Radio-Electronics®

HOW IT WORKS: LASER VIDEODISC

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Self-diagnostic car electronics
How to build your own robot
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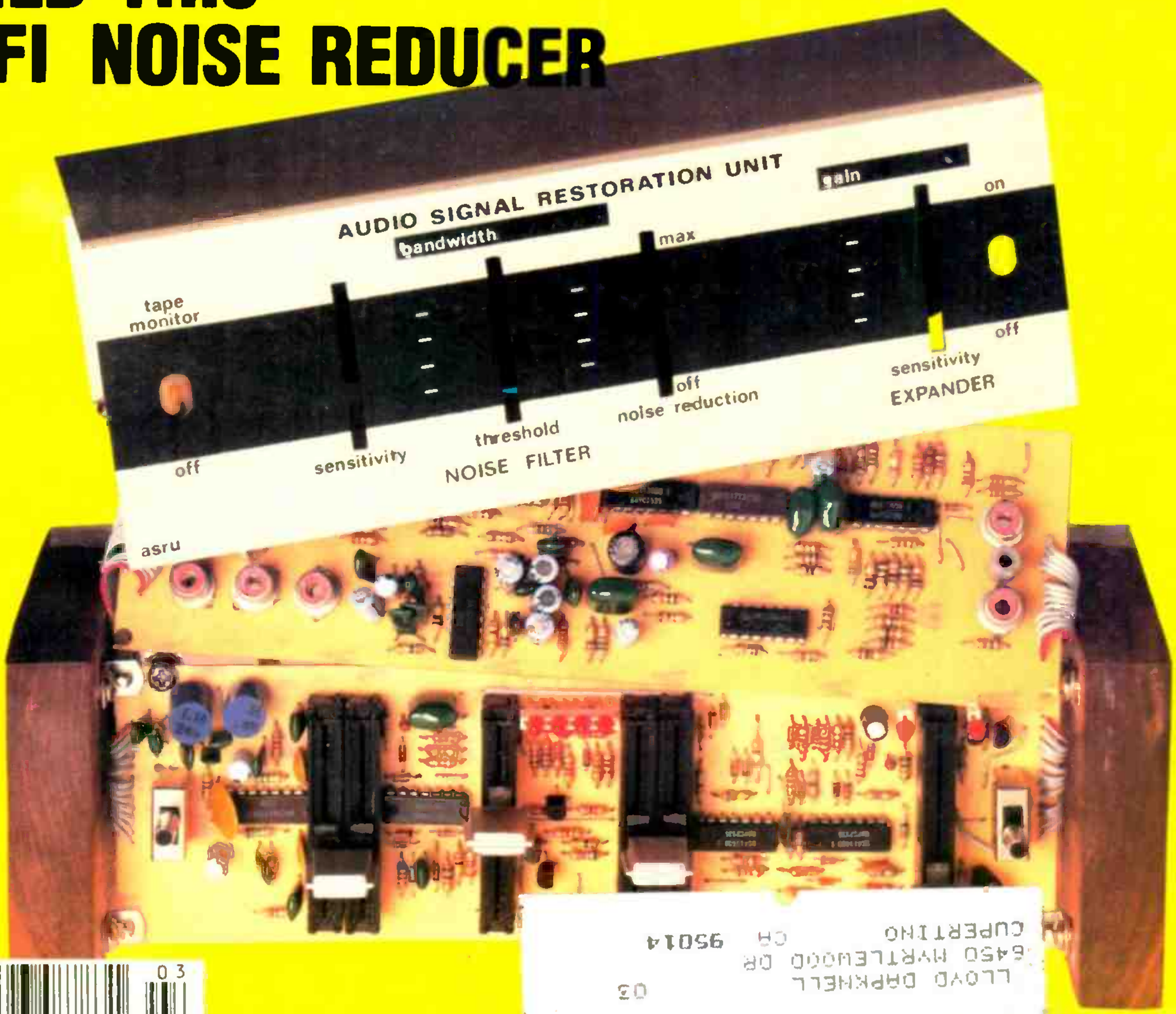

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THE NEW

performer.

. . . UNBEATABLE PRICE / PERFORMANCE RATIO

The Model 7000 Universal Counter / Timer

ONLY $300

MADE IN USA

Built for your budget, the Model 7000 is a micro-processor controlled reciprocal universal counter. It is capable of measuring both input signal frequency and period over the full 5Hz to 80 MHz range in one second with six digit resolution. The autoranging unit has both frequency and multiple period averaging measurement capability. Its microprocessor executes the optimum measurement and displays the desired format, frequency or period.

1. High resolution, μP controlled reciprocal counting design provides both input signal frequency and period measurements.
2. 80 MHz frequency measurement plus event counting to 1 billion and elasped time measurement from 100 μS to 100 hours.
3. Single function knob for easier operation and built in self testing confidence test circuit.

Its ease of operation, versatility and accuracy make the Model 7000 an ideal instrument for the hobbyist, technician or engineer. The Model 7000 can also be ordered with a temperature-compensated oscillator for applications where higher accuracy is needed.

See your Triplett distributor, Mod Center or representative for a free no-obligation demonstration. Triplett Corp., Bluffton, Ohio 45817. (419) 358-5015, TWX (810) 490-2400.

THE MARK OF QUALITY OVER 75 YEARS

Triplett performance... a tough act to follow

TRIPLETT

CIRCLE 60 ON FREE INFORMATION CARD

CIRCLE 61 FOR IN-PLANT DEMONSTRATION

Bone Fone Clone

If you thought the Bone Fone was great, wait until you hear what's new. Here's the latest on the Bone Fone spin-offs.

It started with the Bone Fone. And this very unusual stereo system has created a whole new series of products.

The Bone Fone is an AM/FM stereo radio that drapes around your neck like a scarf. Two speakers, placed near your ears, not only provide excellent stereo separation, but vibrate slightly through your bones to give you the same sensation as standing in front of your home stereo system.

UNEXPECTED APPLICATIONS

Shortly after it was introduced, the Bone Fone became a very popular product for a variety of reasons. A lady in Helena, Montana who bought the unit for her son told us, "It's made a significant contribution to my sanity. No more rock n' roll blasting through the house, the sound goes where my son goes."

A jogger in Rowlett, Texas wrote us "Amazing separation, fantastic stereo response, helps my jogging tremendously. I wasn't really expecting this type of quality through a magazine ad at this price."

But one of the most unexpected letters came from a man in Belle Center, Ohio. "You don't have to be young and jog to enjoy Bone Fone. You see, I'm 73 years old. I just sit and listen."

LETTERS EVERYWHERE

Letters have come from mailmen, roller skaters, skiers, cyclists, motrocycle enthusiasts, hikers and even people who listen to the Bone Fone stereo while walking their dog. The Bone Fone appeals to practically every American.

The Bone Fone was designed by an engineer who wanted to listen to good stereo music without carrying heavy box radios or bulky headphones. Headphones block out all other sounds—even warnings which could be dangerous outdoors, and box radios are heavy and disturb those around you. So he invented the Bone Fone—"the stereo sound you wear around."

Weighing only 17 ounces and powered by 4AA cell batteries the Bone Fone stereo provides a sound that would be impossible to describe in an advertisement. The cliche, "you've got to hear it to believe it," certainly applies here. And for **$69.95** it's the lowest priced stereo entertainment product available.

But what about the sport enthusiast who can care less about stereo music? Or the person who wants just the news? Or simply the person that just listens to AM radio and doesn't want to spend $69.95?

The Bone Fone drapes around your neck like a scarf and has a sound that you find incredible when you first hear it.

Enter NUTS! NUTS is the AM version of the Bone Fone for sports nuts, news nuts, jogging nuts or anybody who wants a low cost Bone Fone without FM or stereo. NUTS sells for **$39.95** complete with two speakers and a strap that firmly attaches the unit to you for any physical activity.

Sitting at a football game, walking your dog, jogging—NUTS gives you a convenient way to listen to music, news and sports without paying a premium for stereo.

But the Bone Fone spinoffs don't end there. There's the Neck Fone—a device you place over your shoulders and plugs into your home stereo system. This lets you enjoy your home stereo without disturbing those around you and without the bulk of headphones. The Neck Fone sells for **$34.95**.

So there you have it. Three exciting products—Bone Fone, NUTS, and the Neck Fone—three unusual solutions designed to solve any gift-giving problem.

LOWEST-PRICED STEREO

Compare the Bone Fone price with any box radio, stereo system or even the new $200 Sony Walkman. The Bone Fone is the lowest-priced quality personal stereo system you can buy. It is also safer than headphones as it leaves you free to hear the sounds around you and keeps you in touch with the environment.

To order any of the above products, simply send your check or money order for the amount listed above plus $2.50 for postage and handling (Ill. residents add 6% sales tax) to the address below, or credit card buyers may call our toll-free number below. Each unit is backed by a 90-day limited warranty and a service-by-mail facility as close as your mailbox. Service should rarely be required as the units use solid-state components and are designed to take rugged treatment. JS&A is America's largest single source of space-age products—further assurance that your modest investment is well protected.

The Bone Fone started a small revolution. Be part of that revolution with the space-age way to listen to music, news and sports. Order a Bone Fone product at no obligation, today.

JS&A

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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

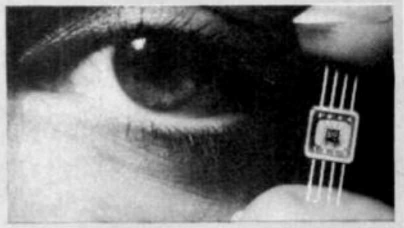
Electronics publishers since 1908

MARCH 1981 Vol. 52 No. 3

ON THE COVER

The ASRU (*Audio Signal Restoration Unit*) is a combination noise-reduction and signal-expander device that offers features not even found on some commercial units. Build one yourself and hear things from your records and tapes that you never heard before. The first part of this project begins on page 41.

FIND OUT HOW laser videodisc players handle the complex signals inscribed on those shiny platters. The story starts on page 67.



UNMARKED IC's can be a bargain. Learn how to find out what's inside those plain black packages on page 55.

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looking ahead

TYPEWRITER WILL TRAVEL

Combining high-density magnetic recording, miniaturization and consumer-electronics design principles, Sony has introduced what could be the forerunner of a major and basic new kind of product—a noiseless, completely portable electronic typewriter. Sony's *Typecorder* actually is far more than a typewriter. In a slim 8½ × 11 × 1½ inches, weighing only three pounds, it combines a word-processing terminal, a dictating machine and a stenotype system. A built-in microcassette can store up to 120 pages of typed material and make sound recordings. There is a 40-character (half-line) LCD readout on the machine.

A portable printer makes the *Typecorder* a complete out-of-office typing system, or with various peripherals, it can be integrated into word-processing systems. An interface lets it operate any IBM Selectric typewriter, either directly or via phone line. Another accessory will punch out a Telex tape from its cassette, or it can be interfaced as a remote terminal to any word-processing system via a modem. The *Typecorder* will be available around midyear at $1400. The portable printer accessory will be about $600. *Typecorder's* debut marks Sony's entry into the office-equipment word-processing business. A new Sony line of word-processors is geared to a new 3½-inch floppy-disk drive, with a recording density 1.47 times that of a 5.25-inch floppy disk. Sony's Series-35 word-processing equipment also employs microcassettes and is compatible with the *Typecorder*.

HI-VI?

Is video the next wave in hi-fi? Apparently many audio manufacturers think so. Advent was the first audio manufacturer to go into video, through its VideoBeam projection system. Pioneer is now making and selling the LaserDisc optical videodisc system and will add a vido projector. Who's next? Well, Fisher will have a deluxe console containing audio equipment, an optical disc player and Beta VCR, scheduled for next fall. And Sansui plans to bring out a VHD videodisc player later this year, followed by a VCR. Superscope is expected to go into video under the Marantz brand, possibly bringing out both a projection TV set and a videodisc player. Advent will add an optical videodisc player, and both Kenwood and Aiwa are studying possible entry into the video market in the U.S.

RCA'S DISC LAUNCH

This is the month that RCA's CED *SelectaVision* videodisc player makes its debut—scheduled to go on sale the week of March 22 in 5,000 stores coast-to-coast, backed by a record advertising campaign on television, in newspapers and magazines. RCA already has trained technicians in 1,000 company-owned and independent service shops. The number of players on hand for the start of sale will be at least 20,000 and possibly as high as 30,000. The player will carry a suggested list price of $499.95, and the initial disc catalog will contain 100 titles, selling at $14.98 to $27.98, but most of the discs will sell for under $20 with the highest-priced selections containing more than one two-hour disc. Movies will be the mainstay of RCA's first offerings, although there will also be classic TV shows, sports, and music, as well as children's and educational selections. RCA says it will offer 25 new titles in May; 25 in September, and 10 monthly thereafter. RCA's disc-ad campaign will stress programming, simplicity of operation, and low cost.

PROJECTION'S CLEAN SWEEP

Projection TV, too, is sweeping the American television industry, seven years after Advent popularized the first home color-projection system. Major holdout RCA has introduced a single-piece three-tube unit, to be followed soon by Zenith, Magnavox, Sylvania and Curtis Mathes, with giant-screen sets now fielded by virtually all American TV brands and most Japanese ones. Sears Roebuck added its own projector late last year. Three-tube projection sets are also being offered by GE, Sony, Quasar, Panasonic, Toshiba, MGA and Kloss Video, with Hitachi, Sanyo and Toshiba expected to come along soon. Sales of specially built TV projectors (as opposed to modifications of small-screen sets) totaled about 28,000 in 1979, rising to nearly 50,000 in 1980 and are expected to reach 75,000 this year.

SPEED VIEWING

With all of the new video information sources available to us, will we soon be required to watch and listen at a faster pace to take it all in? VSC Corporation thinks we will, and it is forecasting that the next generation of home VCR's will incorporate its new variable speech-control IC which permits speeded-up audio without a change in pitch. Although most VCR brands now offer special-effects models that permit high-speed viewing, all except JVC disable the audio. One JVC model contains the VSC IC and allows watching and listening to programs at less time than it took to record them. Just think of all the extra viewing you can do if you can watch *60 Minutes* in 30.

DAVE LACHENBRUCH
CONTRIBUTING EDITOR

Magnavision® is Gourmet Video.

Video for people who know and love video.

Simulated TV picture.

If you seek the ultimate in your electronic gear, Magnavox has a bright idea for you called Magnavision. It is Gourmet Video for the video gourmet.

A picture that's clearer than tape and less costly, too.

Magnavision is an advanced LaserVision™ videodisc player. Its optical laser scanner, a videodisc and your TV set team up to give you a picture that's amazingly sharp and clear.

Even better, the Magnavision picture remains this good even after thousands of viewings. That's because there is no direct contact between our laser and the disc. Unlike your phonograph, Magnavision doesn't use a needle.

The hearing's as good as the seeing.

Magnavision is designed to be played through your home stereo system so you hear what you see in full high-fidelity stereophonic sound. And since there is no disc wear, the Magnavision sound stays crystal clear, playing after playing.

Studio-like controllability puts you in command of the action.

Now the real fun begins. You not only watch and hear Magnavision. You play with it, too. Reverse, Slow Motion, Still, Fast Forward, Search, Numerical Index, Stereo Sound. Only LaserVision systems like Magnavision let you watch and play so many different ways.

Watch what you want whenever you want.

With Magnavision, you have a complete library of MCA DiscoVision® programming to choose from. Blockbuster movies like *The Electric Horseman*. Classic films like *The Bride of Frankenstein*. Cooking lessons by Julia Child. Documentaries from Jacques Cousteau. How-to-do-it tennis, golf, swimming and crafts. Music, concerts, cartoons, the arts and NFL football.

Discover Gourmet Video today. Call toll-free 800-447-4700 for the Magnavision dealer nearest you. In Illinois, call 800-322-4400.

