side of the instrument are labelled in microfarads, nanofarads, and picofarads.

Capacitance selection begins at 100 picofarads, incrementally advancing in 100-picofarad steps to a maximum value of 99.9999 microfarads. All capacitors below 10 microfarads are rated at 100 volts; those above 10 microfarads will tolerate 25 volts.

Capacitors are parallel-tied, with a residual circuit capacitance of 30 picofarads. Capacitors in this section are specified at 4% tolerance. We decided to check their actual values to see whether they are really that close. Electrolytic capacitors are especially notorious for drifting away from their rated value, and electrlytics are typically rated below their actual capacitances.

Checking the specifications

The instrument we used to check the capacitors was IET's own *CM-500* autoranging digital capacitance meter, certified earlier as being accurately calibrated.

Below 10 microfarads, the capacitors in the RCS-500 were well within tolerance, with most measuring ± 2 to 3 percent. At 10 microfarads and above, tolerance fell back a little, as was expected, to an accuracy of between 7 to 8 percent. Still, that is better than the usual +50% found on many electrolytics!

Internally, the circuit-board assembly and layout shows the care we have found to be typical of IET craftmanship. The cabinet is high-impact plastic, heavy-duty thickness, and all functions are clearly labelled.

The *model RCS-500* measures 7.40 × 4.33 × 2.36-inches and weighs a mere 14.5 ounces. While the *RCS-500* (or the separate resistance and capacitance boxes) are certainly adequate for the vast majority of applications found in servicing and prototype design, a new series of tight-tolerance substituters has been announced. The *RX-201* resistance box uses 0.1% resistors, while the *CS-301* capacitance box features 1% capacitors.

But for most of us, the accuracy of the *RCS-500* resistance/capacitance substitution box is more than adequate.

Remember that when you use a substitution box certain precautions must be taken: Voltage ratings for the capacitors must not be exceeded; nor should switches be continually flipped among high-capacitance values which are connected across B+. That will produce arcing which could gradually break down the contact surfaces of the thumbwheel switches. Also, don't forget that excessive current-flow through resistors will cause them to heat up, often permanently changing their resistances if not totally destroying them.

Properly used, an R–C substitution box of the quality of the IET unit will offer years of trouble-free service. The RCS-500 digital resistance/capacitance substituter sells for $185.95. For further information, write IET Labs, Inc., 761 Old Country Road, Westbury, NY 11590. **R-E**

Datong Model AD-170 Active Antenna

MILITARY RECEIVING INSTALLATIONS HAVE used active antennas for years. Recently, their high performance and reasonable cost have caught the attention of many shortwave listeners. Several manufacturers now offer variations on that unique antenna principle.

Datong, a British firm, offers the *Model AD-170* indoor receiving antenna system that is designed for continuous coverage from 60 kHz through 70 MHz. It consists of several interconnecting parts: antenna preamplifier, wire dipole elements, interface unit, interconnecting cable and power supply.

In application, the wire dipole is suspended

horizontally as high as possible indoors. An attic space, away from electrical wiring or metallic mass, is ideal. The manufacturer advises the user to experiment with a number of mounting configurations, both in direction and polarity. In some cases, vertical mounting of the elements will work better than horizontal mounting.

The *AD-170* is designed to feed its signal into a receiver's 50-ohm antenna input. An AC adapter that comes with the unit supplies 12-volts DC at 120 mA. The antenna preamplifier is not waterproof, so a protected installation is required. Transmission line length is only 15 feet, requiring indoor use.

Internally, the *AD-170* is nicely laid out. Components are carefully hand soldered onto a glass epoxy circuit board.

Specifications of the antenna system are impressive. Third-order intermodulation products are typically −90-dB relative to 100 mV. Second-order intermodulation distortion is −80-dB relative to 50 mV. Response is essentially flat over its operating frequency range.

The received signal "sees" the *AD-170* as a high-to-low impedance converter, capacitively coupled to the signal as 12 picofarads. A switchable preamplifier allows an additional 12-dB gain that is to be used for weak signal reception.

Although the *AD-170* is very short (10 feet dipole length), it is equivalent in performance to a full size 16 MHz half-wave dipole. At higher frequencies, performance increases at the rate of 6 dB-per-octave. Below 16 MHz the gain decreases at the same rate, 6 dB-per-octave as compared with a full size half-wave dipole at the frequency of interest. It is easy to see that although the response of the *AD-170* is down 18 dB at 2 MHz, a full size 2-MHz dipole would be 250-feet long. This much wire is entirely unnecessary to capture adequate signal for modern high-sensitivity shortwave receivers. In fact, broadcast-band interference would create a real problem with intermodulation in most cases. An antenna needs only to be long enough to present a signal of high enough intensity to override system noise.

We decided to test the overall performance of the *AD-170* against a 66-foot reference dipole. The dipole was approximately 15 feet above the soil and the *AD-170* was mounted only 8 feet high. Both antennas were mounted in the same direction to cancel directional effects.

A McKay-Dymek *DR-33C* receiver with a calibrated S-meter was used as the broadband receiver. The antennas were switched through a Daiwa *CS-201* UHF coaxial antenna switch. The receiver was tuned to dozens of signals throughout the 100-kHz to 50-MHz range. In virtually every case, the *AD-170* was clearly superior to the dipole, often by 10 or 20 dB, sometimes more. The only times that the large reference dipole was ahead was when it was receiving signals near its self-resonant frequency, and even then the difference was only about 5 DB.

Use it as an RDF

As an experiment, we connected two 5-foot lengths of lightweight aluminum rod to the preamplifier. That dipole was then rotated while monitoring a variety of signals throughout the spectrum broadcast through CB. The directional effects were quite pronounced. Variations on that arrangement will probably occur to readers who are interested in erecting a wide frequency coverage direction-finding antenna. The system would also be valuable for nulling out interference.

We would recommend two improvements to the manufacturer. One would be the availability of a coaxial-cable extension so that the line can be run less directly for cosmetic reasons. Connectors on the interconnecting cable are European, and difficult to find in this country. The second would be a weatherproofing kit consisting of a plastic housing for the little preamplifier and its terminals.

We found the *AD-170* to be thoughtfully designed, competently engineered, and reasonably priced. For the apartment dweller, or for the SWL who doesn't have an enormous amount of real estate to erect a large dipole, an active antenna like the *AD-170* is hard to beat. The *AD-170* active antenna system sells for $89.00. Available from Gilfer Associates, P. O. Box 239, Park Ridge, NJ 07656. **R-E**

Micronta BP-1 Blood-Pressure Tester

SEVERAL YEARS AGO, MEDICAL EXPERTS BEGAN to realize that premature death might be largely avoided if a certain number of telltale signs were heeded. Those "risk factors" included, among other things, obesity, smoking, stress, and blood pressure.

It is a well established fact that high blood pressure (hypertension) is a major contributor to a shortened life span. Fortunately, it is easily diagnosed; unfortunately, too few Americans bother to have it checked.

Traditionally, blood pressure (BP) is tested by a gadget with the fancy name, sphygmomanometer. That is the familiar inflatable cuff

continued on page 44

EQUIPMENT REPORTS

continued from page 43

aparatus found in every doctor's office, ambulance, clinic, dentist's office, and even some American homes as well. It works in a manner similar to a barometer. The inflated cuff blocks circulation in an artery of the arm, and the meter indicates the amount of pressure necessary to cause the stoppage.

CIRCLE 104 ON FREE INFORMATION CARD

Each time the muscular lower chambers of the heart contract (systole), the forward surge of blood builds up pressure in the arteries. Between beats (diastole), the pressure drops lower. A comparison, or ratio, between the systolic and diastolic pressures is the familiar fraction used to indicate blood pressure. An average, healthy adult might show a blood pressure of 120/80. This means that during the increased pressure of the heart beat, the pressure in the vessel is equivalent to a column of mercury 120 millimeters in height. Between beats, the pressure drops to an equivalent of 80 millimeters of mercury. In fact, the older sphygmomanometers used a column of mercury as the indicator.

Most present-day blood-pressure measuring devices display their measured pressure on a calibrated dial. That instrument is similar to an aneroid barometer.

The use of any conventional blood-pressure tester requires a two-step procedure. First, the cuff has to be wrapped and inflated. Second, a stethoscope is required to detect the cutoff pressure so that the readings can be taken. It is very difficult for an individual to measure his own blood pressure when working under such an arrangement.

Now, Micronta has released a "do-it-yourself" blood-pressure tester available from Radio Shack. The pressure cuff is still there, but it is equipped with a buckle and Velcro combination that makes one-arm application easy. A white dot on the cuff shows the proper location for the artery at the elbow joint of your arm. Under the dot, a small pressure transducer monitors the blood pressure, signalling the electronic circuitry in the instrument.

As with older stethoscope units, the cuff is inflated until arterial pressure no longer supplies an increase of systolic pressure. On the Micronta *BP-1*, that is indicated by an audible "beep" as well as a flashing red LED. A thumb-operated pressure-release button is then activated to reduce pressure until the beep is no longer heard, and the light ceases its flashing; that indicates diastolic pressure. Those two points are read on the gauge, and recorded in the usual fashion. A handy printed

continued on page 84

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Once you learn, in about 30 minutes, how to use the Hieronymus Machine, you will be able to discover whether a person is calm or stressful — merely by monitoring his or her voice.

DEFINITELY NOT A "LIE DETECTOR"

The Hieronymus Machine is not a lie detector. Nor is it a "truth" device. Even the famed polygraph machine is not a lie detector, plain and simple. The polygraph can be used to monitor a person's pulse, respiration, blood pressure, and galvanic skin response, bodily functions affected by stress.

And in the hands of a skilled operator, the polygraph can be used to gain insights about a person's stress levels when talking about certain topics. But a very real part of the polygraph's usefulness is the "Hieronymus Effect," which we'll get to in a moment.

SPIES AND COUNTERSPIES

During wartime, counterintelligence experts wondered if science could come up with something simpler than the polygraph to help ferret out spies. Researchers became attracted to the theory that human voices emit "micro-tremors," low-frequency vibrations that are generally inaudible or masked by other voice components.

An article in **Popular Electronics** (April 1980) describes the theory in detail. But the short story is that after spending millions of dollars, researchers developed a voice stress analyzer. Now, the authors of the definitive article in **Popular Electronics** have perfected a personal voice stress analyzer, which we call the Hieronymus Machine.

WHAT IT DOES, HOW YOU USE IT

The Hieronymus Machine electronically measures changes in voice micro-tremors. The read-out is simple: one red diode indicates normal, two show moderate stress, and three reveal greater stress, ranging from mild to severe anxiety.

You, as the operator, could use the Hieronymus Machine like a thermometer, checking the "fever level" of stress. As you gain skill, your judgment will improve, enabling you to pursue or avoid a line of questioning or discussion that produces stressful responses.

MANY USES AT HOME OR WORK

You can use the Hieronymus Machine at home to have fun with your family. You'll discover how it responds to different people's voices, what effect laughter and singing have on it, and even evaluate politicans' speeches over TV or radio. It works quite well on transmitted voices, as well as over the telephone or with tape recordings.

Next, try it on friends. See how well someone's favorite fish story holds up when you point out that the Hieronymus Machine doesn't believe a word of it. And watch that poker face disappear as the "stress" diode steadily insists you're not getting the whole story.

BIOFEEDBACK FOR YOU

If you're required to talk in front of groups or need to speak convincingly to one person at a time, you can use the Hieronymus Machine to monitor your voice and learn a more relaxed, self-assured, persuasive style of delivery. If you wanted to learn hypnotism, a relaxed voice would be a real asset — and the Hieronymus Machine could help you achieve it.

At work, there are numerous situations in which the Hieronymus Machine could work wonders. Here's how: Hieronymus Bosch was a 15th-century painter known for his startling originality. He was also something of a medical practitioner, and he believed that patients could be cured by passing stones over their bodies. Bosch achieved success because his patients **believed** that a cure was taking place.

Nearer our own time, a couple of science fiction writers concocted a devise they named after Bosch: it produced varying sensations in the user depending on where a dial was set, from zero to 100. The amazing thing was that this machine worked on subjects even when it wasn't plugged in — a perfect Hieronymus Effect!

Now we have a true Hieronymus Machine, the Voice Stress Analyzer. It actually works, and among other things of a scientifically verifiable nature, it produces the Hieronymus Effect. In its presence, people suddenly become more forthright. In some cases, with such a machine present, employees being asked about office theft became very cooperative in answering questions truthfully. Naturally, you'll want to use the Hieronymus Machine in plain sight and tell people what it does. This actually gets more cooperation from them.

30-DAY TRIAL, MONEY-BACK GUARANTEE

The potential uses of the Hieronymus Machine are limited only by your imagination. Try it at no risk for 30 days. We'll send you one or more with complete instructions (9v. battery not included). You'll be able to try it, experiment, even conduct your own "investigation."

Governments and police departments and huge corporations are already using large (briefcase-sized) versions of this kind of machine, and they have to pay $3,000 or so for theirs. But you can have a personal Hieronymus Machine for only **$119.95.** If you're not satisfied, send it back (insured) for a full refund, no questions asked. If you want two, the cost is **$109.95** each. And if you want three or more for business use, it's only **$99.95** each. You're also protected by a 1-year parts and labor warranty.

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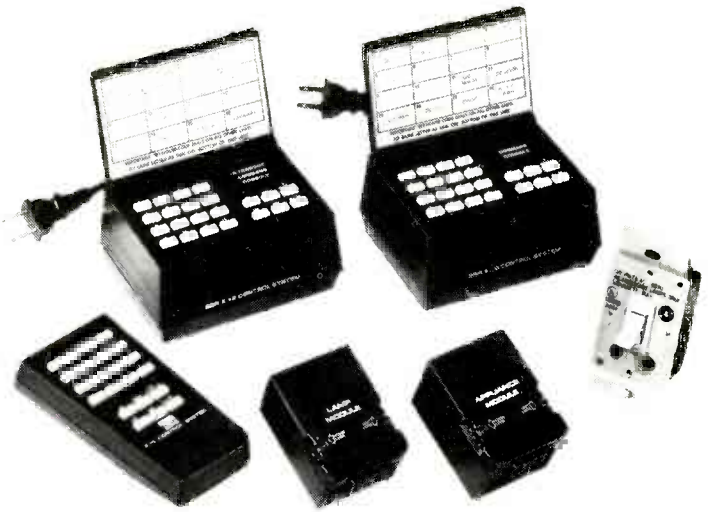
Plug-in Remote Control SYSTEM



LSI technology now brings us armchair control of electrical devices throughout the home. Here's the inside story on how those controllers work.

STEVEN A. CIARCIA*

"SAVING ENERGY AND SAVING STEPS" are two of the basic selling points in the advertising for the BSR *Model X-10* Home Control System. In actuality, the features of this unit combine to make the X-10 one of the most ingenious remote control systems yet introduced to the consumer market.

The X-10 (also sold under the trade names of Sears' *Home Control System* and Radio Shack *Plug'n Power*, and in Europe by Busch-Jaeger Electro) incorporates custom-made IC's that allow the user to turn lights or appliances on or off from the comfort of an easy chair. Typical applications can include such things as turning on the outside lights, the TV, and the toaster oven—all with just the push of a few buttons.

If you are too practical to accept that concept on convenience alone, consider energy and security applications as well. The X-10 makes it easier to turn off extra lights and appliances when you are not using them. It can turn on all lights in the event of an emergency, turn everything off when you go to bed, or dim lights in order to reduce power consumption.

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FIG. 1—PROGRAMMABLE TIMER permits control of lights and appliances without any human intervention.

The X-10 system components

The X-10 system consists of five separate modules: the Command Controller, Cordless Controller, Lamp Module, Appliance Module, and Wall Switch Module. There is also a new programmable timer unit (see Fig. 1) that provides the system with a semblance of automatic control.

The command controller is the central element in the system. It sends commands to the three types of receiver modules by coded messages sent through the AC power lines. The cordless controller is a remote extension of the command controller and has a matching keyboard. When pointed at the command console from up to 30 feet away, any command that is selected on it will be transmitted to the command controller and carried out. The communication between the two units is done ultrasonically.

Lamp- and wall-switch modules are essentially the same. They are triac-controlled on/off switches that include dimmers. The lamp module is plugged into a wall outlet in series with the light to be controlled while the wall-switch module replaces a conventional wall switch. Those units are rated at 300 watts. For heavier, or non-resistive loads, a contact-closure-output appliance module is used. It is rated at 15 amps (about 1700 watts).

Inside the command controller

Figure 2-a is a block design of the command console. There are two versions of that unit on the market. One has the ultrasonic receiver/cordless-controller capability; the other hasn't. An internal view of a controller including the ultrasonic circuitry is shown in Fig. 3. At the heart of that, as well as of the other system components, are custom LSI IC's manufactured for BSR by General Instruments Corporation. Fully expanded, the BSR system can accommodate 256 independently addressable receivers. That is accomplished using 16 sets of addresses called "house codes" and 16 "device codes"

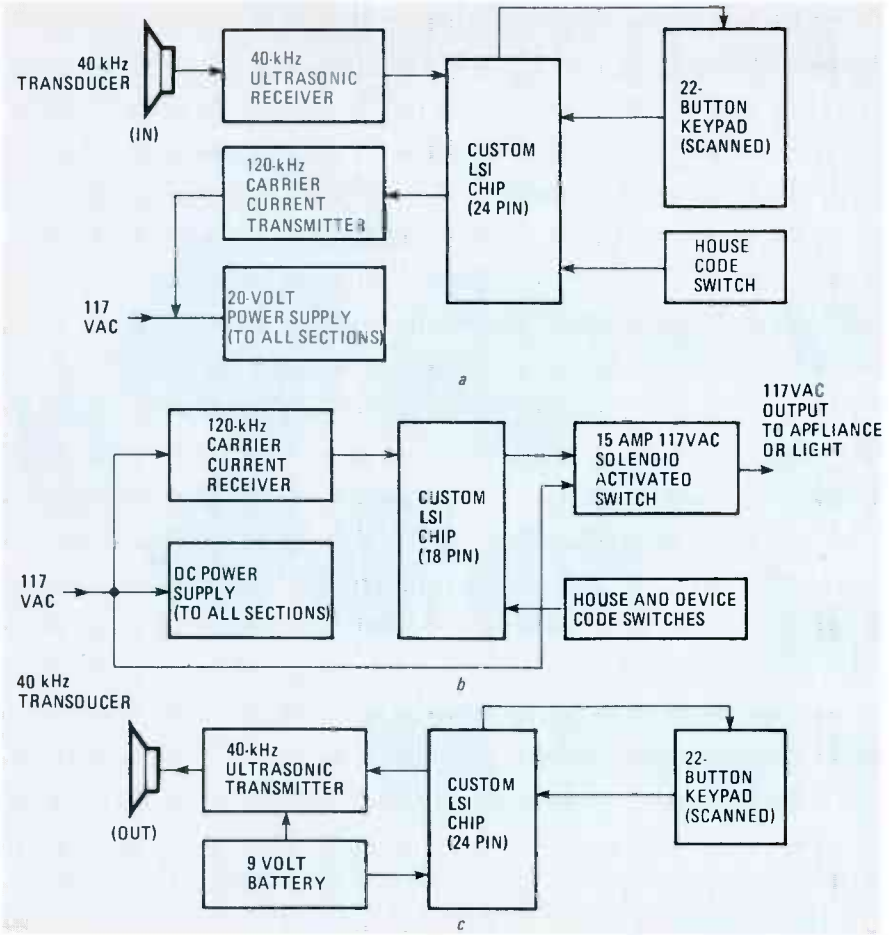


FIG. 2—FUNCTIONAL DIAGRAMS of *a* command module, *b* appliance module, and c remote-control transmitter. Text describes operating principles

FIG. 3—CONTROLLER MODULE, despite its complexity, is surprisingly small—only 4½ × 3½ × 2½ inches.

HANDHELD remote controller uses a single IC to encode and transmit all commands.

ALL COMMANDS available from main console are also found on remote-control keypad.

for each house code. The separate house codes allow next-door neighbors to use X-10's without interfering with each other. A thumbwheel switch on the bottom of the command console sets the 4-bit house code. The keyboard selection determines the channel code. This is shown in Fig. 4 and Table 1.

In normal operation the 22-button keypad, which is wired as a 3×8 matrix, is scanned at a rate of 3.8 kHz. When a button is pressed, its designated function and the house code are combined into a single message. The digital message is directed to the transmitter section where it generates 120 kHz signals that are used to pulse-width modulate the AC line. (See Fig. 5.)

In order to synchronize the digitally-encoded serial output (pin 15) with the 60-Hz AC line, the circuit must include zero crossing detection. That is done by feeding the AC line into the trigger input (pin 12) where the switching point is detected within 100 microseconds of zero crossing. (Incidentally, pin 13 provides for 50- or 60-Hz operation.)

The transmitted message, now synchronous with the line, is clocked, a bit at a time, on zero crossing. A command message contains 9 bits of information consisting of the 4-bit house code and 5-bit matrix (keyboard function) code. Each message is transmitted in true and inverted format on successive half-cycles of the AC waveform. That is illustrated in Figs. 6 and 7. A logic-1 bit is three 1-millisecond bursts of 120 kHz signal commencing approximately 200 μs after the zero crossing of each of the phases. A logic-zero bit is represented by no signal for that half cycle. To synchronize the receivers with the transmitter, a trigger code consisting of three successive logic-1 bits followed by a logic-zero bit is used. The complete message takes 11 full AC cycles (183 ms) to complete.

Actual attachment to the line is by means of a transformer and capacitor coupler. That combination is necessary both for protection and economics. The effective range of this system is generally all the wiring from the controller to the nearest power company step-down transformer. There are usually five or six houses on each transformer and some coordination with respect to the choice of house codes may be

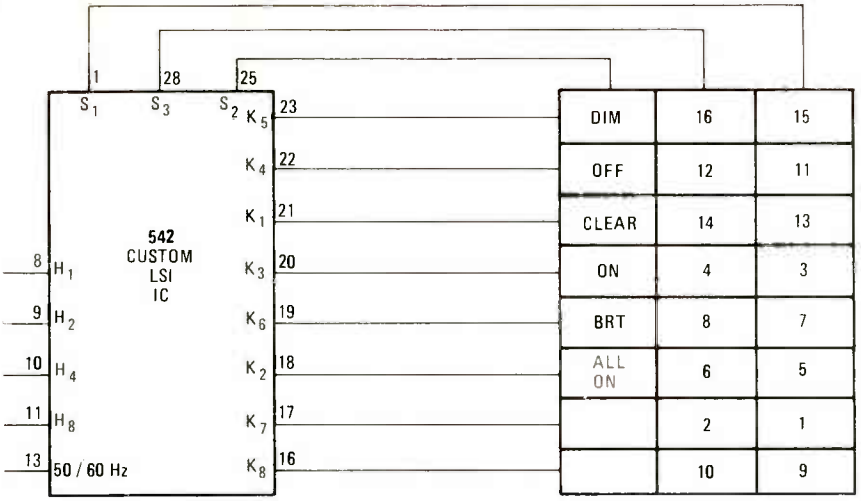


FIG. 4—KEYPAD FUNCTIONS and connections to 542C custom IC. Pin 13 of the IC allows for 50 or 60 Hz operation...at 117 volts AC.

TABLE 1

House Code	H8	H4	H2	H1
A	1	0	0	1
B	0	0	0	1
C	1	1	0	1
D	0	1	0	1
E	1	1	1	0
F	0	1	1	0
G	1	0	1	0
H	0	0	1	0
I	1	0	0	0
J	0	0	0	0
K	1	1	0	0
L	0	1	0	0
M	1	1	1	1
N	0	1	1	1
O	1	0	1	1
P	0	0	1	1

necessary. Also, since the version of the X-10 sold in the U.S. is a 117-volt unit, and most homes derive their 117-volt power from both sides of a 220-volt line, sometimes there can be problems in obtaining consistent operation when receiver modules are used on both the 117-volt lines and relatively few 220-volt appliances are in operation to act as a communication bridge. Placement of the receivers could require some experimentation.

Ultrasonics and the X-10

There is a second method by which the command console designates a control function and transmits instructions. That is through the ultrasonic handheld controller. When a key is pressed, a code is generated and transmitted as a series of 40 kHz tone bursts. The command console, receiving that information through its ultrasonic receiver section and injecting it into pin 7 of its LSI IC, accepts it as if a button had been pushed on the command console. It then adds the house code and retransmits the command message over the house wiring.

Figure 8 and Table 2 show in detail the communication between the two subsystem components. Each of the 22 buttons has a unique 5-bit code. For example, channel 5 would result in a code of 00010 corresponding to bit positions D8, D4, D2, D1, and F respectively. "All lights on" would be 00011.

The actual message which communicates that selection is approximately 100 ms long and comprised of thirteen 8-ms segments. Each segment consists of a burst of 40 kHz directed to an ultrasonic transducer. A logic-1 is a 4-ms burst and a logic-0 is a 1.2-ms burst. To signify channel 5 the cordless controller first sends a trigger bit to alert the receiver in the command console that a message is coming. That is a 40

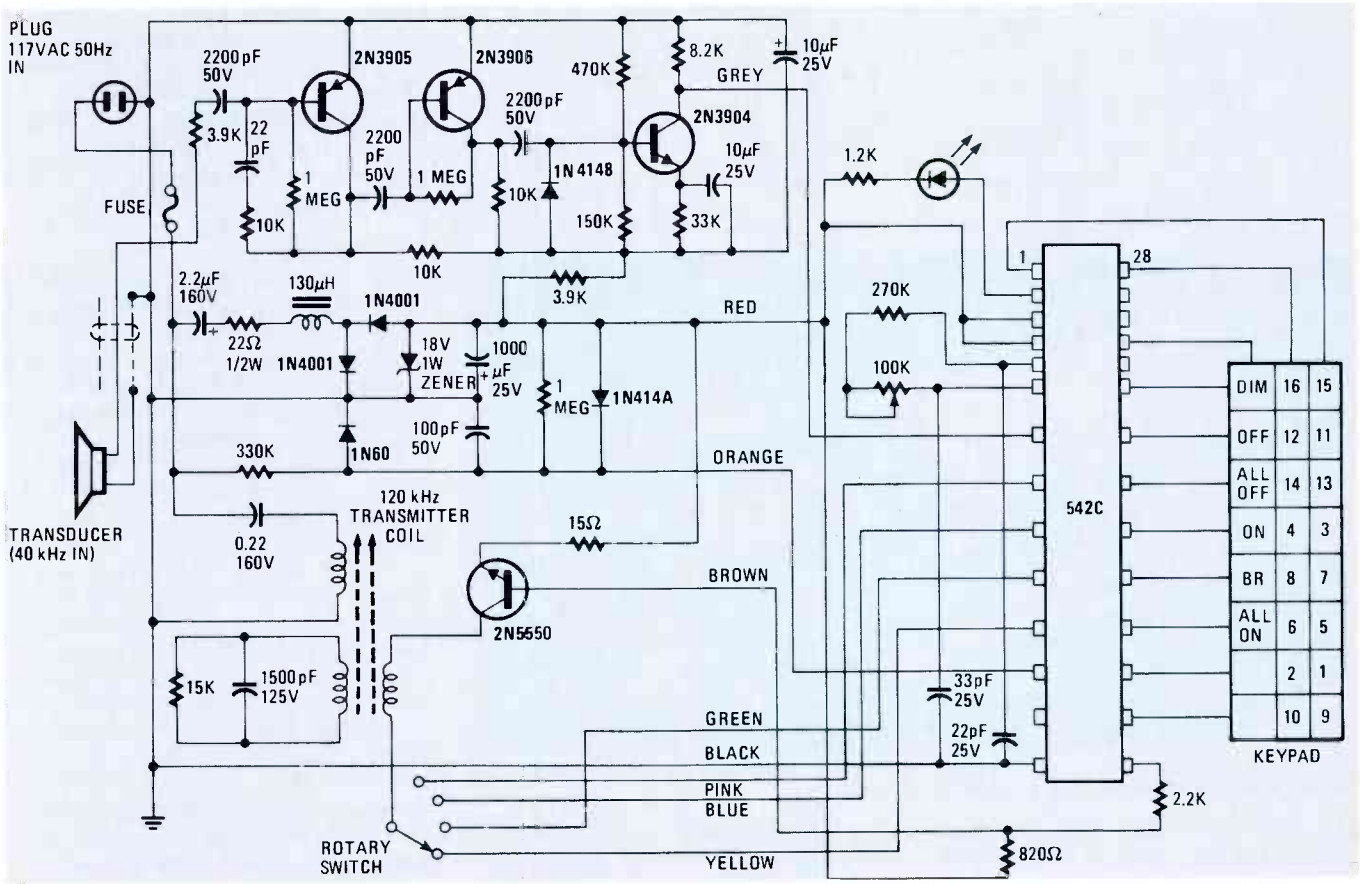


FIG. 5—COMMAND CONSOLE schematic allows you to visualize how information is encoded and transmitted over AC line. Also shown is transducer for use with ultrasonic remote control. (Courtesy BSR [USA] Ltd.)

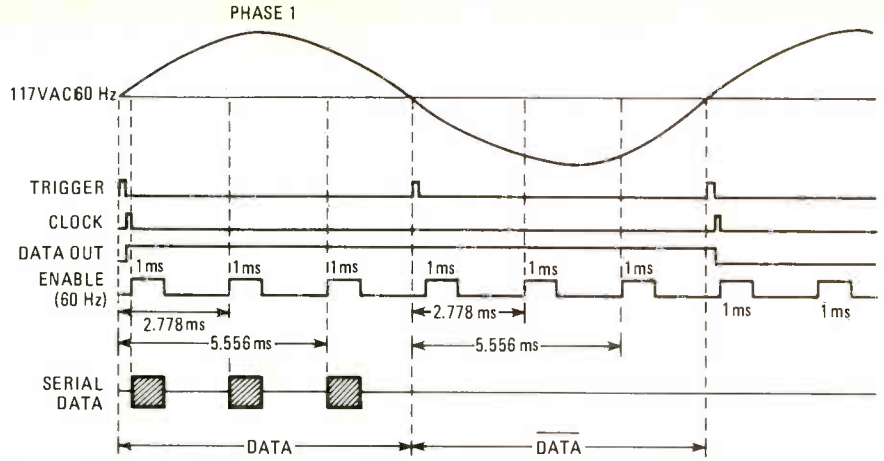


FIG. 6—TIMING DIAGRAM shows how AC line current is pulse-width modulated to transmit information from command console to appliance and lighting modules.

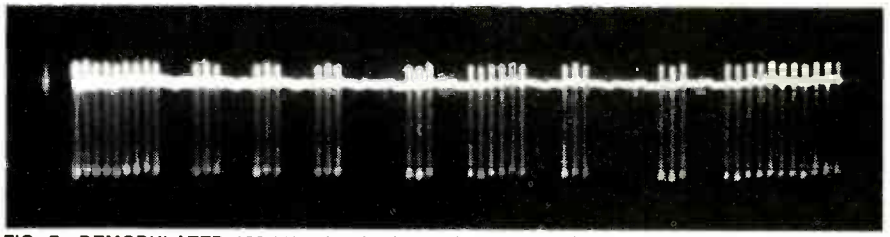


FIG. 7—DEMODULATED 120 kHz signals that make up control message.. The three 1-ms bursts signifying a logic "1" are clearly seen.

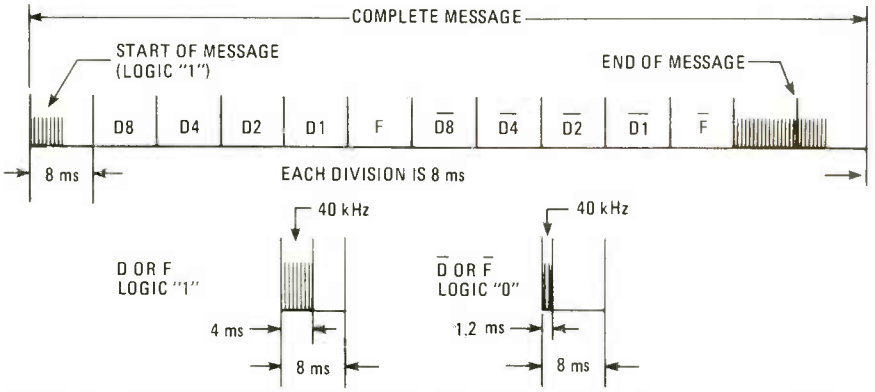
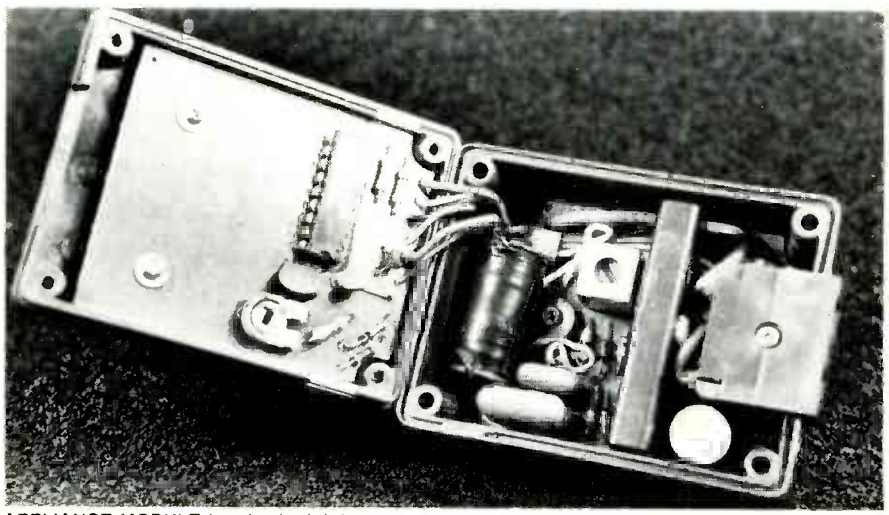


FIG. 8—MESSAGE FORMAT used by the ultrasonic remote controller. Tone bursts are 40 kHz.



APPLIANCE MODULE interior is tightly packed. The solenoid and 15-amp switch mentioned in the text are at the left of the case; the AC outlet at right.

kHz tone for 4 ms. Next, the 5-bit matrix-selection code is sequentially transmitted as a series of 1.2- and 4-ms bursts of 40 kHz signal. It is followed by a transmission of the logical inversion of the previous 5-bit selection code and then a 12-ms "end of message" burst. All messages use the same format—only the 5-bit selection code varies. Also, since the command console already has a preset house code, that is not sent ultrasonically. The handheld controller is limited to operation on the 16 channels of the single house code set on the command console.

The serial-input capability of the X-10 is not limited to use with ultrasonic data transmission. Specific control of the receivers can be accomplished by injecting a digital command message directly into the serial input pin. At least one personal computer manufacturer is marketing an AC remote-control system using this method. Be advised, though, that the X-10 has a live-wire ground and any attachment to it should be done through optoisolators.

TABLE 2

Channel Number or Function	Binary Code				
	D8	D4	D2	D1	F
1	0	1	1	0	0
2	1	1	1	0	0
3	0	0	1	0	0
4	1	0	1	0	0
5	0	0	0	1	0
6	1	0	0	1	0
7	0	1	0	1	0
8	1	1	0	1	0
9	0	1	1	1	0
10	1	1	1	1	0
11	0	0	1	1	0
12	1	0	1	1	0
13	0	0	0	0	0
14	1	0	0	0	0
15	0	1	0	0	0
16	1	1	0	0	0
Clear	0	0	0	0	1
All Lights On	0	0	0	1	1
On	0	0	1	0	1
Off	0	0	1	1	1
Dim	0	1	0	0	1
Brighten	0	1	0	1	1

The receivers

The receiver end of the system is quite sophisticated considering that each receiver costs less than $17. All receivers (lamp modules, appliance modules, and wall switch modules) are essentially the same. A block diagram of an appliance module is shown in Fig. 2-b. Also incorporating a custom LSI IC, the receiver section monitors the AC line, waiting for a coded message corresponding to its unique house code (A through P) and unit device code (1 through 16). To turn on channel 10, one simply press 10 and ON. one after the other. When the appliance module activates, it sounds like a relay energizing. In actuality, the appliance modules use an inexpensive solenoid to operate a 15-amp snap-action switch. The lamp and wall switch modules use a triac instead, and have the capability to brighten or dim in response to control commands. The appliance module has only on/off capability. Schematics of the appliance and lamp modules are shown in Figs. 9 and 10.

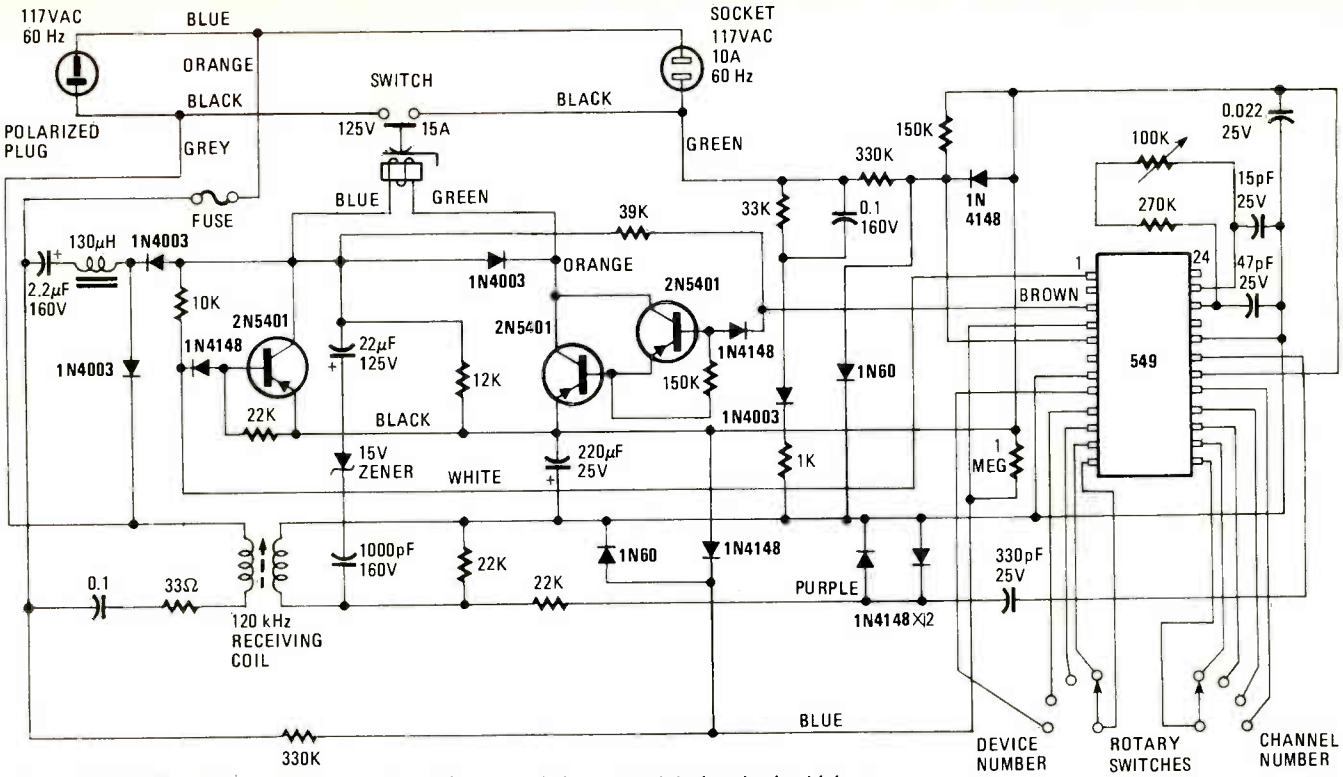


FIG. 9—APPLIANCE MODULE uses solenoid and 15-amp switch to control devices having high current-requirements. (Courtesy BSR [USA] Ltd.)