CIRCLE 48 ON FREE INFORMATION CARD

MAGNAVOX

The brightest ideas in the world are here to play.

what's news

Encyclopedia on one disc?

Drs. Alan E. Bell and Robert A. Bartolini of RCA Labs, Princeton, NJ, have received U.S. patent for a recording method that makes it possible to put 100 *billion* bits of information on the two sides of a single disc. That is 10 to 100 times the capacity of any magnetic-storage disc used today.

The information is recorded with an intense beam from a novel semiconductor laser, which burns a series of microscopic holes in a thin tellurium layer deposited in the coating structure of the plastic disc. The information is read out by a less intense beam from the same laser. It shines through the microscopic holes and is reflected by a layer of aluminum located below the tellurium.

The high-density system has many potential applications. A multi-volume encyclopedia could be stored on the two sides of a single disc. It may also be possible to replace conventional X-ray film, which requires expensive silver. Other possible applications are in word processing, still and motion pictures, and in storing bulky business and government records.

THE HIGH DENSITY DISC is held by Dr. Bell. Dr. Bartolini is at left.

Video viewers are passive

The average video viewer of prospective video viewer shows little interest in programs that call for viewer participation, such as do-it-yourself programs. Those interest only 15.9 percent of the potential audience, while new movies would attract 66.5 percent, or two-thirds, according to a recent survey by Venture Development of Wellesley, MA.

Movie classics are next highly regarded, with a 50.2 percent rating, and PBS series and specials follow with 31.6 percent.

Between 20 and 30 percent of the prospective audience would be interested in pop, rock, and jazz concerts, educational courses, plays and dramatic specials, sports events, and old television series. Comedy specials, classical music concerts, and news and documentaries all rank between 14 and 20 percent, while musical-variety specials would interest only 14 percent. At the bottom of the list are children's programs, sports lessons, and foreign-language movies, all with ratings lower than 10 percent.

Power savings for UHF TV

A committee of nineteen Public Television engineers have reported that the efficiency of UHF stations using klystron transmitting tubes can be increased to make a power saving of nearly 50 percent with no decrease in output, or with a considerable increase in output if input power is maintained. The statement was backed up with a 67-page report describing experiments at several television stations and with a transmitter manufacturer.

One of the techniques is to cut the beam perveance, reducing beam current while raising the voltage to maintain the same output power. Another is to pulse the modulation anode—the element in a klystron that corresponds most closely to the grid in a triode tube—during the TV sync periods. That increases efficiency notably. In effect, the power of the tube is increased during the sync pulses.

Greater efficiency was also achieved by using a system of tuning, or "alignment" developed by the BBC, and now used by most European stations. A significant amount of power was also saved by cutting the ratio of audio to video power from the conventional 20 to 10 percent and installing a special audio coupler that would increase efficiency.

Because UHF stations require several times as much power as VHF stations, savings on power can mean a significantly greater net income to many UHF TV stations, most of which use klystrons.

Allocated territories for Tronics 2000

Tronics 2000—a new nationwide franchising organization designed to give the independent service shop owner the prestige that small business proprietors in other fields have achieved through national franchise organizations—has sold its first three territories, during its first three weeks of operation.

Robert P. Neal, of Able Electronics, Waukegan, IL, has purchased a master fran-

continued on page 12

Facts from Fluke on low-cost DMM's

Direct readings in decibels: Keeping track of your gains and losses.

If you'd rather forget about the last time you got wrapped up in an audio jungle, you'll want to respond to this ad.

Meet our new 4½-digit Model 8050A Multimeter – the first low-cost DMM with self-calculating dB features that let you keep your mind on your mission instead of on conversions and formulas.

While most analog meters read dBm referenced only to 600 ohms, the Fluke 8050A delivers direct readouts in decibels over a 108 dB range referenced to any one of 16 impedances (8 to 1200 ohms) with 0.01 dB resolution.

Push one button, and the microprocessor in the 8050A scrolls through its reference impedances. Simply stop at the one that matches your system and get back to work. No more math; just action. And with the 8050A's relative reference feature you can measure gains or losses in dB throughout your system faster than you thought possible.

When you're dealing with voltage, current or resistance, an offset function provides a means of comparing stored inputs with all subsequent inputs, automatically displaying the difference. A real timesaver.

And there's more. True RMS measurements to 50 kHz; 0.03% basic dc accuracy; conductance (measures leakage and high resistance); extensive overload protection and safety features; a full line of accessories; and a low price of $349 U.S.

For all the facts on how to maximize your gains with the 8050A, call toll free **800-426-0361**; use the coupon below;or contact your Fluke stocking distributor, sales office or representative.

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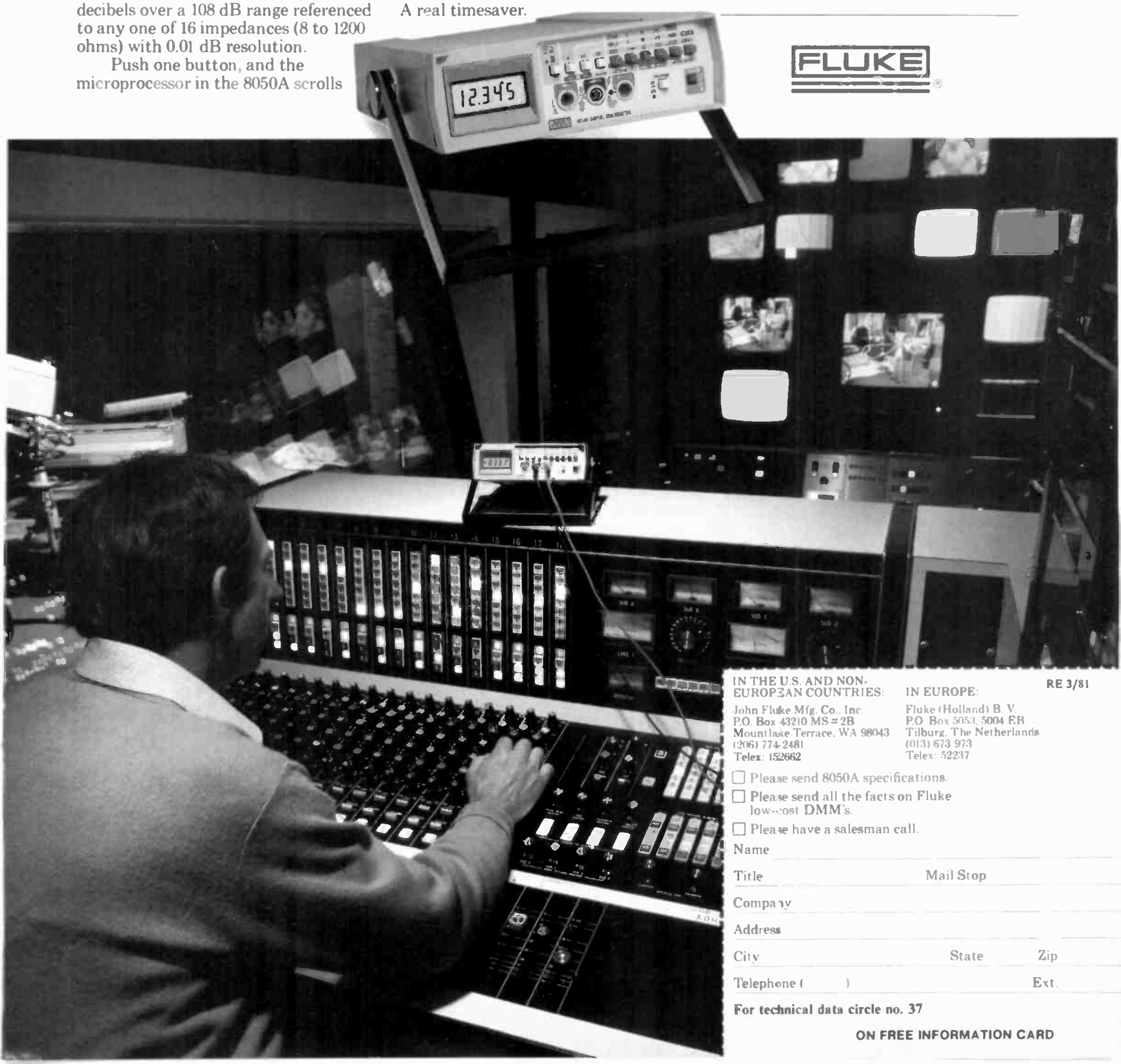

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☐ Please send 8050A specifications.
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☐ Please have a salesman call.

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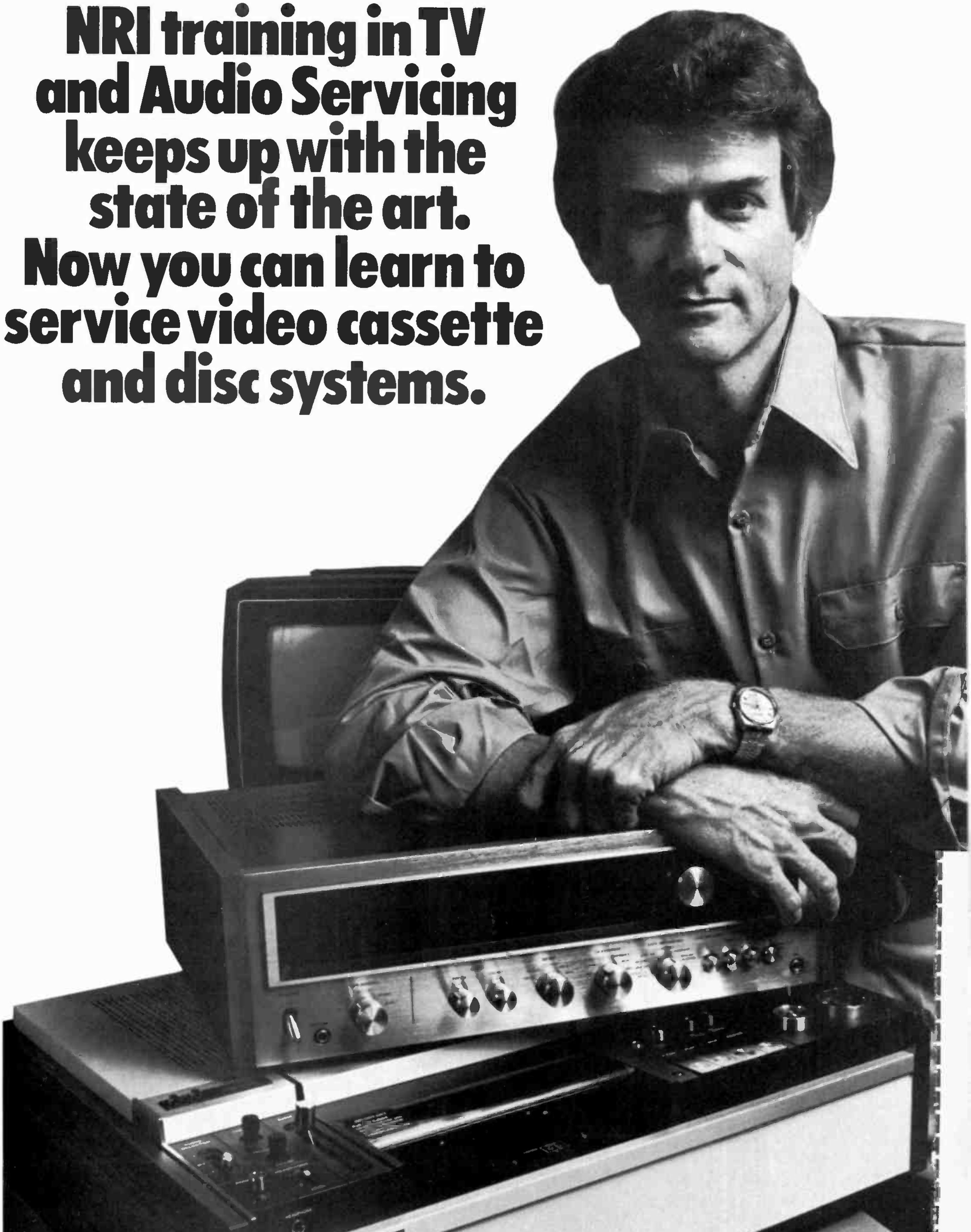
For technical data circle no. 37 ON FREE INFORMATION CARD

NRI training in TV and Audio Servicing keeps up with the state of the art. Now you can learn to service video cassette and disc systems.



You build color TV, hi-fi, professional instruments.

Now, in addition to learning color TV and audio systems servicing, you get state-of-the-art lessons in maintaining and repairing video cassette recorders, and the amazing new video disc players, both mechanical and laser-beam types.

Learn at Home in Your Spare Time

And you learn right at home, at your own convenience, without quitting your job or going to night school. NRI "bite-size" lessons make learning easier...NRI "hands-on" training gives you practical bench experience as you progress. You not only get theory, you actually build and test electronic circuits, a complete audio system, even a color TV.

Build Color TV with Computer Programming

As part of your training in NRI's Master Course in TV/Audio/Video Systems Servicing, you actually assemble and keep NRI's exclusive designed-for-learning 25" (diagonal) color TV. It's the only one that comes complete with built-in computer tuning that lets you program an entire evening's entertainment. As you build it, you introduce and correct electronic faults, study circuit operation, get practical bench experience that gives you extra confidence.

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

NRI Includes the Instruments You Need

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

NRI Training Works... Choice of the Pros

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

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

Other NRI training includes Computer Technology, Complete Communications Electronics.

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

Free Catalog... No Salesman Will Call

Send today for our free 100-page catalog which shows all the kits and equipment, complete lesson plans, and convenient time payment plans for courses to fit your needs and budget. Or explore the opportunities in other NRI home study courses like Microcomputers & Microprocessors, CB and Mobile Radio, Aircraft and Marine Radio or Complete Communications. Send the postage-paid card today and get a head start on the state of the art. If card has been removed, write to:

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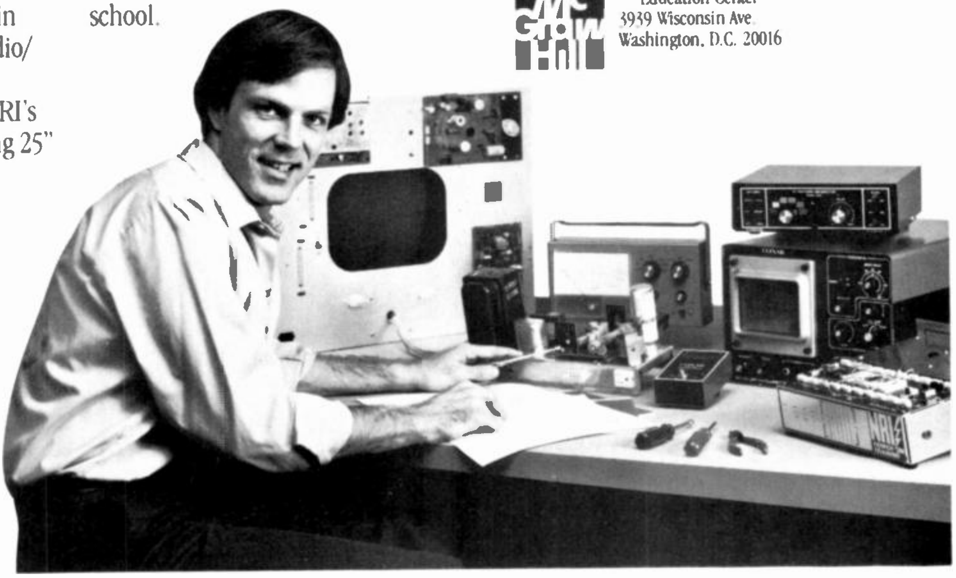
Washington, D.C. 20016



Learn at home at your convenience.

continued from page 6

chise for three counties with a total population of 615,000. Jim Cardnell, Homosassa Springs, FL, has also purchased a three-county block, with a population of about 685,000, and William B. Terrel, Cincinnati businessman, has become the master franchiser of Hamilton County, with a population of around 877,000.

Each of the Tronics 2000 territorial franchisers will offer franchises to a limited number of qualified service centers in their territories, with programs in advertising, volume buying, technical support, and business management.

"The consumer-electronics service industry is one of the largest left unfranchised in the United States," says David Hagelin, President of Tronics 2000 and former publisher of *Electronics Technician/Dealer*. "And today independent operations, rightly or wrongly, often mean consumer mistrust."

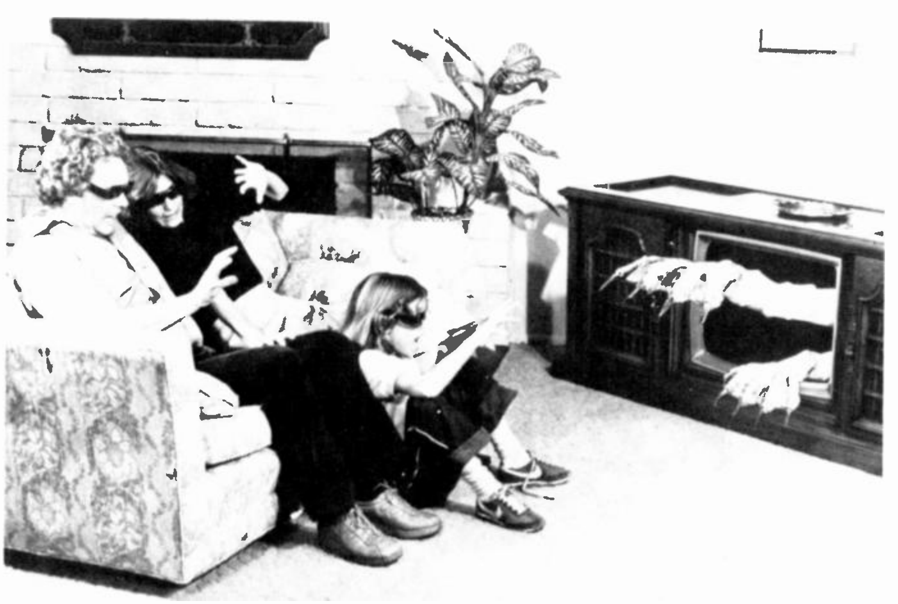
The concept that Tronics 2000 has in mind, says Hagelin, is close to what Century 21 has done in the real estate field. "Franchisees will receive assistance in all phases of business management, including training, advertising, promotion, and individual consultation. Advertising will be local and regional, with a national identity symbolized by a bold blue logo that will identify the Tronics 2000 operation to the consumer wherever he goes in the United States."

3-dimensional television

The world's first public transmission of 3D television is claimed by 3D Television Systems of North Hollywood, CA. Subscribers to the SelecTV television-cable system saw 3D films for the first time on December 19, 1980.

3D is well known in movies—though it has never become popular—and has been transmitted experimentally on TV. The process developed by 3D Television transfers three-dimensional films electronically to a master 3D videotape. Viewers of SelecTV on Channel 22 were able to see the 3D pictures by wearing stereo glasses similar to those used for 3D movies. Complimentary glasses were made available to SelecTV subscribers before the transmissions.

The system is described as "being able to portray objects coming out of the screen to within several inches of the viewers' eyes and then going deep back into the television screen."



VIEWERS BEING TERRIFIED by the latest development in television

Test lab for nuclear fusion

The Lawrence Livermore National Laboratory, operated by the University of California, is constructing a Mirror Fusion Test Facility (MFTF) to explore the possibility of producing power by nuclear fusion. To that end, a contact has been let to RCA to produce 48 Neutral Beam projectors for the project.

Producing a plasma in the MFTF requires evacuating a 40-foot diameter by 60-foot long cylindrical fusion chamber to an almost perfect vacuum. Thereafter, 20 start-up Neutral Beam injectors mounted around the wall of the chamber insert bursts of deuterium atoms to form the target plasma, which is confined in the center of the machine by powerful magnets. Once the plasma is formed, 24 high-powered Neutral Beam injectors raise the plasma termperature to the more than the 100-million degrees Celsius required for fusion.

Deuterium is the heavy isotope of hydrogen, in which a neutron as well as proton are contained in the nucleus. Deuterium is available in nearly unlimited quantities through extraction from sea water.

The 48 Neutral Beam injectors to be built by RCA include two spares of each type. Each consists of an arc chamber to ionize the deuterium working gas as well as an accelerator assembly to inject and focus the ion stream, which is later neutralized to form atoms, into the vacuum chamber. Twenty-two of the beam injectors are start-up beam sources, rated at 20-kilovolts accelerator voltage and 100-amperes current with pulse durations of 0.01 second. The remaining 26 devices are sustaining beam sources; they are rated at 80 kilovolts and 80 amperes, with pulse durations of 0.5 second.

Nuclear fusion is expected to provide power generation with improved safety, efficiency, and lower cost compared with present fission (splitting the atom) methods. For those reasons, many engineers believe fusion may be the basis for the nuclear power plants of the next century.

CB installers are warned

The Electronic Industries Association (EIA) has issued a warning about the danger of electrocution while installing CB or TV antennas. (Through long and bitter experience, many amateurs have learned to keep away from power lines and icy roofs. However, recent casualty figures show that many CB and TV users still have to learn that lesson.)

The EIA recommends that anyone putting up an antenna obtain the free U.S. Government *Antenna Alert* sheet, by writing to Antenna Alert Sheet, Consumer Product Safety Commission, Washington, DC 20207. The Association also reiterates some important points of that document:

> Make sure the antenna is twice its length away from any power or light lines. Remember that even insulated lines are dangerous. Insulation may be worn, or be cut through when struck by an antenna.
>
> If the antenna is more than 30 feet high, or is to be erected in an area where light or power lines are closer than twice the antenna height, better use professional help.

The EIA warning and the government "Alert" confine themselves to electrical dangers. Probably more accidents—with TV antennas at least—consist of falling off roofs. The mast erected from the ground and fastened to the side of the building is many times safer for the non-professional installer. R-E

Sabtronics.
An entire range of low-cost, top-quality instruments.

A. 2010A — $84.00*, B. 2015A — $99.00*, C. 8610A — $99.00*, D. 5020A — $85.00*, E. 8000B — $199.00**, F. 2035A — $79.00*, G. 2037A — $99.00*

IN CANADA CONTACT: Kumar & Co., Mississauga, Ont. Canada

Sabtronics revolutionized the market with the first low-cost, high-performance Digital Multimeter. Now we have an entire range of outstanding instruments in a reasonable range of prices. In fact, nobody can beat us in our price/performance ratio. And we can sell at a low price for some very good reasons. Our engineers design high performance products to be built at a low cost. And we refuse to stick on high mark ups. Plus we make sure your price stays low by selling directly to you. Because we sell so many instruments, we don't have to charge a high price. Naturally, we also offer all the helpful accessories you might want. And all our products are under warranty for good quality and high performance. In addition, you get from us the same quality aftersale service as any high priced instrument manufacturer. With Sabtronics instruments available, there's no need for you to spend a lot of money to do highly accurate testing and measuring.

2010A 3½ Digit LED DMM
2015A 3½ Digit LCD DMM
8610A 600 MHz 8-Digit Frequency Counter
8110A 100 MHz 8-Digit Frequency Counter
5020A 0.2 to 200 KHz Function Generator
8000B 1 GHz 9-Digit Frequency Counter
8610B 600 MHz 9-Digit Frequency Counter
2035A 3½ Digit LCD Handheld DMM
2037A 3½ Digit LCD Handheld DMM

*price in kit form. Also available factory assembled, tested, and calibrated. Call us for prices.
**price fully assembled, tested, and calibrated.

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Error... Error... Error... Error...

THE MISSING LINK

A serious omission was made in Part 2 of the "Pay TV Decoder" article that appeared in the February 1981 issue of **Radio-Electronics** (page 51). Someone apparently got so excited over the photo of Bo Derek that the first page of Part 1 was printed (again) instead of the first page of Part 2. What got left out was most of the conclusion of the "theory of operation" part of the article. The missing text appears below, and we apologize for any inconvenience this slip may have caused.

IN THE FIRST PART OF THIS ARTICLE WE discussed how pay-TV signals are scrambled and began talking about a device to decode them. Refer to Part 1 and Fig. 3 as we finish the discussion and describe the construction and connection of a decoder board.

Returning to IC1 for a moment, the phase-locked oscillator produces a square-wave output signal at pin 11 that is used to trigger a 74123 dual one-shot (IC2-a and -b). That one-shot produces the gating signal required to restore the sync and blanking pulses. The first section, IC2-a, has a period of approximately 30 microseconds. The trailing edge of its output pulse is used to trigger IC2-b, which has a period of approximately 12 microseconds—the width of the horizontal-blanking pulse. Because of the design of IC1, the 15.75-kHz output signal at pin 11 occurs somewhere in the middle of a scan line. An adjustable delay that allows the gating signal to begin at the proper time is provided by IC2-a. The actual gating signal is generated by IC2-b, and its width is set to match the width of the horizontal-blanking interval. The combination of R6-C9 is used to position the gating signal and the combination of R7-C10 is used to control its width. The gating signal appears at pin 13 of IC2-b, and its amplitude is controlled by R8. That signal is used to increase the IF gain of the TV receiver during the horizontal sync- and blanking-pulse intervals and thus correct the video waveform.

We have now discussed all of the circuitry required to reconstruct the original video and audio signals. Now it is necessary to re-combine them into a useable TV signal. We have obtained a stable picture, but still have no sound. However, the intended use of our adapter is to provide a VHF signal for viewing on another, unmodified, TV set. Therefore, the video signal is taken from the video detector and applied to IC4, which is a complete video-modulator IC. The tank-circuit L1-C21 is used to set the video-carrier frequency. Resistor R21 controls the voltage at pins 2, 3, 4, and 13 of IC4 which, in turn, controls the percentage of modulation of the video input at pin 12. The sound is generated by FM-ing a 4.5-MHz oscillator using a transistor

NOTE:

The legality of the use of privately-owned devices to decode subscription TV broadcasts is currently the subject of much debate and pending litigation. The subscription companies have taken the position that decoding of broadcasts without payment is "theft of service" and the FCC has issued a notice to the effect that subscription-TV decoders are subject to FCC approval.

This article merely explains how such decoding devices are built and used, and you should obtain independent advice as to the propriety of its use depending upon your individual circumstances.

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satellite tv news

DIRECT-BROADCAST SATELLITE PLAN REVEALED

Satellite Television Corp., the direct-to-home broadcasting subsidiary of Comsat, has revealed details of its plans to create a high-power pay-TV service that could be in operation by 1986. The three-channel service would offer major motion pictures, popular concerts, children's programs, sports, experimental theater and other shows, beamed directly into homes via a 2.5-foot dish to be placed atop roofs nationwide. The satellites that will carry the signals will operate in the 17-GHz band on the uplink and be received in the 12-GHz range, with signals beamed via a high power carrier (1700 watts). The birds will be of the new PAM-D class, a refinement of the current breed now used by other Comsat subsidiaries.

Satellite TV Corp., which is applying to the FCC for permission to build the new pay-TV satellite system, envisions that subscribers will pay about $100 for the reception antennas and then about $25 per month for the decoder. It will also be possible to buy the receiving equipment, then pay about $18 per month for the programming alone. STC engineers promise that the encoding/scrambling format for the video signal will be so complicated that the programs will be immune from piracy by unauthorized receivers.

STC wants to launch four separate satellites during 1986, each of which would cover a different time zone in the U.S. (with the Western satellite including spot beams for Alaska and Hawaii). The birds would be spaced about 20° apart in orbital arcs at 115°, 135°, 155° and 175° west longitude. Two other satellites would be used as in-orbit spares in case one of the primary birds encounters technical troubles.

The entire project will cost at least $400 million, STC estimates. In addition to the 2.5-foot dishes atop home roofs, the company expects that apartments and other housing complexes—especially areas without cable TV—will be users of the new pay-TV service.

The FCC, which is currently examining a number of Direct Broadcast Satellite policy options, is expected to begin consideration of the STC plan within the year. In any case, STC admits that it will take at least three years to build and launch the system.

ABUNDANCE OF NEW EQUIPMENT

Lower-priced—and more versatile—satellite reception equipment continues to flood the market, as was evident at several recent industry meetings. Manufacturers serving both the hobbyist market and the low-cost professional user are offering a variety of new antennas and terminal devices. For example, such established companies as Microdyne Corp. (PO Box 7213, Ocala, FL 32672; phone 904-687-4633) are offering new 12-foot antennas, with EIRP contours between 36 and 33 dBW. Hughes has unveiled a new expandable dish, offering a basic 3.7 meter TVRO antenna that can be upgraded to 5-meter diameter. Hughes says the 3.7 meter version provides 52% more gain than a standard 3-meter dish, and that it can be expanded to the 5-meter configuration without upgrading the foundation or mount structure. (Hughes Microwave Communications Products, PO Box 2999, Torrance, CA 90509; phone 213-517-6100.)

Downlink Inc., a new company, unveiled a modular satellite-TV system during the Consumer Electronics Show, with a promise that it intends to "become the Apple comupter of satellite TV"—a reference to the successful easy-to-use home-computer system. The Downlink package includes a control console with receiver mounted at the antenna, 12-foot spherical antenna, 120° low-noise amplifier, feedhorn and rotor with back assemblies, plus 100 feet of cables. (Downlink Inc., PO Box 33, Putnam, CT 06260; phone 203-928-7955.)

Chaparral Communications has introduced a new Feed Horn, designed to optimize the capabilities of parabolic antennas—providing an improvement of at least half a dB of system operation over a conventional rectangular horn. The $135 feed horn consists of a standard WR220 waveguide flange and a front plate which is held in place with a set screw. The Chaparrel feed is not intended for use with spherical antennas because of their high focal length-to-diameter ratios (Chaparral, PO Box 832, Los Altos, CA 94022; phone 415-941-1555.)

AROUND THE SATELLITE CIRCUIT

Cable News Network, the all-news channel (Satcom I, Transponder 14) is carrying an electronic cable-TV guide on a sideband. The slow-scan video listings offer a program directory to what is being carried on cable-TV systems, including a rundown of that day's programs on other satellite-fed cable channels. The slow-scan sideband signals are intended to be used by cable systems on an otherwise blank channel.

Intelsat V, the $34 million international satellite, completed its launch sequence and is now slated to go into operation in May as the primary Intelsat bird over the Atlantic Ocean. The big bird (4,300 pounds, two video transponders) is the first of nine new Intelsat satellites being built by Ford Aerospace.

GARY ARLEN
CONTRIBUTING EDITOR

Hand-held computer power is here!