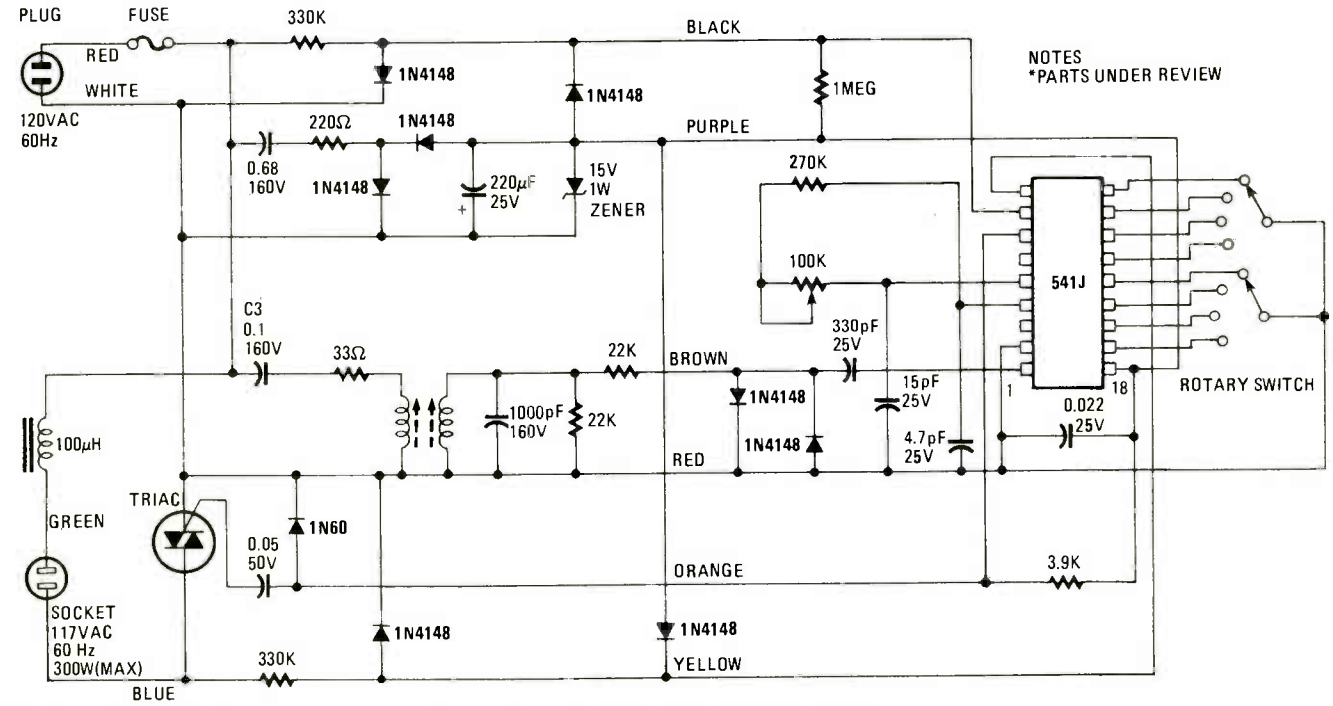


FIG. 10—LAMP MODULE can turn on or off, or dim, resistive-load devices up to 300 watts by means of triac (lower left). (Courtesy BSR [USA] Ltd.)

The next step—automatic control

The X-10 is basically a manual remote-control system. There are however two easy methods to automate the controller's activities. One is the BSR *model TC-201* automatic timer and the other is the BUSY BOX. The BUSY BOX (available from the MICROMINT, 917 Woodmere, NY 11598; 516-374-6793) allows an Apple II, TRS-80, or S-100-based personal computer to control the BSR system.

Security while away from home, and convenience while at home, are two of the benefits that may be provided by using the *model TC-201* automatic timer. By preprogramming on/off times for various lights it is easy to give a house a "lived in" look to discourage intruders. The timer has the capacity to control up to eight lights or appliances and incorporates a built-in green fluorescent digital clock. Each module can be programmed for as many as two "on" and "off" times in a 24-hour period.

We have just barely scratched the surface of potential applications for this system. Convenience is an easy justification for owning the BSR X-10 but environmental, and energy-management, considerations also come to mind. In combination with a computer, the X-10 can bring the concept of computer-controlled living within reach of the average person. **R-E**

HOW TO HOOK UP HOME VIDEO SYSTEMS

CATV converters and VCR's aren't always compatible. Here are ways to get around the problem.

FRANK GATES

YOU HAVE JUST SPENT THIS YEAR'S vacation money on a new video recorder and you are anxious to get it home and hook it up. The dealer assured you that there would be no installation problems—simply follow the directions. He was right as long as you are hooking it up to a conventional house antenna or a 12-channel MATV or CATV system. But what happens if you are a pay-TV subscriber or your cable system offers more than 12 channels? In both situations, some sort of a decoder or channel selector/converter is required for you to be able to receive those additional channels and that is where you start to have installation problems.

You will find that if you want to record the pay-TV channel, you will not be able to watch any other channel at the same time—which defeats one of the biggest features of owning a video recorder. Or maybe you spent a little more for a programmable video recorder and now you find out that the converter or decoder defeats the programmable feature of the recorder. I am going to show you how to overcome those and similar problems, and at the same time get the most out of your home video system.

What is a converter box?

Initially, the most that any cable system could offer its subscribers was 12 channels. That was due basically to two things—line loss with coax cable limited the cable systems to the VHF range of frequencies (or 54-300 MHz) and the home receiver would only tune in 12 of those VHF channels. UHF channels were down-converted to VHF at the cable system's antenna site and then were delivered to the home receiver through the cable system on a locally unused VHF channel. In short order, all 12 available channels were filled with local VHF or UHF stations.

So what happened when the cable systems added more channels? The only way that a home receiver could get those additional channels was through the use of an external tuning device, thus the converter box.

What that device does is enable the home receiver to display the additional cable channels without any modification to the TV set itself. It is simply a tuner/converter that enables you to select manually any incoming VHF channel (54-300 MHz) and convert it to a single conventional VHF channel on your TV tuner (i.e. Channel 3 or 4). In that manner your receiver is able to receive up to 30 or more incoming channels simply by having the converter installed as shown in Fig. 1. With that type of installation, the TV tuner is set to the output channel of the converter box (i.e. Channel 3 or 4) and all channel selecting is done with the converter itself.

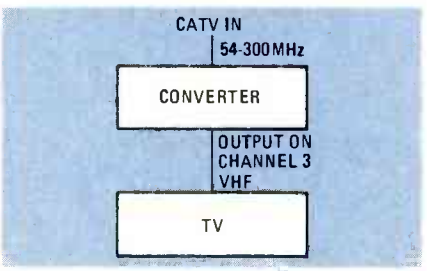


FIG. 1—CABLE-TV INSTALLATION consists of connecting a converter box between the TV set and the cable. The converter outputs all channels on a preselected VHF channel.

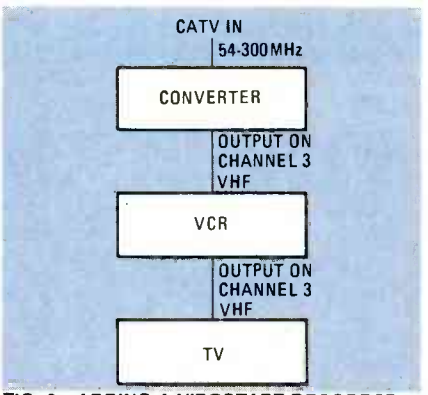


FIG. 2—ADDING A VIDEOTAPE RECORDER to a cable-TV installation consists of connecting the VCR between the converter box and the TV receiver. With that hookup, however, you must watch the same program that the VCR is recording.

Now you install your VCR as shown in Fig. 2. That enables the VCR to record any channel offered by the converter box. Again, all of the incoming VHF channels must go through the converter box and they are delivered to the VCR on the output channel of the converter box, let's say Channel 3. (Notice the absence of any UHF connections. Everything has now been converted to VHF.

On the front panel of the VCR is a switch that is designed to enable you to monitor all record/playback functions in one position and then switch over and view any of the incoming channels in the other position; thus you have the ability to record one channel and view another at the same time. With the setup shown in Fig. 2, record/playback will be OK but when you try to view any other channel while the VCR is recording you will find that you are unable to do so. This is because when the converter box is installed,

there is only one channel available to the VCR, the output channel of the converter box, Channel 3. So when you switch the VCR/TV switch on the front panel to either position, all you can monitor is the output channel of the converter box.

Now take a look at Fig. 3. A two-way coax splitter has been added to the system and a simple A/B type switch. That will enable you to record one channel and view any other channel from Channel 2 through Channel 13 at the same time. The way that this is possible is that when you have the A/B switch on the A side you have basically the same setup as in Fig. 2. The A path from the splitter enables you to record any of the 30 or more channels that are available on the cable system, and then while the VCR is recording and the switch in the B position, you are able to view any of the Channels 2 through 13 that are now available to the tuner on your TV set.

If you wanted full 30-or-more channel capability on the B path of this system, it would require another converter box to be installed between the two/way splitter and the A/B switch. (I recommend that you spend a few extra dollars and get a good quality A/B switch, one with good isolation; that can save you some headaches in the long run.)

What about the decoders?

Decoders are what the pay-TV stations use to insure that their product is only available to those who are paying for it. There are several different methods that are currently being used by the various pay-TV stations across the country but how they encode and decode the signal does not affect the way that their device is integrated into the home video system.

Decoding devices can be treated almost the same as a cable TV converter box! In most cases, the decoder is interchangeable with the converter box shown in Fig. 3. The decoder will have a preselected output channel, probably the same channel as the converter box or the VCR, so the setup in Fig. 3 should overcome any of the same problems that were caused by the converter box.

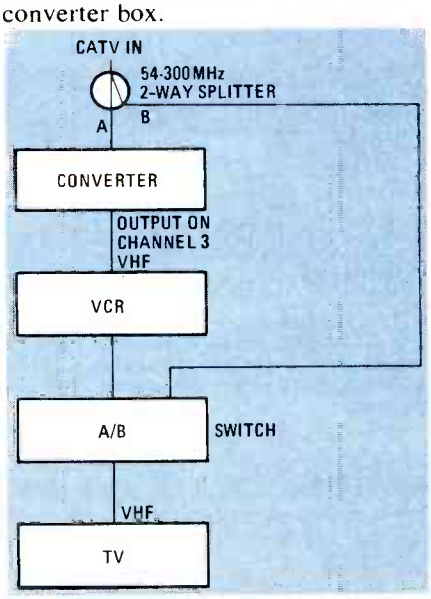


FIG. 3—TWO-WAY SPLITTER AND SWITCH enables you to watch a program different from the one the VCR is recording. However, you can only watch the standard VHF channels.

What about programmable VCR's?

The problem associated with programmable VCR's is common to both the converter box and the decoder. The programmable VCR must have all of the channels available to it on their own separate frequencies for the programmable feature to function properly. If those channels go through any type of converter device (like those that were described earlier), then the VCR's tuner must remain tuned to the output channel of the converter device. None of the installations outlined so far are compatable to a programmable VCR. There are several methods to get around the problem but the simplest and most effective is by using a VHF-to-UHF converter.

What is a VHF-to-UHF converter?

This converter does exactly what the name implies: it converts the entire VHF band up to the UHF band. It is a simple device that replaces most of the components that have been necessary in the first three figures.

Figure 4 shows a VHF-to-UHF converter in use with a programmable VCR. The cable signal feeds into the VHF input of the device; that is all 30 or more channels carried at VHF frequencies on the cable system. The device passes the basic 12 VHF channels, (2 through 13) straight through and on out the VHF output terminal of the device. Now available at the UHF output terminal are all of the 30 VHF input channels (including Channels 2 through 13), now at UHF frequencies.

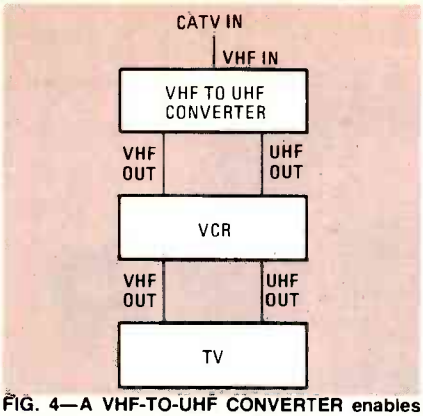


FIG. 4—A VHF-TO-UHF CONVERTER enables you to watch all the cable channels while the VCR is recording a different channel. That connection provides the ideal solution.

There is no longer any need for the cable TV converter box as that device makes all of the cable channels available to the VCR through the VHF/UHF terminals and now the VCR can pass those channels on to the receiver in the same manner. The end result is that now everything works just as it would on your own house antenna or any other 12-channel system. The programmable VCR now has all channels available at frequencies that will enable the programmable feature to work normally. You will need the conversion chart for those additional cable channels that are now available on the UHF tuner. it will tell you that cable Channel A is now UHF Channel 47. and so on. (See Table 1.)

The VCR/TV switch on the front panel of the VCR will now function as it was originally intended. If you had a built-in remote-control device with your TV that had been rendered useless for channel selection since the cable converter box was installed you can dust it off and start using it again also). One source for the VHF-to-UHF converter is ETCO Electronics, North Country Shopping Center, Route No. 9, Plattsburgh, NY 12901.

TABLE 1—WHERE THE CABLE-TV channels are moved to in the UHF band when using a UHF-to-VHF converter

CATV/UHF	CATV/UHF
2=36	7=56
3=37	8=57
4=38	9=58
5=40	10=59
6=41	11=60
	12=61
A=47	13=62
B=48	
C=49	J=63
D=50	K=64
E=51	L=65
F=52	M=66
G=53	N=67
H=54	O=68
I=55	P=69
	Q=70
	R=71

Cable TV plus off-air pay-TV

Chances are that if you have a cable system plus a local pay-TV channel available, the cable system will already carry that pay-TV channel and make it available to you through a normal converter device that would be compatable with the systems shown earlier or through a UHF-to-VHF converter. A cable system decoder would also be treated in the same manner as the converter box.

In the case where the cable system does not carry the local pay-TV channel, and it is only available through off-air reception and you still want to have the cable system plus the pay-TV channel, you are going to have to use a little of each of the systems that have been discussed so far. (You are also going to be paying a pretty high monthly TV bill.)

Because of all the various possibilities in different areas of the country and the various methods employed, Fig. 5 shows a typical solution to that kind of problem and you can modify or build on to suit the requirements of your particular needs.

In Fig. 5 both pay-TV and cable are kept separate through the entire installation. That prevents any adjacent problems or other problems due to lack of available unused channels to accommodate the preselected output channels of the various devices (VCR, decoder, UHF converter). That type of installation also eliminates the need for any type of manual switching network, another potential source of mixing problems.

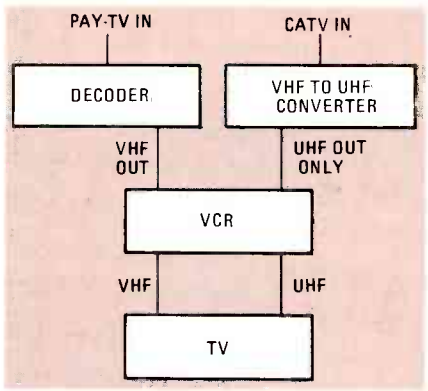


FIG. 5—PAY-TV can be added to a cable-TV installation along with a VCR as shown above. All the features of a programmable VCR are retained.

The pay-TV signal is processed through the decoder and then fed into the VHF input terminals of the VCR. Most off-the-air decoders have two inputs, one for your house system and the other for the off-the-air pay-TV channel. There is a front panel switch that allows you to select either the regular house system or the decoded pay-TV channel that will be on a preselected output channel (i.e., Channel 3). In the installation shown in Fig. 5 you would simply leave the decoder switched to the descramble (premium) position and then whenever the pay-TV channel is broadcasting it would be available to your VCR or TV, decoded on Channel 3 (the preselected output channel of the device). That would also be the only channel on the VHF tuner of both the VCR and the TV.

On the cable side, all of the available cable channels would be up-converted through the VHF-to-UHF converter and would now be available on the UHF tuners of both the VCR and the TV. (See Table 1 for a channel conversion chart.)

There is one additional modification to this type of installation that might be necessary if your home video system is readily accessible to your friends and neighbors. Anyone who is not familiar with that type of installation will have problems operating the TV set. When they switch the tuner over to any conventional VHF channel on the set itself they will find everything is snow except for the single pay-TV channel. All of the remaining channels have been up-converted and are now available only on the UHF tuner. If you feel that it is necessary to have the regular VHF channels back down on the VHF tuner you can do that with just a few modifications to the installation shown in Fig. 5.

Start by inserting a two-way coax signal splitter on the input side of the VHF-to-UHF converter. Leave one leg still attached to the VHF input of the VHF to UHF converter and run the other leg to the input of the decoder device that is normally intended for your house antenna. It will be necessary to move the decoder device to a physically convenient spot near the TV or VCR as you will now have to switch the output of the device back and forth manually from either the pay-TV channel or the VHF Channels 2 through 13. Now you're able to leave the system with the conventional VHF Channels 2 through 13 available on the TV for anyone who wants to watch TV or you can switch back to the setup in Fig. 5 that enables your programmable VCR to select anything (cable or pay-TV) available for recording.

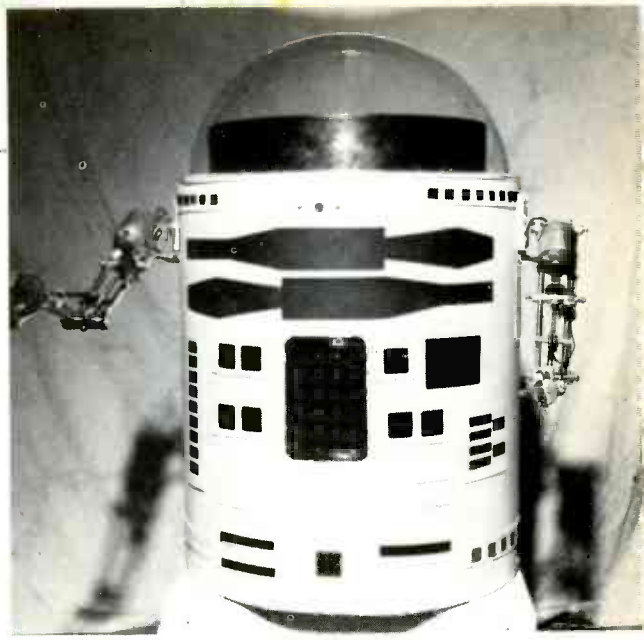
Helpful hints

Keep it simple. The fewer active devices or switches, the more reliable and trouble-free your system will be. If you have two or more pay-TV channels available in your area, or you want to run the output of your VCR to several different rooms in your home (or maybe you have two or more VCR's, or maybe you have all of those), your best bet is to use a centrally located

continued on page 104

BUILD THIS

UNICORN-1 ROBOT



Part II—By the end of this section, your robot's arm will be operational. Here are instructions for completing the arm, and for building several types of hands.

JAMES A. GUPTON, JR.

UNICORN-ONE IS A ROBOT THAT YOU CAN build for between two- and-four hundred dollars, depending on your ingenuity and scrounging abilities. It is fully mobile and has the ability to use its arms and hands. It can be controlled by a cable link to a console, by radio control from a console, or in conjunction with a computer.

The first part of this series described some of the components used in the robot's construction, and covered most of the assembly of its *manipulator(s)* (arms).

In this installment we will complete Unicorn-One's manipulators and build its *end-effectors* (hands). From time to time we will present you with certain options that you may or may not want to include in your version of the robot.

Remember that one of this project's objectives is to build a working robot, but at a reasonable cost. When you start adding frills—which *you* may consider necessities—that cost is going to go up. It might be wisest to start with the essentials, to prove that what you have set out to do *can* be done, and to add the extras later. Unicorn-One was designed with that plan in mind and all the options described—as well as most extras that you'll think of yourself—can be added afterward, with no major alterations to the robot already constructed.

Completion of manipulator

The last part of the manipulator to be fabricated is the *contractor-bar* (we saved the easiest for last). That is simply a bar of aluminum ¼ × ½ × approximately 6 inches long. The actual length will depend on how far you want the elbow to bend, but we've found that 6 inches is a good size to work with. Use a No. 33 bit to drill a hole close to each end of the rod so it may be connected to the rest of the arm with No. 4-40 screws at the two contractor-bar pivot pieces. See Fig. 9 and Fig. 6 (part 1, last month) for details.

At this point you are probably anxious to see how (and whether) the elbow action of the manipulator works. Before you power it up, though, there is one more step that must be taken. If you were to turn on the mechanism now there is a very good chance that you would unintentionally allow the threaded rod to travel too far . . . and jam. That could prove extremely embarrassing.

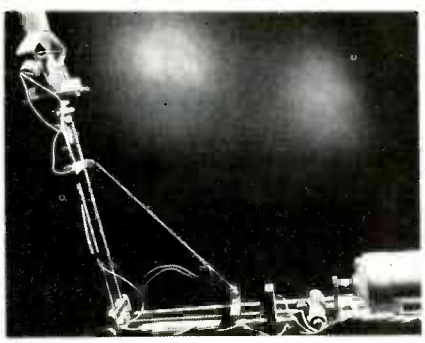


FIG. 9—MANIPULATOR, showing contractor-bar and its attachment to the two pivot-pieces.

To prevent jamming from taking place, we have to install *limit switches*. Those are lever-type snap-action switches that are placed so that power to the elbow motor will be cut when the part in motion reaches the desired limit of its travel.

Both upper- and lower-limit switches are used to protect the mechanism during motion in either direction. If power is applied to the elbow motor through one of the limit switches, the threaded rod will turn and cause the forearm to move up or down. When it has gone as far as it can, it will contact the limit switch and stop the motor.

Since we are using DC motors, reversing the current flow in the windings (connecting the power source "backwards") will make them turn in the opposite direction. Therefore, to make the arm move the other way, the other limit switch supplies the motor with current of the opposite polarity.

Almost any size lever-type, N.C. (*N*ormally-*C*losed) snap-action switch may be used, as long as there is room to mount it. There is no firm rule as to where the limit switches must be located—the objective is to place them so that they will be turned on by some moving part of the arm in time to stop its motion before damage occurs.

Figure 10 shows one possibility for the placement of the upper- and lower-limit switches. Here, the upper-limit switch is attached to the side rod so that its contacts are opened when it is contacted by the upper pivot hinge. The lower is placed so it will contact the side rod when the arm is lowered and the side rod and contactor-bar are nearly parallel. There are other ways of achieving the same results, of course.

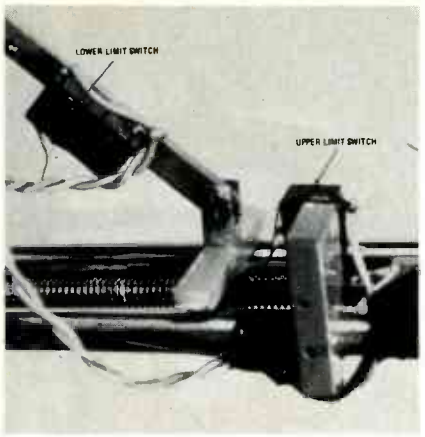


FIG. 10—LIMIT SWITCHES attached to contractor-bar and aluminum block on side rod.

There are two things to bear in mind when placing the limit switches. First, make sure that positive contact will always be made and that there is no possibility that the switch can be turned on accidentally. Second, when taping the switches' wires (and those of the other electrical parts, such as the motors) in place, take care that the tape and wires do not impede the action of any of the moving parts.

The wiring of the limit switches, end-effectors and motors will be covered in some more detail toward the end of this section.

End-effectors

An arm is of little use without a hand at the end of it, so we will present two elementary, but serviceable, types of end-effectors for you to choose from and give you the option of constructing a more complex (and expensive) one, should you so desire.

The two basic hand types we'll describe are the *finger* and the *claw*. Your robot, being ambidextrous, can actually have one of each, using one for one purpose, and one for another.

The grasping action of both types of hand is provided by solenoids—electromagnetic coils with rods through their centers. When a current is passed through the coils, the rod is either pulled into them or pushed out of them. If that rod is connected to part of the hand, the hand will close (in our case) when power is applied to the solenoid. When power is cut, the hand opens by means of a spring which is either part of the solenoid or part of the hand mechanism itself.

Selection of the solenoids is not critical. There are three conditions which must be satisfied: voltage, size, and degree of travel.

The solenoids should be rated to turn on with 12 volts since the robot will almost certainly be using a self-contained 12-volt storage battery when it is operating under its own power. The size of the solenoids will determine the strength of its grip. You may want to use a stronger solenoid in one hand than in the other to allow the robot to perform tasks requiring

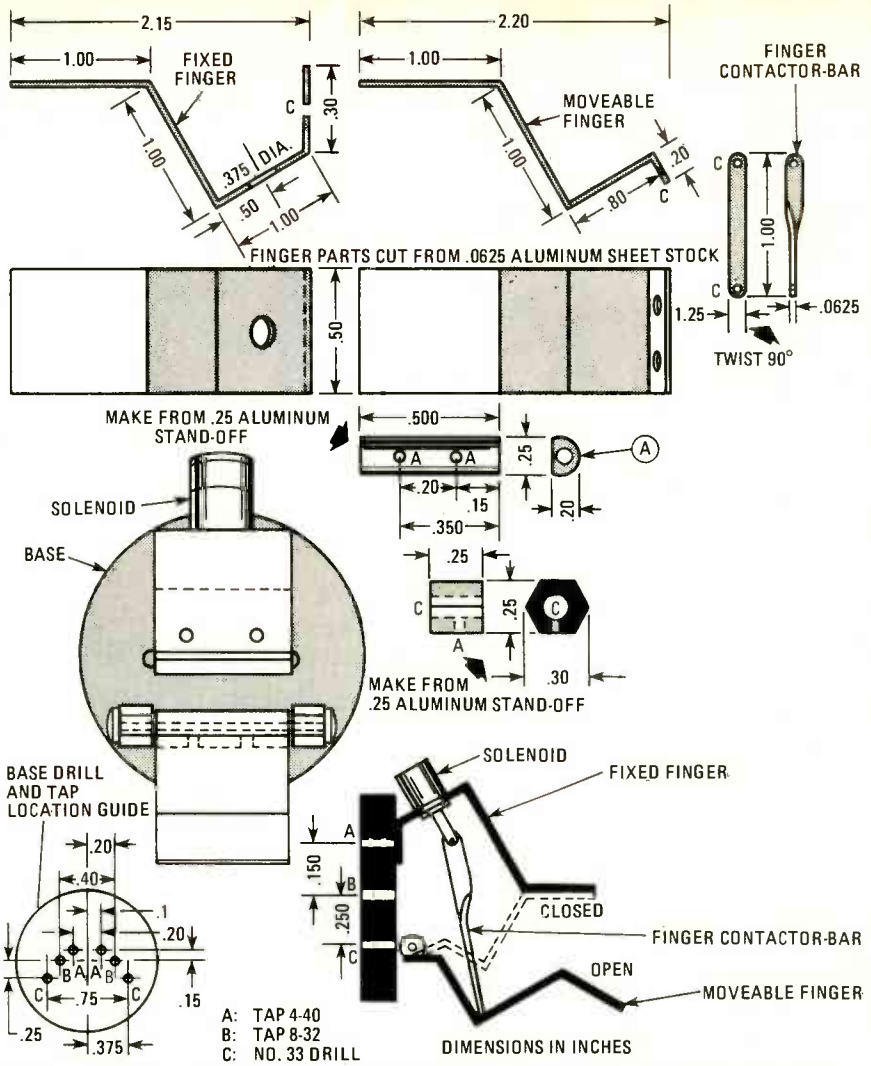


FIG. 11—FINGER-TYPE end-effector assembly drawing. Hinge construction is described in text.

different degrees of delicacy. As for the degree of travel (the distance of the solenoid's rod can move) we've found that a ½- to-¾-inch rod allows the hand to open far enough for most applications.

Finger-type

Dimensions of the finger-type end-effector are shown in Fig. 11 and one of the completed units in Fig. 12. The material used for that part is 1/16 × ½-inch sheet aluminum. The fixed (upper) finger is made from a piece 3.3 inches long and the movable (lower) finger, from a 3-inch one. The angles should be formed by placing the metal in a vise and bending as evenly as possible. Use a hammer to give uniformity to the surface.

The *finger contractor-bar* is made of 1/16 × ¼-inch aluminum, drilled at both ends. The length depends on the solenoid's travel. As shown in Fig. 11, a half-twist is put into that bar. One end of the bar is attached to the solenoid, which is mounted on the outside of the fixed finger, and the other is inserted through a slot sawed in the outside edge of the movable finger and secured with a cotter pin or similar device.

The movable finger is attached to the hinge (refer to Fig. 13) by two No. 4-40 screws. The hinge itself is supported at

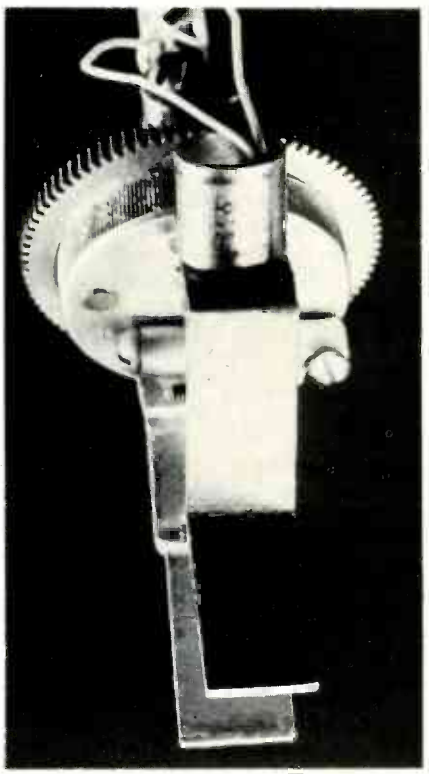


FIG. 12—COMPLETED FINGER-TYPE end-effector. Gear is non-functional, but adds to appearance.

one end by a ½-inch diameter piece made from a section of an aluminum stand-off with a long No. 4-40 screw acting as the hinge pin. The finger/hinge assembly is

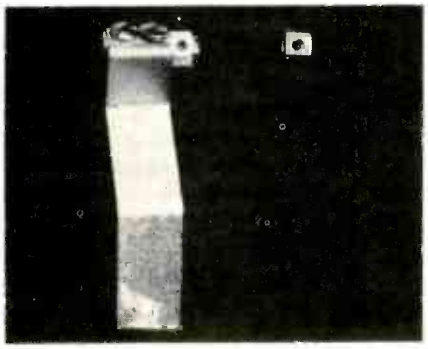


FIG. 13—DETAILS OF HINGE used in finger-type end-effector assembly.

fastened to an end-plate one inch or more in diameter and ½ inch thick using No. 8-32 screws and that, in turn, is mounted to the last cross-rod of the manipulator's forearm. The original Unicorn-One used a non-functional gear to build up the end plate and to give the robot a touch of class.

The finished end-effector may be fixed horizontally, vertically, or at any angle in between. Its position depends on the use to which the member will be put.

Claw-type

For heavier-duty applications, you might want to use a claw-type end-effector; that type of hand is shown in Figs. 14 and 15. On ¼-inch aluminum plate, use a scribe to mark the outline of the two sections. Rough-cut the pieces, taking care to keep to the outside of the outline to allow a margin for error.

Using a hacksaw on the inside angles of the claw may prove to be difficult or even impossible. Instead, try drilling a closely-spaced series of small holes along the *outside* of the part. Then, using a cold chisel, knock it out and file it to shape, along with the rest of the claw.

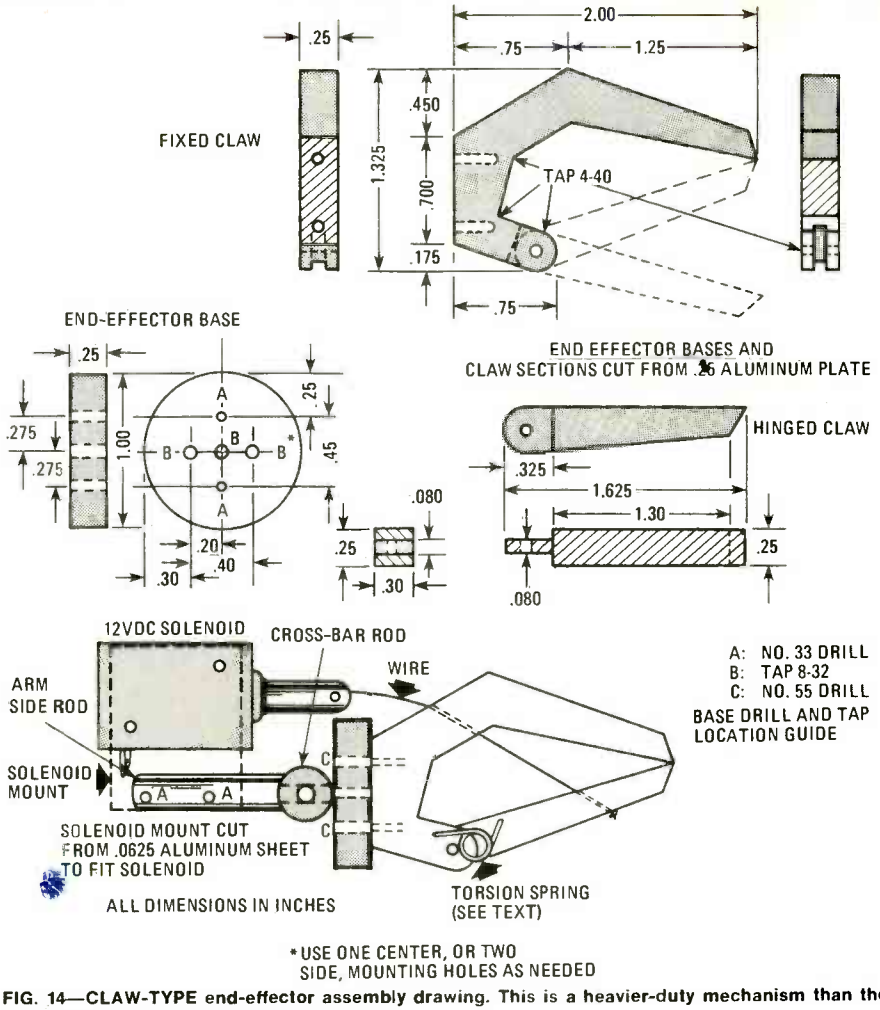


FIG. 14—CLAW-TYPE end-effector assembly drawing. This is a heavier-duty mechanism than the finger-type and you may want one of each.

Drill two small holes through the two claw sections, in the plane of movement (parallel to the flat sides of the claws), to pass the cable from the solenoid, which can be anchored by a screw to the lower

PARTS LIST

Item	Size	Quantity	Supplier's part no.	Supplier
Sheet aluminum	.0625 in. thick	1 X 7.5 in.*	SA625	A
Sheet aluminum	.250 in. thick	1.5 X 6 in.*	SA250-9	A
Sheet aluminum	.250 in. thick	0.5 X 6 in.	SA250-3	A
Solenoid†	Size 50, ½ X 1 in. 12 VDC	1	176801-035	F
Solenoid†	Size 75, ¾ X 1½ in. 12 VDC	1	174610-031	F
Solenoid†	½-in. stroke, 12 VDC	1	26	G
Solenoid†	½-in. stroke, 12 VDC	1	L26	H
Solenoid†	"D"-frame, 12 VDC	1	290001-033	F
Snap-action switch	Subminiature roller-lever-type, 5-amp	4	275-017	I
Snap-action switch	Subminiature lever-type, 5-amp	4	275-016	I
Machine screws	2-56 X ⅜	8		
Machine screws	4-40 X ½	11		

SUPPLIERS

A The Robot Mart
Room 1113
19 W. 34th St.
New York, NY 10001
(Catalog $3.00)

B Winfred M. Berg, Inc.
499 Ocean Avenue
E. Rockaway, NY 11518

F Ledex, Inc.
Box 427
Vandalia, OH 45377

G Guardian Electric Mfg. Co.
Advertising Dept.
1550 W. Carroll Ave.
Chicago, IL 60607
(Write for list of local distributors.)

H Liberty Controls, Inc.
500 Brookforest Avenue
Shorewood, IL 60431

I Radio Shack
Consult your local telephone directory.

NOTES: Items marked with "*" were already specified in the parts list for Part One of this series. Items marked with "†" are to be selected according to the builder's requirements. Components may also be available from suppliers other than those indicated. Some suppliers have minimum order requirements. Inquire before placing order.

FIG. 15—ASSEMBLED CLAW-TYPE end-effector. Piano wire may be used to connect solenoid and lower portion of claw.

claw. A small hole should also be drilled into the *flat* side of each claw into which the ends of the spring which will keep the hand open when the solenoid is not turned on.

Robot manipulator-claw springs are not an off-the-shelf item in most places, so you'll probably have to make your own. Figure 16 will give you an idea of what you'll need. If you haven't taken apart any clocks recently, you might try using a section of the type of spring used to close

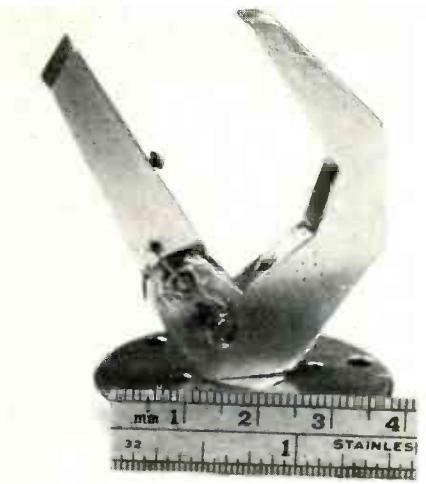


FIG. 16—CLAW-TYPE end-effector showing homemade torsion spring. Text gives details.

screen doors in the summer. Material 1/32-in. in diameter seems to work out well.

The tension of the spring will affect the claw's actions. If it's too strong, the claw will not close properly and the robot's grip will suffer, and if it's too weak, there can be problems with keeping it open. If that sounds confusing, bear in mind that the purpose of this particular spring is to hold the claw *open,* not closed.

Attachment to the manipulator is similar to that for the finger-type end-effector, but you may decide to mount the solenoid (which will probably be larger than the one used for the other) directly on the forearm and feed the cable through to the claw.

You might want to line this hand—or possibly both—with foam rubber or a similar material to give it a better grasp on slippery objects.

A more elaborate type of end-effector is shown in Fig. 17. It also uses the claw-type mechanism but has an additional *degree of freedom*—a term referring to the different ways a joint can move. (Your own arm, for example, has three degrees of freedom: It can twist, move up and down, and move from side-to-side.)

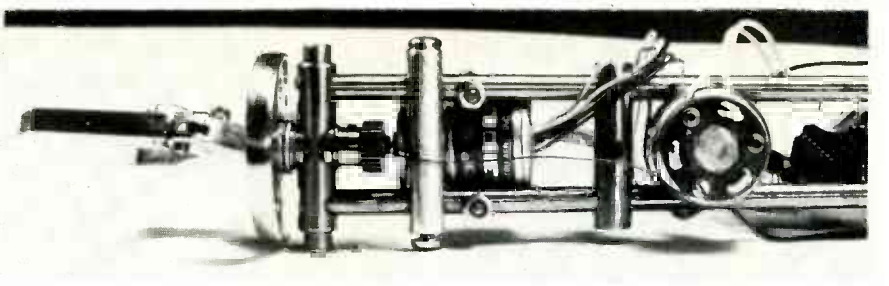


FIG. 17—ROTATABLE end-effector mentioned in text. Stepper motor supplies wrist action.