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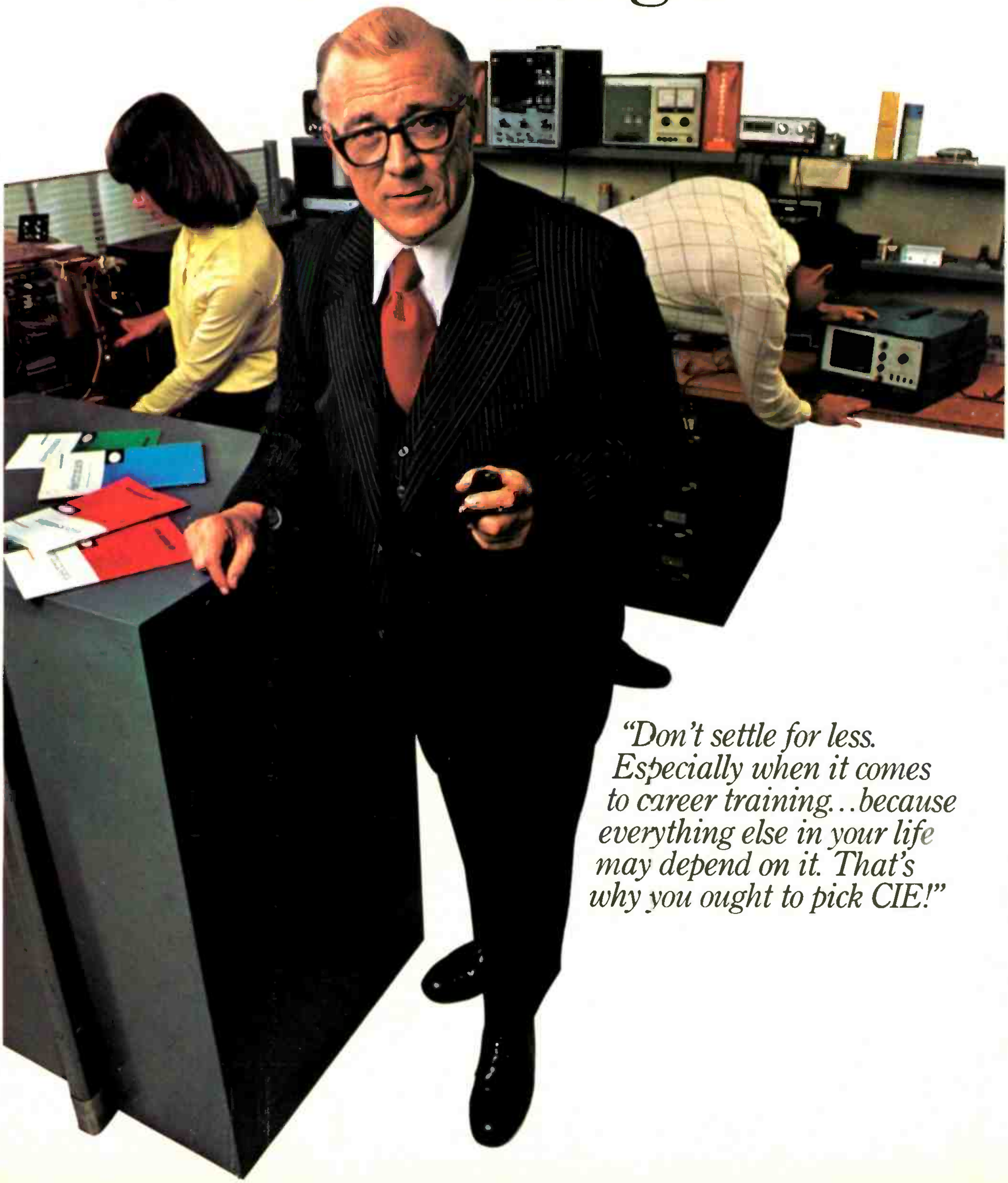

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letters

SWEEP/FUNCTION GENERATOR

Thank you for the comprehensive review of our *model 3020* Sweep/Function Generator in your October 1980 "Equipment Reports" section.

Actually, the instrument is even a bit more versatile than your review indicates. An internal gate with an adjustable duty cycle and repetition rate is provided for tone bursts. In addition, provision is made for external gating, as your review indicated. That feature, combined with those you listed, makes the B&K-Precision *model 3020* an exceptional stand-alone instrument. The only external signal requirement is for the amplitude-modulation function.

GUS ROSE,
Dynascan Corporation

THE BSR SYSTEM X-10

Mr. Steve Ciarcia's article on the BSR *System X-10* ("Plug-In Modular Remote Control", September 1980 issue) was very good, but he glossed over a problem that has been a thorn in my side ever since I bought the system. According to Mr. Ciarcia: ". . . since . . . 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 sides of the 117-volt lines."

His solution? "Placement of the receivers could require some experimentation." C'mon, Steve—you can do better than that! There must be some way (or ways) to couple the 120-kHz control signals from one side of the line to the other—capacitively, with a tuned circuit, or even perhaps an active circuit that would function as a repeater. There *has* to be a way—otherwise, I'm going to be stuck with a houseful of *X-10* receivers and transmitters that can't talk to each other unless they're in the same room. Please help!

ANDREW BAIRD,
Princeton, NJ

With every article I write, I have to balance safety considerations against the interest that readers with a wide variety of sophistication may have in experimenting with new devices. Yes, there are ways to jump the signal across the two legs of the AC line. The easiest way is to amplify the command-controller's output and pump a few watts into the line.

Unfortunately, there is no single solution. In some cases, it may only require a few capacitors between the lines. In others, you could use repeaters and still have problems. Also, there are occasions in winter (when 220-volt heaters are in operation) when nothing extra is required for a complete coupling. The answer is not an extra paragraph in a general article on the X-10.

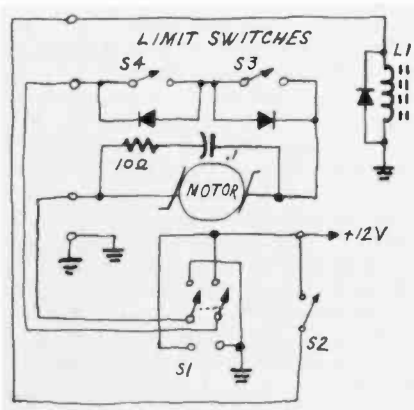
I cannot apologize for evading this apparent limitation of the X-10. *To achieve consistent results, any suitable solution requires attaching circuitry directly across the 220-volt power line at its entrypoint to the house. Besides being risky, the power company usually frowns on such activities.*

As to the limitations of the X-10, *aren't you expecting a lot from a $15 remote-control device? Perhaps you should consider using a more conventional remote-control device in conjunction with the BSR system to fill in the gaps. In my own application, I have combined it with hard-wired relay-controlled outlets for more predictable*

control. If you are interested in learning more about this, I refer you to a three-part article I wrote for the January, February, and March 1980 issues of Byte *magazine. The title is: "A Computer Controlled Security System."*
STEVE CIARCIA

UNICORN-1

I am following with interest your series on building your own robot. However your readers may be interested to know that the manipulator arm wiring can be simplified by using two additional diodes. The circuit shown in the figure below (compare with Fig. 18 on page 58 of the September 1980 issue) performs the same functions, but



reduces the amount of wiring required on the arm and saves four positions on the terminal barrier strip. The diodes should be rated at 50 volts and be able to handle the motor current.

Also, the network shown across the motor can profitably be used across all motors and solenoids to protect the switches from damage caused by arcing when the power is suddenly turned off. Without those, the life of the switches may be considerably shortened. If the current through a motor or solenoid is always in the same direction, a clamping diode, as shown on the "hand" solenoid can also be used.

It's easy to remember which way to connect a clamping diode: simply orient it so it *doesn't* short out whatever it is connected across!
GUY JUTRAS
Ottawa, Ontario, Canada

VIDEO SIGNALS

Any government attempt to "stop unauthorized reception" of video signals is logically equivalent to prohibiting you from hearing the governor burp.

Incidentally, Officer Brown (Letters, October 1980), "laws" prohibiting radar detection are equally illegitimate in the U.S.A.

"Piracy?" Commissioner, if you don't wish to water your neighbor's lawn, then direct your hose elsewhere.
JACK D. DENNON
Warrenton, OR

ON EINSTEINIAN IMPOSSIBILITIES

I am astonished that you would print such a letter as "Einsteinian Impossibilities," by A. H. Klotz even in your "April Fool" issue.

In fairness to your other readers, you should have pointed out the obvious flaw in Mr. Klotz's argument:

The constant velocity of light is *not* predicted by Einstein's theory, as Mr. Klotz apparently believes. But the scientifically-proved fact that the velocity of light is constant, regardless of its source, is one of the physical world's anomalies that prompted Einstein to formulate his theory in the first place.

To argue with Einstein's theory, one must ask the question: "How can I account for the fact that the velocity of light from all sources (some of which are moving) is constant?"

If Mr. Klotz has new evidence about the speed of light, I am sure we would all like to hear about his experiments.
JERRY MILLER,
Littleton, CO

WIDE-RANGE AUDIO GENERATOR

In reference to the "Wide-Range Audio Generator" article in your May 1980 issue: It has 2 Zener diodes. Those are *not* 0.1-volt Zeners as stated but rather both numbers are for 5.1-volt Zener diodes (1N5231 and 1N751).

I ordered all required parts, but had trouble finding a 0.1-volt Zener diode. Fortunately the numbers given were in an ad in the back of the issue, so I checked both of them, and both turned out to be 5.1-volt Zeners.

It sure looks like a good project and I'm looking forward to completing it.
CRAIG LEWIS,
Kailua, HI

R-E

equipment reports

Keithley Model 169 DMM

CIRCLE 101 ON FREE INFORMATION CARD

THE CHOICE OF A NEW DIGITAL MULTIMETER IS influenced by many factors. Since most units within a certain price range will have almost identical accuracies, other features such as ease of operation, special ranges, and cabinet sizes may be more important. In the past it was common to select a portable unit to take advantage of its use in the field as well as on the bench. In most cases however it has been discovered that a hand-held unit is not the most convenient one for bench use.

Keithley Instruments, Inc. (28775 Aurora Road, Cleveland, OH 44139) has introduced its *model 169*, a digital multimeter designed for bench use. Since the *model 169* uses six C-size batteries for power, it can also be taken into the field if the need arises.

The *model 169* features a large (0.6-inch) 3½-digit LCD display. The easy-to-understand front panel has color-coded pushbuttons. Units are displayed on the LCD to confirm the range and use selected. Since the front panel is larger than that of a hand-held unit, the pushbuttons are easier to operate and the cabinet (again due to the larger size) remains stable One hand can be used to change ranges. A large bail-type carrying handle attached to the sides of the cabinet also serves as an adjustable stand to allow the user to position the meter at an angle. The cabinet has four feet attached to the underside. Those feet have provisions for test-lead storage. Test leads can be connected to the front panel with standard banana jacks. That means you will still be able to use your favorite special-function leads. The *model 169* is supplied with standard test leads, including probes.

Input protection is provided for all functions on the *model 169*. Those who forget to change the ranges and functions will be happy to know that the *model 169* will withstand 1400 volts (peak) on the voltage ranges and 300 volts on the resistance ranges. A two-ampere fuse protects the current ranges and the fuse is accessible without removing the cabinet.

These specifications will provide the reader with a brief idea of the *model 169*'s versatility. Both AC and DC voltage is measured on five ranges from 200 mV up to 1,000 volts full-scale. Accuracy on the DC ranges is 0.25% of reading + 1 digit. Accuracy on AC is 0.75% of reading + 5 digits at frequencies under 1 kHz. Input impedance is 10 megohms shunted by less than 100 pF. Current can be measured on five scales from 200 μA to 2,000 mA full-scale on both AC and DC, although the DC readings are more accurate than AC. Resistance is measured on six ranges from 200 ohms to 20 megohms full-scale. Voltage resolution will vary from 100 μV to 1V, depending upon the range, in either the AC or DC functions. Likewise current resolution is from .0001 to 1 mA and the resistance ranges offer resolutions of from 0.1 to 10K ohms.

continued on page 26

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EQUIPMENT REPORTS

continued from page 24

Overrange is indicated when the three least significant digits are blanked on the display. There is automatic polarity reversal, and a display indicator will signify the polarity of the test voltage or test current. The display will also indicate when there is less than five percent of battery life remaining. The estimated battery life is 1,000 hours when carbon-zinc batteries are used, and 2,000 hours with alkaline batteries.

The instruction manual also serves as a repair manual for those who like to maintain and calibrate their own equipment. It contains exploded views of the unit, complete parts lists, and an extra large two-page schematic diagram. In addition, there is an excellent discussion of the instrument's theory of operation and how the instrument is used.

All circuitry is contained on a $4\frac{1}{2} \times 7\frac{1}{2}$ inch printed-circuit board and, due to the relatively large size, troubleshooting is greatly simplified. The front panel is attached to the board with connectors that makes removal easy. The LCD display is fastened to the panel by two studs and it is connected to the main board by ribbon cable. The *model 169* measures $3\frac{1}{2} \times 9\frac{1}{4} \times 10\frac{3}{4}$ inches and has a net weight of three pounds.

The unit has been tested and it performed well. All ranges equalled or exceeded the published specifications. If you are in the market for a large DMM that can also be used in the field, it may be worth your time to check out this versatile unit. The *model 169* from Keithley sells for $169. **R-E**

A P Products Hobby-Blox Solderless Breadboarding System

CIRCLE 102 ON FREE INFORMATION CARD

IT SEEMS THAT EVERY TIME WE TURN AROUND, someone has taken another step toward making prototyping less complicated, more instantaneous, and, admittedly, a little more fun. A P Products' *Hobby Blox*, are a very versatile series of breadboarding products that, working together, perform as a complete system for circuit building.

The generous use of color and the low prices of the several elements of the *Hobby-Blox* system can easily lead to the impression that it is a system intended strictly for beginners. That is not the case. *Hobby-Blox* perform on a par with any professional breadboard, in most applications. Its many unique elements permit the easy incorporation of circuit elements that would be difficult to accommodate with many breadboarding products.

Part of the secret of the flexibility of *Hobby-Blox* lies in its unique carrier tray. In addition to its primary purpose of providing structural rigidity for the breadboard strips, the tray also has a number of molded-in features that contribute to the modularity and expandability of the system. The side rails, for example, feature a tongue on one edge and a mating groove on the opposite. There are also slots spaced along one edge to accommodate the blank panel, control panel, or speaker panel elements of the system.

The trays can be readily stacked side-to-side or, with tray extender clips, end-to-end. Also available is a right-angle, vertical tray pack that includes a smaller tray and adapter strip. Either large or small trays, however, may be vertically mounted using the adapter strip.

The standard tray is 6.3×3.12 inches and the shorter tray is 3.7×3.12 inches. The inside width, between the side rails, is 2.75 inches. That is the same as each of the solderless strip elements of the system except one—a between-the-trays, 6.3-inch long, bus strip with two continuous rows of 60 connected, solderless tie points each.

There are five different types of solderless breadboarding elements designed to fit in the *Hobby-Blox* tray. Yellow terminal strips provide a row of 26 three-tie-point terminals. Red distribution strips each provide two rows of 26 connected tie points. Gray 3×16-inch terminal strips repeat arrays of 16 three-tie-point terminals (arranged as twin columns of eight each on either side of a 0.3-inch DIP-standard center spacing) three times across its width—perfect for placing three 7-segment DIP displays in a row. Gold LED strips accept six discrete LED's, provide a solderless tie-point connection to each solderless LED socket lead,

continued on page 32

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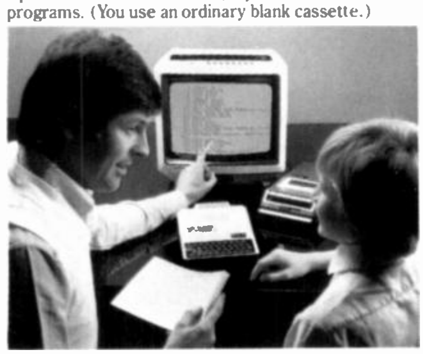

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EQUIPMENT REPORTS
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and include a bus of 23 connected tie points for easy connection to power buses through limiting resistors. Blue discrete component strips provide 14 terminals with five connected, solderless tie points each. These strips use 0.2-inch center spacing (versus DIP-standard 0.1-inch spacing used in the other elements) with adjacent rows staggered 0.1 inches.