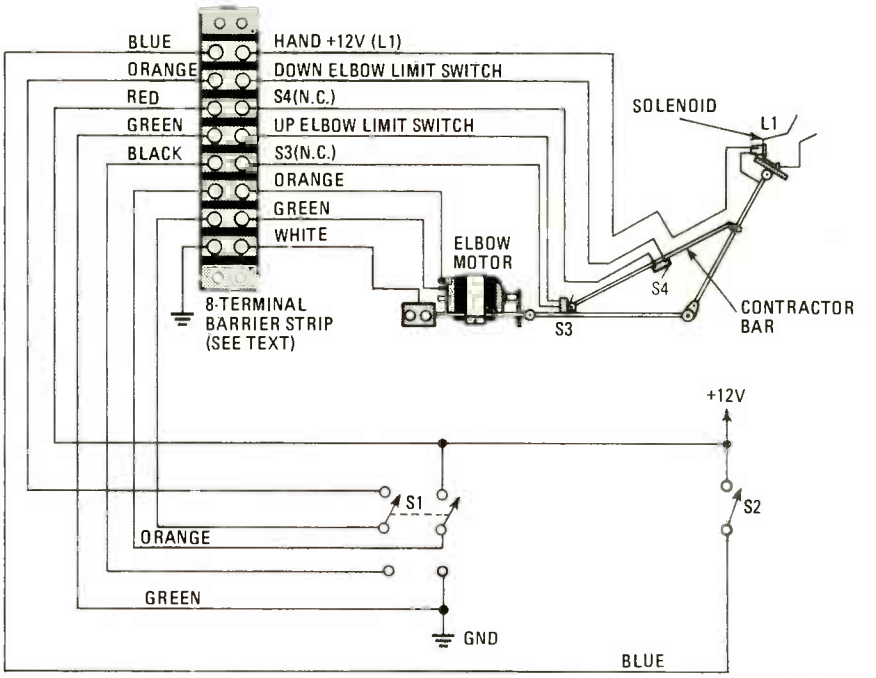


FIG. 18—WIRING DIAGRAM for manipulator and end-effector. Color-code wires in order to avoid confusion.

The added mobility is gained by placing a stepper motor between the arm and the hand. The stepper motor's shaft turns through a small portion of an arc each time a short electrical pulse is applied to it. The result, if enough pulses are applied, is a twist of the wrist—and an added degree of freedom!

Because those pulses are best generated by a digital electronic circuit—which we have not yet discussed—we'll postpone a description of the construction of this type of hand until we start putting together Unicorn-One's electronics. For certain applications, though, it can be indispensible.

Wiring and testing

A wiring diagram for the motor, solenoids, and microswitches, with their associated controls, is shown in Fig. 18. The eight-position terminal strip illustrated is actually part of a 32-position strip, which will terminate all motor and switch connections. Since 32-position terminal blocks are difficult to locate, do the best you can with smaller ones—but allow for at least 32 positions. That will give you several extra positions which you can later use for your own options.

Color-code the wiring to simplify circuit tracing and make sure that everything goes to the right place and that you have electrical continuity.

Now, with the limit switches installed, you can check out the actual operation of the manipulators and end-effectors. In fact, this is the best time to do so. (If you were to wait any longer, and the arm were attached to the body, you might have to do quite a bit of tearing-apart to get to, and correct, any problem that showed up.)

The parts list shows sources of supply used by the author. There are certain to be others, though, possibly more accessible to you. In fact, many of the materials specified can probably be found, in a form close enough to work with, at your local hardware or building-supplies store. Even closer—and more economical—may be your basement or a nearby junkyard.

The next part of the Unicorn-One series will concern itself with design considerations and construction of the robot's mobility base—the section that gets it from place to place. Also included will be details of the main 32-position terminal strip, which will be the heart of the robot's electrical distribution and control system. The design of that section will permit easy changeover, when you're ready, from manual control by cable-connected console to radio control and, later, to control by microcomputer. **R-E**

PIEZO-ELECTRIC SOUNDER APPLICATIONS

Solid-state "beepers" have a variety of interesting applications. This should give you a few ideas.

CALVIN R. GRAF, W5LFM

IS IT A BUZZER? IS IT A SOUNDER? THOSE are good questions to ask, because the piezoelectric sounder is partly both but unique in its own right. It doesn't buzz, so it's not a buzzer. It doesn't click like the telegraph sounder of days past, so it's not a clicker. But it does sound out with a pure tone when a DC voltage is applied to it, and it operates on the piezoelectric effect. So it is accurately called a piezoelectric sounder.

First introduced by P. R. Mallory about 15 years ago, the sounder was called the Sonalert. It immediately found wide acceptance by the electronic circuit-and-system designer because it emits a near spectrally-pure 2900-Hz tone when a DC voltage between 1 and 28 volts is applied to its terminals. The piezoelectric sounder has been used extensively in applications where a low-current annunciator is needed. Those include wrist watches, alarm clocks, radio beepers, telephone sets, smoke detectors, testing devices, electronic games, intrusion alarms, automobile warning and monitoring, office machines, electronic calculators, timers, and computer peripherals. Many manufacturers produce piezoelectric sounders today. A typical unit is shown in Fig. 1.

A Sound Approach

Sound waves, as you know, are variations in the rate of change in the sound-pressure level. A frequency, or tone, is a measure of the air-pressure variation. A foghorn produces slow variations in air pressure. The whine of a jet engine is produced by many variations in air pressure. A ride in a fast elevator or a passing weather front are also examples of air-pressure

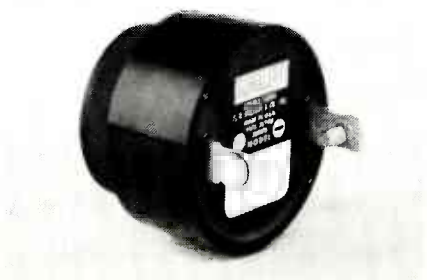


FIG. 1—THE PIEZOELECTRIC SOUNDER is a low-current device that produces an almost pure tone. This is a *Sonalert*, made by the Mallory Components Group of Emhart Corp.

changes. However, those are not rapid enough for us to hear as sounds, but we do feel the effect on our ears or see the effect on a barometer.

What frequencies are most pleasing to the ear? Research has shown that sound-pressure changes between 700 and 900 Hz are most pleasing to the ear. Those frequencies which attract our attention the most lie between 2000 and 4000 Hz. And you probably well know that a pulsing sound will really get our attention, as compared to a continuous tone.

Ways to sound off

In the army, everyone learns to "sound off" by counting "one, two, three, four." In electronics there are currently three ways to produce an alerting sound.

Electromechanical—The familiar buzzer is probably over 100 years old. That type of audio producer consists of a mechanically-tuned lever with contacts that vibrate back and forth much like a relay using breaker-point switching. The making and breaking of the current, however, generates radio-frequency interference (RFI) that can be detected beyond 10,000 MHz. The breaker-point lever is connected to a metal disc that vibrates the air to produce a sound. This type emits a buzzing sound and has a high harmonic content that is usually harsh sounding. Others of this type use a small motor to vibrate against a metal or plastic disc to produce a sound.

Speaker-Oscillator—This type of sound producer is a speaker (usually very small and compact) used to deliver sound generated by an electronic oscillator circuit.

Piezoelectric Transducer or Sounder—Truly solid state, this type uses a thin ceramic element bound to a brass disc. The element is connected to a built-in oscillator that drives the ceramic causing it to vibrate a brass disc which flexes and generates a sound wave. This type of sounder is a low-power device that produces a high audio output, and has a long operational life. The piezoceramic sounder by itself (without its transistor driving oscillator circuit) transforms AC voltages to sound-pressure waves. It will also generate an AC voltage across its terminals when stimulated, or vibrated, by a sound-pressure wave. (Is it a speaker or is it a microphone?)

Basic circuits and uses

The basic circuit for the piezoelectric sounder is shown in Fig. 3. It can be used in circuits built around TTL, CMOS, 9-volt transistor batteries, and 12-volt automobile batteries. The sound-output level increases directly with applied voltage, starting near 1 volt and increasing to 20 volts. A higher voltage, approaching 30 VDC, can be used if applied for short periods of

time (a few seconds). The piezoelectric sounder is readily available from many parts sources and its characteristics are shown in Table 1. In Fig. 3. we show a new symbol for the piezoelectric sounder using two wavy lines to indicate that it generates acoustic energy. A single wavy line (sine wave cycle) indicates a generator but without further designation as to whether it is a power generator, an audio generator, or a signal (RF) generator.

Table 1—PIEZOELECTRIC SOUNDER CHARACTERISTICS

Typical Solid-state Piezoelectric buzzer

Frequency ..... 4.8 kHz
Voltage ..... 1.5 to 20 VDC
Current ..... 9 mA at 9 VDC
Size ..... 1 3/8" by 3/8" thick

FIG. 2—THIS SOLID-STATE BUZZER operates with 1.5 to 20 volts DC and delivers a 4.8-kHz signal.

Flashing and sounding circuits

By adding a flasher LED and series-dropping resistor as in Fig. 4, we are able to make the piezoelectric sounder pulse or beep, at the flash rate of the flasher LED. (Be careful and do not confuse the flasher LED with National's LM3909 LED flasher/oscillator.) The 1000-ohm resistor limits the voltage applied to the flasher LED (nominally 5 VDC). In the circuit of Fig. 4, the pulse rate of the sounder is 3 PPS. The pulsating sounder can be used in automobile turn signals and electronic and electrical trouble-shooting. When mounted on the rear of a vehicle and powered from the back-up light circuit it becomes an automotive back-up warning device. The flasher LED is readily available from several manufacturers. The flasher is an IC that switches

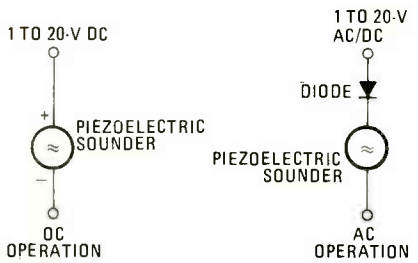


FIG. 3—BASIC CIRCUIT AND SYMBOL for the piezoelectric sounder. Sound energy is produced with as little as 1 mA.

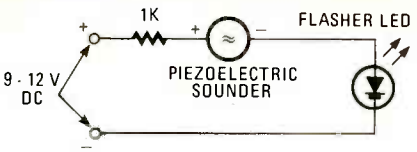


FIG. 4—The PIEZOELECTRIC SOUNDER is made to pulse at a 3 pulse-per-second rate by adding a flasher LED.

Table 2—SOUNDER AND FLASH RATE vs. voltage and capacitance (refer to Fig. 5)

Capacitance, C	Voltage	Flash/ Sound Rate
47 μF	3 VDC	6 pulses in 5 seconds
	6 VDC	4 pulses in 5 seconds
	9 VDC	No output
33 μF	3 VDC	4 PPS
	6 VDC	2 PPS
	9 VDC	No output
100 μF	3 VDC	4 PPS (soft note)
	6 VDC	2 PPS
	9 VDC	No output

voltage to a LED at a 3 PPS rate. Current drawn at 5 VDC is about 20 mA. The cost is under $2.

We vary the pulse of the piezoelectric sounder by connecting a capacitor across it as in Fig. 5. Now the flasher-LED flash rate is sensitive to applied voltage as shown in Table 2.

Light Input to Photocell—When we place a photocell across the piezoelectric sounder, we make the circuit sensitive to ambient light. Figure 6 shows a circuit that will make the sounder and LED pulse at 3 PPS when

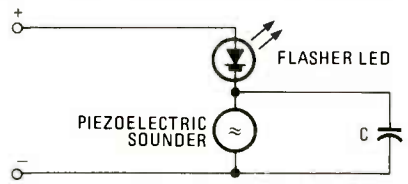


FIG. 5—VARYING PULSE RATES are produced by placing a capacitor across the sounder. (See Table 2.)

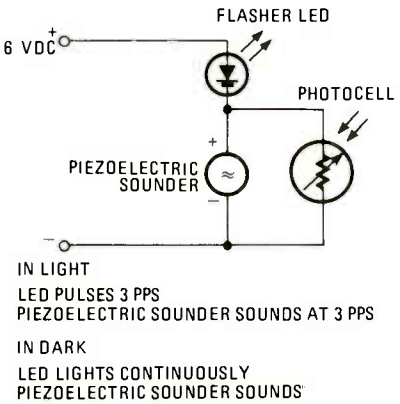


FIG. 6—ADD A PHOTOCELL to make the pulsing sounder respond to different light levels.

the photocell is illuminated (low photocell resistance), but will remain on continuously in the dark (high photocell resistance). In Fig. 7, we see a circuit arrangement that draws no current in its standby, or dark mode (high photocell resistance), but begins pulsing when the light level reaches a certain level (low photocell resistance). The circuit gets its power from a 9-volt battery.

We will now look at a very simple circuit that uses the low-current characteristics of the piezoelectric sounder. With it, we can check for continuity, or for voltage in a circuit. The few components required for this simple tester can be assembled in the plastic-top cap of a shave cream or other spray can. Use two 24-inch long leads with alligator clips for test leads.

Continuity Tester—The circuit in Fig. 8 is arranged so when the switch is set for CONTINUITY, a small amount of current is drawn through the piezoelectric sounder and the external circuit under test. By shorting the probes, you can establish an audio reference

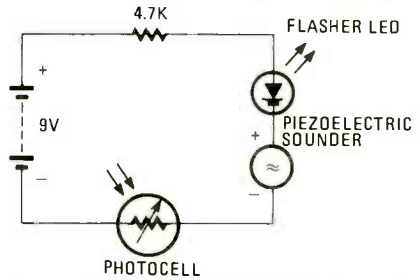


FIG. 7—CONNECT A PHOTOCELL in series to turn the circuit off in the dark (high photocell resistance). Light will cause the sounder to pulse.

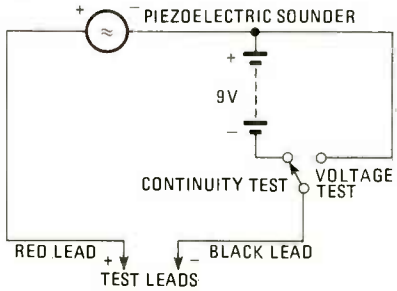


FIG. 8—CONTINUITY/VOLTAGE TESTER using the piezoelectric sounder. Observe correct polarity for voltage tests.

level for zero ohms. An open circuit is obviously infinity and no sound is produced. With a good ear and a good battery, you will be able to hear an indication for 20K to 30K resistance in the circuit under test. That arrangement is good for testing continuity of light bulbs, resistors, diodes, coils, transistors, motors, relays, etc. When you test volume controls for continuity, you can spot a "scratchy" control because the audio level of the tone of the piezoelectric sounder will shift abruptly.

continued on page 99

Better than DOLBY B???

New Noise Reduction System for Tape Recorders

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

This new noise-reduction system from Nakamichi provides a dynamic range 18 dB greater than Dolby B.

EVERY CASSETTE TAPE-DECK USER OWES a debt of gratitude to Dr. Ray Dolby. His introduction of the Dolby B noise-reduction system more than ten years ago was largely responsible for the wide acceptance of cassette tape recording as a true high-fidelity program storage medium. Although the cassette format delivers much higher performance quality today than it did ten years ago, it is still far from being a "noise-free" system.

The Dolby B noise-reduction system represents a clever choice of compromises that provide a reasonable amount of noise reduction with a minimum of undesirable side effects, at low cost. Those compromises involve limiting the total amount of noise reduction as well as the frequency bandwidth of the system. Until now, the tape-recording enthusiast has had to be content with the 8-to-10 dB of signal-to-noise improvement of the Dolby B system. While modern cassette decks almost universally have built-in Dolby B, tremendous strides in the quality of pre-recorded program sources and a growing interest in live recording demand further improvements in cassette deck performance. Critical listeners often feel that the Dolby system does not provide enough noise reduction for those more esoteric recording applications.

Principles of noise reduction

Nakamichi first became interested in developing a better noise-reduction system several years ago, after evaluating a professional noise-reduction system called Telcom C4D developed by Telefunken of Germany. According to Nakamichi, that system (although too expensive for consumer applications) provided an unusually large ratio of noise reduction and was particularly free of such undesirable side effects as noise pumping or signal coloration. A cooperative effort between Telefunken and Nakamichi has resulted in a modified consumer version of that noise-reduction system, Nakamichi calls it *High-Com II*. Nakamichi's first commercial version of the system is in the form of a separate add-on device, (see Fig. 1) that can be added to any high-quality cassette deck.

Fig. 1—HIGH-COM II noise-reduction system can be used with any high-quality cassette deck.

Before discussing the specifics of the *High-Com II* noise-reduction system, let us examine the basic principle behind noise-reduction systems. The *compander* concept that forms the basis of *all* noise-reduction systems is quite simple. Before recording, the dynamic range of the program is compressed by a circuit, the signal of which is controlled by the signal level itself. Once compressed, the program "fits" on the tape. The weakest signals are amplified and recorded at a level well above the tape noise while strongest signals are compressed and recorded below the level at which distortion occurs because of tape saturation. During playback, the exact converse action takes place: Strong signals are expanded or amplified to compensate for the compression they receive during recording, while the level of weak signals is reduced, restoring them to the relative intensity they had before recording.

While the basic principle sounds simple, Nakamichi soon discovered that designing a cost-effective noise-reduction system that works well in conjunction with a cassette deck is not an easy task. Each element of the system had to be carefully considered and optimized. If necessary, a compromise between optimum and practical had to be selected.

The ultimate choice of the compression/expansion ratio is a good example. For an expander to be free of noise pumping, most of the recorded signal must be well above the noise floor of the tape. Since the cassette deck's low speed limits the maximum signal levels that can be recorded on the tape, a relatively high compression ratio is needed to maintain a great enough margin between low-level signals and noise. If too high a compression ratio is chosen, however, it becomes difficult to recover the original dynamics during expansion and the entire system becomes very sensitive to slight level variations, such as those caused by inconsistencies in the tape coating itself.

New noise reduction system

In the *High-Com II* system, a 2:1 compression ratio is used to get a 20-dB improvement in signal-to-noise. The 2:1 ratio is maintained throughout most of the dynamic range of the system, except at very low input levels, where the ratio is restored to 1:1. That largely linear-transfer characteristic of the system makes it relatively immune to minor mismatches in level. The 2:1

ratio is not enough, however, to overcome noise pumping completely. That effect is caused by a compander at frequencies other than those of the input signal.

A good example of that is recording a single tone. Noise in the immediate vicinity of the tone's frequency will be masked by the tone signal itself; but noise well above or below that frequency is not masked. It is the modulation of that unmasked noise by the action of the compander that is often noticeable and objectionable. What makes matters even worse is that with 20 dB of basic noise reduction there is less of a constant overall hiss level to mask the noise modulation.

Both the professional Dolby-A and Telcom C4D noise-reduction systems effectively eliminate that type of noise modulation by processing the signal in four frequency bands. In other words, companding action in one frequency range is controlled separately from that in another. Such a complex configuration is far too costly for a consumer version of either system. The Dolby B system combats the problem by limiting its operation to only the high frequencies. The action of Dolby B can be understood by referring to Fig. 2, a sequential trace of residual tape noise, using a spectrum analyzer over the range from 20 Hz to 20 kHz. Vertical

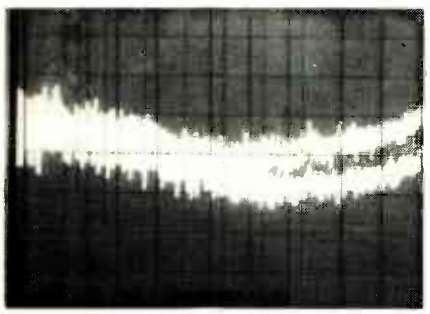


Fig. 2—HOW DOLBY B compensates for high-frequency noise. Action begins above 1kHz.

sensitivity is 10 dB per box. Note that the two plots (without and with Dolby B turned on) are identical from around 20 Hz to just beyond 1 kHz. At that point the action of the Dolby B system reduces high-frequency noise at a sliding or increasing rate (lower noise trace) out to the limits of the sweep. That makes sense for cassette tape because the overwhelming proportion of noise at the slow tape speed is high-frequency hiss.

However, with 20 dB of noise reduction provided by the *High-Com II* system, it is no longer acceptable to concentrate solely on the higher frequencies. A 20-dB reduction of hiss with no corresponding reduction at low frequencies would only make low-frequency noise equally more audible. The *High-Com II* noise-reduction system deals with that problem and minimizes noise pumping still farther by processing the signal in two bands. Using more than two frequency bands would, of course, provide added insurance against noise pumping, but the benefits had to be weighed against the cost. The Telefunken HighCom IC, developed for the *High Com II*, provides a wide selection of attack and release times, and with two bands of processing, an appropriate set of dynamic characteristics could be selected for each frequency range. Comparing the noise-reduction results obtained by using Dolby B (Fig. 2) with those obtained by using the *High Com II* system (Fig. 3), both the increased amount of noise reduction and the fact that some noise reduction is taking place even at mid-to-low frequencies are obvious.

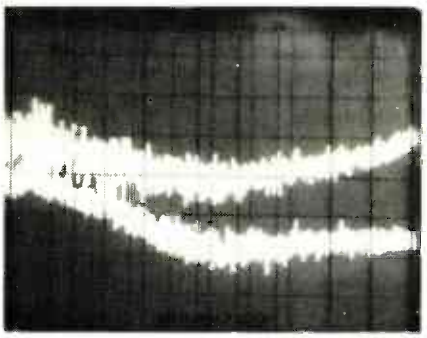


Fig. 3—EFFECT OF High-Com II on residual tape noise. Compare this with Dolby B in Fig. 2.

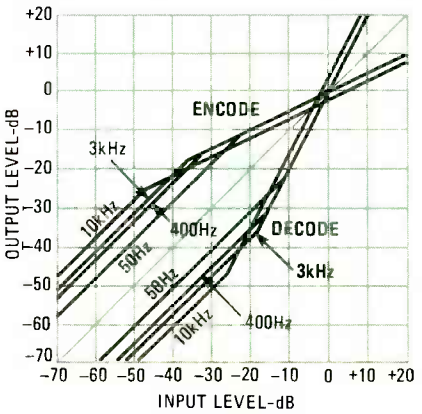


Fig. 4—ENCODING/DECODING and input/output characteristics of the High-Com II system.

Figure 4 shows the encode and decode characteristics of the *High Com II* system and its input/output characteristics. The 0 dB shown is the reference level of the system and the level recorded on the tape for that reference is 200 nWb/m (Nano-Webers Meter—measure of magnetic flux-density). The degree of encoding or decoding is small at low frequencies, increasing as the frequencies get higher. Depending upon frequency, below a certain level the encode-to-decode ratio becomes 1:1, suppressing the breathing noise changes in signal levels cause.

Figure 5 shows the record-play amplitude response and noise analysis of the *High Com II* system coupled to a Nakamichi *Model 680* cassette deck using metal particle cassette tape. It was supplied to us by Nakamichi. The pen traces on the lower right corner of the figure show wideband noise levels

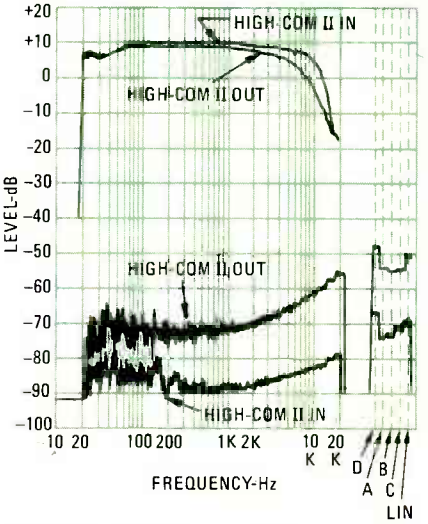


Fig. 5—HIGH COM II record/playback amplitude response and noise analysis.

with various weighting filters. Note that the noise reduction with no weighting filter applied is a full 19 dB. With "A" weighting, the noise reduction is exactly 20 dB, or about 12 dB greater than with the Dolby B system. Actually the increase in dynamic range is somewhat better than 20 dB because, unlike the Dolby B system, the *High Com II* system continues its companding action beyond the reference 0 dB level.

Since 3% total harmonic distortion on that tape deck normally occurs at a true recording level of +6 dB (0 dB equals 200 nWb/m), the 2:1 compression level permits an input level of +12 dB as a maximum. That accounts for the high output of the +10 dB trace in Fig. 5. It would normally be lower because of saturation, but with the 2:1 compression, the actual record level reaching the tape is equivalent to +5 dB. Since the "A" weighted noise with the *High Com II* system turned on is 74 dB below 0 dB, the total dynamic range available, referenced to the 3% total harmonic distortion point, is 74 dB plus 12 dB or 86 dB! That is a full 18 dB better than the dynamic range that is available (referenced to 3% total harmonic distortion level) using Dolby noise reduction.

To preserve high-frequency transients, any compander must have a fast attack time. It must recognize an abrupt change in signal level quickly, or the characteristics of the transient will be altered or destroyed. On the other hand, if the compander has *too* fast an attack time, it will tend to fol-

continued on page 104

B.I.C./Avnet Model T-3 Cassette Deck

1

CIRCLE 106 ON FREE INFORMATION CARD

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

AS MOST OF YOU KNOW, CASSETTE DECKS ALL operate at a single, standard speed of 1⅞ inches-per-second. All, that is, except B.I.C./Avnet Corporation's new series of stereo cassette decks, each of which operates at that speed and also at twice that speed, or 3¾ ips. Three such two-speed decks are now being marketed by B.I.C./Avnet, and, in all likelihood, even more models (probably higher priced than the first models) are on the way. There are many industry rumors about how B.I.C./Avnet was able to "break with tradition" (not to mention the Philips agreement that presumably governs all cassette-deck manufacturers, since Philips originated the cassette-tape format), and offer speed options in cassette decks. In any case, B.I.C./Avnet has done it and assures everyone that the company is on safe legal ground. We certainly hope so because with increased speed comes vastly increased performance capability.

Of the three two-speed decks now available, we chose to test the third—the top-of-the-line *model T-3*, which is the first of those decks to offer true three-head operation and its related tape-monitoring capability. In the *model T-3*, the record and play heads are electrically separate components, but are mounted in a common housing. As a result, no tape azimuth alignment is required, as would be the case when three-head decks use physically separated record and play heads.

A front-panel view of the *model T-3* is shown in Fig. 1. The left-hand section of the black front panel contains the cassette compartment; when the STOP/EJECT push-button is depressed, the cassette door opens smoothly and slowly (the action is viscous-damped). Additional piano-key-type tape-transport controls below the cassette compartment include a RECORD switch; REWIND, PLAY, and FAST-FORWARD switches; and a PAUSE switch. Tape motion is controlled by a dual-capstan tape-drive system powered by a two-speed DC servomotor. The POWER on/off push-button is located in the lower left-hand corner.

To the right of the cassette compartment are a three-digit resettable tape counter, a MEMORY push-button (that permits you to rewind the tape to a preset zero point on the digit counter), and a pair of calibrated peak-reading record-level meters that can be accurately read all the way from −40 dB to +5 dB. Note that "0 dB" on those record-level meters corresponds to a level of 200 nanowebers-per-meter (rather than the lower 185 or 160 nW-per-meter often used as 0 calibration points for cassette-deck meters). Keep that in mind when evaluating the headroom figures cited later in this article. An innovatively designed LED indicator is located between the two peak-reading meters. As long as peak record levels are in a safe (or low-distortion) area, the LED glows green. If instantaneous record levels exceed the value considered acceptable by B.I.C./Avnet, the LED magically changes color and glows red, warning the user to back off on record levels or suffer the consequences of over-recording and high distortion levels during playback. Below the two meters are a pair of large, concentrically-mounted record-level controls, while to the right are an output-level control and a separate phone output-level control. The deck can therefore handle headphones with a wide range of sensitivities, and you can adjust the sound level from the headphones without affecting main output level that is being fed to the rest of the system.

The lower edge of the front panel contains a speed-selector switch (with settings for 1⅞ or 3¾ ips); and an equalization-selector switch (with settings for either 120 or 70 μs). There is a three-position bias-selector switch (marked low, normal, or high, rather than being referenced to specific tape types); and a three-position RECORD switch with settings labeled SAFE, READY, and MUTE. In addition, there's a Dolby-mode switch (with a COPY and ON position that lets you use the built-in Dolby circuitry for purposes other than just tape recording and playback); and an MPX filter switch. That is useful when recording stereo FM programs off-the-air from tuners whose outputs contain significant subcarrier high-frequency products that might upset Dolby operation and calibration, or might beat with the deck's bias oscillator. Three pushbuttons to the right of those switches select source of tape monitoring, introduce a record-calibration test tone, and select microphone or line inputs. (Mixing of microphone and line inputs is not possible with this deck.) Left and right microphone-input jacks, as well as a phone-output jack (stereo) at the lower right, complete the panel layout. Line-input and line-output connections are both made at the rear panel through phono-tip jacks.

RADIO-ELECTRONICS AUDIO LAB
R.E.A.L. SOUND RATES
B.I.C./AVNET T-3 CASSETTE DECK
SUPERB

MANUFACTURER'S PUBLISHED SPECIFICATIONS*:

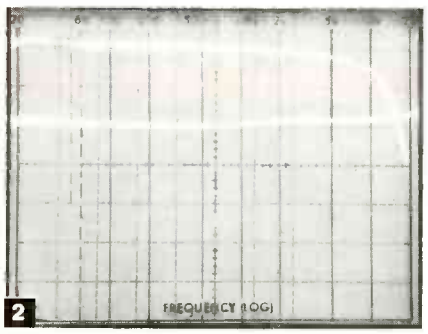
(*Items shown to either side of slash mark correspond to operation at 1⅞ ips/3¾ ips running speeds.)
Frequency Response (±3 dB): 70 μs or CrO_2 tape, 25 Hz–19 kHz/25 Hz–22 kHz. **S/N Ratio. (A-Weighted):** 70 μs tape, 55/58 dB (Dolby off); 63/67 dB (Dolby on). **Wow-and-Flutter** (WRMS): 0.05/0.035%; unweighted, 0.09/0.06%. **Harmonic Distortion:** 70 μs tape, 1.8/1.5%, at 0 VU record level. **Fast-Forward or Rewind Speed** (C-90): 45 seconds. **Input Sensitivity:** line, 200 mV. **Output Level:** 2 volts. **Meter Type & Range:** peak reading, −40 to +5 dB. **Power Requirements:** 105/135 volts, 50/60 Hz, 35 watts. **Dimensions:** 17 15/16 W × 6⅞ H × 10⅛ inches D. **Weight:** 14.8 lbs. **Suggested Retail Price:** $529.95.

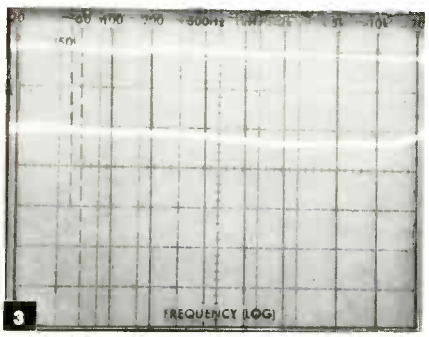
Lab measurements

To evaluate and measure the two-speed deck's performance properly, we treated the unit as though it were *two* separate decks: one operating at a standard 1⅞-ips speed, the other at the increased speed of 3¾ ips. So many performance characteristics change when the speed is increased (all of them for the better, by the way) that we have shown our results for slow and fast operation separately. Table 1 summarizes our results at 1⅞-ips operation, while Table 2 shows measurements obtained at the higher 3¾-ips speed. We made all measurements using TDK-type AD C-90 cassettes as the "standard" sample, while TDK-type SA C-90 cassettes were used for all measurements in the 70-microsecond equalization setting. As mentioned earlier, the manufacturer did not assign generic tape names to the three bias

positions on the front-panel switch. They do, however, list recommended bias-switch settings for different brands and grades of tape. In many instances, the settings are *not* the same for high speed as they are for the standard speed. For example, we found (and B.I.C./Avnet recommends) that the high bias setting should be used for TDK-SA tape (whose bias requirements are similar to those of chrome tape) at both low and high speeds. However, for the TDK-AD tape we found that using the low bias setting at slow speed and the high (not the normal) setting at high speed yielded best overall results with respect to frequency response, signal-to-noise (S/N) ratio and distortion.

Since the *Model T-3* is a three-head tape deck, we were able to conduct sweep-frequency measurements (in addition to point-by-point plots or tabulations) of overall record/play response. That was done for the TDK-SA tape at both the slow-speed (Fig. 2) and high-speed (Fig. 3) modes for −20-dB and 0-dB record levels. The frequency-response figures shown in Tables 1 and 2 are those we obtained at the −20-dB record level. The upper traces in Figs. 2 and 3 show a particularly interesting phenomenon: At the slow 1⅞-ips speed, the typical high-frequency rolloff caused by tape saturation occurs. In contrast, at the 3¾-ips speed, even when the frequency sweep is made at a record level of 0 dB, response remains virtually flat all the way out to 20 kHz! What that means is enormously increased headroom at high frequencies, in addition to other benefits (abundantly evident when you compare the measured distortion, signal-to-noise, and wow-and-flutter specs shown in Tables 1 and 2).





By changing the spectrum analyzer's sweep mode from frequency log (as shown in Figs. 2 and 3) to linear (from approximately 0 Hz to 20 kHz), we were able to display the improvement graphically in both S/N and third-order distortion that is gained by increasing the tape speed to 3¾ ips. Figure 4 shows a 1-kHz signal recorded onto the TDK-SA sample tape (this signal appears as the tall spike to the left in Fig. 4). On the right another spike represents

RADIO-ELECTRONICS PRODUCT TEST REPORT

TABLE 1

Manufacturer: **B.I.C./Avnet** Model: **T-3**

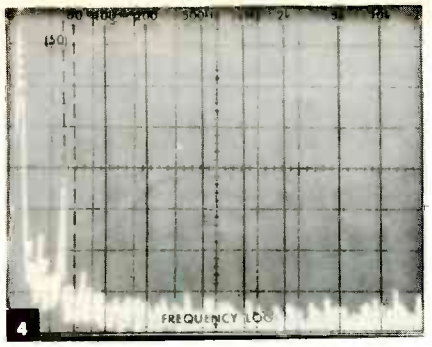
CASSETTE TAPE DECK MEASUREMENTS AT 1⅞ IPS

	R-E Measurements	R-E Evaluation
FREQUENCY RESPONSE MEASUREMENTS		
Frequency response, standard tape (Hz-kHz ± dB)	10-19, 3.0	Excellent
Frequency response, CrO_2 tape (Hz-kHz ± dB)	10-23, 3.0	Superb
Frequency response, other (see text) (Hz-kHz ± dB)	N/A See Fig 2	N/A
DISTORTION MEASUREMENTS (RECORD/PLAY)	TDK-SA/TDK-AD	
Harmonic distortion −3 VU (1 kHz) (%)	1.2/1.2	Superb
Harmonic distortion 0 VU (1 kHz) (%)	1.3/1.3	Superb
Harmonic distortion +3 VU (1 kHz) (%)	2.0/1.5	Excellent
Record level for 3% THD (dB)	+4.0/+5.5	Excellent
SIGNAL-TO-NOISE RATIO MEASUREMENTS		
Standard tape, Dolby off (dB)	57	Excellent
Standard tape, Dolby on (dB)	65.5	Excellent
CrO_2 tape, Dolby off (dB)	57	Very good
CrO_2 tape, Dolby on (dB)	66	Excellent
MECHANICAL PERFORMANCE MEASUREMENTS		
Wow-and-flutter (%, WRMS)	0.045	Superb
Fast wind and rewind time, C-60 (seconds)	45	Superb
COMPONENT MATCHING CHARACTERISTICS		
Microphone input sensitivity (mV)	0.16	
Line input sensitivity (mV)	35.0	
Line output level (mV)	1.9 volts	
Phone output level (mV)	317/8 ohms	
Bias frequency (kHz)	N/A	
TRANSPORT MECHANISM EVALUATION		
Action of transport controls		Superb
Absence of mechanical noise		Excellent
Tape head accessibility		Good
Construction and internal layout		Excellent
Evaluation of extra features, if any		Excellent
CONTROL EVALUATION		
Level indicator(s)		Excellent
Level control action		Very good
Adequacy of controls		Excellent
Evaluation of extra controls		Excellent
OVERALL TAPE DECK PERFORMANCE RATING		Superb

TABLE 2

CASSETTE TAPE DECK MEASUREMENTS AT 3¾ IPS.

	R-E Measurements	R-E Evaluation
FREQUENCY RESPONSE MEASUREMENTS		
Frequency response, standard tape (Hz-kHz ± dB)	20-23, 3.0	Superb
Frequency response, CrO_2 tape (Hz-kHz ± dB)	16-24, 3.0 See Fig. 3	Superb
DISTORTION MEASUREMENTS (RECORD/PLAY)	TDK-SA/TDK-AD	
Harmonic Distortion at −3 VU (1 kHz) (%)	0.8/1.0	Excellent
Harmonic distortion at 0 VU (1 kHz) (%)	1.0/0.8	Superb
Harmonic distortion at +3 VU (1 kHz) (%)	1.0/0.9	Superb
Record level for 3% THD (dB)	+7.5/+11.0	Superb
SIGNAL-TO-NOISE RATIO MEASUREMENTS		
Standard tape, Dolby off (dB)	59	Excellent
Standard tape, Dolby on (dB)	67	Superb
CrO_2 tape, Dolby off (dB)	61	Superb
CrO_2 tape, Dolby on (dB)	69	Superb
MECHANICAL PERFORMANCE MEASUREMENTS		
Wow-and-flutter (%, WRMS)	0.025%	Superb
Fast wind and rewind time, C-60 (seconds)	45	Superb
COMPONENT MATCHING CHARACTERISTICS		
Microphone input sensitivity (mV)	See Table 1	
Line input sensitivity (mV)	See Table 1	
Line output level (mV)	See Table 1	
Phone output level (mV)	See Table 1	
Bias frequency (kHz)	See Table 1	
TRANSPORT MECHANISM EVALUATION		
Action of transport controls		Superb
Absence of mechanical noise		Excellent
Tape head accessibility		Good
Construction and internal layout		Excellent
Evaluation of extra features, if any		Excellent
CONTROL EVALUATION		
Level indicator(s)		Excellent
Level control action		Very good
Adequacy of controls		Excellent
Evaluation of extra controls		Excellent
OVERALL TAPE DECK PERFORMANCE RATING		Superb



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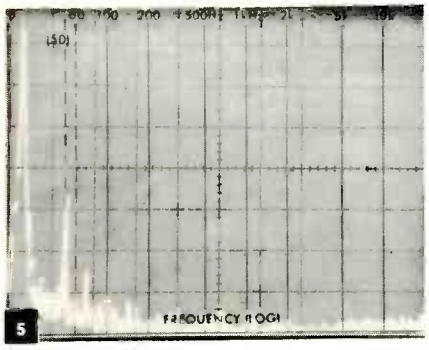

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third-order or third-harmonic content (3 kHz, in that instance), while the lower section of the photo displays the random noise content reproduced during playback. In the scope photo of Fig. 5, only the speed was changed, while the 1-kHz recorded signal amplitude and all the gain and sweep settings remained the same. You will note that third-harmonic distortion is measurably lower and overall random noise level is considerably decreased throughout the bandwidth (to 20 kHz).

Summary

Recently, we had occasion to discuss the implications of metal-particle tape with one of the B.I.C./Avnet engineers. As you know, pure metal-particle tape promises to deliver greater headroom (or dynamic range) and improved frequency response especially when it is used in the cassette format. The B.I.C./Avnet engineer pointed out that operating a cassette deck at twice the so-called standard speed produces exactly the same benefits without having to create new higher-bias circuits, new erase-electronics and heads, and new higher-capacity recording heads. He further indicated that while operating cassette tape at twice the normal speed does indeed use up twice as much tape, the pure metal-particle tape will cost considerably more than even the best grades of cassette tape presently available. He believes therefore that the company's two-speed cassette tape decks negate the actual need for a better tape such as metal-particle tapes. Of course, you can always argue that metal tapes, if used at *higher* speed in a compatible cassette deck, would yield even *further* overall improvement in performance.