Unique and welcome features on those *Hobby-Blox* elements include raised molded lines to show the electrical connections between solderless tie points, and a molded letter-and-number indexing system for each hole.

The yellow terminal strips may be spaced for standard (0.3-inch center) or LSI-wide (0.6-inch center) DIP spacing by using a 0.3 × 2.75-inch spacing strip. Those include the same molded slots as the side rail, and can double as support strips.

The *Hobby-Blox* system includes a battery-holder pack that houses a standard 9-volt battery (not included), plus twin three-tie-point terminals for power connections and a binding-post strip with one black and two red binding posts. Each binding post is brought out to a solderless tie point.

A P Products has made available two starter packs, one for IC's at $5.97 and one for discrete components at $6.57. Each starter pack includes a tray, breadboarding elements, and a book of 10 well-documented, easy-to-build projects. Prices for individual elements range from $1.29 to $3.59.

All-told, *Hobby-Blox* represents a very interesting and well planned approach to solderless breadboarding. Its features should appeal to beginner and professional alike. A P Products, 9450 Pineneedle Drive, Mentor, Ohio 44060. **R-E**

Hickok Model 216 Transistor Tester

CIRCLE 103 ON FREE INFORMATION CARD

ANYONE WHO HAS SPENT ANY AMOUNT OF TIME with an illegibly-marked group of three-legged semiconductors knows how frustrating and time-consuming a task it is to sort through them. Hickok (10514 Dupont Avenue, Cleveland, OH 44108) has automated the task with an amazing new handheld tester, the *model 216*, that performs in- or out-of-circuit pass/fail tests. It also identifies NPN, PNP, or FET type; diode and SCR polarity; and the base or gate lead—all in a few seconds.

A device can be plugged into the front-panel transistor socket (graphics clearly identify which of the pins to use to test diodes), or a set of three colored leads may be plugged into the front-panel jacks and alligator-clipped to the device. The comprehensive instruction manual offered by Hickok specifies that for in-circuit testing, the maximum load between any two leads is 500 ohms, 0.2 μF, or any impedance equivalent to 500 ohms at 1000 Hz.

All indications are made through six front-panel LED's. There is a red LED marked FAIL and two green LED's marked PASS, one with the letter P and a diode symbol with the cathode at the left and the other with the letter N and a diode symbol with the cathode at the right. Each of the three terminals to which the device under test is connected has a red LED associated with it. That is true both for the socket on the front panel and the three banana jacks that the color-coded (red-black-yellow) test leads plug into.

A single switch controls operation of the *model 216*, selecting the transistor test mode, the diode test mode, or off. After a few seconds (approximately four) of blinking through the test sequence, the LED's hold on a fixed pattern that identifies whether the device is PNP (P LED lights) or NPN (N LED lights). The LED associated with the lead connected to the

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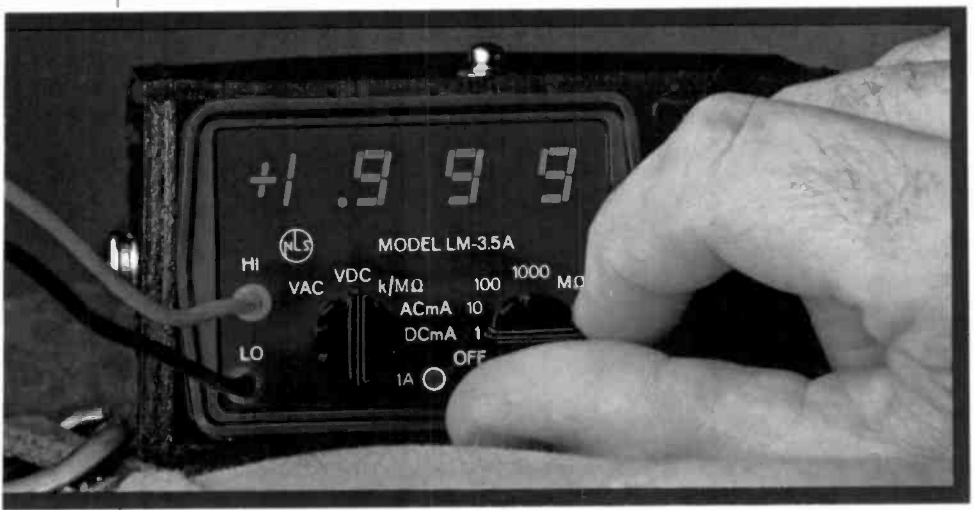
Light-torque rotary switches make the LM-3.5A DMM as easy to operate as it is to carry.



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

LM-3.5A at a glance.

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

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

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

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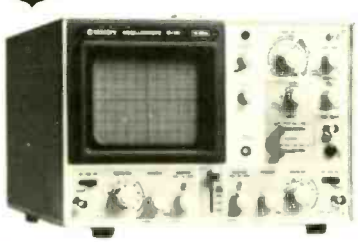

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base of the transistor also lights. If the device is bad, the FAIL LED flashes alternately with the others. If the device is an FET, the N indicates N-channel, the P indicates P-channel, and the lead LED signifies the gate. The *model 216* will not give a correct indication on some low g_m FET's because of their low on-resistance, though it will indicate the validity of *any* P-N junction in the diode test mode. Also, the *model 216* cannot test where there is no junction, as in the gate lead of an IGFET.

In the diode test mode, only the two lead connections marked with a circled D are used, and a good device is indicated by the lighting of the appropriate PASS LED's, indicating the polarity of the diode or junction. The instruction manual explains how to use that mode to test SCRs, triacs, bridges, and other devices. The *model 216* will not test PUT's or temperature-compensated Zeners.

The circuitry of the Hickok *model 216* is a fascinating hybrid of analog and digital approaches to semiconductor testing. A 4022 octal counter/driver scans the tester through a sequence of tests, controlling a total of 12 analog switches. A bipolar oscillator's output is applied to two leads of the device under test, and its third lead is connected to the input of an op-amp configured as an inverting lowpass (DC-smoothing) filter. All three permutations of lead connections are tried, in sequence.

It can be shown that for the two-diode model of a semiconductor, a device with an open or shorted junction will always provide a zero output from the op-amp for at least one of the three configurations of leads, but a good device never will.

The output of the first scan goes from the op-amp filter to an op-amp integrator, and the result of the three lead configurations (two always result in one polarity of voltage out of the filter, the third in the opposite polarity) is stored while the same three configurations are repeated.

Thanks to some very clever use of logic gates, a comparison between the integrator-stored majority-vote voltage polarity and the second-scan output of the op-amp filter triggers three events: first, a four-second delay is introduced, inhibiting the next count of the 4022 and permitting adequate display time for the results of the tester's analysis; second, another op-amp circuit lights either the P or N LED depending upon the polarity of its input (intriguingly, that same op-amp resets the 4022 to light the FAIL LED in the case of a zero-voltage out of the filter); third, as that sequence of events has uniquely indentified the base lead, the approximate LED is lit.

The *model 216* does not (nor is it intended to) provide any information on the gain or any other device characteristic. Those seeking quantitative tests must look elsewhere. But as a qualitative tester, it is one of the simplest, most foolproof, thorough and informative instruments we've encountered.

Power for the *model 216* comes from a pair of 9-volt batteries and a rechargeable battery option is available. All inputs are protected with back-to-back Zener diodes in case of residual voltages during in-circuit (power-down) tests. Hickok offers a one-year limited warranty. The 18-page instruction manual includes a complete parts list, a schematic, and a printed circuit diagram.

Manufacturer's suggested U. S. retail price for the *model 216* is $135. It's available through electronic distributors. **R-E**

Gold Line Model 1139 Base Station Power Supply

CIRCLE 104 ON FREE INFORMATION CARD

ALTHOUGH THERE ARE NUMEROUS DC POWER supplies on the market, it is difficult to find one with a higher current capacity. Gold Line, (PO Box 115, West Redding, CT 00896), an established name in mobile-radio accessories, has introduced its *model 1139* 3-amp base-station power supply. It is capable of short-term current drains of up to five amps. Overheating prevents long-term use at those current levels and the supply is protected from overloads by a thermal switch.

The 13.5-volt supply is well-regulated, and maintains the voltage output up to 6 amps, at which point the crowbar overload-protection drops the voltage considerably.

An internal trimpot adjusts the output voltage from 13.5-15 volts. Voltage regulation is provided by a type-723 IC, and the pass transistor is a 2N3055. A full-wave bridge consisting of four 1N5400 silicon diodes provides the DC rectification.

The husky transformer is capable of running at the full current limit without becoming hot. The current is limited by the power transistor which does become hot, even though adequately heat-sinked. A thermostatic switch mounted on the heat sink senses excessive heat dissipation and shuts down the power supply for several minutes when overloaded.

All circuit components (except the transformer and output transistor) are mounted on a phenolic circuit board. An internal fuse provides additional circuit protection. That fuse is soldered in place, but a replacement is rarely necessary.

Our test unit worked well, after shipping damage was repaired. The filter capacitor leads had broken loose during shipment and the power transformer was bent slightly on its frame (upright type "A" mount). Fortunately, component spacing proved to be adequate, and no secondary damage occurred from loose or bent components.

The *model 1139* power supply cabinet is finished in a black-wrinkle enamel. Ventilation holes provide adequate cooling if the unit is operated within its specified limits. Rubber foot pads prevent the unit from scratching the surface of a desk or operating table. A front-panel incandescent pilot lamp lights when the unit is on. It is connected across the DC output of the power supply, providing a bleed load when the unit is off. A pair of (red and black) press-release terminals on the rear apron of the supply securely grips power leads.

The supply weighs about 4½ pounds, and measures 4½ × 3 × 6 inches. Our unit came without any literature or instructions.

Because of the 3-amp nominal current rating of the 13.5-volt supply, it proves to be particularly well suited for home operation of most mobile electronic equipment. The *model 1139* 3-amp base station power supply from Gold Line sells for $27.98. **R-E**

Sony ICF-6700W General Coverage Receiver

CIRCLE 105 ON FREE INFORMATION CARD

FOR QUITE SOME TIME, MANUFACTURERS HAVE made either very good or very bad shortwave receivers. There seemed to be nothing in the middle. But now the market is changing. Manufacturers seem to be recognizing the fact that there are a number of serious hobbyists who enjoy casual monitoring of the shortwave spectrum and expect dependable equipment with which to do it.

Sony has continued the trend with a series of

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quality, hobby-class radio receivers. One of the better ones is the *model ICF-6700W*.

The military-styled cabinet measures 18 × 7¼ × 9 inches. Selectable upper or lower sideband, AM, and CW modes are available from .53–29.7 MHz (the receiver skips 10.4–11.3 MHz) with FM coverage from 87.5–108 MHz.

A narrow/wide IF selectivity switch really helps separate closely-spaced stations. Additional audio bandpass shaping is possible with the separate bass and treble controls. The RF gain control may be adjusted to reduce strong signal overload on SSB.

The FM fidelity is very good, with the AM sound quality superior to that found on most small home-entertainment radios. A multiplex output jack allows coupling of the FM IF signal to a stereo adaptor. A timer jack provides for external on/off control of the receiver by a suitable timing clock (unfortunately, neither the stereo adaptor or timing clock are available from Sony.) Separate recorder and headphone output jacks are also included. Audio output is 900 milliwatts (at 10% harmonic distortion).

A switchable AFC control allows FM locking within approximately ± 100 kHz of the center frequency. An illuminated signal-strength meter doubles as a battery tester. The digital, five-character, LED frequency display works on all frequency ranges, and may be switched off to conserve battery power during portable operation of the receiver. It is quite accurate and our sample was within 1 kHz at room temperature on all modes. The display is a little dim in bright ambient light, but that is probably intentional for lower current drain during battery operation.

The gating time of the display is a little slow, so it takes a fraction of a second for the display to catch up during tuning. That has a tendency to slow down the dial-searching process, because the receiver doesn't have a calibrated shortwave dial and the user is entirely dependent upon the digital readout.

Frequency stability of the receiver is excellent. Single sideband reception is quite acceptable, although dial setting is touchy. There is no fine tuning, so the initial setting process is rather delicate.

Minor pulling of the oscillator frequency occurs as a result of the normal AGC action when receiving strong CW and SSB signals. That effect is eliminated by reducing the RF gain. There is some hand-capacitance effect apparent on the front panel, but it is minor. The mechanical stability of the receiver is fair and tapping or pressing the cabinet will result in some frequency instability. No dial backlash was detectable.

The main tuning dial is a flywheel. It has a good rugged feel to it, and seems securely mounted. A linear-preselector dial is used for peaking the RF input to the receiver. It is poorly calibrated, so the user must depend upon an increase in background signal to know whether or not he has optimized receiver sensitivity. That may be a problem; if the preselector dial is peaked on the wrong frequency, image interference will be enhanced, and desired frequencies will be attenuated. Proper preselector setting may take a little getting used to. The receiver does not have a noise limiter and that may pose problems.

Antenna provisions include a built-in ferrite bar for AM broadcast (or push terminals for an external wire antenna), and a collapsible whip for FM and shortwave (or push terminals for an external shortwave antenna). There is no external FM antenna input.

One desirable feature is the automatic frequency-offset readout during upper and lower sideband monitoring. When the station is properly tuned in, the suppressed carrier frequency will be displayed. The offset is ± 2 kHz, ideal for SSB reception.

The battery compartment is accessible from the top of the cabinet (six D-type batteries are used). With the lid flipped up, a world time-zone chart and table of international broadcasting frequency allocations is displayed.

Carrying handles are mounted on the sides of the receiver, and slots are provided to accommodate shoulder straps. Adjustable plastic feet allow the receiver to be tilted for comfortable viewing and operation.

The *model ICF-6700W* may be operated from its own internal batteries, from an external 12-volt source (using a Sony battery cord to drop the voltage to 9 volts), or from AC lines (110, 120, 220, or 240 volts AC, switch-selectable). Power consumption (AC) is 7 watts.

The accompanying service manual is rather brief. It does provide basic user tips, but has very little theory; no schematic or block diagram of the receiver is included. No warranty policy was supplied with the unit that we evaluated, but there was a list of regional service centers.