Our overall product evaluation is contained in Table 3 along with some summary comments regarding this unusual cassette deck. If we have tended to concentrate heavily on the *Model T-3's* performance at its higher operating speed, that is because we were impressed by the observable differences in performance compared with 1⅞ ips operation. The B.I.C./Avent *Model T-3* stereo cassette deck is indeed a superb piece of equipment even when compared with ordinary cassette decks operated at the slow 1⅞ ips speed. Even if you consider this equipment based only on the figures in Table 1, the deck is superb at its price; add the results shown in Table 2 and it becomes a truly incredible machine. **R-E**

RADIO-ELECTRONICS PRODUCT TEST REPORT

TABLE 3

Manufacturer: **B.I.C./Avnet** Model: **T-3**

OVERALL PRODUCT ANALYSIS

Retail price	**$529.95**
Price category	**Medium**
Price/performance ratio	**Superb**
Styling and appearance	**Excellent**
Sound quality	**Superb**
Mechanical performance	**Excellent**

Comments: With respect to the operation of the *model T-3* at 3¾ inches-per-second, it is not possible to compare this unusual stereo cassette deck with any other cassette deck available. As of this writing, there *is* nothing that operates both at the higher 3¾ ips speed and standard cassette speed. We expected that the higher-speed performance of this deck would be much better than the 1⅞ ips performance of more expensive decks, knowing the limitations of slow speed tape recording. What we were not prepared for was the outstanding performance that this deck achieves even when operating at the slower standard speed.

The design engineers could have opted for extended frequency response at the expense of other operating parameters. Instead, they wisely elected to offer a machine in which all the important operating characteristics (i.e., S/N, distortion and frequency response) are beautifully balanced and optimized with respect to each other. At the deck's higher speed, its performance truly *equals* that of many open-reel machines. Of course, operating at twice the normal speed means that you use twice as much tape. In effect, a nominally labelled C-90 cassette effectively becomes a C-45. To the serious recordist who wants the finest possible recordings, this will pose no great problem. And if you want to be miserly about tape usage, Table 1 confirms that even at low speed the deck maintains a level of performance for which you would have to pay considerably more with other decks.

Aside from the superior measurements shown in Tables 1 and 2, we should note that such recording aberrations as contour effect (the tendency for low-frequency response to waver up to around 150 or 200 Hz) have been all but eliminated (see Figs. 2 and 3). The *model T-3's* mechanical performance is as impressive as its electrical performance. Although not solenoid-operated, transport control is smooth and positive, and tape handling is safe and reliable. B.I.C./Avnet should be congratulated for taking this bold step in the cassette-deck marketplace.

Solid State News

Video modulator IC's

Motorola's MC1372 and XC1373 TV video modulators are designed for color TV applications in video games, data terminals, test equipment and videotape recorders. The devices can be driven by the MC6847 video-display generator and other color and video sources.

The MC1372 is a 14-pin device with a chroma subcarrier oscillator using an external 3.58-MHz crystal, a suppressed-carrier double-sideband chroma modulator and an RF modulator.

The lower-cost XC1373, mounted in an 8-pin mini-DIP, has an RF oscillator and dual-input modulator only. It can be used when a composite video source exists in another system.

Both circuits produce signal outputs on Channel 3 or Channel 4 and can alternatively produce inverted or noninverted video output signals. For details, write to Motorola Semiconductor Products, Box 20912, Phoenix, AZ 85036.

Second-generation VMOS device

Siliconix's second-generation VMOS power FET, the VN84GA, is rated at 12.5 amp and 80 volts which is a six-times current increase over previous transistors. With only microwatt input power, the VN84GA produces up to 80 watts output at low frequencies and a 50-watt output at 30 MHz. The devices do not show any of the secondary-breakdown and thermal runaway characteristics of bipolar transistors. These FET's interface directly with CMOS, TTL, DTL, and MOS families for use in devices such as solid-state switching regulators, motor controllers, audio amplifiers and micro-processor interfaces.

Using VMOS devices in linear amplifiers up to 30 MHz produces lower distortion because of the linear-transfer characteristics and good high-frequency behavior of the VN84GA, and the low distortion means that only small amounts of feedback are required. The devices can also be used in Class-D audio amplifiers because of their fast switching and zero storage time.

The VN84GA is mounted in a TO-3 package and is priced at $19.76 in quantities from 1 to 99. Siliconix Incorporated, 2201 Laurelwood Road, Santa Clara, CA 95054. **R-E**

WIPEOUT VIDEOGAME

One integrated circuit equals ten action-packed games. Build this videogame and get in on that action.

L. STEVEN CHEAIRS

BY NOW, NO DOUBT, A NUMBER OF **RADIO-Electronics'** readers associate my name with video games. A fair portion of my articles thus far *have* dealt with that topic—and in the pursuit of the tradition, here is another one. This construction project will provide the reader with ten more black-and-white video games. Both NTSC and CCIR televisions sets may be used; NTSC is the standard 525-line U.S.A. system and CCIR is the 625-line system used in many foreign countries. Both single-player and two-player games are possible. On-screen automatic scoring has been provided.

Two potentiometers, one for each player, provide for vertical paddle motion. A control voltage, determined by the setting of the potentiometer, charges a capacitor; the charge-level of the capacitor is detected by a Schmitt trigger. Thus the rotation of the pot causes a variation in the voltage across the capacitor that is detected and translated to a player-position on the television screen. The player and his score are color-coded for easy identification. The audio circuit outputs tones to indicate hits of the ball by the player, and impacts with the court border or target obstacles. Game selection is made by using a 10-key switch matrix; either fixed—or momentary-contact—switches are acceptable. Two switches are used to start the ball into motion and to keep it in play during the game. A reset switch is provided to clear the screen to prepare for a new game. Three other switches select skill-level options.

About the games

Five single-player, and five dual-player games are contained on the LSI integrated circuit. Figure 1 shows a typical image for each game. There are three major types of game on that integrated circuit; those are *Wipeout*, *Color Squares*, and *Breakthrough*. The first four games that will be described are the wipeout games.

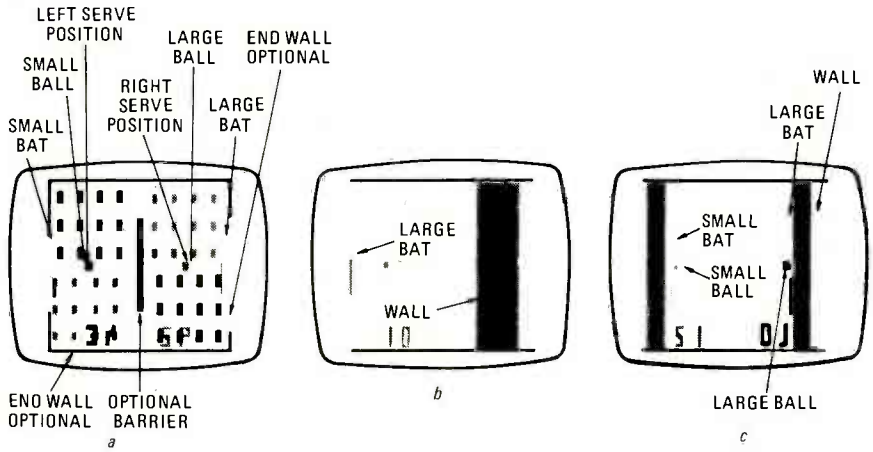
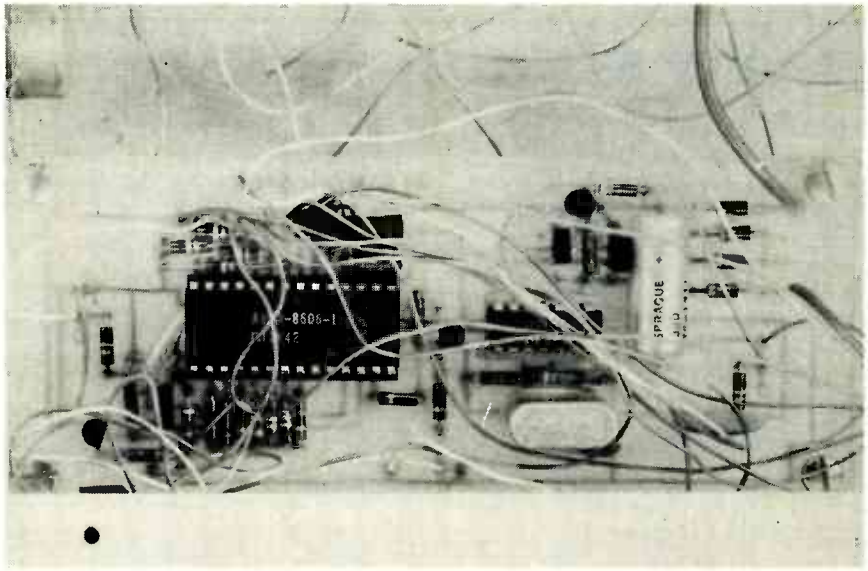


FIG. 1—VIDEO DISPLAYS used by the Ten Action Games. The variations for *Wipeout* and *Color Squares* are shown in *a*. *Breakthrough 1* and *2* appear in *b* and *c*.

Figure 1-a illustrates the different characters that can be generated when playing the four versions of *Wipeout* and the four versions of *Color squares*.

Wipeout 1 is chosen when *select line one* and *strobe line one* are connected, either momentarily or continuously, by switch S9. After game selection and



THE HEART of the Ten Action Games board is the AY-3-8606-1 IC from General Instruments. Many of the components clustered around it are used to set the parameters of the games and display.

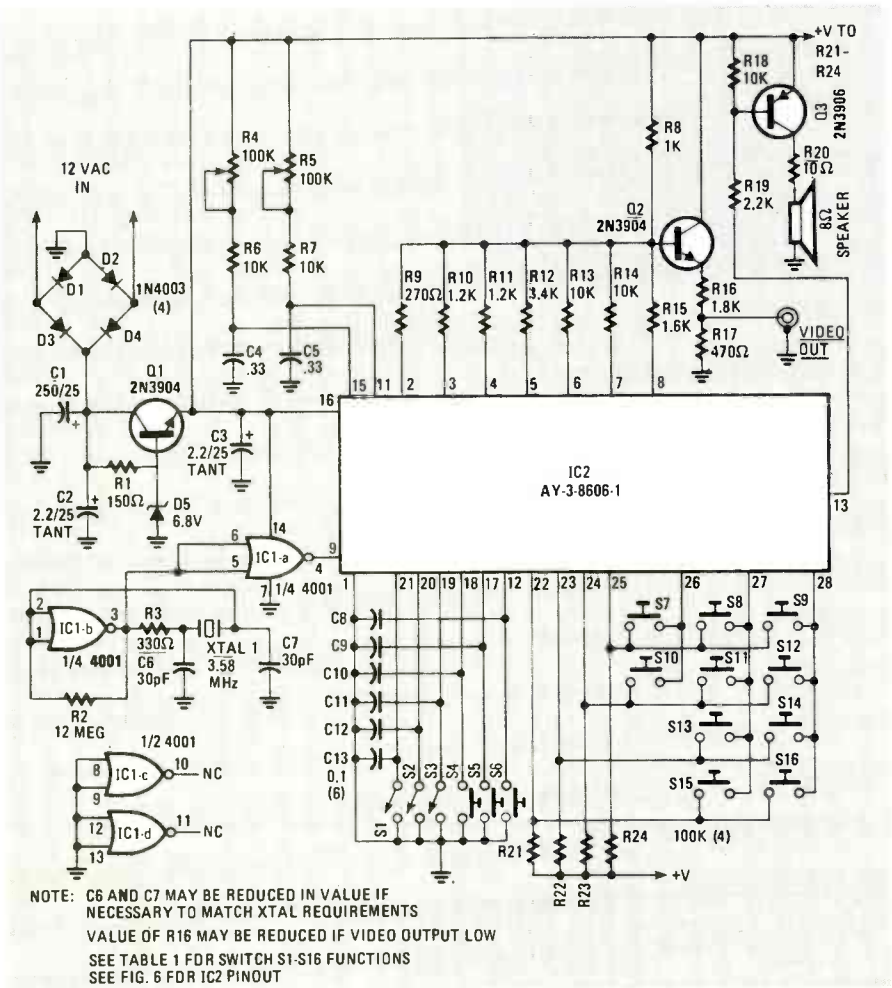


FIG. 2—MAIN SCHEMATIC for the Ten Action Games. A foil pattern is provided in Fig. 4.

game reset, the game is started by pressing either the right or left SERVE button (S5 or S6). The object is to hit every black target-square. The squares disappear as they are hit. No deflection of the ball results from hitting a target-square. The game will end if five consecutive misses occur or if all squares are hit and obliterated. This is a single-player game—the right-hand paddle is used. That paddle is controlled by the pot connected nearest the LSI IC on the PC board. The score, paddle, ball, and boundary are gray. The score displays the number of targets hit.

Wipeout II is also a single-player game; it uses both the left and right paddles. After selection by S12 (*select 1* with *strobe 2*) and reset (S4), the game begins when either SERVE switch is depressed. It will start with a white ball moving toward the right side of the screen. If intercepted by the black paddle, the ball changes color to black and rebounds toward the white side. The color-coded score records the targets removed by its color ball.

If *select 1* and *strobe 3* are shorted together by switch S14, then *Wipeout III* is selected. It is a two-player game—both right and left potentiometers and SERVE buttons are used. The game is played much like the previous *Wipeout* game, but the playing area is totally enclosed. After the game is started it will continue until all target squares are removed. The first player to press his SERVE button after reset has control of the ball until his opponent can intercept it, thus gaining control of it for himself.

The last *Wipeout* game, *Wipeout IV*, is chosen by S16's connecting the *select 1* pin to the *strobe 4* pin. It is also a two-player game. The game is played generally the same way as the others but with one major distinction—the screen is divided by a large vertical barrier. Thus the ball can only cross the field near the very top or bottom of the image and an added set of player strategies is gained. For example, once the ball is on a player's side, it may continually be bounced off the barrier to gain up to half the possible points. To win then, one need only pass the ball to the other side of the playing field. At least one more point will be scored in doing so, winning the game.

Color Squares games follow similar lines to the *Wipeout* set with one major exception—the screen is divided into four sections. Two quadrants are color coded as the white player's and two are color coded as the black player's. Target destruction may only occur by ramming one's own color square. The game ends when all targets of one color are removed. *Color Squares I*, selected by connecting *select 2* to *strobe 1* (S8), is a single-player game. *Color Squares*

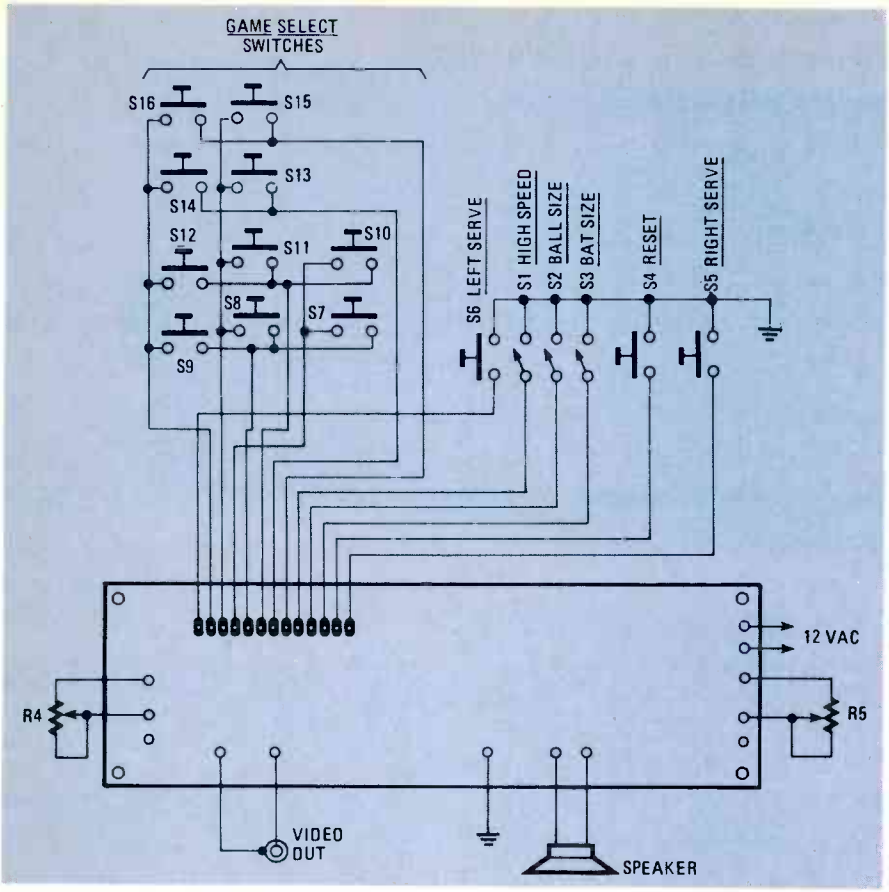


FIG. 3—CONNECTION of case-mounted components to main PC board.

TABLE I		
Switch No.	Function	Pin No's.
S1	High speed	21, Gnd.
S2	Ball size	20, Gnd.
S3	Bat size	19, Gnd.
S4	Reset	18, Gnd.
S5	Right serve	17, Gnd.
S6	Left serve	12, Gnd.
S7	Breakthrough I	25, 26
S8	Color Squares I	25, 27
S9	Wipeout I	25, 28
S10	Breakthrough II	24, 26
S11	Color Squares II	24, 27
S12	Wipeout II	24, 28
S13	Color Squares III	23, 27
S14	Wipeout III	23, 28
S15	Color Squares IV	22, 27
S16	Wipeout IV	22, 28

II is similar, but is a two-player version (it uses S11 to connect *select 2* and *strobe 2*). *Color Squares III* (*select 2* and *strobe 3*—using S13) is played much like *Wipeout IV*. *Select 2* and *strobe 4* (S15) turn on *Color Squares IV*. That is a single-player game, with only one paddle; the field is enclosed on three sides.

The remaining two games are *Breakthrough I* and *Breakthrough II*. *Breakthrough I* (Fig. 1-b) is a single-player game selected by switch S7. The ball is served toward the wall opposite the player's paddle. When it hits the wall a block is knocked out. The object of the game is to knock a hole through the wall and then to pass the ball through the hole. Each time the ball knocks a block from the wall it rebounds. The paddle is maneuvered to intercept the ball and redirect it into the wall. The wall is nine layers thick; only seven misses are permitted. The score, which should be kept as low as possible, records the number of blocks removed.

Breakthrough II (Fig. 1-c) is a two-player game with walls that are four layers thick. The game ends when a breakthrough occurs. Winning is a function of the number of hits. That game is turned on by the *select 3* pin and the *strobe 2* line (S10). No game selection occurs when *select 3* or *4* are shorted to *strobe 3*.

Some features are common to all the games. The targets are arranged in a 4×6 array. Each target is eight raster lines high and four dots wide. The score display is sixteen lines high and six dots wide. Each vertical line is two dots wide and each horizontal line is four raster-lines thick. The ball can be either of two sizes, five lines or nine lines high—switch S2—and the bat size and ball speed are selected by S3 and S1, respectively. The audio signals are the same for all the games.

Construction

This project is relatively simple for the beginner. But, even so, a minimum level of skill in construction is assumed. There are a number of sources (such as back issues of **Radio-Electronics**) where the beginner can find information on construction techniques.

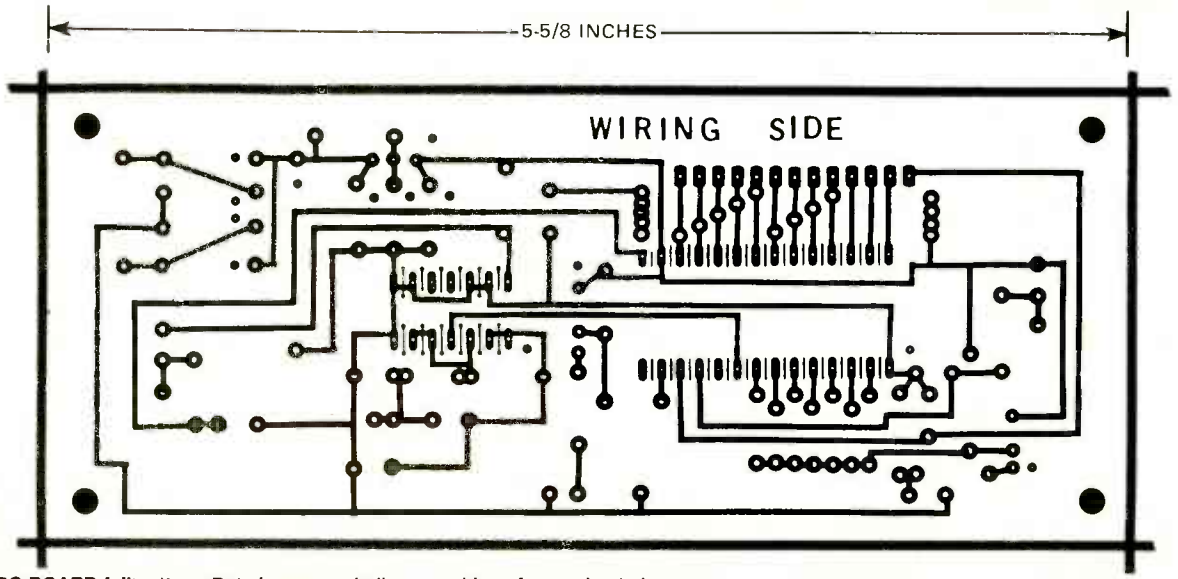


FIG. 4—PC BOARD foil pattern. Dots in corners indicate position of mounting holes.

PARTS LIST

All resistors ¼ watt, 5% unless otherwise specified

Resistors

R1—150 ohms
R2—12 megohms
R3—220 ohms
R4, R5—100,000 ohm pot, linear taper
R6, R7, R13, R14, R18—10,000 ohms
R8—1000 ohms
R9—270 ohms
R10, R11—1200 ohms
R12—3400 ohms
R15—1600 ohms
R16—1800 ohms
R17—470 ohms
R19—2200 ohms
R20—10 ohms
R21-R24—100,000 ohms

Capacitors

C1—250 μF, 25 volt electrolytic
C2, C3—2.2 μF, 25 volt tantalum
C4, C5—0.33 μF ceramic
C6, C7—30 pF ceramic
C8-C13—0.1 μF ceramic

Semiconductors

D1-D4—1N4003
D5—6.8-volt Zener diode
Q1—2N3904
Q3—2N3906
IC1—4001 CMOS quad, 2-input, NOR gate
IC2—AY-3-8606-1 (General Instruments) for U.S.-standard video (525-line) or AY-3-8606 for 625-line standard
XTAL1—3.579545-MHz crystal
S1-S3—SPST toggle switch
S4-S16—SPST normally-open (N.O.) pushbutton switch
T1—12-volt, 1-amp transformer

Miscellaneous: case, 8-ohm speaker, line cord, output jack, four spacers, wire, hardware.

The following may be obtained from Quest-Star Electronics Co., 5412 Burntwood Way, Las Vegas, NE 89108: Kit with all parts (no case or hardware), U.S. standard, G1300, $55.00 or 625-line standard, G1301, $57.00. PC board only, $12.00. AY-3-8606 or AY-3-8606-1, $14.50. For orders of 25 or more contact Quest-Star for prices. Please add $2.25 for shipping—any excess will be refunded. Nevada residents add 3½% tax. Shipment will be made from stock to six weeks.

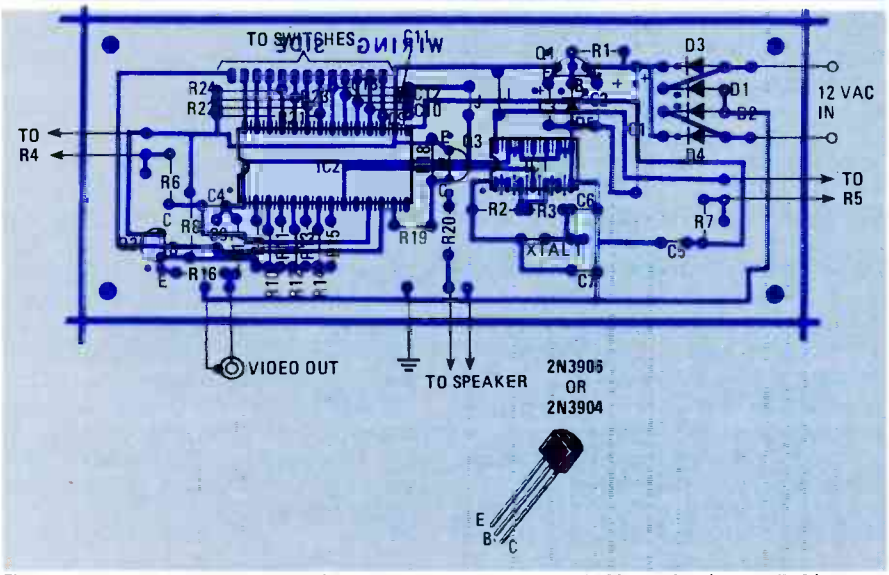
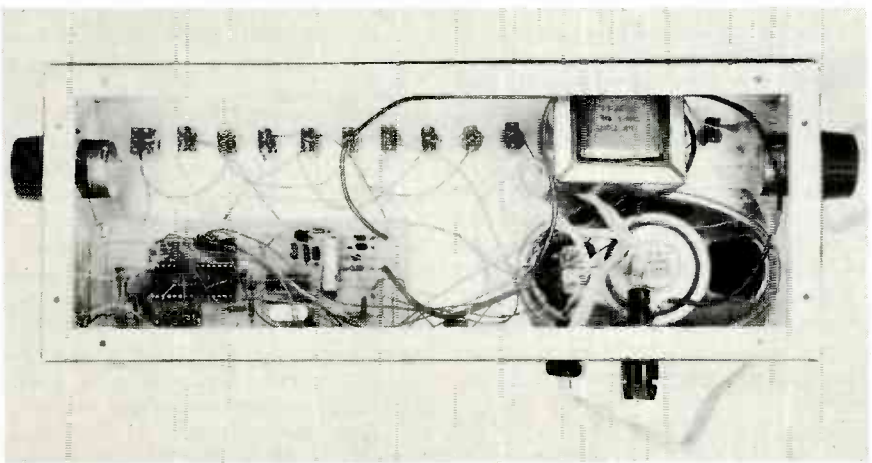


FIG. 5—PARTS PLACEMENT DIAGRAM. Take care to observe all polarities and make sure that jumpers are installed. Do not confuse the 2N3904 and 2N3906 transistors.



SUGGESTED LAYOUT for the PC board and external components within the case. The array of switches at the top is connected to a row of pads located just above the game IC.

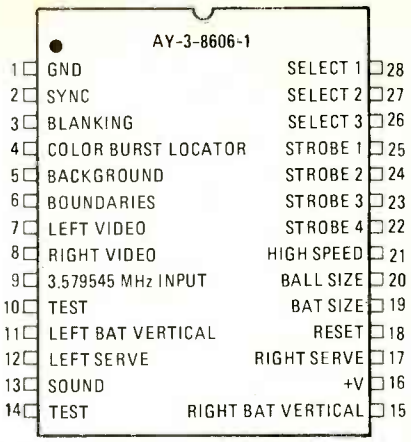


FIG. 6—FUNCTIONAL PINOUT of the AY-3-8606-1 IC. This can help you with the off-the-board wiring and, should it prove necessary, in troubleshooting.

The basic tools one will need are a fine-tip, low-wattage soldering iron (about 27½ watts), a pair of fine-tip pointed-nose pliers, a pair of diagonal-tip wire cutters, and a set of wire strippers. Also, include a spool of rosin-core solder. The game, may be assembled using point-to-point wiring, wire-wrap, or printed-circuit techniques. The printed-circuit approach will be considered here. The other two methods can be undertaken using the parts list and the schematic diagrams shown in Figs. 2 and 3. Table 1 lists the functions of the front-panel mounted switches and their connections.

If the printed-circuit approach is chosen then one can etch his own card using the artwork pattern presented in Fig. 4, or a board layout may be made by referencing the schematic diagram. The simplest course is to buy a ready-made circuit board from the source given in the parts list, Quest-Star Electronics Co.

The first step is to obtain all of the components shown in the parts list; most of those are common items. The main LSI game IC may be a bit difficult to find, but it might be obtained from the same source as the PC board. Also, Quest-Star will provide a complete kit of *all* parts for those who do not have access to all of the components or who want to simplify their shopping. The complete kit includes all of the electronic components, the PC board, and the required hardware.

Having collected all of the parts, place all of the electronic components on a workbench, desk, or table. Make sure that all of the MOS and CMOS integrated circuits remain in their conductive packaging. Compare the components, now laid out, to the items specified in the parts list and if everything matches then proceed.

Take the enclosure and drill the holes required for the potentiometers, switches, transformer, PC board,

speaker, video-output jack, and line-cord. Next, paint the exterior of the case. After the paint is dry use dry-transfer lettering to label the controls. That should be followed by spraying the case with a clear lacquer to protect the finish. Let the case dry for 12-24 hours.

Mount the corner spacers on the foil side of the printed-circuit board. Install the IC sockets in their proper locations—making sure they are oriented properly; Fig. 5 should be consulted. Place a piece of cardboard on top of the sockets and invert the assembly, keeping an even pressure on both sides. Now solder the sockets into place. Return the assembly to the components-side up position.

Install all of the resistors and capacitors; verify their locations and solder. Next install the diodes, transistors, and voltage regulator. Again verify the orientation and placement of the parts before soldering. Lay the PC card aside until final assembly.

When the case is dry, mount the controls, transformer, line-card, output jack, speaker, and PC card. Wire those components as shown in Fig. 3. Before proceeding verify the wiring! Plug the line cord into an AC wall outlet. Check the voltages at the IC +V pins for the proper DC level—about 5 volts. If they are correct, unplug the cord and discharge the capacitors. Install the IC's in their sockets—observing the proper orientation. The assembly is now complete; if an RF modulator is to be used it may be also installed in the case.

Troubleshooting

This section, I hope, will never be needed but if problems should be encountered use the schematic diagram and the pinouts provided in Fig. 6 to aid in troubleshooting the game circuit. Start by following the checklist below:

1. Are all components in the proper location?
2. Are all components oriented correctly?
3. Is the PC card wired correctly to the external components?
4. Is the power-supply voltage correct?
5. Is a 3.58-MHz clock signal present at pin 9 of the game IC?
6. Is there an audio output?
7. Is there a composite video signal?

If the answer to any of these questions is "no," then investigate that portion of the circuit. For example, if no clock signal is observed, check the oscillator. Troubleshooting in that fashion should enable you to locate and remedy any problems rather quickly.

You should obtain a great deal of enjoyment from both the construction and use of this project. **R-E**

TROUBLESHOOTING VHS TRANSPORT CIRCUITS

FOREST BELT

THE VHS VIDEOTAPE TRANSPORT MECHANISM is a complex one, and so are the electronic circuits that control it. Let's take a look at how those control circuits work.

A prime key to the operation of the control circuitry lies among several switches. They open and close at what may seem irregular times during the tape-threading process. But the timing is quite specific, as you will see.

Actually, only two switches (see Fig. 1) work oddly. They operate as follows: While the machine is in the STOP mode—that is, before any button is depressed—the play-1 switch is open, and the play-2 switch is closed. When you first press down the PLAY button, the play-1 switch closes. The play-2 switch remains closed, for that initial movement of the PLAY button. However, by the time the PLAY button reaches the bottom of its travel and latches, the play-2 switch has opened.

Later, pressing the STOP button unlatches the PLAY button. As the play linkage leaves the latched-down play position, the linkage closes the play-2 switch . . . and shortly thereafter opens the play-1 switch.

The switches just described initiate the loading operation. To shut off the threading motor when loading has reached its limit, a loading-end switch closes and applies 12 volts to transistor Q612. The switch, having closed when loading is finished, remains closed until the motion of loading actually begins.

Unloading is initiated whenever the PLAY button unlatches, whether it is done manually or by the auto-shutoff solenoid. As you already know, this action of the PLAY-button linkage closes the play-2 switch and opens the play-1 switch.

Then, when unloading is completed, the unload-end switch closes. That grounds the cathode side of diodes D617 and D618, which redirects voltages around so the motor quits running. The unload-end switch stays closed until such time as the PLAY button again starts a loading operation.

In one variation appearing in recent VHS models, the loading-end switch closes a path to ground instead of to a voltage supply. Of course, circuitry changes somewhat. For operation of the remainder of the section, however, that modification changes practically nothing.

Tape loading

To initiate tape loading, the operator depresses the PLAY button on the front of the machine. Switch play-1 (see Fig. 1) closes immediately. When the button is first pushed, switch play-2 remains closed.

A DC voltage goes through the play-1 switch to a voltage divider (R633-R634) at the base of Q611. That turns Q611 on. The voltage at the collector of Q611 goes low. In digital terms, logic high at the base of Q611 produces a logic low at the collector—a classic inverter action. The low voltage (logic) coupled to the base of Q610 through R632 places a logic high at the Q610 collector and a logic low at its emitter. Both are output points from that stage.

Low bias at the base of Q609 leaves Q609 cut off. A logic high could develop at the collector if there were some path for DC from a supply point. As

Many videotape deck service problems involve the load/unload section. This companion piece to one which appeared several months ago on the Beta mechanism will round out your knowledge and abilities.

you see, however, there is no supply resistor . . . only Q608.

The P collector of Q610 is supplied with 12 volts unregulated through R623 and R624. With no drop across R623, because Q610 is cut off, the base of Q607 stays high, same as the emitter. Lack of forward bias leaves this PNP transistor cut off. Q607 is, in effect, open.

Meanwhile, the play-2 switch has remained closed. (This is still during the first instant of depressing the PLAY button.) The unload-end switch, too, is closed, left that way when the tape last unloaded from the transport mechanism. These two switches create a path to ground for the positive voltage coming through R618. A ground at the cathode of D618 forward-biases D618 and then D619. The voltage at the junction of R618 and D619 stays near zero as long as both switches remain closed.

Hence, Q605 receives no forward bias (logic low) and stays cut off. The resulting low voltage at the emitter of Q605 is seen as a logic low by the base of Q606. So that transistor, too, remains cut off.

A DC supply path exists for the col-

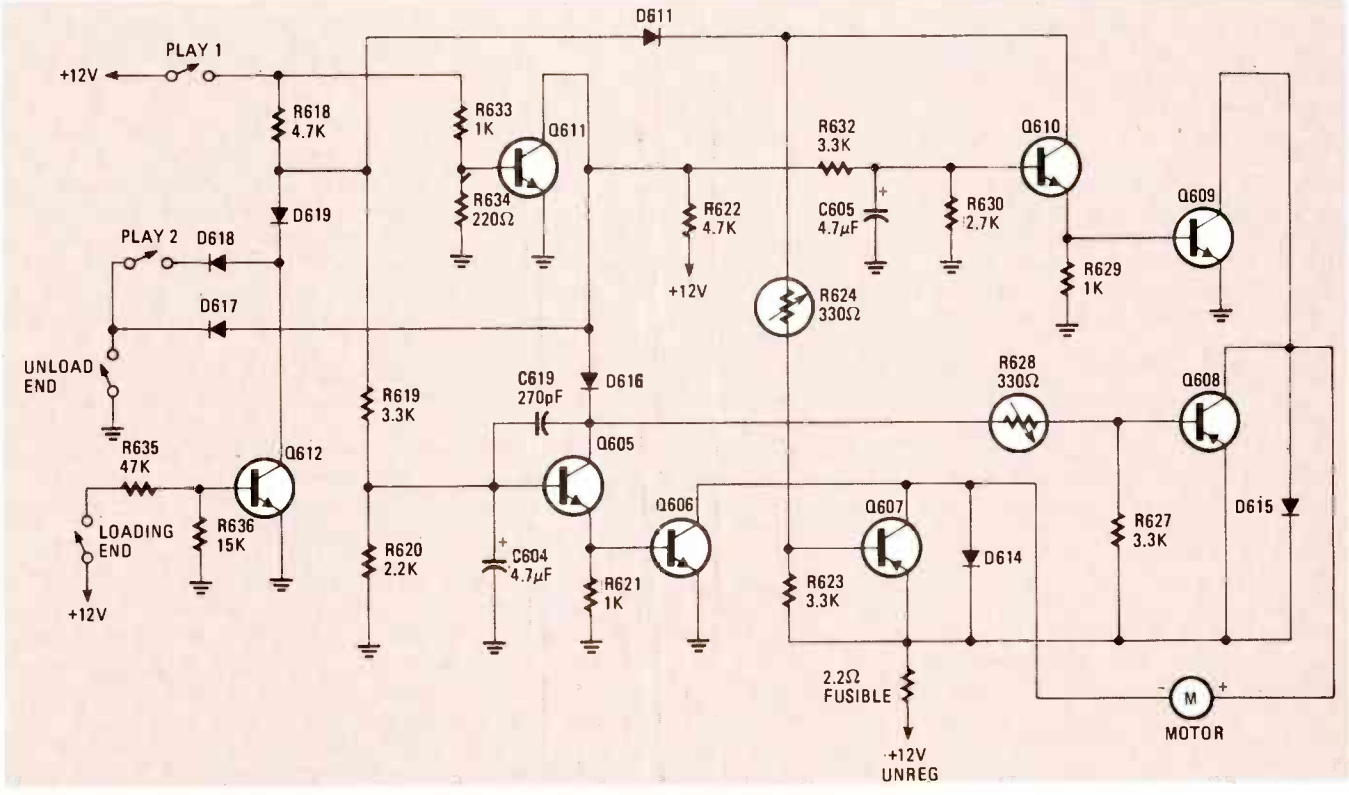


FIG. 1. SWITCHING DIODES AND TRANSISTORS turn threading motor on and off, and apply voltages in reverse for unloading. Limit switches turn the threading motor off at the end of the loading and unloading sequence.

lector of Q605. It starts at the fusible resistor and the 12-volt unregulated line. Resistors R627 and R628 complete the path. But with Q605 cut off, no current flows through those resistors, and no voltage drop occurs. The voltage at the base of Q608 stays at the same level as the emitter, and Q608 remains cut off, too.

All that has taken place in the instant the PLAY button was first pressed downward, closing the play-1 switch. Next, the PLAY button latches at the bottom of its travel. At that extreme, the play-button linkage opens the play-2 switch. Now things begin to happen.

A bias voltage for Q605 now develops across R620. Transistor Q605 turns on. Current flows in the R621-Q605-R628-R627 path from the 12 volts unregulated line. A positive voltage develops across R621, which turns on Q606. The normally-negative motor terminal goes to ground through a conducting Q606.

Current through R627 develops a bias that leaves the base of Q608 less positive than the emitter. That bias turns Q608 transistor on, which applies 12 volts DC to the normally-positive terminal of the loading motor. The motor begins turning, in its "forward" or normal direction. The mechanical loading process thus begins.

The unload-end switch opens as soon as the loading-drive mechanism turns the loading rings. But that has no immediate effect on anything electronic. The play-2 switch opened earlier, when the PLAY button latched. And D617 is reverse-biased anyway, because Q611 is conducting heavily and keeping its collector voltage practically at zero.

End of loading

The threading motor operates the tape-loading mechanism. Eventually, the loading-ring posts reach the limit of their travel, coming up against their V-stops. A protrusion on one ring pushes an arm that closes the end-of-loading leaf switch.

If the switch is the kind that applies 12 volts to R635 and R636, as is shown in Fig. 1, the bias turns on transistor Q612. A highly conductive Q612 acts as a short at the junction of D618 and D619. Diode D619 becomes highly conductive and the voltage at the junction of R618 and D619 goes to zero.

The bias on Q605 ceases and Q605 cuts off. Lack of current through R627 now lets Q608 cut off, removing DC voltage from the positive terminal of the motor. Lack of current through R621 cuts off Q606, which removes the ground path from the negative terminal of the motor. Either change stops the motor from turning.

Note that Q611 stays on. This, through Q610, keeps Q609 and Q607 cut off.

The unload cycle

To initiate unloading in VHS machines, the operator need only press the STOP button. That has no direct electronic effect. It merely unlatches the PLAY button and allows it to return to its up position.

The play-1 switch opens and the play-2 switch closes. The play-2 switch has no effect, because the unload-end switch has remained open ever since loading began.