The *model ICF-6700W* lists for $439.95 and it is available from Sony dealers. From Sony Division, Sony Industries, 9 W. 57th Street, New York, NY 10019. **R-E**

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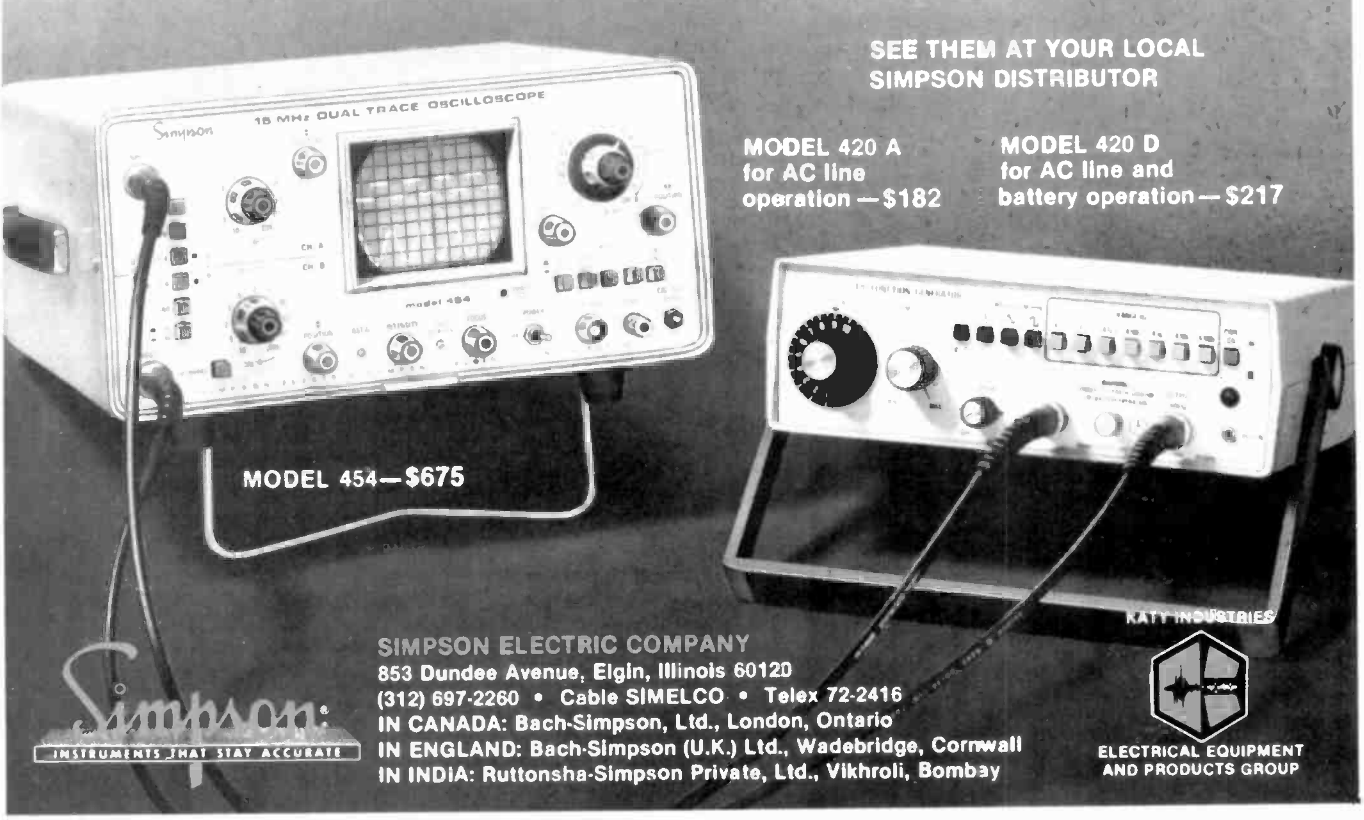

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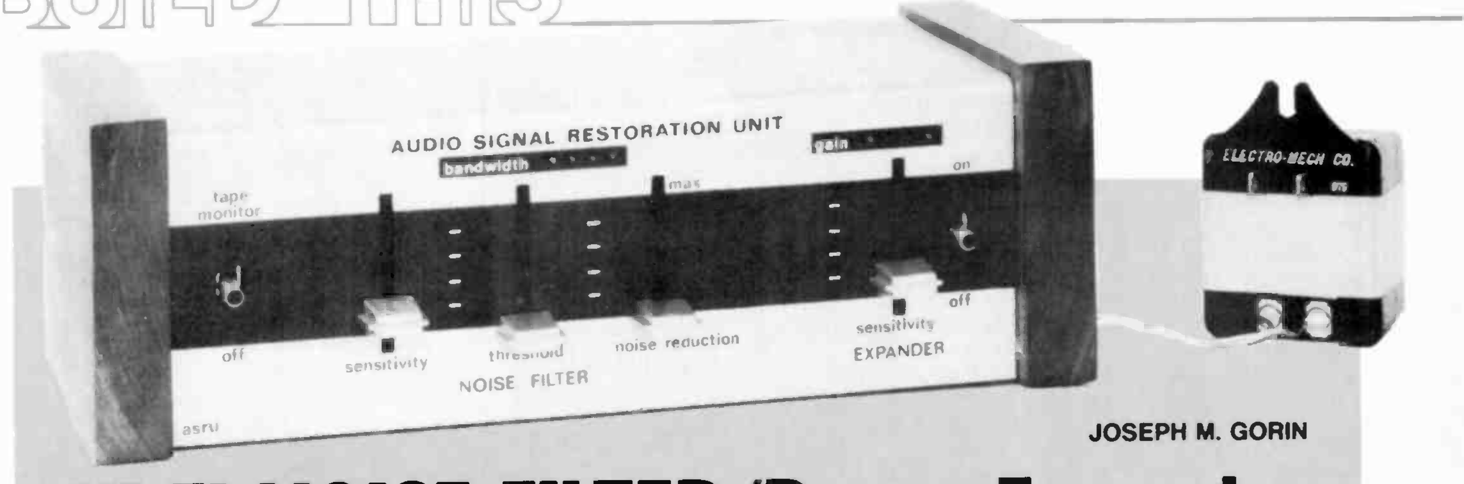

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THE ARTICLE, "NOISE REDUCTION TECHniques," that appeared in the January and February 1981 issues of **Radio-Electronics**, presented block diagrams of commercially available dynamic range expanders and noise filters. That two-part article showed how, by improving the dynamic range of even the best recorded musical signals, expanders and noise filters restore much of the emotional impact that is lost during the recording process. This two-part article will describe the operation and construction of a combination dynamic range expander/noise filter called the ASRU (*A*udio *S*ignal *R*estoration *U*nit).

This month, we will describe the basic operation of the ASRU and provide an in-depth description of how the expander portion of the circuitry works. Next month, we will discuss how the noise-filter circuitry of the ASRU works and provide the construction, installation, and operation details.

The expander—how it works

Like the expanders discussed in the January 1981 issue of **Radio-Electronics**, the expander section of the ASRU makes the low-level signals softer and the loud signals louder, thus providing improved realism and reduced noise. The expansion curve of the circuit is shown in Fig. 1. Note that the total change in gain is about 8.5 dB; the slope is very shallow. It requires over 40 dB of range to change from minimum to maximum gain, for an average expansion rate of about 1.2:1 (the ratio of output-level change to input-level change in dB). The curve shown provides expansion without unnatural side-effects.

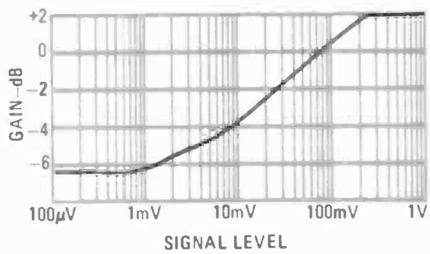


FIG. 1—**EXPANSION CURVE** of the ASRU shows a shallow slope.

A block diagram of the expander portion of the ASRU is shown in Fig. 2.

The first stage sums the right- and left-channel signals coming from the noise filter so that both channels can be controlled together, preventing the stereo image from changing due to variations in signal level in one channel or the other.

The control-voltage filter takes the output of the summing network and attentuates the high- and low-end frequencies to produce an audio signal that approximates the response of the human ear (see Fig. 3). That response is shown by the well-known Fletcher-Munson curves (Fig. 4) that depict the sensitivity of the ear for equal perceived loudness at different frequencies. Note that, at most levels, the ear is significantly more sensitive to midrange frequencies than to high- or low-end ones. In fact, due to the resonance of the ear canal, the ear is most sensitive to sounds in the 4-kHz range.

That midrange sensitivity accounts very strongly for our perception of the loudness of a sound and the control-voltage filter is designed to take advantage of that fact.

The attenuation of both ends of the audio spectrum tends to reduce the effects of noises such as turntable rumble and FM multiplex "hiss."

Furthermore, the steep roll-off at low frequencies prevents low-frequency signals from causing rapid and unnatural-sounding gain changes. That is beneficial because sudden changes in gain during the period of a signal can result in harmonic distortion—something we

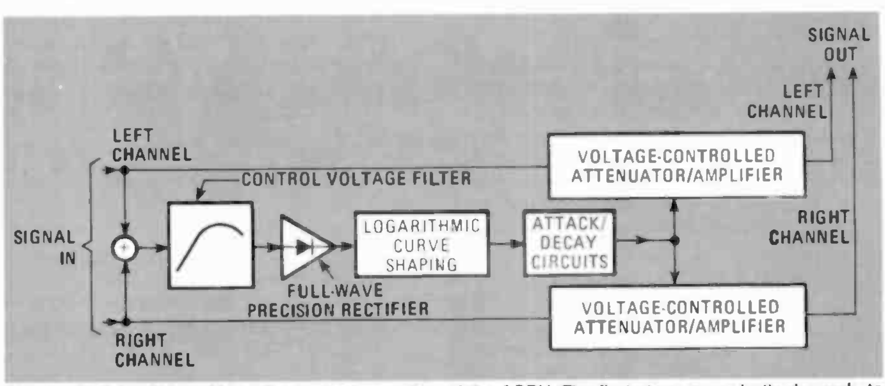


FIG. 2—**BLOCK DIAGRAM** of the expander portion of the ASRU. The first stage sums both channels to maintain stereo imaging.

R-E TESTS IT

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

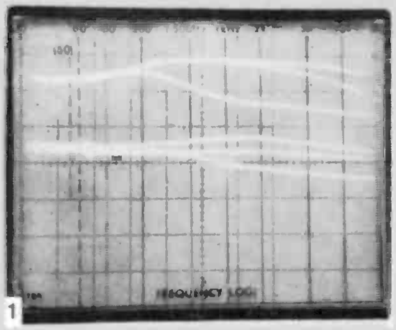
We tested a prototype of the Audio Signal Restoration Unit in our laboratory, using static signals as well as musical program material. As the author suggests, setting up the unit is a bit tricky. To some degree (unless the expander section is turned off altogether), there is some audible interaction between the various front-panel controls on the unit. We found that the best setting for the sensitivity control is such that medium or average loudness-level portions of the program source cause sequential extinguishing of the indicator LED's. The threshold control should be set so that in the absence of any signal, the lowest-level LED flashes only occasionally.

With the expander switch to the ON position, optimum setting of the expander-sensitivity control occurs when the right-hand LED flashes only intermittently. Of course, it is possible to use each section (noise reduction, dynamic filter and expander) as required, to suit program material, but we found that with the controls set as described above, we were able to improve reproduction of most program sources without having to make extensive readjustments every time we altered program material or content.

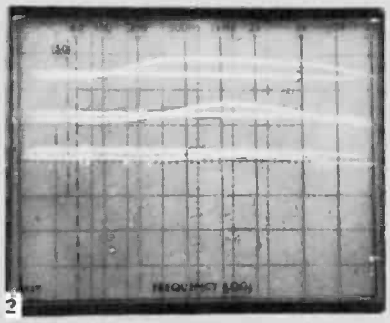
With the expander out of the circuit, and with the unit set for widest bandwidth (no dynamic filtering or noise reduction), overall frequency response of the unit measured flat within ±0.75 dB from 20 Hz to 20 kHz. The unit has essentially unity gain, but that may be varied by means of the input sensitivity control. With 0.5 volt input, we measured a signal-to-noise ratio of 90 dB, IHF "A"-weighted. With both the expander and the noise filter on, total harmonic distortion for a 1-kHz input signal at the 0.5-volt level measured 0.17%. With the expander turned fully off (the threshold control at its minimum position) but the noise filter on, distortion decreased to less than 0.1% for the same test signal.

A series of composite spectrum analyzer sweep photos for the expander/filter/noise-reduction unit is shown in Fig. 1. In both the upper and lower series of sweeps, the expander is on and degree of expansion is varied, as are the noise reduction and filtering action. Note that greater expansion occurs at the higher signal-level (upper traces) and that regardless of the level at which the tests were made, no expansion is evident at the low-bass frequencies.

Figure 2 shows the expander action alone (without any noise reduction or band-filtering action). With the expander turned off, response is flat from 20 Hz to 20 kHz; but with the expander turned on, the degree of expansion for louder passages, less for moderate passages and, in the lower traces, even a bit of downward expansion for quietest passages.



1 COMPOSITE spectrum-analyzer sweep photos for the ASRU.



2 SPECTRUM-ANALYZER sweep photos for the expander alone.

The Audio Signal Restoration Unit operates with very few side effects once it is properly adjusted. By not allowing expansion to take place at the bass frequencies, the designer has overcome some of the pumping and breathing effects common to other linear expanders. The 1.2:1 ratio of expansion is quite moderate, compared with some other commercially available expanders, but nevertheless is sufficient to add a measure of realism to most program material that has been compressed during recording.

As for the variable-bandwidth filters: if used to excess, they can create some undesirable audible effects; but it is possible to benefit from them without suffering such effects if adjustment of threshold and bandwidth is carefully done while listening to program material. We did not find the indicator LED's to be as helpful in setting up the unit as the author had suggested; but we did find that, with a little practice, we were able to use the "ASRU" with just about any component system that is equipped with an ordinary tape-out/tape-play monitor loop. The tape-monitor loop on the amplifier that is used to conect this unit is duplicated on the unit itself, so owners of cassette or open-reel tape decks need not worry about losing it.

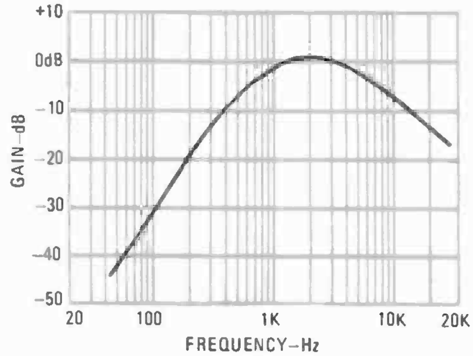


FIG. 3—FREQUENCY RESPONSE of control-voltage filter matches that of ear.

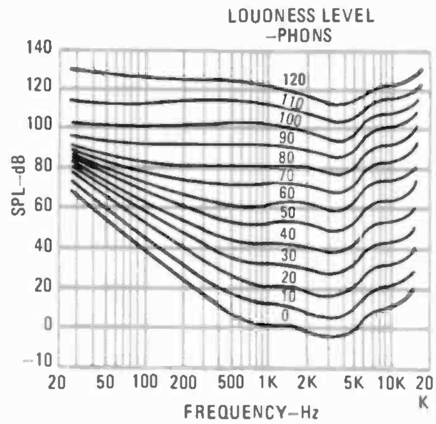


FIG. 4—FLETCHER-MUNSON curves show that the ear is most sensitive to midrange frequencies.

can do without.

The audio from the filter is passed through a precision full-wave rectifier that generates a current used to produce the control signal.

The logarithmic curve-shaping and attack/delay circuits convert that current into a control voltage that is approximately proportional to the logarithm of the current and that section of the expander provides attack and decay times that adjust themselves to the rate of change in signal strength.

Finally, the control voltage is supplied to the voltage-controlled attenuator/amplifier where it is used to modify the qualities of the original audio signal.

The ASRU's expander does not expand signals in the low-bass region as much as it does in others. There are two reasons for that.

First, consider Fig. 5-a, showing a warp or rumble (very-low-frequency) waveform along with a toneburst. As can be seen in Fig. 5-b, at the moment the toneburst is added, the level of the warp signal will increase because the expander will increase the gain and a "thump" will be evident, even though the warp noise alone was inaudible. Figure 5-c shows what happens when the ASRU is used—the "thump" doesn't occur because the action at very low frequencies is minimal.

Second, although the ear is relatively insensitive to very low frequencies—refer to the Fletcher-Munson curves in

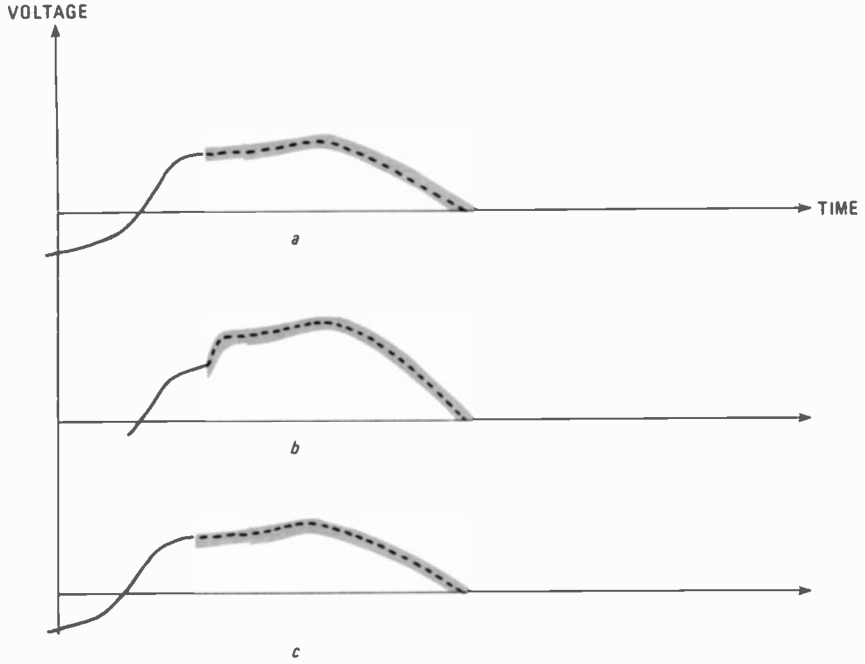


FIG. 5—WARP OR RUMBLE (thin line) with tone burst (thick line). The ASRU (c) eliminates thumps by not expanding such a signal.

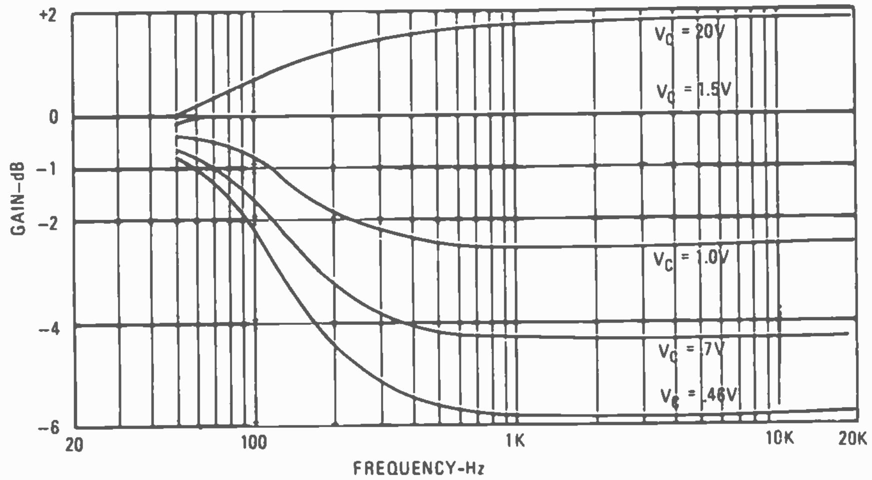


FIG. 6—THE ASRU's gain vs. frequency response curves at varying control-voltages. Note that the low-bass region is not expanded.

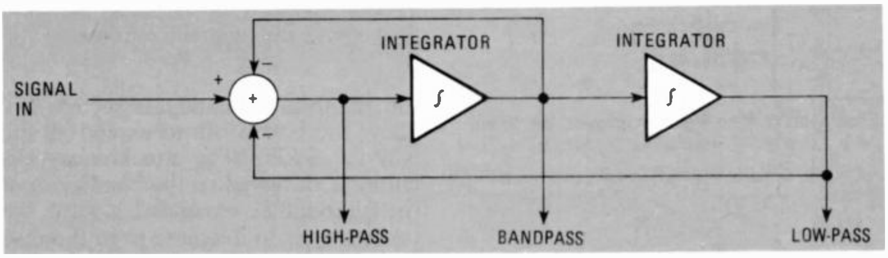


FIG. 7—THE TRIPLE-OUTPUT voltage-controlled filter has two integrators for each channel.

Fig. 4—once their level is above the threshold of hearing, a 2-dB increase appears as great as a 5-dB increase in the midrange area.

For both of those reasons, as well as to keep distortion to a minimum, the ASRU's expander does not expand the low-bass as much as it does the midrange. Figure 6 shows the ASRU's gain vs. frequency response at varying control-voltage levels. Note how well that matches the changes in gain sensitivity shown in Fig. 4.

The ASRU's shallow expansion-slope, midrange-emphasized control-signal and minimized low-bass expansion explain why it is so clean-sounding, while allowing 8.5 dB of effective expansion.

The noise filter—how it works

The heart of the noise-reduction system is a triple-output, voltage-controlled filter, the block diagram of which is shown in Fig. 7. It is a state-variable filter, which means that certain of its characteristics can be modified while others are maintained.

The integrators process the signal for use by later stages of the noise-reduction system (see Fig. 8). For sinewaves, the output is reduced by a factor of two (6 dB) for every octave increase in input frequency. By varying the gain or time-constant of those integrators, or the amount of feedback around them, the corner frequency (the frequency at which the amount of attenuation reaches 3 dB) can be changed without changing the shape of the filter.

Refer to Fig. 8 as we discuss the ASRU noise-reduction system.

If no signal is present, the control voltage sets the corner frequency of the triple-output filter to 1.2 kHz. Figure 9 shows the frequency response of each output of the triple-output filter with the corner frequency set at 1.2 kHz. The overall output of the noise filter is taken from the low-pass output via a buffer. Thus, with no input signal present, any noise will be greatly attenuated.

If a 5-kHz tone is suddenly applied to the input, it will appear unattenuated at the high-pass output and will be greatly attenuated at the low-pass and bandpass outputs. The AC-DC converter connected to the high-pass output will provide a strong signal that will rapidly pass through the attack/delay element and cause the control voltage to increase. As the control voltage increases, the corner frequency of the filter will also increase until it exceeds 5 kHz.

Soon there will be a stronger signal in the bandpass section than in the high-pass section. That is converted to DC and will be fed back and reduce the control voltage. In the case of a steady tone, that action will serve as a feedback loop that forces the bandwidth of the filter to "catch" the input frequency, allowing it to go through the low-pass filter to the output, while the noise above that frequency is filtered out.

Music, of course, is more than just simple tones. The ASRU noise filter will track the highest significant frequency of a complex signal. During a transient—a short, but intense, increase in high-frequency energy—the corner frequency will overshoot slightly. That is desirable, since transients mask noise very well.

If the signal is extremely strong,

PARTS LIST

All resistors ¼ watt, 5% unless otherwise specified

R1, R9, R10, R101, R109, R110, R221, R521,—100,000 ohms
R2-R5, R102-R105, R211, R213, R214, R305, R306, R309, R310, R405, R406, R409, R410, R519, R533, R535—10,000 ohms
R6, R106, R230, R507, R508, R520, R530—20,000 ohms
R7, R12, R107, R112—200 ohms
R8, R14, R15, R108, R114, R115, R205 R501, R502, R529—2200 ohms
R11, R111, R218—36,000 ohms
R13, R113, R201, R208, R209, R212, R215, R220, R222, R229, R513, R522, R528—4700 ohms
R16, R116, R202, R203, R210, R503—10,000 ohms, 30%, slide potentiometer, linear taper
R17, R117, R506, R537—3900 ohms
R204—2700 ohms
R206, R207—1.5 megohms
R216—68,000 ohms
R217, R509—3300 ohms
R219—820 ohms
R224, R307, R308, R312, R407, R408, R412, R514, R531, R532, R534—1000 ohms
R226, R516—270 ohms
R228—150 ohms
R231, R302, R303, R402, R403—270,000 ohms
R232, R304, R404—1200 ohms
R223, R510—6800 ohms
R225, R233, R313, R413, R504—560 ohms
R227, R527—120 ohms
R301, R401, R526, R536—1500 ohms
R311, R411, R525—12,000 ohms
R505—470,000 ohms
R511—910,000 ohms
R512, R515, R517—22,000 ohms
R518, R523—47,000 ohms
R524—47 ohms
R601—1.5 ohms

Capacitors

C1, C3, C5, C101, C103, C105, C201, C202, C204, C506—0.01 µF, 5% Mylar
C2, C6, C7, C102, C106, C107, C503, C504—3.3 µF, 35 volts, electrolytic
C4, C104, C205, C212-C214—0.022 µF, 10%, Mylar
C203—0.001 µF, 10%, Mylar
C206, C208—0.0033 µF, 10%, Mylar
C207, C209—680 pF ceramic disc
C210, C211, C301, C401—10 µF, 25 volts, electrolytic
C215, C505—1 µF, 35 volts, electrolytic
C216, C302, C307, C402, C407, C502—0.1 µF, 5%, Mylar
C303, C304, C403, C404, C501—100 pF, ceramic disc
C305, C306, C405, C406—22 µF, 16 volts, electroytic
C601, C602—1000 µF, 25 volts, electrolytic
C603-C607—0.1 µF, ceramic disc

Semiconductors

D201-D204, D206-D210, D501-D513, D515-D517—1N4148
D205—3.3-volt Zener
D514—4.7-volt Zener
D601-D604—1N4001
LED201-LED204, LED501, LED502—mini-LED (TL209 or equivalent)
Q201-Q203, Q501, Q502—2N3904
Q204-Q206—2N4250
IC1, IC2, IC4, IC7, IC9, IC10, IC11—RC4136 quad op-amp
IC3, IC6—4049 CMOS hex inverter
IC5, IC8—739 dual audio preamplifier
IC12, IC13—78L12A 12-volt positive voltage regulator
L201, L202—6.8 mH coil
T1—13.5 VAC, 350 mA, wall-plug transformer (Dormeyer PS14204 or equivalent)
J1-J4, J101-J104—RCA-type phono jacks
S1, S2—DPDT toggle or slide switch
Miscellaneous: 12-conductor ribbon cable, IC sockets, chassis and end panels, solder, wire, hardware, etc.

The following are available from Symmetric Sound Systems, 912 Knobcone Place, Loveland, CO 80537: Complete kit (ASRU) $110.00; PC boards (ASRU-PC), $18.00. Write for information on assembled units. No other parts or different combinations are available. End panels are unfinished. All prices include UPS shipping within U.S. Colorado residents add 3% tax.

EXPANDER-ONLY KIT

For those requiring only the expander portion of the ASRU, a kit, somewhat different from the one described here, is available from Symmetric Sound Systems. That kit, the EX-1, is priced at $60.00. A bare PC board, the SSS7, is also available for $11.00. See parts list for ordering information. A schematic, parts list, and a diagram for laying out your own EX-1 PC board can be obtained from the above company if a self-addressed, legal-size, stamped envelope (28 cents) is sent along with the request.

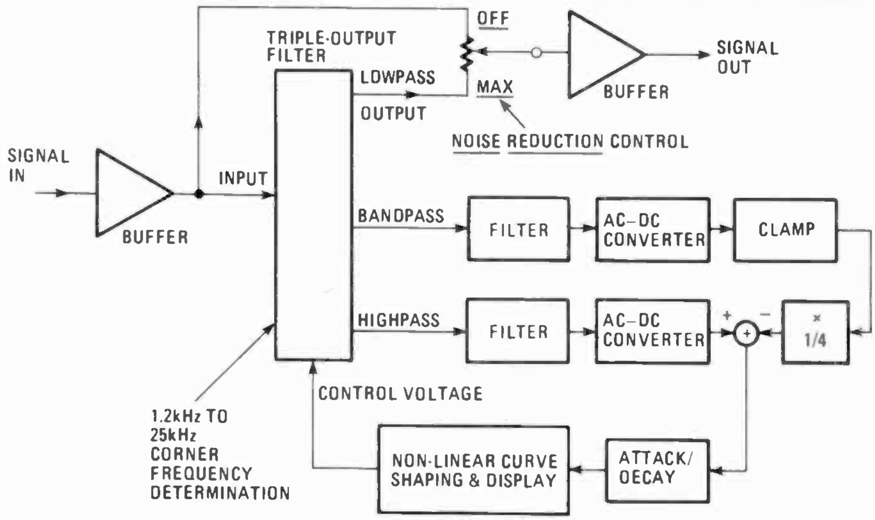


FIG. 8—BLOCK DIAGRAM of the ASRU's noise reduction system. If no signal is present, the corner frequency of the filter is set to 1.2 kHz.

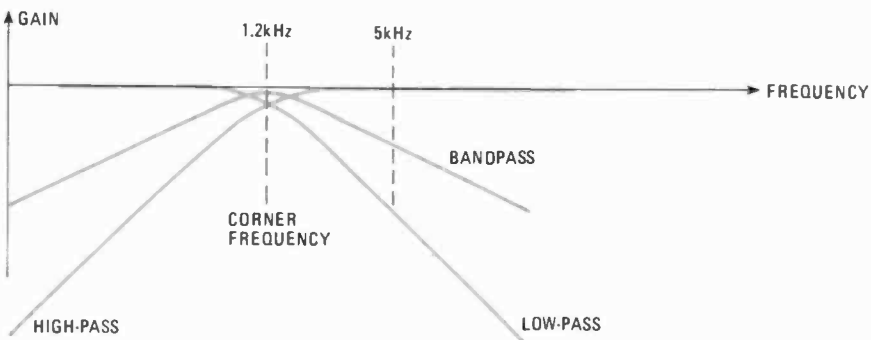


FIG. 9—THE TRIPLE-OUTPUT filter has low-pass, high-pass, and bandpass outputs. The scale here is log-log.

the clamp in the bandpass section will allow the bandwidth to extend all the way to 25 kHz. The attack/decay circuitry is designed so the bandwidth of the filter can be expanded rapidly, but takes longer to decrease than it did to increase. Because of the large amount of feedback used to control the bandwidth, that nonlinear response does not affect the steady-state (constant-level) response, but becomes very important in the case of transients.

As pointed out in the "Noise Reduction Techniques" article in the February 1981 **Radio-Electronics**, one of the advantages of a filter/expander combination is that each section can be adjusted to keep side-effects to a

continued on page 110

NEW DEVELOPMENTS IN JAMMING

With us since radio's early days, jamming stands as the biggest obstacle in the way of fair use of the shortwave broadcast-bands. Here's a look at the current situation.

STANLEY LEINWOLL

WHAT WILL PROBABLY TURN OUT TO BE the most important shortwave broadcasting conference ever held has been scheduled by the Administrative Council of the International Telecommunication Union.

Acting on the recommendation of WARC-79, (World Administrative Radio Conference—1979), the Council has set January 1983 for a shortwave broadcasting WARC that is to establish technical standards and procedures related to planning the use of the shortwave broadcast spectrum. A second session of the BC-WARC is scheduled for October 1984. At that session an attempt will be made to plan the efficient and equitable use of the bands allocated to shortwave broadcasting.

The Conference has its work cut out for it, with a number of major obstacles to overcome before any serious effort at planning can succeed. One of the problems overhanging the Conference like a dark and ominous cloud is jamming. Indeed, many of the world's most competent shortwave broadcasting experts feel that rational planning of high-frequency broadcasting is impossible as long as jamming continues.

To understand fully why jamming and technically feasible high-frequency broadcast planning are judged by many observers to be incompatible, it is necessary to provide some information about jamming, and to describe attempts by jammed broadcasters to overcome it.

Jamming is the deliberate transmission of raucous, irritating noise and other interference on a frequency in order to hamper or utterly destroy the programs of another broadcaster operating on the same frequency.

Jamming doesn't only interfere with the target broadcast; it also degrades the transmissions of broadcasters operating on adjacent frequencies because of its broadband characteristics. Consequently, for each frequency jammed, three are adversely affected, as a rule: the one being jammed, plus the frequency on either side of that one.

During the height of the Cold War, virtually every major Western broadcaster transmitting to the Communist world was jammed. In recent years, however, there has been a decrease in jamming; but it is still a serious blight on the shortwave spectrum. At the present time the USSR and some of its satellite countries are responsible for most of the jamming being observed. Soviet jamming is currently being directed principally toward the broadcasts of Radio Free Europe, Radio Liberty, The Voice of Israel, and the People's Republic of China. In addition, the People's Republic of China jams some Soviet programs beamed to China.