The play-1 switch, upon opening, removes voltage from R618 and R633. The bias for Q611 disappears. Transistor Q611, which has been on all this time, turns off and triggers a whole chain of electronic events.

The voltage at the collector of Q611 rises to the supply value. The positive voltage (logic high) goes through R632 to the base of Q610, turning Q610 on. Current through R629 places a positive bias on Q609, and that transistor becomes highly conductive. Transistor Q609 thus effectively grounds the normally-positive terminal of the loading motor.

Turning on Q610 brings its collector voltage low. Current flows in supply resistors R624 and R623. The voltage drop across R623 makes the base of Q607 less positive than the emitter. Transistor Q607 turns on, applying the positive 12 volts DC at its emitter to the normally-negative terminal of the motor.

The loading motor, with voltages applied in opposite polarity to "normal," begins turning backward. That starts the threading mechanism unloading the tape.

As the loading rings rotate away from the "loaded" position, pressure is released on the loading-end switch. It opens. But that has no immediate electronic effect. When the play-1 switch opened, voltage was removed from R618. Diode D619 was from that moment no longer forwarded-biased, so there was no longer a voltage path through Q612 anyway. The loading-end switch just rests open until another loading cycle calls it into use.

Opening the play-1 switch also removes the voltage from the R618-R619-R620 divider. With no positive bias, Q605 cannot conduct. Lack of current leaves no voltage across R621, and no bias for Q606, which stays cut off. By the same token, there's no current flow through R628 and R627; the base of Q608 stays as positive as the emitter and Q608 remains cut off or open.

End of unloading

Some other electronic effects have developed during the unload cycle. Transistor Q611 is off, and its collector voltage increases in the positive direction. That places a positive voltage on the anode of D617. However, it does not constitute forward bias, because there is no ground return. So far, the unload-end switch is open.

But when the threading mechanism reaches its limit, one loading ring moves an arm that closes the unload-end leaf switch. Now D617 can conduct. And it pulls the voltage at the collector of Q611 to zero.

With bias gone, Q610 turns off, and so does Q609. That removes the ground from the positive motor terminal. Current stops flowing through R624 and R623, leaving Q607 without forward bias either. Transistor Q607 no longer applies a positive voltage to the other motor terminal. The motor stops. Tape has been unloaded. The unload-end switch remains closed until the next load cycle begins.

Safety during threading

Several conditions that trigger automatic-stop have the same effect if they occur during threading. Moisture on the dew detector or a stopped video-head wheel or capstan will prevent loading. The auto-stop mechanism unlatches the PLAY button, letting it return to its up position. That triggers the unload mode and unloading proceeds in the manner just described.

Other safety factors are built into the electronic circuits of the threading/unthreading section. A time-delay sensor, for example, halts loading efforts if anything impedes loading for more than 4 or 5 seconds. Two seconds should be sufficient for normal loading.

You can follow the working of that *misloading* protection arrangement by following Fig. 2, which contains additional control circuitry not shown in Fig. 1.

When the play-1 switch closes, it applies voltage to R638. However, the still-closed play-2 switch grounds out that voltage at the other end of R638, by holding D618 and D620 in conduction. But when the play-2 switch opens (as the PLAY button latches), the ground path through D620 and D618 then disappears.

Diode D621 then conducts. So would D626, which activates auto-stop, were it not for capacitor C606. When voltage first reaches the D621-D626-C606 junction, it goes very low as the capacitor begins charging. Diode D626 therefore cannot conduct.

It takes several seconds for C606 to charge up through R638 and R639. After that time, however, the voltage across C606-R639 increases enough to make D626 conduct. And that sends a logic high to the auto-stop system, activating it.

The purpose is to stop the loading in case something jams the threading mechanism. When loading proceeds as it should, the loading-end switch closes well before C606 reaches any-

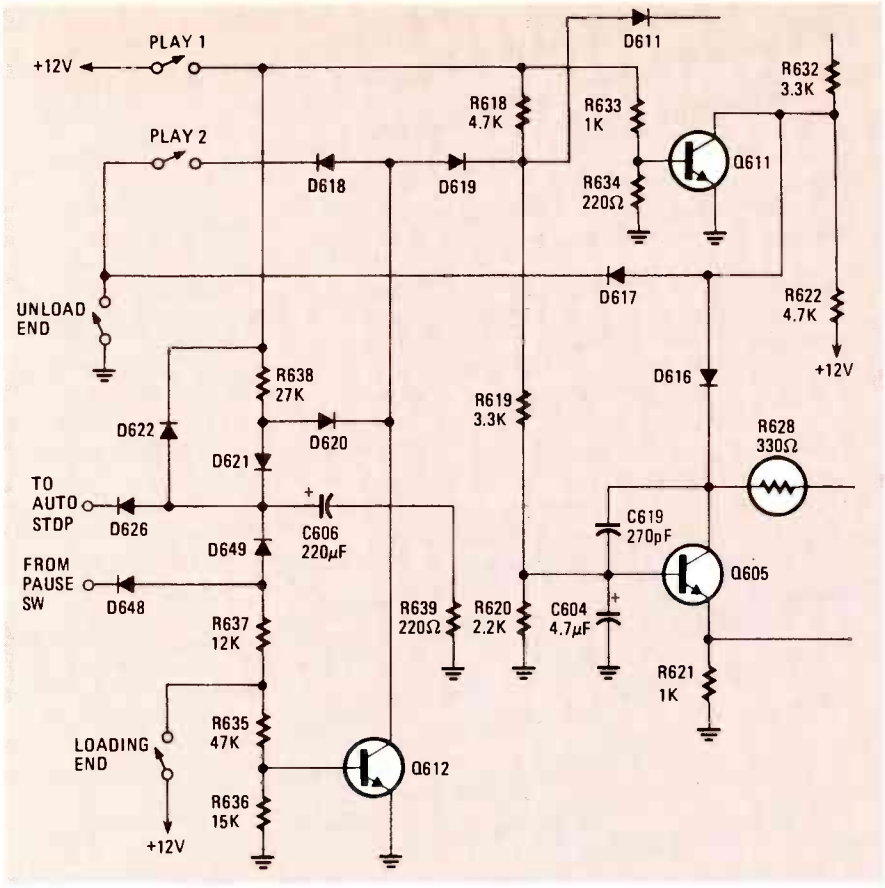


FIG. 2. THE CHARGING TIME of C606 through resistors R538 and R639 delays the voltage rise on D626, to give threading time to complete before the auto-stop mechanism is tripped.

where near a full charge . . . before the voltage attains a level that could make D626 conduct. The loading-end switch turns on Q612, through the bias applied by R635 and R636. Conducting heavily, Q612 grounds out the voltage at the D620-D621 end of R638. Insufficient positive voltage reaches the anode of D626, thus averting auto-stop action.

Power interruption, such as line-voltage failure or even turning off the main power switch of the machine, triggers the auto-stop system. That occurs through an effect which takes place in another portion of the transport control electronics. Figure 3 shows how.

Transistor Q631, which is part of the head-wheel-rotation detection system, draws its collector voltage from an unregulated 18-volt supply. Base bias, however, comes from the power-on line, that carries 12 volts from the main power supply.

An output filter capacitor on the 18-volt line in the power supply (C111, 4700 μF) stores a considerable charge. When the power is interrupted, base bias on Q631 disappears immediately, and Q631 cuts off. The collector voltage on Q631 increases accordingly. The 18-volt supply does not diminish so quickly, due to the large amount of energy stored in the power-supply capacitor.

Diode D629, receives a high positive voltage on its anode and conducts. Resistor R644 carries a logic high to the auto-stop section. To assure quick auto-stop reaction, capacitor C607 and resistor R648 couple the abrupt rising pulse at the collector of Q631 to an advanced stage in the auto-stop section.

The auto-stop solenoid operates, making the PLAY button pop up immediately upon interruption of power to the main supply. Then, when power is reapplied, the threading-control system has been set for unloading. So unloading occurs, no matter how far threading had progressed when power went off.

Troubleshooting load/unload faults

As with other electromechanical operations in a VCR, you generally fare best when you analyze mechanical functions before tackling the electronics. Even though most operations are commanded by electronics, their faults often show themselves mainly in mechanical ways. Having observed movements (or non-movement), you can more readily assess what electronic stages are at fault. Evaluating some ordinary symptoms probably explains best how to diagnose wisely.

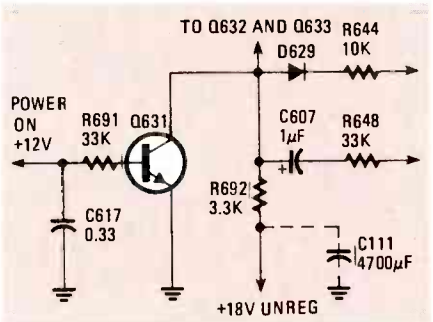


FIG. 3. POWER-SUPPLY CAPACITOR C111 provides power to Q631 long enough for D629 to activate auto-stop after a power failure.

Will not load. Make sure the PLAY button latches. If it doesn't, check its mechanical latch. The stop solenoid could be tripping the PLAY button; make sure the plunger or a linkage is not stuck. If the solenoid trips the PLAY button electronically, determine which transport safety sensor is activating automatic shutoff. That calls for electronic tracing; yet, the auto-stop action might be caused by a mechanical malfunction. There is no escaping the interrelatedness of electronics and mechanics in a video cassette recorder.

Observe the opening-closing sequence of the leaf-type limit switches. Some have a protective cover that you must remove first.

Inspect the Play switches, accessible if you open up the bottom circuit panels (see Figs. 4 and 5). If you doubt that any switch is making contact, use your voltmeter or ohmmeter to verify the switches continuity.

If everything mechanical appears okay, but the machine will not load, start electronic diagnosis. You can begin at either end, but starting at the motor is generally quicker. A DC voltmeter is your most suitable tool. A logic probe can be used, provided you have learned to think in logic high/low terms. When components are discrete rather than IC, most technicians tend to feel more comfortable with regular voltage measurements.

Latch the PLAY button down. With ground as a reference, measure voltage first at the normally negative terminal of the motor. The Voltage there should be zero. If it is high, Q606 may not be conducting. But do not overlook the possibility of a defective contact in the interchassis plug for the motor wiring.

Pull the motor plug from its socket. Measure across the motor terminals with your ohmmeter. Around 20 ohms is normal. Another trick: Connect your voltmeter across the unplugged motor. Spin the flywheel by hand. A normal DC motor *generates* a DC voltage when turned by an external force; the output voltage is positive when you spin the shaft in one direction, negative in the other.

Check bias on Q606, and verify that Q605 works. If bias is missing from Q605 the play-2 switch may not have opened. This microswitch is actuated with a bar pushed by the PLAY button linkage. If the switch stays closed, the

ground path through D619, D618, and the unload-end switch keeps the voltage at the base of Q605 low. Anything that ultimately keeps Q606 from conducting can prevent the motor turning. Transistor Q606 acts as an open circuit instead of as a ground connection.

Check the DC voltage at the normally-positive motor terminal. Assuming Q605 conducts as it should, check the bias on Q608, across R627.

If you find that Q608 operates normally, but the voltage at the plus side of the motor is low, check whether a leaky Q609 might be dragging the voltage down at the collector of Q608. Or, Q609 might be turned on. Trace back to find out why, because Q609 should be off during loading. Transistor Q610 should also be cut off. The appearance of bias at the base of Q610 could indicate that D617 or the unload-end switch is open. A defective Q611 would not leave the bias voltage on Q610 high, because a properly functioning D617 and the unload-end switch (still closed, until loading motion actually begins) holds down the voltage coming through R622.

Another possible fault lies in the loading-end stage. Should Q612 short, the D618-D619-D620 junction stays at zero. Diode D619 prevents any voltage from reaching Q605, so Q606 and Q608 remains cut off. Loading therefore cannot occur. (An open or nonoperative Q612 leaves the loading motor on. You may hear a squeaking as the motor pulley rubs the unmoving drive belt.)

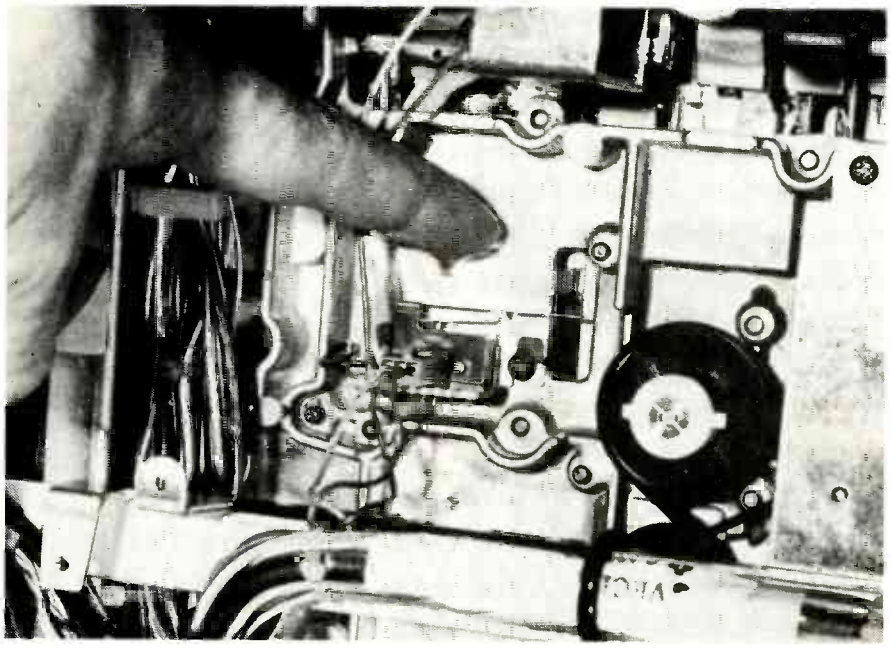


FIG. 4—THE PLAY-1 MICROSWITCH closes when the PLAY button is depressed.

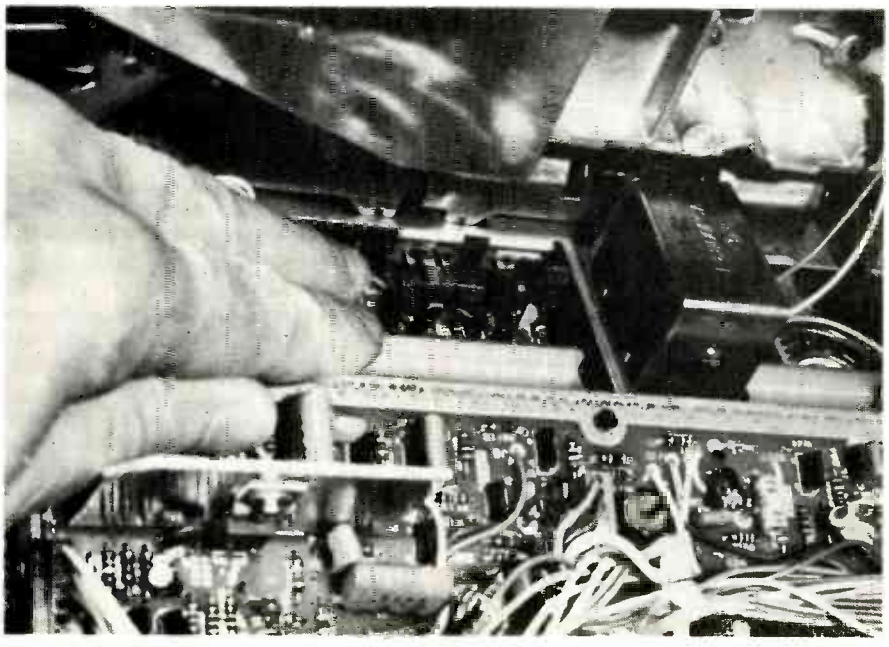


FIG. 5—THE PLAY-2 MICROSWITCH, pushed by a mechanical slide link, opens when the PLAY button latches.

Will not unload. The stages involving Q605, Q606 and Q608 must be okay, since the tape loaded. However, an open Q609, Q610 or Q607 might disable the unloading sequence.

Again, start at the motor with your voltmeter. A missing positive voltage at the normally-negative side of the motor indicates that Q607 is not conducting a positive voltage from its emitter to its collector.

A positive voltage at the normally-positive terminal is wrong when the machine *is trying to unload*. That symptom suggests that Q609 is open or not conducting. A positive voltage at *both* terminals confirms that Q610 and Q607 are working and that the motor and plug show continuity. Transistor Q607 would stay off if Q610 were open or cut off.

If there is no positive voltage at either side of the motor, you should suspect that Q610 is defective. However, a shorted Q611 or a stuck (closed) unload-end switch could prevent unloading, even though the loading has proceeded normally.

Intermittents. Erratic loading or unloading can give you fits. Once you discover which function fails, the hints already given tell you in which stages the fault might be.

Intermittents tend to fall into two categories. One is a cold-soldered connection between some part and the circuit board. An insulated poking-probe can help you find these. Or, if all else fails, take a hot soldering iron to each connection in the stages likely affected.

The other most common intermittents turn out to be in the connecting plugs. The quickest cure, ordinarily, lies in just unplugging and replugging each connector tightly. But inspect the female side of the plug. A damaged wiper can spoil the connection at one pin; that is not uncommon if someone else has been "into" the machine before you. For your own part, be exceedingly careful when plugging a connector back into the pins of the circuit board. One bent wiper and *you're* the culprit. That damage can be hard to trace, and the cure just might be a new plug.

Loads, then unloads. This symptom corresponds with automatic shutoff. The PLAY button pops up and the machine unloads. If the tape fails to unthread, you have an unloading problem, too.

Should anything interfere with completion of the loading motion, the loading-end switch does not turn on Q612. After the time-delay interval, shutoff takes over automatically. Hunt for that trouble in the loading sequence, or in any of the sensor stages. **R-E**

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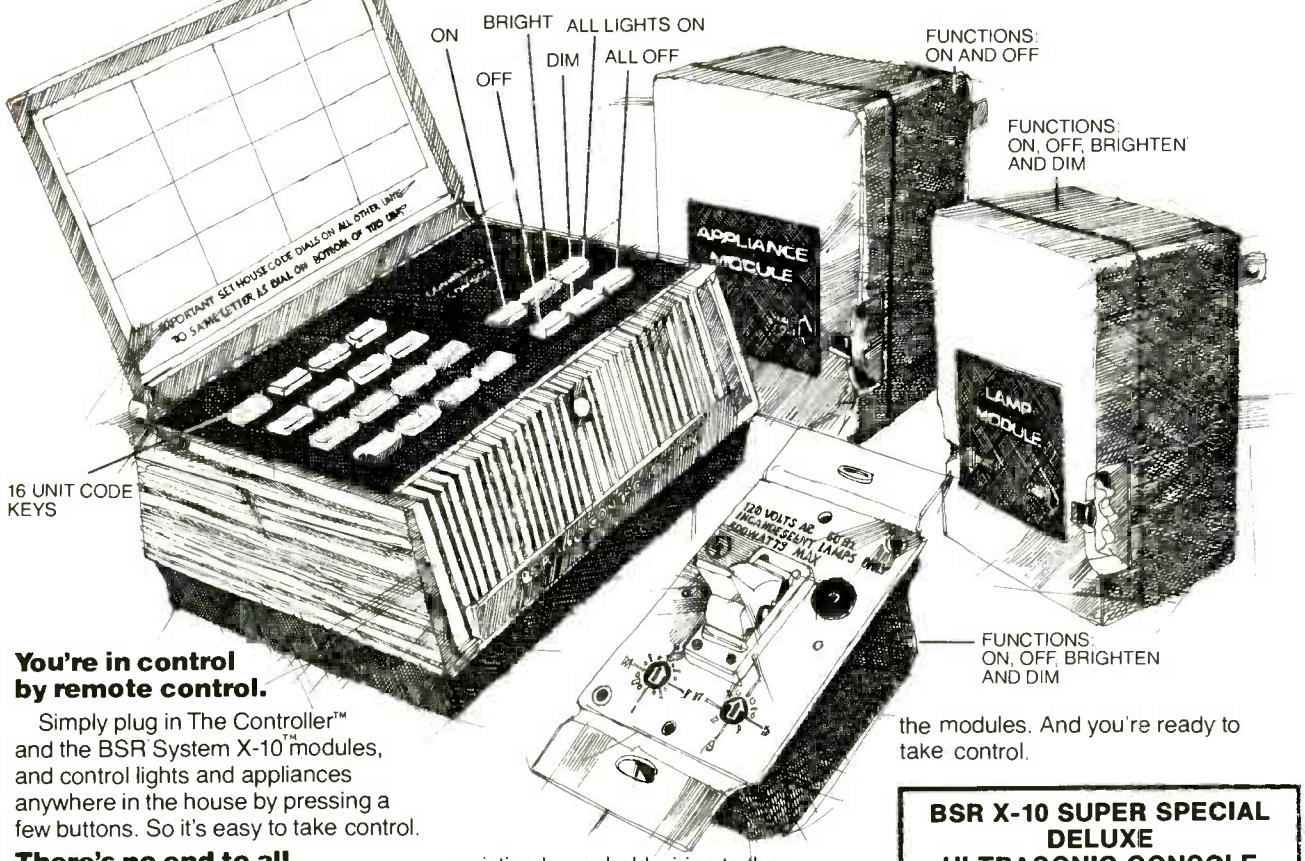

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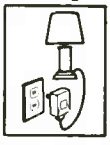

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new ideas

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The Trouble Tone Alert is intended for use with analog meters—just wire a "mini" earphone jack directly across the meter movement, plug it in, and you're all set. The high impedance of the alert keeps it from affecting the accuracy of the meter reading, because most meter movements are on the order of 1800 ohms and the input impedance of the alert is in the megohm range.

This device is as versatile as your meter, since all it reacts to is the meter-movement driving voltage. It will respond to a change in AC or DC voltage, current, or in resistance.

You tell the Trouble Tone Alert whether to look for an increase or decrease by means of the DPDT switch and adjust the threshold control until the tone from the Sonalert just disappears (with the meter in the circuit being tested, of course). After that you can go about your business and wait for the alert to signal you when your intermittent problem has finally shown up.

John J. Augustine

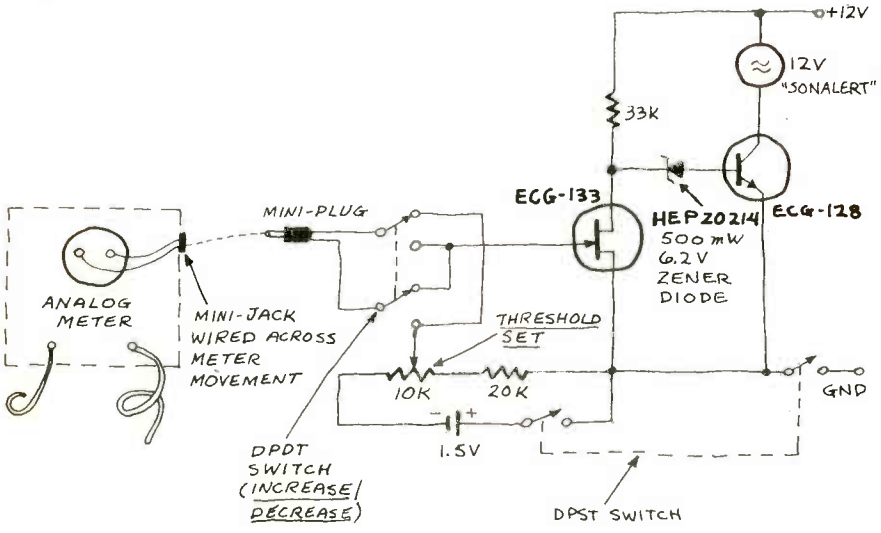
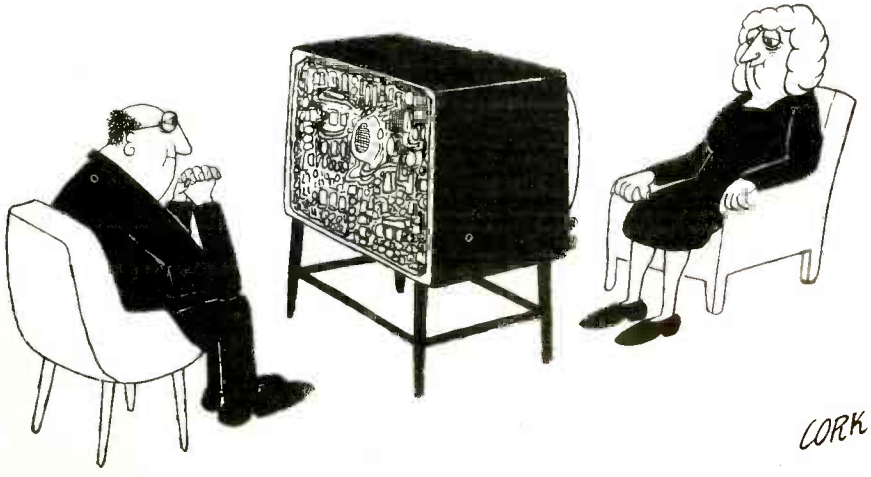


FIG. 1



NEW IDEAS

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

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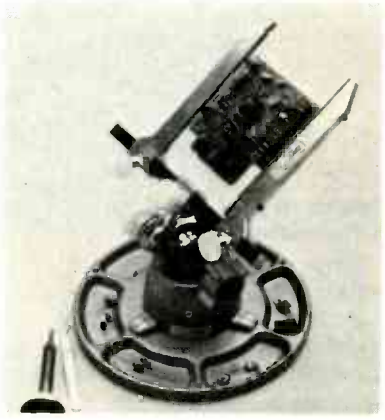

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hobby corner

One-arm bandit circuit plus a new packaging system for your projects.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

HENRY COOPER OF STERLING HEIGHTS, Michigan, has come up with an interesting circuit for a one-armed bandit. There are a number of such circuits around but his is much simpler than most.

Figure 1 is a "cherries/lemons/oranges" circuit based on the one Henry sent in. When I built his, I managed to eliminate a few more components. The present count seems to be about the minimum number of pieces that will do the job.

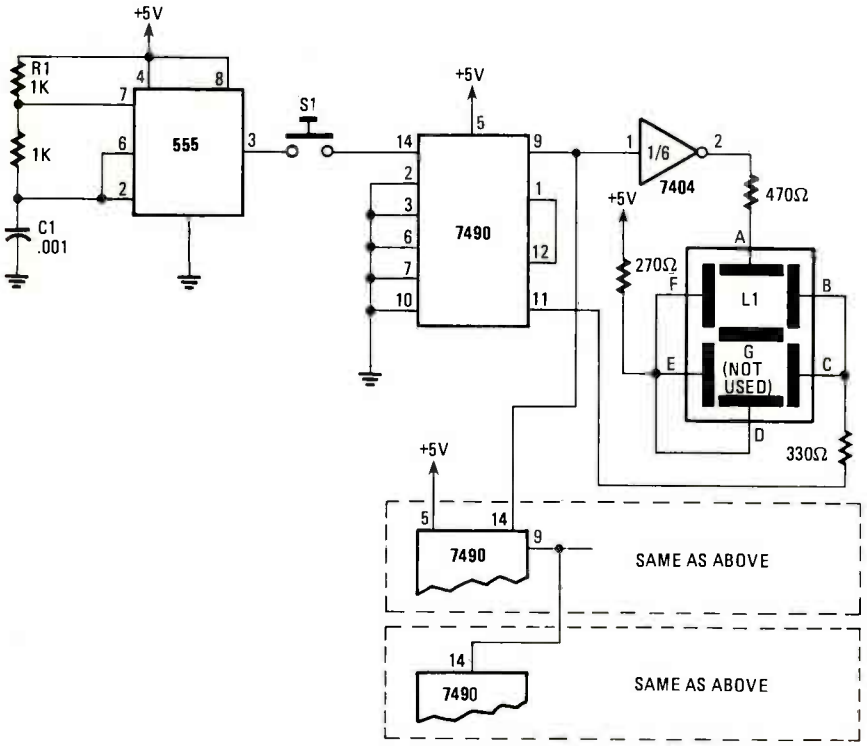


FIG. 1

The readouts are 7-segment common-cathode LED's. Since the circuit wiring is somewhat unorthodox, the LED's are shown in an "exploded" view to prevent confusion.

The 555 serves as a standard astable (free-running) multivibrator that we have discussed before. It drives 7490 counters—one for each "window" LED. That is where the present circuit departs from the usual.

Henry's LED's read "C" for cherry, "L" for lemon and "O" for orange. In each case, the D, E and F segments are on, so he wires them to stay on and doesn't have to worry about controlling them. That leaves only A, B and C segments to control—actually, only two since B and C must go on and off together. The G segment (the center horizontal one) is not used in any of those three displays.

The B and C segments are driven directly by the 7490's. Driving the A segment directly would have it on when it should be off and vice-versa. That is the purpose of the inverter (one-sixth of a 7404)—to reverse the on/off action of the A segment.

When building the bandit, you may wish to examine the readout action more closely. As given, you won't be able to see what is happening while S1 is pressed because the 555 is running at a rate of about 500 kHz.

Increasing the value of R1 and/or C1 will slow it down. Don't forget to put it back to high speed when it is operating to your satisfaction. After all, you don't want the players to be able to see the readout *before* releasing S1!

A little experience with the bandit may cause you to want to change the odds. That can be done by changing the 7490 output pins used to drive the segments and/or the next 7490. Output pins are 12 (1), 9 (2), 8 (4), and 11 (8). Experiment with various combinations. You don't have to drive the A segment and the next 7490 from the same pin, either.

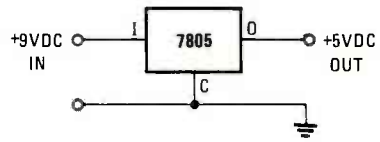


FIG. 2

This little bandit works very well. Build it in a small case such as the *Unibox* mentioned below and it will provide many hours of entertainment. To get it into the smallest possible box and have the greatest convenience, use a small wall-plug-type AC adapter. If you build in the 5-volt regulator shown in Fig. 2, you can use a common 9-volt adapter. Of course, you could also use a 9-volt battery but it won't last long because of the heavy current drain of the readouts.

Thanks, Henry, for sharing your circuit with us.

Packaging your project

As soon as you think you have found an ultimate product—one which cannot be improved—someone comes along and does just that! This time it is small cases/cabinets for electronics projects. Amerex (P. O. Box 2815, Riverside, CA 92516) is the outfit that has made the improvement with their *Unibox* (Figs. 3 and 4).

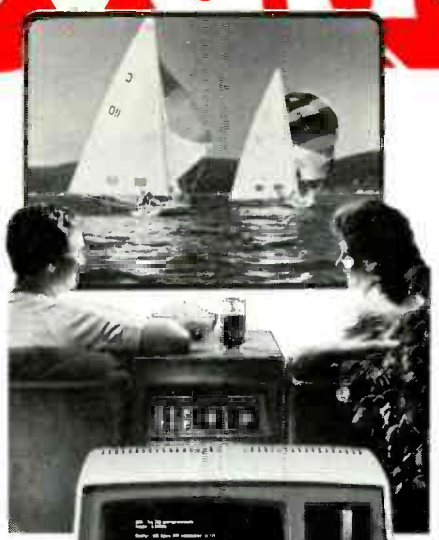
One would expect the choice of colors and sizes (in this case up to 2 × 4 × 5¼ inches) in those tough plastic enclosures. Several other *Unibox* features, however, are not expected.

First, there are epoxy-glass gridboards that mount vertically and/or horizontally inside. Those gridboards are perforated in the standard 0.1-inch hole pattern for easy mounting and wiring of IC's, sockets and other components.

Next, there are red or gray windows for use with LED and other readouts. Then, there are opaque panels that can be used for connectors, switches and so on. The final touch is provided by non-mar-

continued on page 82

Innovations



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CIRCLE 62 ON FREE INFORMATION CARD

continued from page 78

ring feet which can be added.

Altogether, the Amerex *Unibox* is the neatest and most convenient packaging

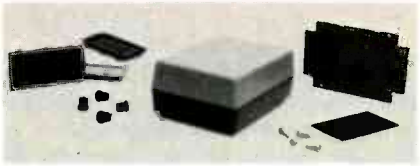


FIG. 3

FIG. 4

system I have found for small projects. Prices are quite reasonable, also. If you can't find *Uniboxes* locally, write to Amerex.

The cell connection

Zvi Rozensher of Briarwood, NY has inquired about methods of connecting parallel alkaline cells. As you know, if one is weaker than the others, they will discharge through that weaker one.

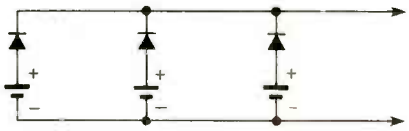


FIG. 5

Of course, the usual way to prevent the discharging is to use diodes as in Fig. 5. However, there is a voltage drop across the diodes. Zvi would like to know if any readers have found another way to connect the cells and avoid that voltage loss.

Circuit handbook

If you do any building at all, you reach a point from time to time when you need a little circuit for some special use. I have accumulated a fair library to search through, when that happens to me. Lately, however, there is one book which I turn to first.

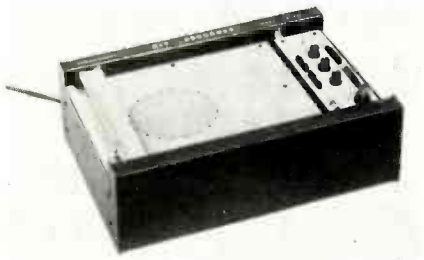
Usually, I find what I need in the new *Archer Engineer's Notebook* (Radio Shack #276-5001 at $1.99). The 128 pages of that Notebook contain much helpful information and literally hundreds of circuits.

Included are circuits that stand alone, and others that are building blocks for larger projects. A wide variety of TTL, CMOS, and linear IC's are used. One glance through the Notebook will convince you that it would be a very useful addition to your own library. **R-E**

new products

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

CHART RECORDER, *the IR-5207,* is an X-Y recorder kit in the test-instrument line. The kit features front-panel input filters with pushbutton controls, an integral paper-holdown that can be used in horizontal or vertical modes, and "zero" controls that allow the pen to be placed anywhere on the chart with zero input at both coordinates.



CIRCLE 50 ON FREE INFORMATION CARD

Calibrated 1, 10, 100 mV- and 1 volt-per-inch ranges are selectable from the front panel. Other features are electric pen lift, calibrated X and Y sweep, and remote capability. The *IR-5207* uses 8½ by 11 inch paper and two kinds of disposable pens are available. Price is $479.94.—**Heath Co.,** Dept. 350-260, Benton Harbor, MI 49022.

FUNCTION/SWEEP GENERATOR, *model LFG-1300S,* provides a wide range of capabilities and is suitable for use in design, testing, and service applications. Housed in an all-metal enclosure, the unit covers frequencies of 0.002 to 2 MHz in 8 ranges and includes linear and logarithmic sweep modes with sweep widths up to 1000:1 and sweep rates of 0.5 to 50 Hz. Waveform outputs include

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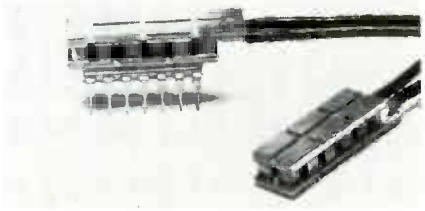
sine, triangle, sawtooth, and pulses. Output level is continuously variable from 0 to 20 V P-P and a push-button attenuator provides up to 70 dB attenuation in 10-dB steps. An auxiliary connector provides TTL level signals for driving logical circuits. price is $495.—**Leader Instruments Corp.,** 380 Oser Ave., Hauppauge, NY 11787.

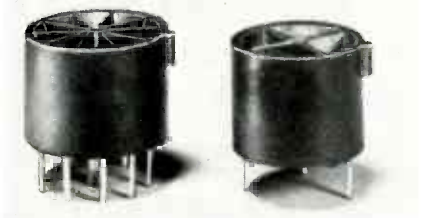
THERMOELECTRIC COOLER, *model 801-1029-01-00-00,* is designed for use with 8, 14, 16, and 18-lead dual in-line packages (DIP's). When placed between the DIP and a heat sink, it can pump out up to 3.5 watts of heat using a modest input of DC power, thereby allowing a DIP to operate in a hot environment. The unit can heat



CIRCLE 152 ON FREE INFORMATION CARD

as well as cool, so the device can also be used to regulate DIP temperatures to any preset value in the range of ambient ±60° Celsius. Price is $4.90.—**Cambridge Thermionic Corp.,** 445 Concord Ave., Cambridge, MA 02238.

BURN-IN SOCKETS, *TS-5173,* are a line of TO-pattern sockets offered in both standard (150°C with BeCu contacts) and high temperature versions (200°C with BeNi contacts). The series is available with from 3-to-12 gold-plated contacts and features very low insertion force and a center



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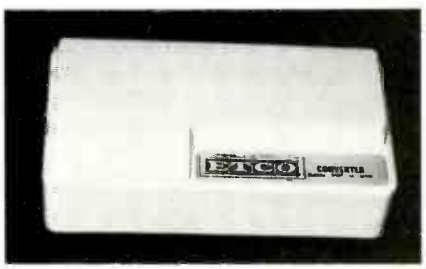
locating stud for greater mounting rigidity. Price is $.63 each for 1000 pieces.—**Robinson-Nugent, Inc.,** 800 E. 8th St., New Albany, IN 47150.

CABLE TV ADAPTOR, *model 047AE,* allows subscribers to tune all cable channels using their TV set's remote control. The system allows reception of cable channels through the set's UHF tuner, which can be operated remotely, thus freeing the viewer from having to get up and go to the cable



CIRCLE 154 ON FREE INFORMATION CARD

converter box everytime he wants to switch to another program. Channels 2 through 13 remain available through the VHF tuner. The system includes the converter, AC adaptor, 75-to-300 ohm transformer and instructions. Price is $39.95 plus shipping (NY residents add appropriate tax).—**ETCO Electronics Corp.,** North Country Shopping Center, Rte 9 N., Plattsburgh, NY 12901. **R-E**

EQUIPMENT REPORTS

continued from page 44

tablet is included, enabling the user to take hundreds of readings and record them for a variety of individuals.

The instrument is powered by a standard 9-volt transistor radio battery. Because of the additional power consumption required by both LED and audible indicators, use of an alkaline battery is recommended.

Testing the BP-1

Unpackaging the Micronta *BP-1* blood-pressure tester, we found that it included a handy vinyl carrying case, complete with contoured cutouts to support the instrument, a hinged lid, and velcro clasps.

A short review of the manual was most informative. Several paragraphs are devoted to an introduction to hypertension, its causes and statistics, and interpretation of blood pressure readings.

A step-by-step procedure is outlined to familiarize the user with the unit. After reading the instructions and taking a few practice readings, using the instrument is a snap.

Two flexible rubber cables from the pressure cuff are inserted into the instrument. The cuff is placed over the upper arm, white dot located over the brachial artery. That location may be found visually by the presence of a superficial dark vein just to the inside of the elbow joint, palm turned up. Or, it may be detected by feeling for a pulse.

With the pressure cuff in proper position, the Velcro wrap is snugly pressed down, holding the cuff in place. A series of squeezes on the bulb inflates the cuff to a pressure of about 200 millimeters. The instrument is then switched on, and the release button is slightly depressed, allowing the air pressure to drop slowly until the indicators begin to signal.

We found the cuff to be very lenient about slightly improper placement. Virtually identical readings were obtained with the white dot off center by an inch or more. But for a correct reading, the arm *must* be elevated to the same height as the heart (mid-chest height). Too low, and the instrument will show an unrealistic high reading; too high, and the instrument will show an inaccurate low reading. The difference will be a significant amount.

How accurate?

To test the accuracy of the *BP-1*, we took our review sample to a local hospital and checked it against three resident instruments. We found slight differences in measurement among all instruments, but the *BP-1* was well within the range of variability. A further test against a newer instrument is a dentist's office showed identical readings.

While the retail cost of the *BP-1* is higher than most consumer-grade stethoscope sphygmomanometers, it appears to be of quality manufacture; ours was certainly equivalent to the two-piece professional units with which it was compared. The unencumbered one-handed application is a distinct advantage. We find the *BP-1* to be both cleverly designed and realistically priced. The *BP-1* blood pressure tester sells for $69.95 and is available at Radio Shack stores nationwide. **R-E**

Start Computing For Just $129.95 With An 8085-Based Professional Computer Kit—

Explorer/85

100% compatible with all 8080A and 8085 software & development tools!

No matter what your future computing plans may be, Level "A"—at $129.95—is your starting point.

Starting at just $129.95 for a Level "A" operating system, you can now build the exact computer you want. Explorer/85 can be your beginner's system, OEM controller, or IBM-formatted 8" disk small business system...yet you're never forced to spend a penny for a component or feature you don't want and you can expand in small, affordable steps!

Now, for just $129.95, you can own the first level of a fully expandable computer with professional capabilities—a computer which features the advanced Intel 8085 cpu, *thereby giving you immediate access to all software and development tools that exist for both the 8085 and its 8080A predecessor (they are 100% software compatible)*—a computer which features onboard S-100 bus expansion—plus instant conversion to mass storage disk memory with either 5-1/4" diskettes or standard IBM-formatted 8" disks.

For just $129.95 (plus the cost of a power supply, keyboard/terminal and RF modulator, if you don't have them already), Explorer/85 lets you begin *computing* on a significant level...*applying* the principles discussed in leading computer magazines...*developing* "state of the art" computer solutions for both the industrial and leisure environment.

Level "A" Specifications

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an 8155 ROM-I/O—all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, *plus* generous prototyping space.

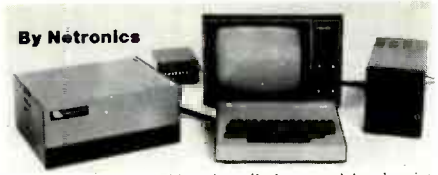
(Level "A" makes a perfect OEM controller for industrial applications and is available in a special Hex Version which can be programmed using the Netronics Hex Keypad/Display.)

Level "A" at $129.95 is a complete operating system, perfect for beginners, hobbiests, or industrial controller use.

PC Board: glass epoxy, plated through holes with solder mask • **I/O:** provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader ...provision for 24-pin DIP socket for hex keyboard/display...cassette tape recorder input...cassette tape recorder output...cassette tape control output...speaker output... LED output indicator on SOD (serial output) line...printer interface (less drivers)...total of four 8-bit plus one 6-bit I/O ports • **Crystal Frequency:** 6.144 MHz • **Control Switches:** reset and user (RST 7.5) interrupt...additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard • **Counter/Timer:** programmable, 14-bit binary • **System RAM:** 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems...RAM expandable to 64k via S-100 bus or 4K on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F000 leaving 0000 free for user RAM/ROM. Features include tape load with labeling ...tape dump with labeling...examine/change contents of memory ...insert data...warm start...examine and change all registers...single step with register display at each break point, a debugging/training feature...go to execution address... move blocks of memory from one location to another...fill blocks of memory with a constant...display blocks of memory ...automatic baud rate selection...variable display line length control (1-255 characters/line)...channelized I/O monitor routine with 8-bit parallel output for high speed printer... serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Version): Tape load with labeling... tape dump with labeling...examine/change contents of memory...insert data...warm start...examine and change all registers...single step with register display at each break point ...go to execution address. Level "A" in the *Hex Version* makes a perfect controller for industrial applications and can be programmed using the Netronics Hex Keypad/Display.



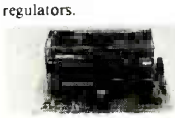
Hex Keypad/Display.

Hex Keypad/Display Specifications

Calculator type keypad with 24 system defined and 16 user defined keys. 6 digit calculator type display which displays full address plus data as well as register and status information.

Level "B" Specifications

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards and includes: address decoding for onboard 4k RAM expansion select-able in 4k blocks...address decoding for onboard 8k EPROM expansion selectable in 8k blocks...address and data bus drivers for onboard expansion...wait state generator (jumper selectable), to allow the use of slower memories...two separate 5 volt regulators.



Explorer/85 with Level "C" card cage.

Level "C" Specifications

Level "C" expands Explorer's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and cards are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card gold plated S-100 extension PC board which plugs into the motherboard. Just add required number of S-100 connectors

Level "D" Specifications

Level "D" provides 4k or RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 0000 to EFFF in 4k blocks.

Level "E" Specifications

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for soon to be available RAM IC's (allowing for up to 12k of onboard RAM).

Order A Coordinated Explorer/85 Applications Pak!

Experimenter's Pak (SAVE $12.50)—Buy Level "A" and Hex Keypad/Display for **$199.90** and get FREE Intel 8085 user's manual plus FREE postage & handling!

Student Pak (SAVE $24.45)—Buy Level "A," ASCII Keyboard/Computer Terminal, and Power Supply for **$319.85** and get FREE RF Modulator plus FREE Intel 8085 user's manual plus FREE postage & handling!

Engineering Pak (SAVE $41.00)—Buy Levels "A," "B," "C," "D," and "E" with Power Supply, ASCII Keyboard/Computer Terminal, and six S-100 Bus Connectors for **$514.75** and get 10 FREE computer grade cassette tapes plus FREE 8085 user's manual plus FREE postage & handling!

Business Pak (SAVE $89.95)—Buy Explorer/85 Levels "A," "B," and "C" (with cabinet), Power Supply, ASCII Keyboard/Computer Terminal (with cabinet), 16k RAM, 12" Video Monitor, North Star 5-1/4" Disk Drive (includes North Star BASIC) with power supply and cabinet, all for just **$1599.40** and get 10 FREE 5-1/4" minidiskettes ($49.95 value) plus FREE 8085 user's manual plus FREE postage & handling!

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333 Litchfield Road, New Milford, CT 06776

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- ☐ **Explorer/85 Level "A" Kit** (ASCII Version), **$129.95** plus $3 p&h.
- ☐ **Explorer/85 Level "A" Kit** (Hex Version), **$129.95** plus $3 p&h.
- ☐ **8k Microsoft BASIC** on cassette tape, **$64.95** postpaid.
- ☐ **8k Microsoft BASIC in ROM Kit** (requires Levels "B," "D," and "E"), **$99.95** plus $2 p&h.
- ☐ **Level "B" (S-100) Kit, $49.95** plus $2 p&h.
- ☐ **Level "C" (S-100 6-card expander) Kit, $39.95** plus $2 p&h.
- ☐ **Level "D" (4k RAM) Kit, $69.95** plus $2 p&h.
- ☐ **Level "E" (EPROM/ROM) Kit, $5.95** plus 50¢ p&h.
- ☐ **Deluxe Steel Cabinet** for Explorer/85, **$49.95** plus $3 p&h.
- ☐ **ASCII Keyboard/Computer Terminal Kit** (features a full 128 character set, upper & lower case, full cursor control, 75 ohm video output convertible to baudot output, selectable baud rate, RS232-C or 20 ma. I/O, 32 or 64 character by 16 line formats, and can be used with either a CRT monitor or a TV set (if you have an RF modulator), **$149.95** plus $2.50 p&h.
- ☐ **Hex Keypad/Display Kit, $69.95** plus $2 p&h.
- ☐ **Deluxe Steel Cabinet** for ASCII Keyboard/Terminal, **$19.95** plus $2.50 p&h.
- ☐ **Power Supply Kit** (±8V @ 5 amps) in deluxe steel cabinet, **$39.95** plus $2 p&h.
- ☐ **Gold Plated S-100 Bus Connectors, $4.85** each, postpaid.
- ☐ **RF Modulator Kit** (allows you to use your TV set as a monitor), **$8.95** postpaid.
- ☐ **16k RAM Kit** (S-100 Board expands to 64k), **$199.95** plus $2 p&h.
- ☐ **32k RAM Kit, $329.95** plus $2 p&h.
- ☐ **48K RAM Kit, $459.95** plus $2 p&h.
- ☐ **64k RAM Kit, $589.95** plus $2 p&h.
- ☐ **16k RAM Expansion Kit** (to expand any of the above up to 64k), **$139.95** plus $2 p&h each.
- ☐ **Intel 8085 cpu User's Manual, $7.50** postpaid.
- ☐ **Special Computer Grade Cassette Tapes, $1.90** each or **3 for $5,** postpaid.
- ☐ **12" Video Monitor** (10 MHz bandwidth), **$139.95** plus $5 p&h.
- ☐ **North Star Double Density Floppy Disk Kit** (One Drive) for Explorer/85 (includes 3 drive S-100 controller, DOS, and extended BASIC with personalized disk operating system—just plug it in and you're up and running!), **$699.95** plus $5 p&h.
- ☐ **Power Supply Kit** for North Star Disk Drive, **$39.95** plus $2 p&h.
- ☐ **Deluxe Case** for North Star Disk Drive, **$39.95** plus $2 p&h.
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- ☐ **Student Pak** (see above), **$319.85** postpaid.
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By Netronics

ASCII/BAUDOT, STAND ALONE

Computer Terminal

COMPLETE FOR ONLY . . . $149.95

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

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

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

VIDEO DISPLAY SPECIFICATIONS

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

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

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

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

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

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CIRCLE 37 ON FREE INFORMATION CARD

communications corner

Transceivers with all the operating controls built into the microphone **HERB FRIEDMAN,** COMMUNICATIONS EDITOR

STARTING WAY BACK IN THE DARK AGES of CB when all transceivers used vacuum tubes, many attempts have been made to place channel selection and other frequently used functions, such as volume and squelch control, in the microphone. (Among other benefits it allows a vehicle's driver to change channels without leaning across the seat, and/or taking his eyes off the road.)

Some early "remote control" designs had RF running all over the place, and they made the "Rube Goldberg" contraptions we used to see in the Sunday comics look like advanced engineering by comparison.

Successful full-feature remote control from the microphone didn't come about until Large-Scale Integration—or LSI as it is more commonly termed—was used for phase-locked oscillators and their control circuits.

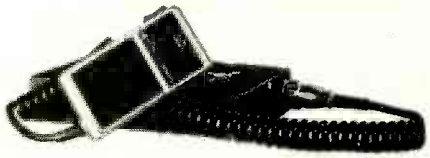

FIG. 1

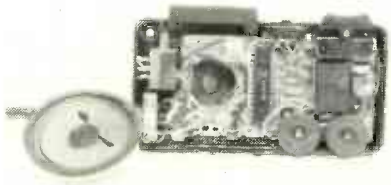

FIG. 2

The phase-locked oscillator generates both the receiver's local oscillator frequencies and the frequencies from which the transmitter's output frequencies are derived. Not very long ago that was a formidable design with a cost and complexity that limited its use almost exclusively to radio astronomers. But by substituting solid-state devices for vacuum tubes, and then using LSI as a substitute for hundreds of discrete components, almost overnight the phase-locked detector became an IC no larger than your index finger. It was priced well under $10 in manufacturing quantities. (Actually pennies in today's marketplace.)

Today, we have Large Scale Integration of Large Scale Integration. That's about the ony way to describe shrinking a device the size of your index finger to something slightly smaller than half the length of your little finger.

Everything has become so small it's now possible to build virtually all transceiver controls, including channel selection, into the microphone itself, just as Cobra has done in their *model 66GTL* remote (Hideaway) 40-Channel

continued on page 92

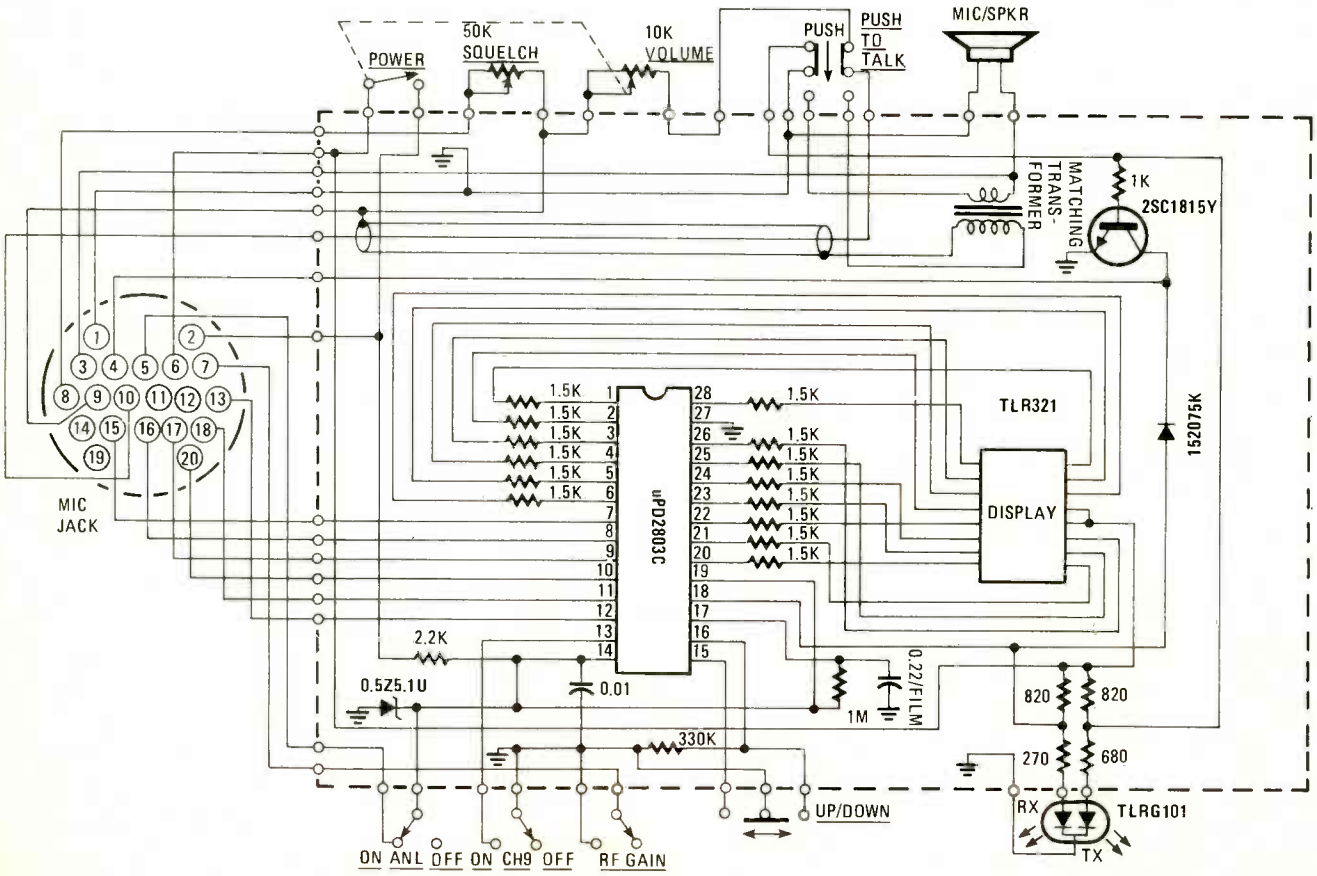

FIG. 3

All new! All construction projects!

Here's the new quarterly magazine *you've* been waiting for—*Radio-Electronics Special Projects*—page after page of *all new, never-before published* construction articles on Test Equipment, Computers, Electronic Music, Communications, Automotive and Hobby Projects.

They're the kind of projects *you* want to build, the kind only *Radio-Electronics* has the expertise to design, and the first issue is filled with brand-new construction articles like these:

Test Equipment

Digital Scope Multiplexer—to convert almost any scope into a 4-trace unit.
Frequency Multiplier—to extend the range of your frequency counter.
Safety Cooker—that protects unattended equipment against electrical problems.
Battery Box/ Switching Box—a great accessory for any bench.
Car Test Probe—use it to test automotive electrical systems.
Digital IC Tester—to make quick work of testing digital IC's.

Electronic Music

The Chord Egg—to generate an endless series of chords automatically.
Words And Music—a programmable music generator that's ideal for doorbells.
Big Sound For Chord Organs—to enhance the sound from electromechanical chord organs.

Computers

Digital Logic Trainer—that teaches how microprocessors work.
Save Your Files—cassette tape recorder controller makes using tape as computer memory storage easy.
Programmable Sound Generator—adds sound capability to almost any computer system.

Hobby

Adventures of the IC's—applications for LM3914 and VMOS power FET's.
Digital Do-Nothing Box—lights, counts, teaches binary and digital number systems.

Communications

Digital Readout Add-on For Communications Receivers—to update older receivers easily.
Microphone Acoustic Coupler—a simple add-on for any communications system.
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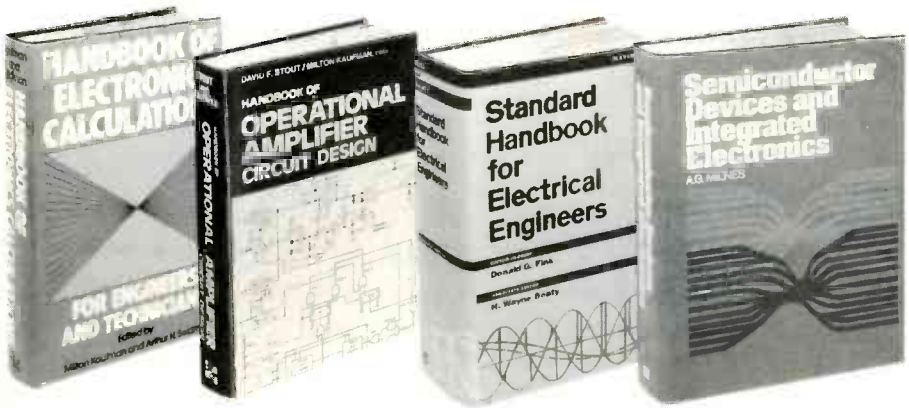

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COMMUNICATIONS CORNER

continued from page 86

CB mobile radio. And it is done at very little extra cost to the consumer because of LSI.

Figure 1 shows the complete Cobra package consisting of the hideaway *main* unit, that can be concealed easily under the dashboard or under the seat, and the plug-in microphone that contains a combination speaker/microphone and all operating controls. They include the channel selector, volume, and squelch controls, ANL on-off switch, RF gain-control switch, instant channel-9 selector switch, and push-to-talk switch. A two-digit LED indicator is the channel display.

The inside of the mike is shown in Fig. 2. Here we see how the magic is accomplished. The speaker, removed from the case so you can see all of the interior, also serves as the microphone. In addition to the miniature controls and switches along both edges of the microphone, there is a single LSI IC in the center. That IC is the key to full remote control operation.

The IC serves as both the driver for the LED channel indicator and the control for the phase-locked oscillator that is located in the *main* unit—no RF flows back and forth between the microphone and the *main* unit. Each time the channel selector is pushed, up or down to step the channel selector one channel at a time, the IC changes the LED display one channel (up or down). It also sends a coded DC signal to the phase-locked oscillator, that generates the operating frequencies corresponding to the indicated channel selection. The instant channel-9 switch, overrides the normal channel selection and forces the IC to transmit the proper DC control signals needed by the oscillator for channel-9 operation. Simultaneously, the IC changes the LED display to indicate a "9."

The microphone schematic is shown in Fig. 3. IC pins numbered 7 through 12 provide the control signal to the oscillator in the *main* unit. Just about everything else is self-explanatory. Simple? Yes? Low cost? Again, yes. Was this possible four or five years ago? Not with only two IC's in a moderately priced package it wasn't. The technology existed; but without LSI and the cost reduction inherent in the multi-million dollar CB marketplace you'd probably still be reading about "Future applications of the phase-locked oscillator," rather than holding it in the palm of your hand.

Temperature compensation in a frequency counter

TCXO means *T*emperature-Compen-

sated *C*rystal *O*scillator. To anyone even remotely involved with communications equipment it conjures up a vision of a crystal wrapped in a thermostatically controlled heating element to maintain the crystal temperature within very narrow limits to reduce, or eliminate, frequency drift. Virtually all broadcast and non-CB commercial communications transmitters (and some receivers) have a TCXO somewhere in the frequency generating or control chain. Most certainly, every lab-grade frequency counter and/or meter has a TCXO, and even an F.C.C.-approved frequency counter (for transmitter frequency tests) has a TCXO.

Now there's a hand-held 8-digit 50 to 500-MHz frequency counter that sells for only $169.95 complete with a rechargeable battery pack and charger. It even has a telescopic antenna that can sense signals from hand-held walkie-talkies. Featuring 0.4-inch LED readouts, the unit, the *model 500HH* from DSI Instruments, also features a 1-PPM TCXO.

Since the unit is battery-powered, a logical question is: "How is the TCXO heater powered?" Actually, there's no heater. Nothing in TCXO means that there *is* a heater; it's simply been assumed that there was, because TCXO's always used a heater for temperature *stabilization*.

What DSI has done is to design their oscillator so it is within 1-PPM over a relatively narrow temperature range of 17° to 40°C, or 62.6° to 104°F. Just great for indoor use; but no 1 PPM is guaranteed when working on a vehicle or boat out in the cold, or in the hot sun. In a sense, the *500HH* is temperature-compensated for *indoor* use, but calling it TCXO is an unfortunate choice of words for a device that doesn't have a heated crystal. Unfortunate, because the *500HH* is an excellent device, well worth the money; yet many techs are obviously going to question the use of "TCXO" to describe an oscillator with an unheated crystal.

The *500HH* has two BNC inputs: one for the direct 50-MHz counter; the other through a ×10 prescaler that provides a 500-MHz input. A switch selects either input. A second switch provides power *off* in the center position and a time base of 0.1 sec for MHz, and 1 sec for kHz. The switch automatically corrects the decimal point. To conserve the battery, because LED's eat up a lot of current, all leading zeroes are suppressed.

In actual field tests—indoors of course—the DSI *model 500HH* was within 10 Hz of an F.C.C.-approved frequency counter's reading at approximately 100 MHz. That's about as good an accuracy as you'll ever need for indoor frequency measurements when troubleshooting equipment.

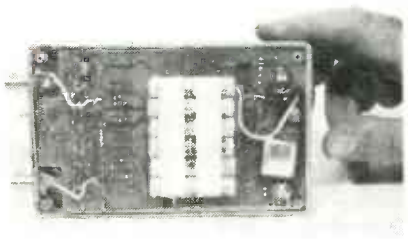

FIG. 4

The unit measures approximately 3-1/2" wide × 5-7/8" long × 1-3/16" thick; a nice size for a toolbox. The BNC connectors and switches are along the top edge. The charger/AC power connector is on the rear, as is an access hole to the crystal's trimmer capacitor. You can take a look at the inside of the counter in Fig. 4.

Overall it's a very convenient and inexpensive frequency meter for the tech or hobbyist on a tight budget. It's simply unfortunate that the temperature range isn't clearly spelled out in °F, a more common reference than °C (at least in this country), and all mention of a non-heated TCXO should be eliminated; the instrument is simply too good for that kind of weasel-wording. Additional information on the *model 500HH* is available from DSI Instruments, Inc., 7924 Ronson Rd., San Diego, CA 92111. **R-E**

radio products

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RADIO DESKS, *model TTY-36* and *model TTY-48,* are designed for RTTY and computer enthusiasts and will accommodate a complete RTTY station including HF and VHF transceivers, terminal units, and accessories. This easy-to-assemble

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CONCEALED-CHASSIS MOBILE CB *model 14T276,* has all the operating controls located on the microphone. The operating controls include a 40-channel LED readout, electronic channel selector, channel-lock switch, Channel-9 emergen-

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cy switch, ANL switch, squelch control and transmit/receive indicator light—all located on the mike. The chassis itself may be mounted behind the dash or under the front seat, or, with an optional 18-foot extension cable, in the trunk of the vehicle. Price is $207.50.**—RCA Distributor & Special Products Division,** 2000 Clements Bridge Rd., Deptford, NJ 08096.

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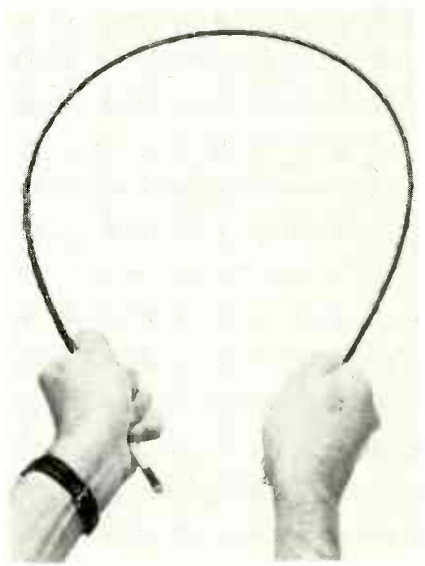

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MODEL 7010A 600 MHz

MODEL 8010A/8013 1.1 GHz/1.3 GHz

MODEL	RANGE (From 10 Hz)	10 MHz TIME BASE			AVG. SENSITIVITY		GATE TIMES	RESOLUTION			EXT. CLOCK INPUT/OUTPUT	SENSITIVITY CONTROL	NI-CAD BATTERY PACK
		STABILITY	AGING	DESIGN	10 Hz to 500 MHz	500 MHz to 1.1 GHz		12 MHz	60 MHz	Max. Freq.			
7010A	600 MHz	± 1 PPM	< 1 PPM/YR	TCXO*	15 mV	N/A	(3) .1, 1, 10 sec.	.1 Hz	1 Hz	10 Hz (600 MHz)	YES OPTIONAL	NO	YES OPTIONAL
7010.1A		± 0.1 PPM											
8010A	1.1 GHz	± 1 PPM	< 1 PPM/YR	TCXO*	15 mV	30 mV	(4) .01, .1, 1, 10 sec	.1 Hz	1 Hz	10 Hz (1.1 GHz)	YES STANDARD	YES	YES OPTIONAL
8010.1A		± 0.1 PPM											
8010.05A		± .05 PPM		OCXO**									
8013.1	1.3 GHz	± 0.1 PPM	< 1 PPM/YR	TCXO*	15 mV	30 mV	(4) .01, .1, 1, 10 sec	1 Hz	1 Hz	10 Hz (1.3 GHz)	YES STANDARD	YES	YES OPTIONAL
8013.05		± .05 PPM		OCXO**									

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

SERIES 7010A

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Typical problems with tripler circuits and some not so typical.

JACK DARR, SERVICE EDITOR

A GREAT MANY SOLID-STATE TV SETS USE voltage multipliers to develop the high voltage for the picture tube. We call those triplers, although some of them are actually quadruplers. In any case, from now on we'll call the device a "tripler" to save space. The symptoms and reactions are the same with both. The units are all encapsulated and, as a rule, quite expensive; so we need tests that will identify troubles that are in the tripler. As with everything else in this business, including picture tubes, we can find symptoms that apparently point to the trouble only to find after replacing the suspect component that the symptoms are still there. That can be definitely non-habit-forming because it's time-wasting and expensive.

The main symptom of a bad tripler is very low or no high voltage at all; some may short internally. For either case, the best test I know of is to unhook the input lead from flyback to tripler, and recheck. If all of the other voltages derived from the flyback are normal (the boost and low DC voltages for example) and there's no sign of overload, that is pretty conclusive. Not definite yet, though!

There are often other things that can cause those symptoms. One is the bleeder resistor used in many sets to develop the focus voltage. That will be tied directly across the high-voltage output of the tripler. If the bleeder should be internally shorted or arcing, that will load down the high-voltage supply and fake a bad tripler. To test the bleeder resistor, first disconnect it and then recheck for high voltage. In one odd case recently, in the Clinic mail, the symptoms were a "frying sound" with hash on the screen and interference in nearby AM radios. That turned out to be internal arcing in the focus bleeder.

The high voltage shutdown circuit may be fed from a tap on the focus-voltage-dropping network; below the main large resistor. However, if there is a problem here, the flyback will not develop the boost and other DC voltages.

Another circuit that causes symptoms often blamed on triplers is the ABL (*A*utomatic *B*rightness *L*imiter). That is sometimes fed from a special tap on the tripler. Key clue here—if the high voltage is up to normal, then the ABL is cutting the raster off.

Figure 1 shows a typical circuit using a dual sense-voltage for the high-voltage shutdown, and an ABL as well. That is used in the Magnavox T989 chassis. Some other sets may use one or both of those or a minor variation. However, they all do the same things. By the way, in all sets, watch out for "run changes!" Some chassis may not have the circuitry shown on the schematic you have. For example, the early run of the T989 didn't use Q303, the high-voltage protection transistor; it is used in later runs. (It's on the mother board just in front of the flyback panel.) Both of the circuits shown do the same thing: trip the SCR shutdown to kill the drive to the horizontal-output stage. The circuit on the "D" panel senses high voltage, while Q303 senses beam current.

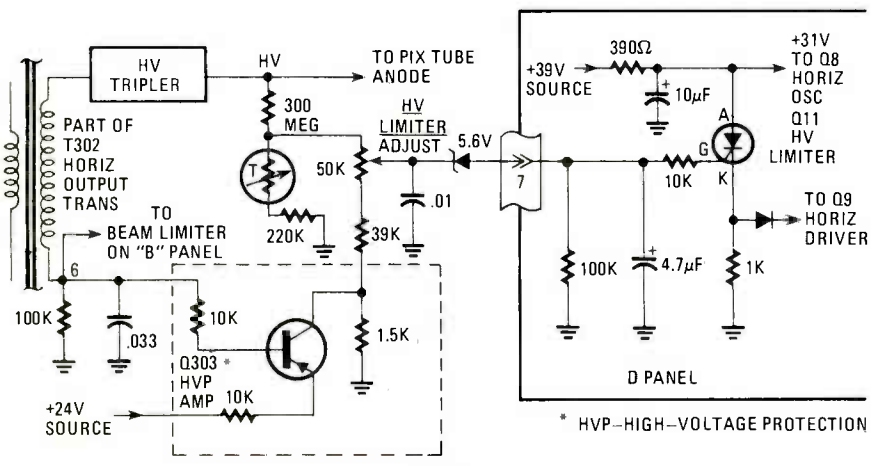

FIG. 1

Magnavox recommends that when a tripler has failed you should check the ABL stage and the LLV (Low-Level Video) board for possible damage to the ABL circuit from transients produced when the tripler went out.

Tripler arcing isn't always "terminal." My friend Leon Caldwell has found some triplers in Philco and Sylvania sets that have arced through the bottom of the case, through the encapsulant. Lift the case away from ground, and the unit works fine.

He cleaned all of the carbon off the bottom, then plastered it with silicone rubber sealant. The case was set up on insulating blocks, and the space below it filled with that sealant. Worked perfectly—no callbacks. I've also heard that Zenith is sending out, together with each tripler sold, small tubes of that type of sealant. It's used to cover all of the tripler terminals to prevent corona or arcover.

In another Magnavox, Leon found what seemed to be high-voltage trouble; raster gradually darkened and went out. Checking, he found that by pushing the VIDEOMATIC button and adjusting the preset controls, the raster came back! That was suspected when the high voltage was found to be up with a dark raster. Cleaning the switch was all it took to fix it up.

An odd case showed up in a Sylvania CX4146W. After repairs to the vertical circuits, retrace lines showed up in the raster. Not really objectionable, but visible. Two days after the set was sent home, the owner reported a loud snapping noise. That was due to arcing from the tripler, which had burnt a hole in the case. After it was replaced, the set worked fine and the retrace lines were gone. The technician who sent that in didn't have an explanation, and neither do I—but it happened.

Incidentally, there have been other cases with similar symptoms which turned out to be a bad electrolytic filter capacitor in the automatic brightness limiter circuit; on the sense-voltage line from the tripler. Check for that possibility if you run into that problem.

So: if you suspect tripler trouble, make the tests given, to make sure that it is actually the tripler, and not some of the other circuits. As usual, there are a number of things that can fake you out, so be sure to be on the lookout for them! Good luck! **R-E**

Service Questions on page 98

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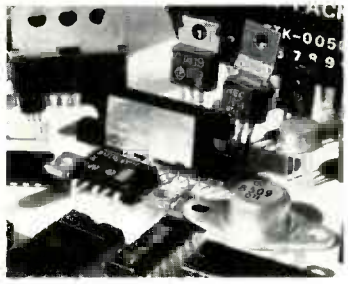

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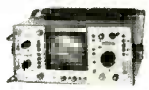
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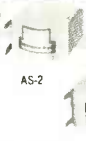
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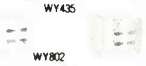
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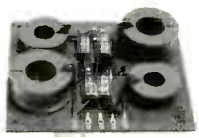

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CIRCLE 66 ON FREE INFORMATION CARD

continued from page 96

service questions

HOT SCREEN RESISTOR

I've got an odd problem. The damper tube in this J.C. Penney 4849A got red hot and burned out. While making voltage checks with it out, R904, 220 ohms got very hot. (Note: That is the horizontal output tube screen resistor.) What is the cause?—V.F., Nebraska City, NE.

Crystal ball says that damper tube could have shorted internally; or, the 6GK6 horizontal output tube is shorted. The hot resistor in the screen is *normal*! If you pull the damper tube, you have no plate voltage on the output tube. The screen grid, being the only element supplied with voltage, thinks it's the plate and tries to conduct all the current. In some sets, I've seen that tube looking like a toaster! The screen grid gets red hot!

Current meter in cathode of 6GK6 will tell you whether that stage is taking too much current. With the damper tube out, all current in that stage must flow through the 6GK6 cathode.

ROLL CHARTS FOR TUBE TESTERS

On a question as to availability of new roll-charts for tube testers, I replied, truthfully, that I'd been looking for years and never located a reliable source. John E. Johnson of Thomasville, GA, comes back with this little jewel:

Coletronics Service Inc., 1744 Rockaway Ave., Hewlett, NY 11557, has new charts for Precision Tube-Master Series 10-12, for $8.95 plus 50¢ shipping. The Hickok Electrical Instrument Co. advised him that for charts for an old TV-7 B/U, to contact: U.S. Navy Supplies, 5801 Tabor Ave., Philadelphia, PA 19120. We pass that along for anyone who might have one of these instruments. Thanks, John.

FOCUS PROBLEM

I'm having a focus problem with an RCA CTC-22. The damper diode was shorted. Changing that restored high voltage but not focus.—L.N., Philadelphia, PA.

I suggest checking all the loads, etc. Since the focus voltage in that chassis comes from the boost voltage, check all of the capacitors around the horizontal efficiency coil and the coil itself.

(Feedback: "I tried those things. The horizontal efficiency coil was shorted! Thanks!")

ODD RASTER DISTORTION

Al Yarborough of Yarborough Electronics, Lexington, NC, sends this along: "Here's field feedback for you. This Toshiba C-095 had a peculiar raster distortion. The upper left hand corner was expanded diagonally. Blooming was present in that area, too. Not due to high-voltage regulation, either.

"You suggested checking for feedback. In a way, that's what it was! A 100 μF capacitor in the pincushion stage apparently had a high power factor. It checked OK on an ohmmeter. A capacitor tester showed it as less than 50 μF. Replacing that fixed it.

"Last question: Years ago, they told us that transistors would do away with intermittents. When are they going to start making those perfect devices?"

Thanks, Al. To your last question, I've been wondering for many years!

HOT RESISTOR

In this GE 25MB chassis, the breaker tripped. I pulled the high-voltage module and that cleared it up. A new module didn't help. Resistor R1318 was high and showed signs of heating. I changed it and the new one overheats. All other modules were checked. What's going on here?—C.C., Amityville, NI.

Resistor R1318 is a series resistor in what seems to be a crowbar circuit in the high-voltage regulator module. It's connected from the +170V line through Q1304, an SCR, to ground. The SCR gate is triggered by sensing the +150-volt regulated DC output. That circuit uses a series Zener diode, and a couple of others. Check the SCR and if it's not shorted, check the trigger diode and others. Something seems to be firing the SCR!

WIGGLE IN SETUP LINE

This Sylvania D-12 had several wrinkles in the left end of the setup lines in with the service switch in the service position. Couldn't think of any reason for it. You suggested it might be something in the deflection yoke. This was a new Thordarson. Turned out that it had a 680 pF capacitor on the top half of the horizontal winding. Replacing that with 100 pF corrected the wiggle and the other problems. Thanks for the aid. William J. Shinn, New Carlisle, OH.

Thanks to you Mr. Shinn! Definite feedback from the field is a huge help to everyone.

GASSY TUBE?

I replaced the horizontal output and damper tube in this Zenith 12B14C50. Works beautifully. However after about 15 minutes of operation, I see little blue flashes around the bottom of the horizontal output tube. Tried a new one and got same thing. Is that tube gassy?—R.O., Daly City, CA.

This is a very old problem showing up in a new set! There are two things that can cause "blue glow" inside of tubes with high voltages applied. One, of course, is "gas," meaning just a wee bit or

air leakage. The typical symptom of that is a soft cloudy blue glow but looking closely, you'll see that it is *inside* the plate cylinder or rectangle.

A similar thing that's fooled lots of us is really quite different. Check your tube; see if those blue flashes are *actually* on the inside wall of the bulb! See if it flickers too. That is just the opposite of gas: It's called fluorescence and is due to a wee bit of the getter material on the walls. That lights up under a high voltage field, means a very *hard* vacuum!

ODD PROBLEMS

First thing on this Zenith 19CC19 was no red. Changed the IC demodulator and fixed that. Now I've got a weird symptom: good picture in the center of the screen but both sides are bowed in; that area is blank. Controls all work. What is it?—J.V., Punxsutawney, PA.

It sounds to me that you're getting some 60-Hz sinewave blanking into the video. Just for luck, scope the DC power supplies, especially the +25 and +34 volt outputs. I see that the +25 volts come directly from the vertical centering control and the B+. There would normally be a 60-Hz pulse here and it should be filtered out by the 500-μF electrolytic on this line. Check that one.

LOW VOLTAGES AND VERTICAL PROBLEMS

In this 16M91 Philco, several of the voltages are low and the boost voltage fluctuates quite a lot. Can't get a setup line with the service switch in the service position. Vertical linearity control arcs, too. What are all those?—C.G., Derry, NH.

Easy one first: If your boost voltage is low, chances are your picture tube screens are, too. That could be why no setup lines. Replace that vertical linearity control if it's arcing internally.

For the rest of the problems, that could be something that is common to the whole circuit! In other words, one of the filter capacitors. (From looking at the schematic, it is suspiciously like my own old CTC-15 RCA! So, if I say "filter capacitors", I know whereof I speak. I've been there. Check all of those ground points on the PC board, too.)

Feedback: It was the electrolytic capacitor on the +275-volt line! Bingo.

LOW-VOLTAGE PROBLEM

There are no low voltages from the flyback in this Sears 528. 42000400. No +27.2 volts DC or +28.8 volts at all. The diode, D504, seems to be good. I see a high pulse on the flyback side (anode) but none on the cathode, and no DC voltage. The high-voltage, boost, etc., are very close to normal. Thanks for any help.—G.P., Silver Spring, MD.

You *should* see pulses on the anode of D504, but you should not see any at all on the cathode. There is a 1,000 μF capacitor to ground here! From your symptoms, the only thing I can see is an open diode! If the pulse is present and no DC voltage is developed, the diodes may be open, or the 1,000 μF capacitor shorted. Your flyback pulse output seems to be normal, since all of the other voltages are in the ballpark. Be sure to use a fast-recovery type diode for D504. Ordinary sinewave types won't last more than 30 seconds!

A DISCO-PICTURE

This J.C. Penney model 2868 came in with an odd symptom. The picture brightness varied like a strobe light in a disco. Also, no color and a small raster. Scoping the DC supply showed a sawtooth of almost 80 volts! After quite a bit of checking, C807 was found open. (Note: That is a 1.0 μF capacitor, on the base of clipper TR802, from the collector of the sawtooth generator TR801. Part of saw-forming network, on the regulator board.)

That caused the regulator to hunt, and almost go into oscillation. Replacing it cleared up the problem.

Thanks to Dean Carpenter, N5AFT, in Garland, TX, for that helpful hint.

PIEZOELECTRIC

continued from page 60

LED's can be checked easily using the CONTINUITY mode of the tester because the LED will glow when properly connected (correct polarity). When the test leads to the LED are reversed, there will be no sound because the LED is open in that direction. In the same manner, you can test infrared (IR) LED's even though you cannot see the IR LED glow. If you get a sound in both directions, the LED is shorted (the same as for a shorted diode). Sound in one direction shows that the LED or diode is conducting in the forward direction (front-to-back) and no sound in the opposite direction (no conduction) shows that the back-to-front ratio is good.

Voltage Tester—Voltage-level tests can be made by using the piezoelectric sounder in its basic mode, where 1 to 20 volts DC is applied to its terminals. It can be used safely in transistor and TTL circuits, automobile trouble-shooting, checking the general condition of batteries, including watch and calculator batteries, because of its low current drain. It is handy for testing in any circuit where you want a general indication of correct circuit activity and where you use the ear instead of the eye to tell you this condition. Piezoelectric sounder and audio alerting devices are more and more coming into our lives advising us of conditions in the environment surrounding us. May they always beep or sound in your favor! **R-E**

stereo products

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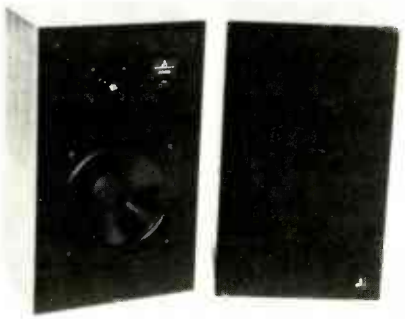
AM/FM RECEIVER, *model R6,* is one of a line of new receivers that feature quartz-locked tuning with digital readout for precise RF reception and a four-function fluorescent metering system. This system gives an accurate readout of AM signal strength, FM signal strength, multipath, and power output. Other features are a low-noise circuit for increased stability with low distortion, a high-speed amplifier section, and external jacks for signal or tape accessories. *Model R6* produces 60 watts-per-channel into 8 ohms, from 20 Hz to 20,000 Hz with 0.05% THD. Suggested retail price is $650.—**SAE, Inc.,** 701 E. Macy St., Los Angeles, CA 90012.

CIRCLE 131 ON FREE INFORMATION CARD

SPEAKERS, *Mitsubishi model MS-20* and *model MS-10,* are two-way acoustic air-suspension units that use a unique honeycomb technology in the woofer. The woofers are built of rigid, lightweight aluminum honeycomb material covered with glass-reinforced plastic, thereby reducing distortion caused by unwanted vibration. The system improves low-frequency performance and the airtight seal made from the honeycomb material improves air-suspension performance.



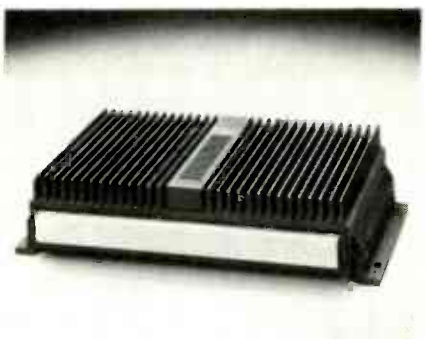
CIRCLE 132 ON FREE INFORMATION CARD

Other features are overload protection circuits and tweeter structures that reduce reverberation. The *MS-20* (shown) can handle power up to 120 watts; *MS-10* up to 100 watts. *Model MS-20* weighs 40 lbs. and measures 14⅜ × 24¾ × 11⅞ inches. Suggested retail price is $250. *Model MS-10* weighs 32 lbs., and measures 12⅝ × 22½ × 11½ inches. Suggested retail price is $165.—**Melco Sales, Inc.,** 3030 E. Victoria St., Compton, CA 90221.

COMPACT DIRECT-DRIVE TURNTABLE, *model SL-10,* is a compact quartz unit measuring the same as an LP record jacket. Everything is automatic and the upper and lower halves of the cabinet are sealed during play. To use the *SL-10,* the user places a record on the turntable, closes the lid to seal it, and presses the start button. The turntable then takes over, determining stylus contact points and the beginning and end of play. With a gimbal suspension and a dynamically balanced tracking arm, the unit can be used in the normal flat position or can be stood upright during record play. A coreless DC motor drives the arm and an optical sensor near stylus tip determines operation. Car battery or any 12V DC power supply can be used, as well as standard AC. Price is $600.—**Technics,** One Panasonic Way, Secaucus, NJ 07094.

CIRCLE 133 ON FREE INFORMATION CARD

AMPLIFIERS, *Model KAC-801* and *KAC-727,* are two high-power amplifiers designed for car stereo systems. *Model KAC-801* (shown) delivers 50 watts-per-channel into 4 ohms over a range of 20 to 60,000 Hz at 1% total harmonic distortion. Other specifications include a signal-to-noise ratio of 80 dB and a frequency response of 20 to 70,000 Hz. The unit has a built-in DC/DC converter to create the high voltage required to supply the output stages and has an electronic fault-protection circuit to prevent wiring shorts or overloads. Measuring 11⅝ × 2¾ × 6¹⁵⁄₁₆ inches, the amplifier is designed for trunk installation but can also mount under a car seat.



CIRCLE 134 ON FREE INFORMATION CARD

The *model KAC-727* is an under-dash model that delivers 15 watts-per-channel into 4 ohms from 20 to 50,000 Hz at 1% THD. It also features built-in circuit and speaker protection and uses IC's to minimize load distortion at high power ratings. The amplifier measures 6¹¹⁄₁₆ × 2⅛ × 6½ inches. *Model KAC-801* is priced at $219; *Model KAC-727* is priced at $95. —**Kenwood Electronics, Inc.,** Dept. P, 1315 E. Watsoncenter Rd., Carson, CA 90745. **R-E**

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Battery operated (PP3) or AC Adaptor
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DM235

Bench/Portable 3½ digit LED Multimeter
0.5% basic DCV Accuracy
21 ranges: DC and AC Volts and Current, Ohms
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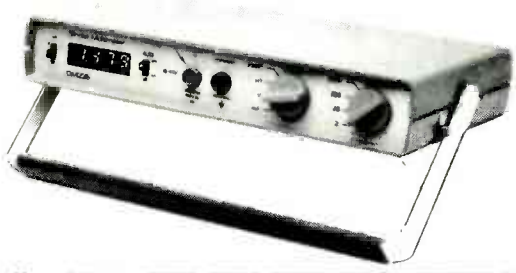
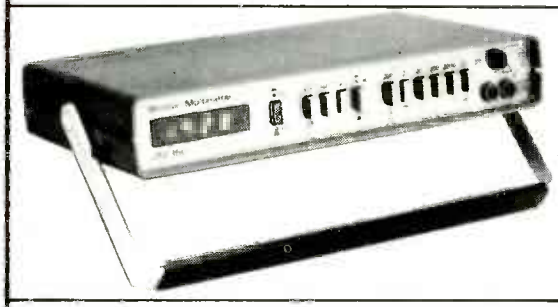
Ranges to 1000V / 1A / 20M
Battery operated (4 'C' cells) or AC Adaptor
Complete with test leads

$69.95





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Complete with test leads

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Bench/Portable 4½ digit LED Multimeter
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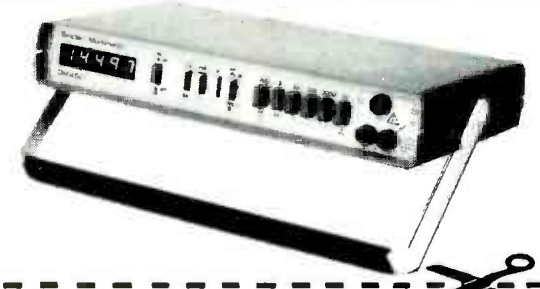
Ranges to 1200V / 10A / 20M
Battery operated (4 'C' cells) or AC Adaptor
Complete with test leads

$129.95



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computer products

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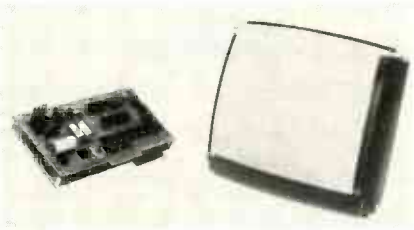
TOUCH SCREEN DIGITIZER, *TSD-12,* eliminates the need for keyboards and light pens at computer terminals. To select an item from the "menu" presented on the screen, all the operator has to do is touch his finger to it.



CIRCLE 121 ON FREE INFORMATION CARD

Applications include: executive data-base interaction, computer-aided instruction, voter registration, banking, and other situations where an operator must interact with a computer data base.

Prices range from $950 for a unit with parallel unfiltered data output to $1,200 for one with filtered RS-232 output and power supply. A special one-time evaluation unit with RS-232 interface and power supply is available for $995. OEM pricing is available upon request.—**TSD Display Products, Inc.,** 35 Orville Drive, Bohemia, NY 11716.

CP/M—COMPATIBLE DESKTOP MICROCOMPUTER series, the *Quay 500* and *520* is based on Quay's 94F/MPS single-board computer with 32K of RAM (expandable to 64K). Both systems use two 5¼-inch disc drives with DMA. The model *500* has a storage capacity of 400 kilobytes (formatted), single-sided, double density, and the *520* uses double-sided, double-density drives to give over 800 kilobytes of storage.

CIRCLE 122 ON FREE INFORMATION CARD

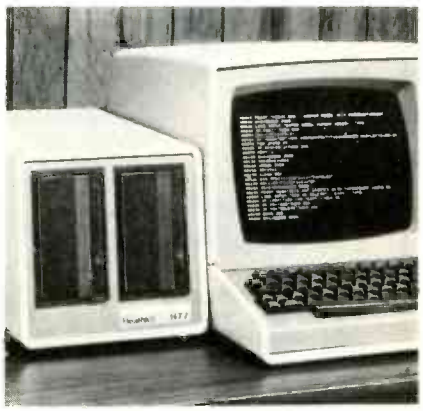
A parallel and serial port are standard and two additional serial ports can be added. An S-100 bus adaptor is also available.

The systems come with the CP/M Version 2.2 operating system. Prices for the *500* and *520* are $2,500 and $3,200, respectively.—**Quay Corporation,** P.O. Box 386, Freehold, NJ 07728.

ADD-ON FLOPPY DISC system, the *H-77,* increases the storage and programming capability of the Heathkit H89 computer. The *H-77* uses standard 5.25-inch, hard sectored, 40-track diskettes, each capable of storing 100K of data. Typical sector-access time is less than 250 milliseconds.

Adding the *H-77* to the H89 means that, not only is storage capacity increased, but both system and program discs can be run at the same time, giving fast and efficient access to programs and data and making disc duplication simple.

Kit price is $595 and includes one drive. A second drive, the *H-17-1* is available for $325. A factory-assembled version, the *WH-87* includes both drives and is priced at $1195. An adaptor kit, the *H-88-6* ($50) is required to install the *WH-77.* All prices are F.O.B. Benton Harbor, MI).—**Heath Company** (a subsidiary of Zenith Radio Corporation), Benton Harbor, MI 49022.



CIRCLE 123 ON FREE INFORMATION CARD

MUSIC SYNTHESIZER for the *TRS-80, The Music Box,* is a complete hardware/software tool that enables you to generate music and sound effects using your computer.

The Music Box can play up to four notes simultaneously and has a range of seven octaves. The waveforms generated can be modified so that the music can sound as if played by as many as four different instruments at the same time. In addition, a variety of sound effects and noises, such as explosions, gun shots, and "phasors," can be produced.

CIRCLE 124 ON FREE INFORMATION CARD

Connection is made to the *TRS-80* keyboard or expansion interface by means of a cable. *The Music Box* includes a volume control, audio amplifier and jack for connection to an external speaker or amplifier. Software is supplied on Level II cassette or disc. A Level II computer with 32K or more of memory is recommended.

Price is $249 with software and user's manual. Add $3 for shipping and $1 more if COD.—**Newtech Computer Systems, Inc.,** 230 Clinton St., Brooklyn, NY 11201. **R-E**

new lit

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

ELECTRONICS CATALOG, 55 pages, lists a variety of quality parts from over 40 manufacturers. Covered are regulators, capacitors, resistors, transistors, IC's, soldering irons, and hundreds of other products. Price information and order form included.—**Tri-Tek, Inc.,** 7808 N. 27th Ave., Phoenix, AZ 85021.

CIRCLE 99 ON FREE INFORMATION CARD

MICROCOMPUTER BOOKS, is a 14-page brochure featuring a comprehensive four-volume series introducing microcomputers and books on assembly language and logic design. Descriptions and complete table of contents are provided. Also listed are BASIC software and program manuals, including three business applications programs and 76 short programs with cassette tape for use with the Commodore PET. **Osborne/McGraw-Hill,** 630 Bancroft Way, Berkeley, CA 94710.

CIRCLE 141 ON FREE INFORMATION CARD

COMPUTER ACCESSORIES, *Catalog No. 112,* contains 16 pages of software, computer boards, systems, printers, semiconductors, and PC aids designed for the computer enthusiast, novice, and businessperson. Each product is described in great detail. Quantity and club discounts available.—**Hobby World Electronics,** 19511 Business Center Dr., Northridge, CA 91324.

CIRCLE 142 ON FREE INFORMATION CARD

PERSONAL COMPUTER CATALOG, *No. 6,* contains 20 pages full of books, software, and merchandise for the computer enthusiast. Offered are back issues of popular computer magazines, and books on various subjects including microcomputers, games, business programs, BASIC language, and much more. Their software includes many different games available in cassette or floppy disk form. T-shirts and posters are also featured. Order form enclosed.—**Creative Computing,** P.O. Box 789-M, Morristown, NJ 07960.

CIRCLE 143 ON FREE INFORMATION CARD

HI-FI CATALOG, is an illustrated 32-page booklet describing AM/FM stereo receivers, integrated amplifiers, AM/FM stereo tuners, front-load cassette decks, audio analyzers, direct-drive turntables, and loudspeaker systems. In addition to photographs and descriptions, there is an overall set of tables in the final pages listing specifications so that the reader can compare the claims for one model with another.—**H. H. Scott, Inc.,** 20 Commerce Way, Woburn, MA 01801.

CIRCLE 144 ON FREE INFORMATION CARD

TWO-WAY MOBILE RADIO CATALOG, *1980,* is an 8-page illustrated brochure covering base station equipment, remote-control equipment, mobile car telephone equipment, mobile radio equipment, paging equipment, and portable radio equipment, including two-way portable radios.—**Mobile Technical Service Corp.,** 6019 South Kenton Way, Englewood, CO 80111.

CIRCLE 145 ON FREE INFORMATION CARD

ARCHER SEMICONDUCTOR REPLACEMENT GUIDE, *1980 edition,* is a 224-page book, featuring cross-reference/substitution listings for over 100,000 devices. It's a comprehensive guide to Radio Shack's complete line of Archer-brand semiconductors and includes detailed data and pin connections for IC's, diodes, SCR's, LED's, and other devices.

There is information on the care of transistors and integrated circuits, case styles and dimensions, transistor testing, display and optoelectronic devices. A glossary of word symbols, and abbreviations is also included.

The 1980 edition of this replacement guide is $1.99 and can be obtained from participating Radio Shack stores and dealers throughout the U.S.A.—**Radio-Shack,** 1300 One Tandy Center, Fort Worth, TX 76102.

CIRCLE 146 ON FREE INFORMATION CARD

MINI-SCOPE SELECTION GUIDE 1979, is a full-color, 4-page leaflet presenting photos and brief specifications of mini-scopes (general-purpose, portable oscilloscopes that weigh 15 lbs. or less, are small enough to fit into a tool kit or briefcase, and can operate from self-contained battery power) and mini-scopes with DMM-counters. The back cover gives detailed ordering information and a list of sales representatives in U.S. metropolitan areas.—**Vu-data Corporation,** 7170 Convoy Court, San Diego, CA 92111.

CIRCLE 147 ON FREE INFORMATION CARD

TURNTABLE/CASSETTE CATALOGS, Dual turntables and Dual cassette decks. Each catalog contains 12 illustrated pages. The turntables all feature ULM (*U*ltra *L*ow *M*ass) tonearms and cartridge systems and models range from single play to fully automatic. The cassette decks feature the new DLL (*D*irect *L*oad and *L*ock) system. Charts on the back covers give a breakdown of the specific features to be found on each model, and photos shows how they are laid out.—**United Audio,** 120 So. Columbus Ave., Mt. Vernon, NY 10533.

CIRCLE 148 ON FREE INFORMATION CARD

KESTER SOLDER (NEW EDITION) is an illustrated, two-color, 12-page brochure covering Kester's broad line of solders and fluxes. The brochure covers acid and resin-cored solders, flux-cored silver bearing solders, and radiator solder, as well as Kester's half-pound spools of acid-core, solid wire and "44" resin-core solders. Also described are package-goods solders and other carded merchandise—metal mender, TV-radio solder, aluminum-repair solder, solder paste flux, and related chemical products. A special feature is questions and answers about soldering, and a 6-step instruction on soldering procedure.—**Kester Solder,** 4201 Wrightwood Ave., Chicago, IL 60639.

CIRCLE 149 ON FREE INFORMATION CARD

SAMS COMPUTER BOOKS, *1980 Catalog,* contains 19 illustrated pages in two colors describing one of the industry's largest selection of computer and computer-based items.

The catalog is laid out in five areas for easy reference: Basics, Programming, Computer Technology, Reference, and Computer-related books. The selections are directed to a wide range of people and interests, from the home hobbyist to the technically-oriented professional.—**Howard W. Sams & Co., Inc.** 4300 W. 62nd St., PO Box 7092, Indianapolis, IN 46206. **R-E**

CIRCLE 150 ON FREE INFORMATION CARD

NOISE-REDUCTION SYSTEM

continued from page 62

low low-frequency signals as continuous level changes and will introduce unacceptable bass distortion.

Spectrum division used in the *High Com II* system solves that problem, too. Since high and low-frequency signals are processed independently, time constants for the high and low-band circuits can be optimized for each particular range of frequencies. The result is extremely accurate reproduction of musical transients, as illustrated by the tone-burst signal (Fig. 6) processed via a *High Com II* system. The frequency within the tone burst was 10 kHz and only a few cycles of that tone were at anything but correct full amplitude after the burst was initiated.

Figure 7 is a dual-exposure oscilloscope photo showing the effectiveness of the *High Com II* system in removing noise components from low-level signals. The upper trace was observed during playback of a 400-Hz signal recorded and played back at a level of −40 dB without the use of any noise reduction. Note that the noise amplitude (blurry thickening of the 400-Hz sinewave) is not much lower than the signal itself. The lower trace represents the playback of a 400-Hz signal recorded at the same input level,

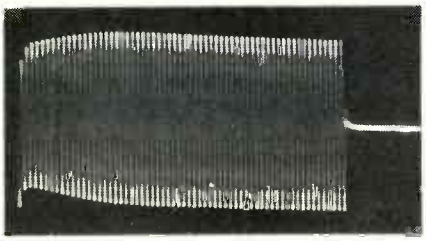


Fig. 6—EXCELLENT TRANSIENT RESPONSE of High Com II illustrated by 10-kHz tone burst.

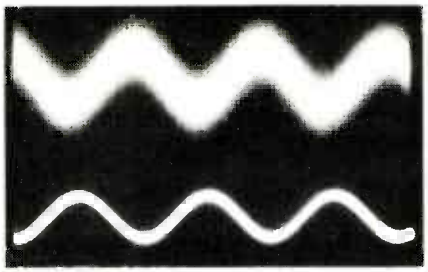


Fig. 7—LOW-LEVEL 400 Hz signal recorded and played back with and without the High-Com II.

but this time recorded and played back using the *High Com II* noise-reduction system.

Nakamichi was probably wise to offer the *High Com II* as an outboard device since it can be connected to any existing cassette deck and, in addition, those listeners who are presently owners of reel-to-reel equipment can also avail themselves of this new noise-reduction system. **R-E**

HOW TO CONNECT HOME VIDEO

continued from page 54

patch panel. Run all of your different inputs and output to a central front panel and use bulkhead fittings and jumpers that have been fitted with BNC type connectors or coax push-on fittings. You want them to be secure but easily rearranged depending on how you are currently routing the signals. If you try to use a switching network in this type of system you can expect problems. (Isolation within the switch becomes a critical factor so if you want to use a switching network, spend the money for good quality switches).

You might find that it is necessary to trap out one particular channel to make room in the system for insertion of a pay-TV device or additional VCR. Use a high-Q type trap that will effectively drop out the desired channel without affecting any adjacent channel.

If you use the installations that have been described as guidelines, you should be able to set up your own home video system to meet all of your particular needs. **R-E**

books

MINIPROCESSORS: FROM CALCULATORS TO COMPUTERS, by David L. Heiserman. TAB Books, Blue Ridge Summit, PA 17214. 196 pp. 5 × 8¼ in. Softcover $5.95; hardcover $9.95.

This book teaches the computer hobbyist how to turn a calculator into a functional hybrid calculator/computer system (or supercalculator) by adding on memory-control circuit boards, I/O boards, branching and looping systems, etc. You first learn how to build a basic arithmetic calculator, and then proceed step-by-step to a fully programmable system with randomly addressable 256-step memory. Construction techniques are given plus full circuit description, component specs and schematics.

THE MULTITRACK PRIMER, by Dick Rosmini. TEAC Corp. of America, 7733 Telegraph Rd., Montebello, CA 90640. 46 pp. 8½ × 11 in. Softcover $4.95.

This booklet acquaints readers with multitrack recording and covers all the basics from setup and layout to cue systems and mikes. It covers such topics as designing a basic studio for a one-man keyboard or guitar, and shows you how to build a tent and baffle. The text is accompanied by charts and line drawings.

ALL ABOUT TELEPHONES, by Van Waterford. Tab Books, Blue Ridge Summit, PA 17214. 190 pp. 5 × 8¼ in. Softcover $4.95.

Now that it's legal and possible to own your own telephone system, this book provides an answer to the most common questions, such as how to go about getting your own phone, the types available, and what is or isn't permissible to do according to FCC regulations. Chapter 2 describes how a telephone works and how it is installed. Chapter 4 details the FCC requirements for both owner and telephone company. Other chapters describe types of phones (picturephone, speakerphone, cordless, etc.) security devices and mobile units.

HEAR ALL THE ACTION, by Van Waterford. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, IN 46268. 128 pp. 5¼ × 8¼ in. Softcover $5.25.

The book guides the hobbyist through the world of international communications via the DX receiver. It starts with a history of DX'ing and a description of radio-wave fundamentals such as frequency, VHF/UHF bands, wavelength, etc. Chapter 2 tells you how to shop for a receiver; Chapter 3 describes accessories and aids; and Chapter 4 deals with antennas. An appendix contains a glossary of terms and lists the abbreviations and codes used in shortwave transmissions.

RADAR DETECTOR HANDY MANUAL, by Van Waterford. Tab Books, Blue Ridge Summit, PA 17214. 79 pp. 5 × 8¼ in. Softcover $2.25.

This handy guide to radar detectors explains the principles, installation and use of these devices, and tells you how to detect highway police radar signals. It also describes how the detectors work, and gives details on radar circuitry. The book includes handy hints on how to avoid speeding violations, plus a chapter on the CB lingo used in reference to police radar.

THE CAMEO DICTIONARY OF CREATIVE AUDIO TERMS. Creative Audio & Music Electronics Organization, 10 Delmar Avenue, Framingham, MA 01701. 100 pp. 5½ × 8½ in. Softcover $4.95.

This first comprehensive dictionary of creative audio terminology that has ever been compiled is aimed at the reader who is *not* technically inclined. The definitions, from "A-B test" to "zenith adjustment" are brief and clearly presented, with diagrams and tables where needed. The object of the book is to provide fundamental and working knowledge of creative audio terminology to all who are involved in this field and industry; it will be of no less value to the interested reader, too, who may just be curious what some of those words and phrases that audiophiles use are about. The dictionary was compiled by Gary Davis & Associates and the focus is on sound recording, sound reinforcement, and signal processing for the performing artist. **R-E**

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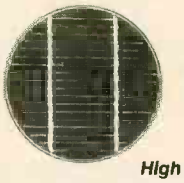

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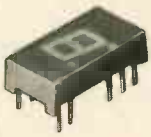

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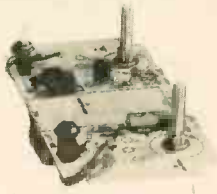

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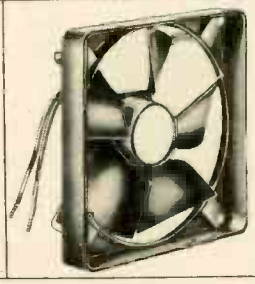

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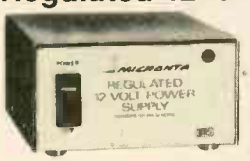

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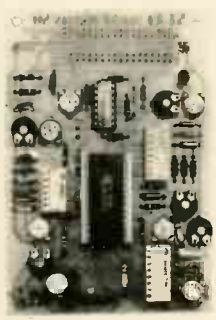

The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477 Sound Chip,** the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot, and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3¼" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains,** or almost an infinite number of other sounds. The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included).

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(Color Organ)
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TY-23

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MARK IV KIT **$31.50**

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It works in 12V DC as well! Kit includes 1 PC SANYO STK-043 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 60 watts (30 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100Mz and 10KHz.

$32.50 PER KIT

BATTERY POWERED FLUORESCENT LANTERN

MODEL 888 R

$10.50 EA

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.

STEREO AMPLIFIER

60 W + 60 W

COMPLETED UNIT — NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8Ω. Power supply is 24 - 36V AC or DC. Complete unit. Assembled **$49.50 ea.**
Power transformer **$ 8.50 ea.**

5W AUDIO AMP KIT

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

PROFESSIONAL PANEL METERS

Type MU-52E

A.	0-50UA	8.50 ea.
B.	0-30VDC	8.50 ea.
C.	0-50VDC	8.50 ea.
D.	0-3ADC	9.00 ea.
E.	0-100VDC	9.00 ea.

All meters white face with black scales. Plastic cover.

SPECIAL 0.5" LED 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 **(FREE)**

DIGITAL AUTO SECURITY SYSTEM

4 DIGITS PERSONAL CODE!!
SPECIAL $19.95

- proximity triggered
- voltage triggered
- mechanically triggered

This alarm protects you and itself! Entering protected area will set it off, sounding your car horn or siren you add. Any change in voltage will also trigger the alarm into action. If cables within passenger compartment are cut, the unit protects itself by sounding the alarm. **3-WAY PROTECTION!**
All units factory assembled and tested — Not a kit!

A NEW LED ARRAY AND DRIVER FOR LEVEL METERS

This series covers a wide range of level indlcation uses, output and input voltage, time related change, temperature, light measurement and sound level. The problem of uneven brilliance often encountered with LED arrangements as well as design problems caused by using several units of varying size are substantially reduced. 12 LEDs in one bar.

LED ARRAY

GL-112R3 Red, Red, Red	**$5.50**
GL-112N3 Green, Yellow, Red	**$6.50**
GL-112M2 Green, Green, Red	**$6.50**
GL-112G3 Green, Green, Green	**$6.50**

LED DRIVERS

1R 2406G is an I.C. specially designed to drive. 12 LED. The number of LED is lineally illuminated according to the control voltage input terminal 21. Operating voltage is 9 12V D.C. **$5.35 EACH**

DUEL CHANNEL VU METER
P.C. BOARD AVAILABLE AT $4.50 EA.

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

FLASHER LED

Unique design combines a jumbo red LED with an IC flasher chip in one package. Operates directly from 5V-7V DC. No dropping resistor neded. Pulse rate 3Hz @ 5V 20mA.

2 for $2.20

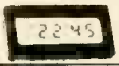
BIPOLAR LED RED/GREEN

2 colors in one LED, green and red, changes color when reverse voltage supply. Amazing!
2 FOR $1.60

LCD CLOCK MODULE!

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

NIC1200 (12 hr) $24.50 EA.
NIC2400 (24 hr) $26.50 EA



WANT TO BUILD YOUR OWN BLACK MAGIC BOX ON TOP OF THE TV FOR FIRST RUN MOVIES?

We have all the parts including hard to find UHF variactor tuners and P.C. board.
Call us for more information.

CIRCLE 5 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.

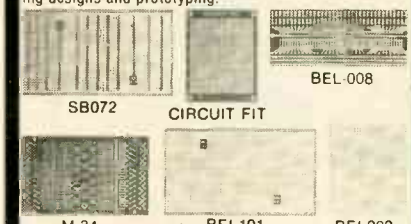
"FISHER" 30 WATT STEREO AMP

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

UNIVERSAL PROJECT BOARD

All P.C. boards are made from high quality phenolic. predrilled in different patterns for different purpose. All boards 1/16" single sided copper. Hole spacing is standard 0.1". Fits all kinds of I.C. transistors, capacitors and resistors. Ideal for school projects, engineering designs and prototyping.



BEL101	3½"x6"	$1.75 EA.
SB072	3½"x6"	$1.75 EA.
M-34	3"x5"	$1.75 EA.
CIRCUIT FIT	3"x3½"	$1.25 EA.
BEL202	3"x4"	$1.25 EA.
BEL-008	2¼"x5½"	$1.25 EA.

PUSH-BUTTON SWITCH

N/Open Contact
Color: Red, White, Blue, Green, Black
3/$1.00
N/Close also Available
50¢ each
LARGE QTY. AVAILABLE

HEAVY DUTY CLIP LEADS

10 pairs — 5 colors Alligator clips on a 22" long lead. Ideal for any testing.
$2.20/pack

BATTERIES

PK/$10.00
2 PKS/$19.00

NICKEL CADMIUM BATTERY PACK 'D' SIZE

ILLUSTRATED LESS COVER

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

"C" SIZE BATTERY PACK

10 C size ni-cd battery in dng pack, gives out 12.5V D.C. 1.8 amp per hour. All fresh code, pull-out from movie cameras. Can be disconnected to use as single c cells. Hard to find **$15.00** per pack of 10 batteries

ELECTRONIC ALARM SIREN

COMPLETE UNIT
Ideal for use as an Alarm Unit or hookup to your car back-up to make a reverse indicator. Light Output up to 130dB. Voltage supply 6 12V

AU-999 **$7.50**

SUB MINIATURE TOGGLE SWITCH

SPST 2 FOR 2.80 SPDT 2 FOR 3.20
6 AMP 125V AC CONTACT

TRANSFORMERS

ALL 117 VOLT INPUT

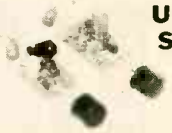
30V	4 AMP	**$8.50 EA.**
36V CT	3 AMP	**$10.50 EA.**
48V CT	3 AMP	**$10.50 EA.**
24V CT	0.5 AMP	**$3.00 EA.**
18V CT	0.5 AMP	**$3.00 EA.**
12V CT	0.5 AMP	**$2.50 EA.**
6.3V	0.5 AMP	**$2.00 EA.**

AC POWER SUPPLY

Wall Type Transformer

12V AC	Output	200 MA	**$2.75 EA.**
16V CT AC	Output	100 MA	**$2.10 EA.**
6V DC	Output	120 MA	**$1.90 EA.**
12V DC	Output	100 MA	**$1.90 EA.**

ULTRASONIC SWITCH KIT



Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver. All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operates by 9-12 DC. **$15.50**

COMPLETE TIME MODULE

0.3" digits LCD Clock Module with month and date, hour, minute and seconds. As well as stop watch function!! Battery and back up light is with the module. Size of the module is 1" dia. Ideal for use in auto panel, computer, instrument and many others! **$8.95 EACH**

SOUND ACTIVATED SWITCH

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

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

FM WIRELESS MIC KIT

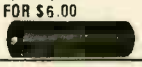
It is not a pack of cigarettes. It is a new FM wireless mic kit! New design PC board fits into a plastic cigarette box (case included). Uses a condensor microphone to allow you to have a better response in sound pick-up. Transmits up to 350 ft.! With an LED indicator to signal the unit is on #FMM2 **KIT FORM $7.95**

REGULATED DUAL VOLTAGE SUPPLY KIT

±4 30V DC 800 MA adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator I.C. Kit includes all electronic parts, filter capacitors, I.C., heat sinks and P.C. board.
$12.50 PER KIT

AA SIZE NI-CD RECHARGEABLE BATTERIES

SPECIAL SALE
4 FOR $6.00
LIMITED QUANTITY AVAILABLE



POCKET SIZE AM-FM RADIO TR-945 with LED TUNING EYE

New design body with see thru speaker grill.
SPECIAL PRICE $16.50 EACH

TR-945

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**

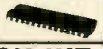
0-30 Power Supply **$10.50 each**

I.C. TEST CLIPS

Same as the E-Z clips With 20" Long Leads In Black and Red Colors **$2.75 per pair**

SOUND GENERATOR I.C.

Creates almost any type of sound — gun shot, explosion, train, car crash, star war, birds, organ ext. A built-in audio amplifier provides high level output. Operates from one 9V battery, 28 pin dip; we supply the datas. **$2.90 EACH**



ELECTRONIC SWITCH KIT

CONDENSER TYPE
Touch On Touch Off uses 7473 I.C. and 12V relay
$5.50 each

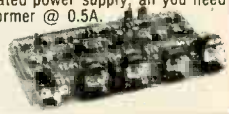
1 WATT AUDIO AMP

All parts are pre-assembled on a mini PC Board. Supply Voltage 6 9V D.C. **SPECIAL PRICE $1.95 ea.**

LOW TIM DC STEREO PRE-AMP KIT TA-10 20

Incorporates brand-new D.C. design that gives a frequency response from OHz — 100KHz ±0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuation!
Specifications: • T.H.D. less than .005% • T.I.M. less than .005% • Frequency response: DC to 100KHz ±0.5dB • RIAA deviation: ±0.2dB • S/N ratio: better than 70dB • Sensitivity: Phono 2MV 47K/Aux. 100MV 100K • Output level: 1.3V • Max. output: 15V • Tone control: bass ±10dB @ 50Hz/treble ±10dB @ 15Hz • Power supply: ±24 D.C. @ 0.5A
Kit comes with regulated power supply, all you need is a 48V C.T. transformer @ 0.5A.

ONLY $44.50
X'former
$4.50 ea.



SOLID STATE ELECTRONIC BUZZER

Mini size 1" x ¾" x ¾"
Supply voltage 1.5V - 12V
Ideal for Alarm or Tone Indicator

$1.50 each

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Westfield, N.J. 07090
(201) 654-6008

MOTION DETECTOR: Features include transparent, optical IC completely assembled on circuit board with necessary capacitors. Extensive specs and application notes included./$5.00

CRYSTALS—3.579545 MHz 99¢
6.0 MHz 2.95

JUMBO LED's
Green, 7/1.00-Yellow, 7/1.00-Red, 10/1.00
100/13.00 100/13.00 100/9.00

MOUNTING CLIPS—12/1.00

7 SEG Displays (comp. grade)
.3"/95¢-.6"/1 45 (specify ann. or cath.)

AM/FM RADIO CHIP—(#4408) 2.00 or 3/5.00
Complete AM/FM IC-external IF required

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.47 µf 35V (1" leads) 10/1.00

SUPER SUB MINI LYTICS
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1000µf 50V (1⅜" L X ⅜ W), 75¢ or 10/6.00
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1000µf 50V—1.00 1000µf 185V—2.00

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HEAT SENSITIVE SWITCH—4/1.00
self contained unit opens at 150 C

9 DIGIT FLUORESCENT DISPLAY by NEC
complete with driving circuitry-2.50

EXTRA LOUD 9V BUZZER—3/2.00

WALL PLUG ADAPTER—5VDC @ 160ma-1.50

6.3V 1.2 Amp Transformer—1.75

MINI AUDIO TRANSFORMERS—3/1.00

DIGITAL MOTION/UNIT COUNTER MODULE
(Fairchild) with large 4 digit display & specs-7.00

8035 Microprocessor, 17.00

INTERFACE CHIP-D8243
16 line I/O extender for all single chip µ Ps 5.75

SUBSCRIPTION TV EDUCATIONAL KIT
If there's a TV channel in your area which you can't tune to and get a proper picture or sound, chances are you're seeing a subscription TV signal. Now you can find the signal. Our 24-page illustrated manual contains a description of how such a system works and includes construction details for building a circuit to restore the audio and video signals to their original state. Our kit is proven to work in many areas of the U.S. but does require use of a scope and is not intended for beginners.

Manual only	$15.00
Drilled and etched PC project board	23.00
Board and manual	35.00
Complete kit	69.00

FREQUENCY COUNTER CHIP
ICM 7225 IPL
(40 pin), with on board dividers, decoders/drivers. 18.95-specs included

ZENER DIODES—20V 1 amp 10/1.00

TV SATELLITE TRANSISTOR
MRF 901 (prime) $4.50

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LM 307	.35	LM 1307E	.90
LM 308H	.95	LM 1310	1.75
LM 308	.90	LM 1391	1.50
LM 310	1.05	LM 1414	2.25
LM 311H	.85	LM 1800	2.90
LM 317K	5.00	LM 1808	2.75
LM 318H	1.25	LM 1820	1.75
LM 320K-15	1.15	LM 1828	1.75
LM 320K-12	1.15	LM 1830	1.50
LM 324	1.25	LM 1841	1.75
LM 325	1.85	LM 1848	1.75
LM 339J	1.00	LM 1889	4.50
LM 340K-12	1.25	LM 2111	1.60
LM 341P-12	1.25	LM 2113	1.75
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LM 377	2.00	LM 3046	1.10
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LM 381	1.60	LM 3064	2.00
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LM 386	1.50	LM 3067	2.50
LM 389	1.50	LM 3070	2.50
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Govt surplus walky talky, used cond. 47-55.4 mc range. Ant. $5 each extra. With data.

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AN/PRC-6

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For the student who has completed S-1. GOAL: To provide an over-all and practical understanding of the concepts of Micro-Computer Programming. 2.5 hours.
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74LS20	28	74LS170	198
74LS21	38	74LS174	90
74LS22	38	74LS175	90
74LS26	39	74LS190	110
74LS27	38	74LS193	98
74LS30	26	74LS195	98
74LS32	39	74LS196	85
74LS38	39	74LS221	140
74LS42	78	74LS240	245
74LS48	78	74LS241	245
74LS51	25	74LS243	220
74LS54	35	74LS244	245
74LS74	52	74LS245	295
74LS75	65	74LS253	98
74LS83	95	74LS257	98
74LS85	115	74LS258	98
74LS86	45	74LS259	295
74LS90	70	74LS279	55
74LS93	70	74LS283	100
74LS107	45	74LS293	198
74LS112	48	74LS298	120
74LS113	48	74LS368	98
74LS122	50	74LS367	98
74LS123	115	74LS368	98
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APPLE II Computer with full 48K of memory!
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MEMORY ADD-ON KIT INCLUDES INSTRUCTIONS, RAMS, AND JUMPERS. NO TOOLS REQUIRED

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SOROC TECHNOLOGY, INC

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MINI KITS - YOU HAVE SEEN THESE BEFORE NOW HERE ARE OLD FAVORITE AND NEW ONES TOO. GREAT FOR THAT AFTERNOON HOBBY.

FM MINI MIKE

A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

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See music come alive! 3 different lights flicker with music. One light each for, high, mid-range and lows. Each individually adjustable and drives up to 300 W. runs on 110 VAC.

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Converts any TV to video monitor. Super stable, tunable over ch. 4-6. Runs on 5-15V, accepts std. video signal. Best unit on the market! Complete kit, VD-1 $7.95

Led Blinky Kit

A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts. Complete kit, BL-1 **$2.95**

Super Sleuth

A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2 W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker. Complete kit, BN-9 **$5.95**

CPO-1

Runs on 3-12 Vdc 1 wall out, 1 KHZ good for CPO, Alarm, Audio Oscillator. Complete kit **$2.95**

FM Wireless Mike Kit

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.

FM-1 kit $3.95 FM-2 kit $4.95

Whisper Light Kit

An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Includes mike, controls up to 300 W, runs on 110 VAC. Complete kit, WL-1 **$6.95**

Tone Decoder

A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts. Complete kit, TD-1 $5.95

Universal Timer Kit

Provides the basic parts and PC board required to provide a source of precision timing and pulse generation. Uses 555 timer IC and includes a range of parts for most timing needs.

UT-5 Kit $5.95

Mad Blaster Kit

Produces LOUD ear shattering and attention getting siren like sound. Can supply up to 15 watts of obnoxious audio. Runs on 6-15 VDC

MB-1 Kit $4.95

Siren Kit

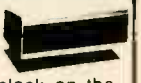
Produces upward and downward wail characteristic of a police siren. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker.

Complete kit, SM-3 $2.95

60 Hz Time Base

Runs on 5-15 VDC. Low current (2.5ma). 1 min/month accuracy. TB-7 Kit $5.50
TB-7 Assy $9.95

CLOCK KITS



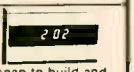
Your old favorites are here again. Over 7,000 Sold to Date. Be one of the gang and order yours today!

Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six .4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors: silver, gold, black (specify).

Clock kit, 12/24 hour, DC-5 **$24.95**
Clock with 10 min. ID timer, 12/24 hour, DC-10 **$29.95**
Alarm clock, 12 hour only, DC-8 **$29.95**
12V DC car clock, DC-7 **$29.95**

For wired and tested clocks add $10.00 to kit price. Specify 12 or 24 hr. format

Car Clock



The UN-KIT, only 5 solder connections

Here's a super looking, rugged and accurate auto clock, which is a snap to build and install. Clock movement is completely assembled — you only solder 3 wires and 2 switches, takes about 15 minutes! Display is bright green with automatic brightness control photocell — assures you of a highly readable display, day or night. Comes in a satin finish anodized aluminum case which can be attached 5 different ways using 2 sided tape. Choice of silver, black or gold case (specify).

DC-3 kit, 12 hour format **$22.95**
DC-3 wired and tested **$29.95**

Calendar Alarm Clock

The clock that's got it all: 6-.5" LEDs, 12/24 hour, snooze, 24 hour alarm, 4 year calendar, battery backup, and lots more. The super 7001 chip is used. Size: 5x4x2 inches. Complete kit, less case (not available)

DC-9 **$34.95**

Under Dash Car Clock

12/24 hour clock in a beautiful plastic case features: 6 jumbo RED LEDS, high accuracy (.001%), easy 3 wire hookup, display blanks with ignition, and super instructions. Optional dimmer atuomatically adjusts display to ambient light level

DC-11 clock with mtg. bracket **$27.95 kit**
DM-1 dimmer adapter **$2.50**
Add $10.00 Assy. and Test

Video Terminal

A completely self-contained stand alone video terminal card. Requires only an ASCII keyboard and TV set to become a complete terminal unit. Features are: single 5V supply, XTAL controlled sync and baud rates (to 9600), complete computer and keyboard control of cursor. Parity error control and display. Accepts and generates serial ASCII plus parallel keyboard input. The 6416 is 64 char. by 16 lines, with scrolling, upper and lower case (optional) and has RS-232 and 20ma loop interfaces on board. Kits include sockets and complete documentation.

RE 6416, terminal card kit (add $60.00 for wired unit) **$189.95**
Lower Case option **$13.95**
Power Supply **$14.95**
RF Modulator kit **$7.95**

PARTS PARADE

IC SPECIALS

LINEAR

301	$ .35
324	$1.50
380	$1.50
555	$ .45
556	$1.00
565	$1.00
566	$1.00
567	$1.25
741	10/$2.00
1458	$ .50
3900	$ .50
3914	$2.95
8038	$2.95

CMOS

4011	.50
4013	.50
4046	$1.85
4049	.50
4059	$9.00
4511	$2.00
4518	$1.35
5039	$1.75

READOUTS

FND 359 .4" C C	$1.00
FND 507/510 .5" C A	1.00
MAN 72/HP7730 .33" C A	1.00
HP 7651 .43" C A	2.00

TRANSISTORS

2N3904 NPN	15/$1.00
2N3906 PNP	15/$1.00
2N4403 PNP	15/$1.00
2N4410 NPN	15/$1.00
2N4916 FET	4/$1.00
2N5401 PNP	5/$1.00
2N6028	4/$1.00
2N3771 NPN Silicon	$1.50
2N5179 UHF NPN	3/$2.00
Power Tab NPN 40W	3/$1.00
Power Tab PNP 40W	3/1.00
MPF 102/2N5484	$.50
NPN 3904 Type	50/$2.50
PNP 3906 Type	50/$2.50
2N3055	$.60
2N2646 UJT	3/$2.00

TTL

74S00	$ .40
7447	$ .65
7475	$ .50
7490	$ .50
74196	$1.35

SPECIAL

11C90	$15.00
10116	$ 1.25
7208	$17.50
7207A	$ 5.50
7216D	$21.00
7107C	$12.50
5314	$ 2.95
5375AB/G	$ 2.95
7001	$ 6.50

FERRITE BEADS

With info and specs 15/$1.00
6 Hole Balun Beads 5/$1.00

Sockets

8 Pin	10/$2.00
14 Pin	10/$2.00
16 Pin	10/$2.00
24 Pin	4/$2.00
28 Pin	4/$2.00
40 Pin	3/$2.00

Diodes

5.1 V Zener	20/$1.00
1N914 Type	50/$1.00
1KV 2Amp	8/$1.00
100V 1Amp	15/$1.00

25 AMP 100V Bridge **$1.50 each**

Mini-Bridge 50V 1 AMP **2 for $1.00**

Resistor Ass't

Assortment of Popular values - ¼ watt. Cut lead for PC mounting, ½" center, ½" leads, bag of 300 or more. **$1.50**

Switches

Mini toggle SPDT $1.00
Red Pushbuttons N.O. 3/$1.00

Earphones

3" leads, 8 ohm, good for small tone speakers, alarm clocks, etc **5 for $1.00**

Mini Speaker

Approx. 2¼" diam. Round type for radios, mike etc. 3 for $2.00

Solid State Buzzers

small buzzer 450 Hz, 86 dB, sound output on 5-12 vdc at 10-30 mA, TTL compatible. **$1.50**

Slug Tuned Coils

Small 3/16" Hex Slugs turned coil, 3 turns. **10/$1.00**

AC Outlet

Panel Mount with Leads **4/$1.00**

CAPACITORS

TANTALUM Dipped Epoxy
1.5 µF 25V 3/$1.00
1.8 µF 25V 3/$1.00
22 µF 25V 3/$1.00

ALUMINUM Electrolytic
1000 uF 16V Radial $.50
500 uF 20V Axial $.50
150 uF 16V Axial 5/$1.00
10 uF 15V Radial 10/$1.00

DISK CERAMIC
01 16V disk 20/$1.00
1 16V 15/$1.00
001 16V 20/$1.00
100 pF 20/$1.00
.047 16V 20/$1.00

DC-DC Converter

+5 vdc input prod. -9 vdc @ 30ma
+9 vdc produces -15 vdc @ 35ma $1.25

Ceramic IF Filters

Mini ceramic filters 7 KHz
B. W. 455KHz **$1.50 ea.**

25K 20 Turn Trim Pot $1.00
1K 20 Turn Trim Pot $.50

Trimmer Caps

Sprague - 3-40 pf Stable Polypropylene **.50 ea.**

Crystal Microphone

Small 1" diameter ¼" thick crystal mike cartridge $.75

Mini RG-174 Coax **10 ft. for $1.00**

Coax Connector

Chassis mount BNC type **$1.00**

9 Volt Battery Clips

Nice quality clips 5 for $1.00
⅜" Rubber Grommets 10 for $1.00

Parts Bag

Asst. of chokes, disc caps, tant., resistors, transistors, diodes, MICA caps etc sm. bag (100 pc) $1.00 lg. bag (300 pc) $2.50

Connectors

6 pin type gold contacts for mA-1003 car clock module price .75 ea.

Leds

- your choice, please specify
Mini Red, Jumbo Red, High Intensity Red, Illuminator Red 8/$1
Mini Yellow, Jumbo Yellow, Jumbo Green 6/$1

Varactors

Motorola MV 2209 30 PF Nominal cap 20-80 PF - Tunable range - **.50 each or 3/$1.00**

Crystals

3.579545 MHZ	$1.50
10.00000 MHZ	$5.00
5.248800 MHZ	$5.00

AC Adapters

Good for clocks, nicad chargers, all 110 VAC plug one end

8.5 vdc @ 20 mA	$1.00
16. vac @ 160mA	$2.50
12. vac @ 250mA	$3.00

Audio Prescaler

Make high resolution audio measurments, great for musical instrument tuning, PL tones, etc. Multiplies audio UP in frequency, selectable x10 or x100, gives .01 HZ resolution with 1 sec. gate time! High sensitivity of 25 mv, 1 meg input z and built-in filtering gives great performance. Runs on 9V battery, all CMOS.

PS-2 kit **$29.95**
PS-2 wired **$39.95**

600 MHz PRESCALER

Extend the range of your counter to 600 MHz. Works with all counters. Less than 150 mv sensitivity. specify -10 or -100

Wired, tested, PS-1B **$59.95**
Kit, PS-1B **$44.95**

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain. 1 W in for 8 out, 2 W in for 15 out, 4W in for 30 out. Max output of 35 W, incredible value, complete with all parts, less case and T-R relay.

PA-1, 30 W pwr amp kit **$22.95**
TR-1, RF sensed T-R relay kit 6.95

MRF-238 transistor as used in PA-1 8-10db gain 150 mhz **$11.95**

RF actuated relay senses RF (1W) and closes DPDT relay. For RF sensed T-R relay TR-1 Kit **$6.95**

Power Supply Kit

Complete triple regulated power supply provides variable 6 to 18 volts at 200 ma and +5 at 1 Amp. Excellent load regulation, good filtering and small size. Less transformers, requires 6.3 V @ 1 A and 24 VCT.

Complete kit, PS-3LT **$6.95**

OP-AMP Special

BI-FET LF 13741 - Direct pin for pin 741 compatible, but 500,000 MEG input z, super low 50 pa input current, low power drain.

50 for only $9.00 10 for $2.00

Regulators

78MG	$1.25	7812	$1.00
79MG	$1.25	7815	$1.00
723	$.50	7905	$1.25
309K	$1.15	7912	$1.25
7805	$1.00	7915	$1.25

Shrink Tubing Nubs

Nice precut pces of shrink size: 1" x ¼" shrink to ⅛". Great for splices. 50/$1.00

Mini TO-92 Heat Sinks

Thermalloy Brand 5 for $1.00
To-220 Heat Sinks 3 for $1.00

Opto Isolators - 4N28 type **$.50 ea.**
Opto Reflectors - Photo diode + LED **$1.00 ea.**

Molex Pins

Molex already precut in length of 7. Perfect for 14 pin sockets. 20 strips for $1.00

CDS Photocells

Resistance varies with light, 250 ohms to over 3 meg 3 for $1.00

ULTRAVIOLET INTENSITY METER

new

by BLAK-RAY

TWO MODELS: LONG WAVE AND SHORT WAVE

Meter consists of a sensor cell attached to a compact (3" x 3¼" x 3") metering unit. Can be hand-held or placed directly on surface for measuring. Can be used remotely, while connected to a meter housing by a 4-foot extension cord. Two models available – one for long wave and one for short wave ultraviolet. Readings are in microwatts per square centimeter. Weight: 1 lb.

Completely assembled (includes sensor cell, reduction screen, extension cord, contrast filter and certification report.)

J-221 LONG WAVE (300nm-400nm) **$242.00**

J-225 SHORT WAVE (200nm-280nm) **$260.00**

EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes
- Maintains constant exposure distance of one inch
- Special conductive foam liner eliminates static build-up
- Built-in safety lock to prevent UV exposure
- Compact – only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips

UVS-11E **$69.95**

Jumbo 6-Digit Clock Kit

- Four .630"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾ x 3⅛ x 1¾

JE747 ..... **$29.95**

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

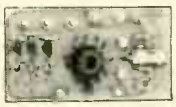
JE701

6-Digit Clock Kit $19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200 ..... **$14.95**



ADAPTER BOARD – Adapts to JE200 – ±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 ..... **$12.95**

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

8080A	CPU	$ 7.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	14.95
8238	System Controller	5.95
8251	Prog. Comm. I/O (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. I/O (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS—MISCELLANEOUS

Z80(780C)	CPU	$13.95
Z80A(780-1)	CPU	15.95
CDP1802	CPU	19.95
2650	MPU	19.95
6502	CPU	11.95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95

SHIFT REGISTERS

MM500H	Dual 25 Bit Dynamic	5.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	2.49

UART'S

A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS

M-Z80	User Manual	$7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

ROM'S

2513(2140)	Character Generator(upper case)	$9.95
2513(3021)	Character Generator(lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

RAM'S

1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	7.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin 250ns	7.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00

PROM'S

1702A	2048	FAMOS	$5.95
2716INTEL	16K*	EPROM	59.95
TMS2516	16K*	EPROM	24.95
(2716)	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

Function Generator Kit

Provides 3 basic waveforms: sine, triangle and square wave. Freq. range from 1 Hz to 100K Hz. Output amplitude from 0 volts to over 6 volts (peak to peak). Uses a 12V supply or a ±6V split supply. Includes chip, P.C. Board, components & instructions.

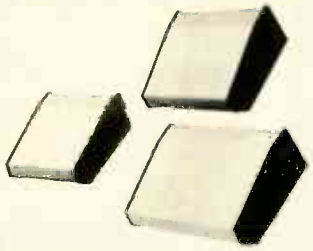
JE2206B **$19.95**

DIGITAL THERMOMETER KIT

- Dual sensors—switching control for indoor/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Slim, walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 .....**$39.95**

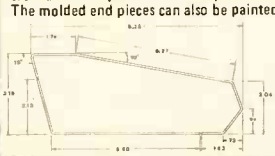
DESIGNERS' SERIES
Blank Desk-Top Electronic Enclosures



- High strength epoxy molded end pieces in mocha brown finish.
- Sliding rear/bottom panel for service and component accessibility.
- Top / bottom panels .080 thk alum. Alodine type 1200 finish (gold tint color) for best paint adhesion after modification.
- Vented top and bottom panels for cooling efficiency.
- Rigid construction provides unlimited applications.

CONSTRUCTION:

The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to ¼" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.



Enclosure Model No.	Panel Width	PRICE
DTE-8	8.00"	$29.95
DTE-11	10.65"	$32.95
DTE-14	14.00"	$34.95

$10.00 Min. Order – U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage – Add 5% plus $1 Insurance (if desired)

Spec Sheets – 25¢
1980 Catalog Available – Send 41¢ stamp

FREE 1980 CATALOG

Jameco ELECTRONICS

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS – WORLDWIDE
1355 SHOREWAY ROAD, BELMONT, CA 94002
PRICES SUBJECT TO CHANGE

9/80

The Incredible "Pennywhistle 103"

$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable)
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space; 2225 Hz for mark
Transmit Channel Frequencies	Switch selectable. Low (normal) = 1070 space, 1270 mark. High = 025 space, 2225 mark.
Receive Sensitivity	–46 dbm accoustically coupled.
Transmit Level	–15 dbm nominal. Adjustable from –6 dbm to –20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
* 8 each UPD416-1 (16K Dynamic Rams) 250NS
* Documentation for conversion

TRS-16K **$59.95**

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 @ 10mA for operation. Features: 60 keys generate the full 128 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.

JE610 (Case not included) **$79.95**

Desk-Top Enclosure for JE610 ASCII Encoded Keyboard Kit

Compact desk-top enclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 14½"W x 8¾"D.

DTE-AK $49.95

SPECIAL: JE610/DTE-AK PURCHASED TOGETHER
(Value $129.90) $124.95

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.

JE600 (Case not included) **$59.95**

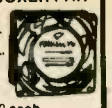
Desk-Top Enclosure for JE600 Hexadecimal Keyboard Kit

Compact desk-top exclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 8¾"W x 8¾"D.

DTE-HK $44.95

SPECIAL: JE600/DTE-HK PURCHASED TOGETHER
(Value $104.90) $99.95

PEE WEE BOXER FAN

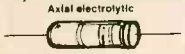


IMC #PWS 2107FL
115 VAC 36 CFM
3 1/8"x3 1/8"x1 ½"
7-Blade Fan

NEW $13.50 each

8,000 mfd. 15VDC

Axial electrolytic

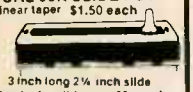


Large Capacity - Small package
3-7/8" long x 1-1/16" diameter

$1.50 each

DUAL 50K SLIDE POT

linear taper $1.50 each



3 inch long 2¼ inch slide knobs for slide pots 20¢ each

50K SLIDE POT 75¢ Each

Knobs for Slide Pots 20¢ each

audio taper

● 3-1/2 inch long ● 2-3/4 inch slide

REED RELAYS

9-15 VOLT D.C.
NORMALLY OPENED
CONTACTS: 1 amp max. switch — 2 amp max. carry
BODY SIZE: approx. 1 inch long ¼ inch high

S.P.S.T. 1500 ohm coil $1.15 each

D.P.S.T. 1200 ohm coil $1.30 each

3.P.S.T. 750 ohm coil $1.50 each

ALCO HEAVY DUTY MINIATURE SIZE TOGGLE

- Rated: 10 amps @ 120 vac
- Contacts: solid silver S.P.D.T.
- Body Size: 9/16" dia. cylindrical body ¾" high

$1.50 each specify handle style

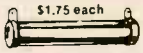
HOUSE MARKED DARLINGTON TRANSISTOR

SPECIFY NPN OR PNP
5 AMPS 65 WATTS
80 VOLTS
SIMILAR TO TIP 121NPN TIP 126 PNP TO220 CASE

75¢ each

1 OHM 175 WATT WIREWOUND RESISTOR

$1.75 each



8 ¾" long. 1-1/8" dia.

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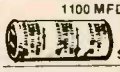
PHOTO — FLASH CAPACITOR

1100 MFD 330 VOLTS



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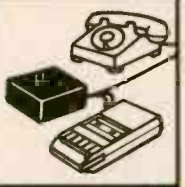
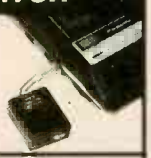
ONLY $125.00*

PHONE RECORDING ADAPTER



Record incoming and outgoing calls automatically with this all solid state unit connected to your telephone jack and tape recorder. Starts recording when phone is lifted. Stops when you hang up, making a permanent record. Easily installed. No monthly charges.
FCC APPROVED $24.50*

VOX VOICE ACTIVATED CONTROL SWITCH



Solid state. Self contained. Excellent adjustable sensitivity. Voices or other sounds activate and control recorder. Uses recorder mike or remote mike.
2¼ x 1¾ x ¾" $24.95*

Phone call Adapter $24.50*, VOX $24.95*, (* plus $1.00 ea. shipping & handling), 10 hr. Recorder $125.00* (* plus $4.00 shipping & handling). California residents add tax. Mail Order, VISA, M/C, cod's okay, quantity discounts available. Money back guar. Free data.

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4020-S	14 stage counter	4/$2
4023-S	Triple 3 input NAND	12/$2
4044-S	Quad R-S latch	4/$2
4046-S	Phase locked loop	2/$2
4071-S	Quad 2 input OR	12/$2
4093-S	Quad 2 in NAND Schmitt trig	4/$2
4507-S	Quad EX-OR	4/$2
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5101-S	1024 bit stat. RAM 4x256	10/$12.50

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(package type. M = TO99 N = minidip D = dip TK = TO66)

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723D-S	Voltage regulator	6/$2
741M-S	Compensated op amp	15/$2
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7918-S	-18V regulator	2/$2
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- NPN transistor similar 2N3904 100/$7.95
- PNP transistor similar 2N3906 100/$8.95
- 4N28-S opto-coupler 6 pin minidip, MCT-2/IL-1 pinout 5/$2
- SN76477-S complex sound generator 1/$2.50
- MA1003 12V DC clock module w/ case $19.95
- Opto-isolator Grab Bag - 50 mixed opto-isolators from a major manufacturer. Unmarked 6 and 8 lead minidips include single and dual types with diode, transistor, and darlington outputs. Test them yourself and save! Not recommended for beginners. 50/$4

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☐	3-SOUND TRIGGERS, sound activated amp, SCR triggered, on 3" board, (#3625)	2.99
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- ASCII Compatible Original Factory Keyboards
- Includes; 53-Key Alphanumeric, PLUS 20-Key Hexadecimal Arrays!

Complete 73-Key PET keyboards include all Alphabetical, Numeric, Graphics, Game, and Command legends commensurate with the PET 8K microcomputer. 64 ASCII characters are available without shift and all 64 graphic & reverse field characters are accessible from keyboard (with shift). Keys are color-coded for quick reference, and are precision mounted in a compact 9½" x 3-7/8" high impact plastic frame. Terminates in standard 18-contact single-sided edge connection. Removed from equipment. 100% functional.

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Wt 5 lbs.

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Boards have Phase Lock Loop IC. Heat-sinked 9W Amp Chip. RF and Modulation transistors Size 6" x 6" x 2"(H) Wt. 9 oz.

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"SELECTRIC" TYPEWRITER TERMINAL

Just imagine; an IBM Model 725 "SELECTRIC" typewriter built into a complete table-top RS-232 terminal! These **surplus** terminals were formerly on lease and appear to be in good condition (we test 'em to make sure the *printer is functional*!) These fantastic **BCD-Coded** terminals feature:

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While we will check out each unit, we MUST offer these unique bargains *"AS-IS"*: Meaning they may need some service but are basically operational. Add $20.00 for packing crate, you pay shipping on delivery.

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IMMEDIATE DELIVERY OF QUALITY RESISTORS

CARBON FILM RESISTORS 1/4 & 1/2 watt

CARBON FILM 5%
1/4watt (R.Ohm RZ5) .095"dia X .250"long (body)
1/2watt (R.Ohm R50) .146"dia X .354"long (body)

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

VALUES STOCKED (ohms)

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

Rohm QUALITY RELIABILITY

METAL FILM RESISTORS 1/4 & 1/8 watt

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

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

VALUES STOCKED (ohms)
Standard decade values from 10ohm to 475Kohm

10.0	12.1	14.7	17.8	22.6	27.4	33.2	40.2	48.7	59.0	71.5	88.7
10.2	12.4	15.0	18.2	23.2	28.0	34.0	41.2	49.9	60.4	73.2	90.9
10.5	12.7	15.4	18.7	23.7	28.7	34.8	42.2	51.1	61.9	75.0	93.1
10.7	13.0	15.8	19.1	24.3	29.4	35.7	43.2	52.3	63.4	76.8	95.3
11.0	13.3	16.2	19.6	24.9	30.1	36.5	44.2	53.6	64.9	80.6	97.6
11.3	13.7	16.5	20.0	25.5	30.9	37.4	45.3	54.9	66.5	82.5	
11.5	14.0	16.9	20.5	26.1	31.6	38.3	46.4	56.2	68.1	84.5	
11.8	14.3	17.4	22.1	26.7	32.4	39.2	47.5	57.6	69.8	86.6	

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

Rohm QUALITY RELIABILITY

METAL FILM 1%
RN55 (R.Ohm CRB14FY) 1/8watt
Low temp coef - 50ppm/°C
.094"dia X .225"long (body)
color banded

total quantity	ea	pk-10	pk-50	pk-100	pk-500
1-999	$.25	1.00	4.00	7.50	35.00
1000-	.20	.90	3.60	7.00	32.50
5000-	.20	.85	3.40	6.50	30.00
10000-	.20	.80	3.10	6.00	27.50

VALUES STOCKED (ohms)

10.0	27.4	75.0	348	1.74K	5.11K	11.0K	20.5K	31.6K	54.9K	140K	324K
10.2	28.7	78.7	402	1.87K	5.36K	11.3K	21.0K	32.4K	57.6K	147K	332K
11.0	30.1	84.5	475	1.96K	5.49K	11.5K	21.5K	33.2K	60.4K	150K	348K
11.5	31.6	90.9	487	2.05K	5.76K	12.1K	22.1K	34.8K	64.9K	158K	374K
12.1	33.2	100	499	2.21K	6.04K	12.4K	22.6K	36.5K	68.1K	165K	402K
13.0	35.7	107	604	2.43K	6.49K	12.7K	23.2K	37.4K	69.8K	174K	432K
14.0	37.4	121	649	2.49K	6.81K	13.0K	23.7K	39.2K	75.0K	182K	453K
14.7	40.2	127	715	2.74K	7.15K	13.3K	24.3K	40.2K	76.8K	191K	464K
15.0	43.2	137	750	2.87K	7.50K	14.0K	24.9K	41.2K	82.5K	200K	475K
16.2	45.3	150	909	3.01K	8.25K	14.7K	25.5K	43.2K	90.9K	205K	1M
17.4	47.5	165	1.00K	3.16K	8.66K	15.0K	26.1K	45.3K	95.3K	210K	
18.2	49.1	191	1.02K	3.32K	9.09K	15.4K	26.7K	46.4K	100K	221K	
19.1	54.9	200	1.10K	3.57K	9.53K	16.2K	27.4K	47.5K	105K	232K	
20.0	57.6	210	1.21K	4.22K	9.76K	16.9K	28.0K	48.7K	110K	249K	
22.1	60.4	232	1.27K	4.53K	10.0K	17.4K	28.7K	49.9K	115K	255K	
23.2	64.9	249	1.30K	4.75K	10.2K	18.2K	29.4K	51.1K	121K	287K	
24.9	71.5	301	1.43K	4.87K	10.5K	19.1K	30.1K	52.3K	130K	294K	
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4010	.45	4035	.97	4511	.95	74C95	1.40
4011	.35	4040	1.00	4514	1.95	74C86	.50
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4020	1.10	4053	1.10	74C10	.27	74C174	1.20
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400	.09	.25	.65	1.50	6.50	9.60
600	.11	.30	.80	2.00	8.50	12.50
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7407	.35	7480	.45	74166	1.05
7408	.27	7483	.60	74167	1.35
7409	.24	7485	.75	74170	1.60
7410	.17	7486	.42	74173	1.30
7411	.22	7489	1.60	74174	.85
7412	.22	7490	.50	74175	.75
7413	.42	7491	.56	74176	.75
7414	.90	7492	.50	74177	.75
7416	.33	7493	.50	74180	.75
7417	.37	7494	.60	74181	1.90
7420	.17	7495	.60	74190	1.20
7425	.35	7496	.60	74191	1.20
7426	.33	74107	.35	74192	.79
7427	.35	74121	.35	74193	.79
7430	.17	74122	.39	74194	.85
7432	.27	74123	.42	74195	.65
7437	.27	74125	.45	74196	.85
7438	.27	74126	.45	74197	.87
7440	.17	74145	.75	74325	2.25
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74LS08	.35	74LS162	1.10		
74LS08	.35	74LS163	1.20		
74LS09	.35	74LS164	1.20		
74LS10	.30	74LS168	1.25		
74LS11	.45	74LS169	1.25		
74LS12	.35	74LS170	1.70		
74LS13	.95	74LS173	1.30		
74LS14	1.20	74LS174	1.00		
74LS15	.36	74LS175	1.00		
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74LS21	.55	74LS190	1.25		
74LS22	.35	74LS191	1.25		
74LS26	.35	74LS192	1.00		
74LS27	.45	74LS193	1.10		
74LS28	.45	74LS194	1.05		
74LS30	.35	74LS195	1.10		
74LS32	.40	74LS196	1.20		
74LS37	.45	74LS197	1.10		
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74LS54	.35	74LS251	1.29		
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74LS75	.69	74LS258	1.50		
74LS76	.45	74LS259	1.50		
74LS86	.45	74LS266	.70		
74LS90	.90	74LS279	.70		
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74LS93	.90	74LS293	.80		
74LS107	.45	74LS295	1.50		
74LS109	.45	74LS298	1.50		
74LS112	.45	74LS365	.80		
74LS113	.45	74LS368	.80		
74LS114	.55	74LS367	.80		
74LS125	.90	74LS368	.80		
74LS126	.90	74LS375	.86		
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SN7447N	.59	SN74177N	.85
SN7448N	.79	SN74179N	1.80
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SN7476N	.36	SN74194N	.85
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SN7480N	.59	SN74196N	.85
SN7481N	1.10	SN74197N	.85
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CD4034	3.25	74C04	.39
CD4035	1.19	74C08	.49
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CD4041	1.25	74C20	.39
CD4042	.99	74C30	.39
CD4043	.99	74C32	.99
CD4044	.99	74C42	1.85
CD4046	2.25	74C48	2.39
CD4047	1.25	74C73	.99
CD4048	.69	74C74	.99
CD4049	.69	74C85	2.49
CD4050	.69	74C89	4.95
CD4051	1.10	74C90	1.85
CD4052	1.10	74C93	1.85
CD4053	1.10	74C95	1.85
CD4055	1.95	74C107	1.19
CD4056	2.95	74C151	2.49
CD4059	9.95	74C154	3.50
CD4060	1.39	74C157	2.10
CD4066	.89	74C160	2.39
CD4069	.35	74C161	2.30
CD4070	.69	74C163	2.39
CD4071	.35	74C164	2.39
CD4072	.35	74C173	2.59
CD4073	.35	74C174	2.75
CD4075	.35	74C175	2.75
CD4076	1.29	74C192	2.39
CD4077	.35	74C193	2.39
CD4078	.35	74C195	2.39
CD4081	.35	74C922	7.95
CD4082	.35	74C923	8.95
CD4085	1.95	MM80C95	1.50
CD4089	2.95	MM80C97	1.25

74LS00

74LS00N	.35	74LS164N	1.19
74LS01N	.28	74LS165N	.89
74LS02N	.28	74LS166N	2.48
74LS03N	.28	74LS168N	1.89
74LS04N	.39	74LS169N	1.89
74LS05N	.28	74LS170N	1.99
74LS08N	.39	74LS173N	.89
74LS09N	.39	74LS174N	.99
74LS10N	.28	74LS175N	.99
74LS11N	.39	74LS181N	2.20
74LS12N	.39	74LS190N	1.15
74LS13N	.47	74LS191N	1.15
74LS14N	1.25	74LS192N	.98
74LS15N	.39	74LS193N	.98
74LS20N	.26	74LS194N	1.15
74LS21N	.38	74LS195N	.95
74LS22N	.38	74LS196N	.89
74LS26N	.39	74LS197N	.89
74LS27N	.39	74LS221N	1.49
74LS28N	.39	74LS240N	2.99
74LS30N	.26	74LS241N	2.49
74LS32N	.39	74LS242N	2.29
74LS37N	.79	74LS243N	2.29
74LS38N	.39	74LS244N	2.95
74LS40N	.26	74LS245N	8.95
74LS42N	.79	74LS247N	1.10
74LS47N	.79	74LS248N	1.10
74LS48N	.79	74LS249N	1.69
74LS51N	.26	74LS251N	1.79
74LS54N	.35	74LS253N	.98
74LS55N	.35	74LS257N	.98
74LS73N	.45	74LS258N	.98
74LS74N	.59	74LS259N	2.95
74LS75N	.68	74LS260N	.69
74LS76N	.45	74LS261N	2.49
74LS78N	.65	74LS266N	.59
74LS83AN	.99	74LS273N	1.75
74LS85N	1.19	74LS275N	4.40
74LS86N	.45	74LS279N	.59
74LS90N	.75	74LS283N	1.10
74LS92N	.75	74LS290N	1.29
74LS93N	.75	74LS293N	1.95
74LS95N	.68	74LS295N	1.10
74LS96N	.98	74LS298N	1.29
74LS107N	.45	74LS324N	1.75
74LS109N	.45	74LS347N	1.95
74LS112N	.49	74LS348N	1.95
74LS113N	.49	74LS352N	1.65
74LS114N	.55	74LS353N	1.65
74LS122N	.55	74LS363N	1.49
74LS123N	1.19	74LS365N	.99
74LS124N	1.35	74LS366N	.99
74LS125N	.89	74LS367N	.99
74LS126N	.89	74LS368N	.99
74LS132N	.79	74LS373N	2.75
74LS136N	.59	74LS374N	2.75
74LS138N	.89	74LS375N	.69
74LS139N	.89	74LS377N	1.95
74LS145N	1.25	74LS385N	1.95
74LS148N	1.49	74LS386N	.65
74LS151N	.79	74LS390N	1.95
74LS153N	.79	74LS393N	1.95
74LS154N	2.49	74LS395N	1.70
74LS155N	1.19	74LS399N	2.95
74LS156N	.99	74LS424N	2.95
74LS157N	.99	74LS668N	1.75
74LS158N	.75	74LS670N	2.29
74LS160N	.98	81LS95N	1.99
74LS161N	1.15	81LS96N	1.99
74LS162N	.98	81LS97N	1.99
74LS163N	.98	81LS98N	1.99

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78M06	1.49	LM1458CN/N	.49
78M G.	1.49	MC1488N	1.49
LM105H	.99	MC1489N	1.49
LM108AH	2.95	LM1496N	.89
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LM304H	.98	LM1820N	.95
LM305H	.89	LM1850N	.95
LM306H	3.25	LM1889N	3.95
LM307CN/H	.29	LM2111N	1.75
LM308CN/H	.98	LM2900N	.99
LM309K	1.49	LM2901N	2.50
LM310CN	1.25	LM2917N	2.95
LM311D/CN/H	.98	CA3013T	2.29
LM312H	1.75	CA3018T	1.99
LM317T	2.75	CA3021T	3.49
LM318CN/H	1.49	CA3023T	2.89
LM319N/H	1.25	CA3035T	2.75
LM320K-XX*	1.49	CA3039T	1.49
LM320T-XX*	1.25	CA3046T	1.29
LM320H-XX*	1.25	LM3053N	1.49
LM323K	4.95	CA3059N	3.25
LM324N	1.25	CA3060N	3.25
LM339N	.95	CA3062N	4.95
LM340K-XX*	1.49	LM3065N	1.49
LM340T-XX*	1.25	CA3080N	1.29
LM340H-XX*	1.25	CA3081N	1.69
LM344H	1.95	CA3082N	1.89
LM348N	1.85	CA3083N	1.99
LM358CN	.98	CA3086N	1.29
LM360N	1.49	CA3089N	2.75
LM372N	1.95	CA3096N	2.49
LM376N	3.75	CA3097N	1.99
LM377N	3.75	CA3130T	2.49
LM380CN/N	1.25	CA3140T	2.49
LM381N	1.79	CA3146N	2.49
LM383T	1.95	CA3160T	1.49
LM386N	1.49	CA3190N	1.95
LM387N	1.49	CA3401N	.89
LM390N	1.95	MC3423N	1.49
NE531V/T	3.75	MC3460N	3.95
NE555V	.39	SG3524N	3.95
NE556N	.98	CA3600N	3.50
NE561T	19.95	LM3900N	.59
NE562B	7.95	LM3905N	1.49
NE565N/H	1.25	LM3909N	.98
NE566H/V	1.75	RC4131N	2.95
NE567V/H	1.50	RC4136N	1.10
NE592N	2.75	RC4151N	4.50
LM702H	2.99	RC4194	4.95
LM709N/H	.29	RC4195	4.40
LM710N/H	.98	ULN2001	1.25
LM711N/H	.39	ULN2003	1.50
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LM723N/H	.75	SN75451N	.49
LM733N/H	.98	SN75452N	.49
LM739N	1.15	SN75453N	.49
LM741CN/H	.33	SN75454N	.49
LM741CN-14	.19	SN75491N	.89
LM747N/H	.79	SN75492N	.89
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Model LP-1 Digital Logic Probe	50.00
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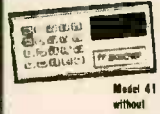

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Bare Board w/all parts less mem. 99.95

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  - Low Power
  - 2 MHz or 4 MHz
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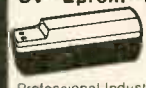

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Professional Industrial Model

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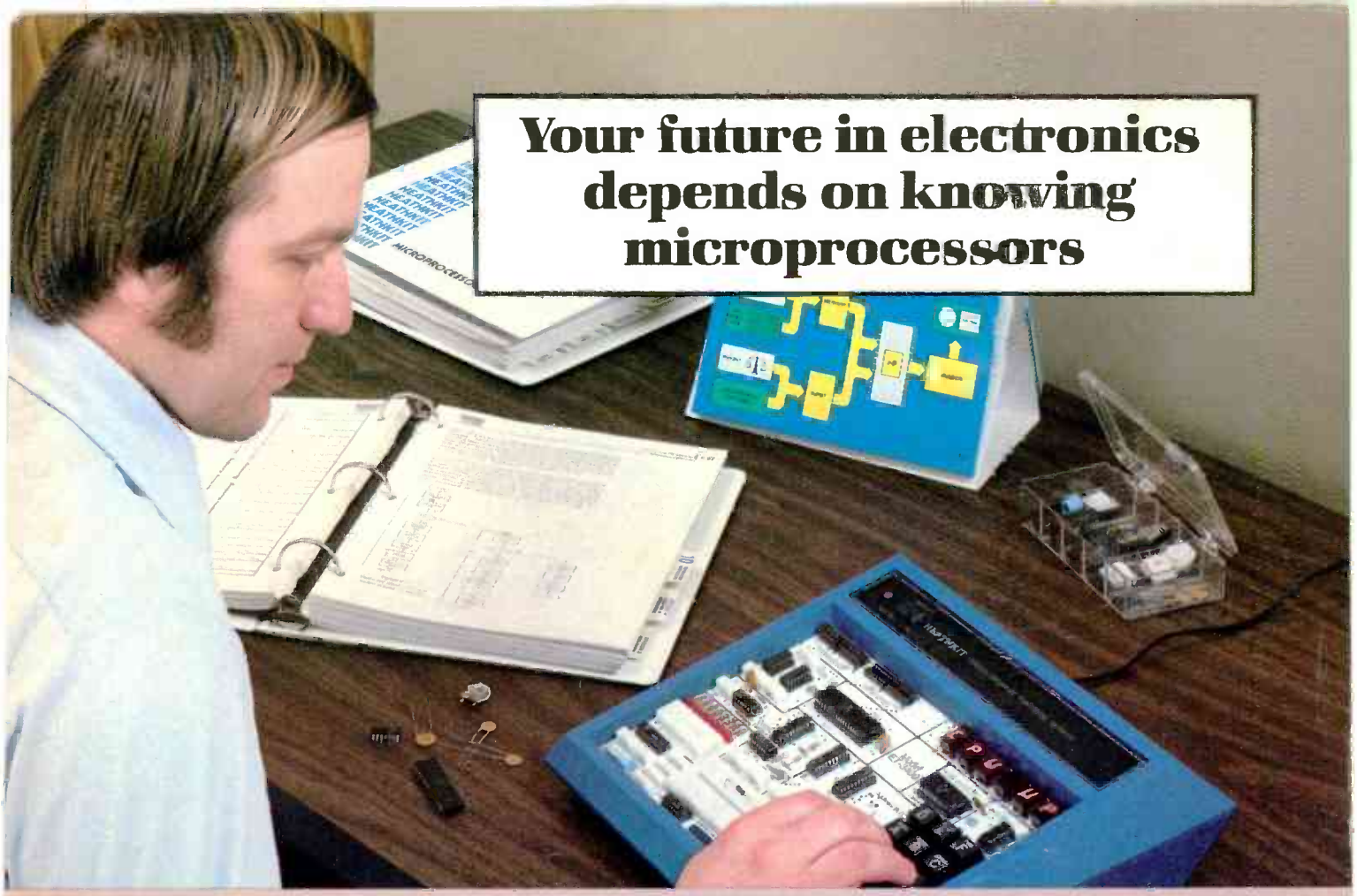

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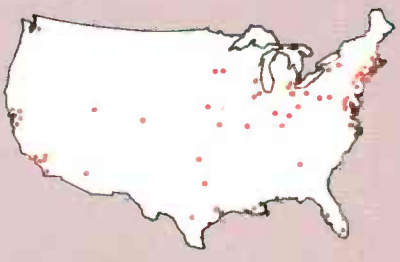

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Unconditionally guaranteed for 12 months. Guaranteed against cracking, chipping, or rusting. Guaranteed against mechanical failure. Guaranteed against electrical failure. No exclusions. No gimmicks. For a full 12 months.

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