To accomplish their task, the USSR and its satellites have developed a highly complicated and very sophisticated jamming network, consisting of several thousand jammers at hundreds of different locations throughout eastern Europe. It is estimated that it takes about five thousand technicians and administrators to operate the jamming system at a cost far exceeding that of the broadcasts being jammed. Furthermore, the original cost of setting up such a jamming system probably exceeded a quarter of a billion dollars.

There are two types of jammers: local, and sky-wave. Local jammers operate primarily in and around large population centers, usually those with a population of a quarter of a million or more persons. They are generally located so that they overlook the region to be jammed. Local jamming, which is often incorrectly referred to as

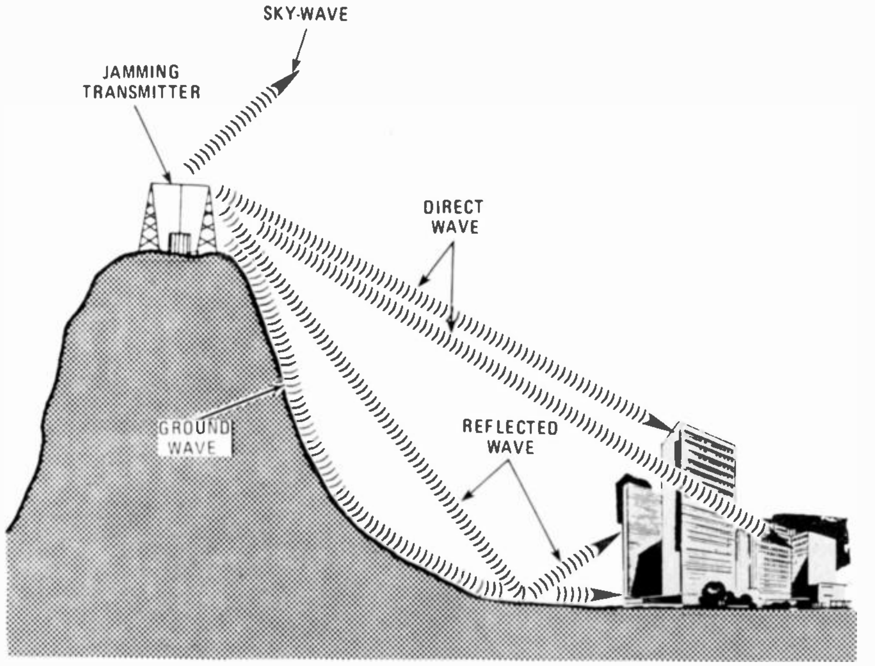


FIG. 1—LOCAL JAMMING consists primarily of a direct wave and a reflected wave. The ground wave is fairly unimportant in this type of jamming.

ground-wave jamming, consists principally of a direct wave and a reflected wave, as shown in Fig. 1. It is evident, from Fig. 1, that ground-wave jamming plays a relatively minor role in the effectiveness of that type of jammer.

The effective range of local jammers depends on the height of the jamming antenna. Although the average range is about 20 to 30 kilometers from the antenna tower, it is obvious that the higher the antenna, the greater the distance the jamming signal will travel. Most local jamming antennas are placed on tall buildings, church steeples, or on hills or mountains overlooking the target.

Depending on the size of the area they must cover, and the number of people in it, local jamming stations have between fifteen and fifty jamming transmitters. Those are of relatively low power, which ranges from 5 kW to 20 kW each.

Sky-wave jammers are used to propagate the jamming signals great distances via the ionosphere. They can cover considerably larger areas than the local jammers, and their principal mission is to blanket areas lying in the rural and suburban parts of a target area that lie beyond the range of the local jammers. That is shown in Fig. 2.

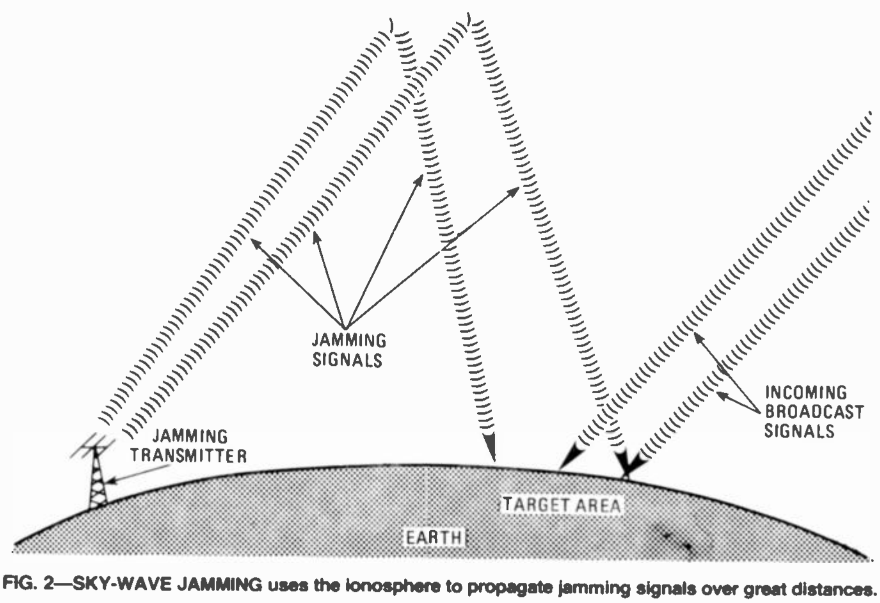


FIG. 2—SKY-WAVE JAMMING uses the ionosphere to propagate jamming signals over great distances.

Sky-wave jamming transmitters are of much higher power than local jammers, being of the order of 50 kW to 100 kW each. The antenna systems used are more sophisticated (rhombics and log-periodic antennas, compared with low-gain broadband dipoles employed with local jamming transmitters.)

Jamming transmitters are modulated in two ways: *white noise* is produced electronically and covers most of the audio spectrum. It is referred to as noise jamming and is very effective.

In *Mayak* jamming, distorted program material is transmitted in lieu of white noise. The word *mayak* means "beacon," which is the name of one of the Soviet domestic home-service programs. It is not unusual to find three or four simultaneous Mayak transmissions, each slightly out of phase with the orders, each distorted, operating on one frequency. They, too, are highly effective.

Over the years, broadcasters whose transmissions were being jammed have tried to overcome its effects in a number of ways. Some of those techniques have failed while others have been highly successful. In order to assess fully the impact of jamming on planning efforts at WARC-83/84, the major anti-jamming techniques will be discussed.

Those anti-jamming techniques include using high-power transmitters of up to 1000 kW, and high-gain, highly directional curtain antennas, by means of which effective radiated powers of more than 100 megawatts can be achieved. That *brute force* technique produces very high signal-levels, on the order of five to ten millivolts-per-meter, delivered to the target areas. Signals of that order of magnitude put considerable strain on the jammers and increase areas in which desired signal strengths are above the jammer noise. That enables listeners to receive the programs.

One of the best methods of countering the effects of jamming is generally known as *saturation-* or *barrage-*broadcasting, in which as many transmitters as possible—each on a different frequency—are massed simultaneously to carry a particular program. Saturation-programming has been quite successful in putting pressure on the jamming system to the point where some of the frequencies being used to transmit a program are either thinly covered by the jammers, or not covered at all.

It is obvious that even in population centers with their own local jamming networks, if more than fifteen transmitters are used to carry a program and the jammer complex has fewer than fifteen jammers, some frequencies will be clear of local jamming.

In the past, when broadcasts of BBC, VOA, Deutsche Welle, etc.

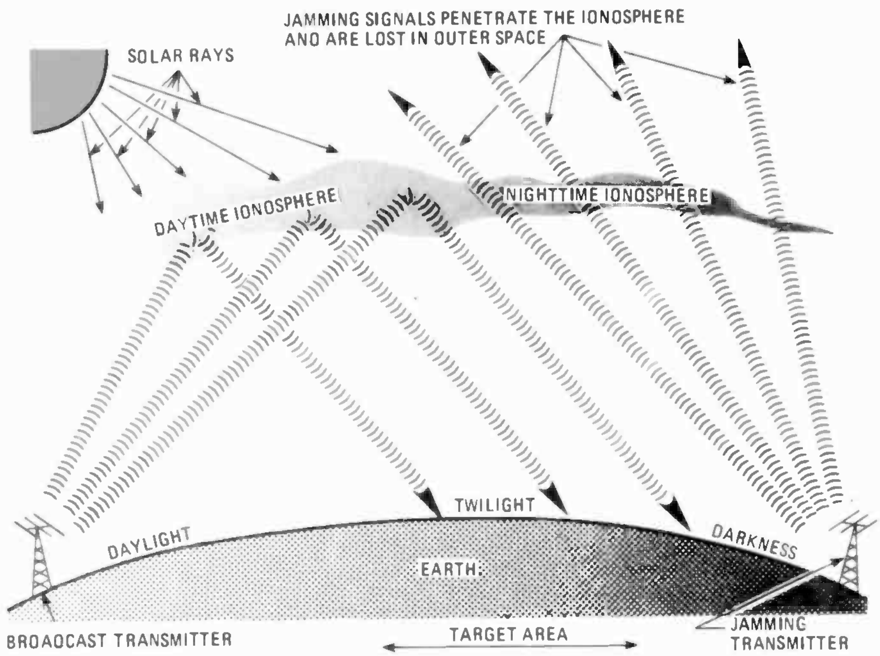


FIG. 3—DURING THE TWILIGHT PERIOD only local jamming is effective because key-wave jamming signals are not reflected by the ionosphere.

were jammed, efforts were made to coordinate programming among them so that the maximum number of frequencies were being used to carry jammed transmissions. That method, when used, was highly successful.

Perhaps the most effective method of all for overcoming jamming is the use of a basic shortwave radio propagation technique usually referred to as *twilight immunity*. During the daylight hours the ionosphere is able to propagate higher frequencies than at night. That is so because radiation from the sun produces ions and free electrons in the ionosphere. The range of frequencies the ionosphere can reflect is proportional to the number of those particles. At night, radiation from the sun is cut off and free electrons and ions begin to re-combine, resulting in a less dense ionosphere, which is capable of supporting only the lower frequencies.

It follows, therefore, that a transmitter to the west of a target area will enjoy a period of several hours in the late afternoon (twilight) when the path between the transmitter and the target is in daylight, but the target area itself is in darkness. That is shown in Fig. 3. During that twilight period as many high-frequency transmissions as possible are scheduled. Examination of Fig. 3 shows that jammers operating via the sky-wave mode are relatively ineffective because attempts to use the higher frequencies are generally fruitless, since those frequencies are not reflected by the ionosphere. During twilight immunity-periods only local jammers are effective. Since there are literally thousands of cities and towns that do not have local jammers, a high degree of effectiveness can be achieved by using the saturation technique.

It is clear at this point that attempts by WARC-83/84 to develop technical standards or to plan the rational use of the spectrum will be severely hampered by continued jamming.

Preliminary planning for the broadcasting WARC has included discus-

A HISTORY OF JAMMING

The Germans are generally credited by radio historians as being the first to use jamming techniques. As early as 1915, they transmitted random characters to disrupt a radioteletype circuit between France and Russia, which were allies during World War I.

In the 1920's, before radio broadcasting was regulated, some broadcasters deliberately transmitted on frequencies being used by competing broadcasters in an effort to drown out their programs. Although some of the interference caused during those early days was accidental, there is no doubt that much of it was intentional.

The first case of political jamming occurred in the mid-1930's before the German-Austrian *anschluss*. The government of Chancellor Dolfuss of Austria jammed some Nazi-German broadcasts to Austria that were critical of that country. The Nazis themselves were quick to recognize the effectiveness of jamming to keep out unfavorable comment, and the Spanish, French, Russians, Japanese, and Italians soon followed suit.

Jamming increased in intensity and effectiveness during World War II, being used as a military weapon, both to keep out unwanted broadcasts and to disrupt military circuits. The Germans jammed broadcasts of the BBC extensively, and the escape to the open seas of the German warships *Scharnhorst, Gneisenau,* and *Prinz Eugen,* under the nose of British artillery, was possible because the Germans effectively jammed British radar installations overlooking the English Channel.

With the advent of the Cold War after the conclusion of World War II in 1945, jamming flourished to an extent that had not been dreamed of before. The Russians jammed programs in the Russian language that were beamed to the USSR from Franco Spain, and the Spanish, in turn, jammed Spanish-language broadcasts emanating from the Soviet Union.

In early 1948, however, a jamming effort was begun by the Russians that dwarfed anything that had been attempted before. In February of that year a dozen or so Russian transmitters were used to jam the Russian-language programs of the Voice of America. The Russian-language broadcasts of the BBC were jammed shortly thereafter, and by 1950, over 450 such jamming transmitters were in operation.

Although we have no way of knowing for certain, it appears that the decision to launch a massive jamming campaign was two-pronged: first, it was a method of keeping control of the information monopoly within the USSR, where total censorship of news from external sources was the policy. Second, jamming could be used militarily, as had been demonstrated in World War II, and by operating large numbers of jammers the military jamming-machine was kept well oiled.

By the end of 1951, most of the other countries in the Communist orbit had commenced jamming operations of their own against Western broadcasts; and in the beginning of 1952, over 1,000 jamming transmitters were in continual operation.

By 1956, between 2,500 and 3,000 jamming transmitters were in operation against most major Western broadcasters, with particular attention to Radio Free Europe and Radio Liberty, which had begun broadcasting in 1951 and 1953 respectively.

On November 24, 1956 the first break in the electronic curtain occurred when jamming directed against RFE Polish-language broadcasts abruptly ended after a series of riots in the Polish city of Poznan, and the coming to power of a new Polish leader, Ladislaw Gomulka.

The Polish press had been complaining vociferously about jamming, and there is considerable evidence to indicate that the people of Poland resented it. That is supported by the fact that during the first hours of the Poznan riots the local jamming station in that city was destroyed.

The hiatus in jamming against RFE Polish-language programs lasted 14 years. In 1970, following food riots in the north of Poland, jamming against RFE Polish programs was hastily resumed. Apparently caught off-guard, Polish authorities ordered that transmitters being used by Radio Warsaw in its external shortwave broadcasting service be redeployed and operated as jamming transmitters. Until jamming transmitters became available, Radio Warsaw international service was sharply curtailed.

Additional major breaks in the jamming pattern began in June 1963, when jamming directed against BBC and VOA broadcasting in the languages of the USSR, including Russian, were discontinued shortly after the conclusion of an atomic test-ban treaty. That marked the first time in 15 years that those programs were unjammed, and were another indication that a thaw in the Cold War had occurred. In July 1963, Romania stopped jamming all Western broadcasts; in February 1964, Hungary followed suit.

Two months later, Czechoslovakia stopped most jamming of BBC and Voice of America programs, but continued jamming RFE.

However, jamming can be turned on and off at the discretion of the Communist bloc; therefore, the situation proved to be temporary. On August 21, 1968, 200,000 Warsaw Pact troops invaded Czechoslovakia and within hours massive jamming of VOA, BBC and Deutsche Welle was resumed. It continued until 1973, when it was again discontinued.

The jamming transmitters no longer being used against BBC and VOA broadcasts were not taken out of service. Relations between the USSR and the People's Republic of China had worsened in 1973, and many of the jamming transmitters were rescheduled against Peking transmissions in Russia to the Soviet Union.

In addition, the Soviets had launched a major jamming effort against the Voice of Israel, whose broadcasts to the Soviet Union called for a more liberal emigration policy toward Soviet Jews—a position not greeted with enthusiasm by the Soviet Politburo.

At the present time, all Radio Liberty programs beamed to the Soviet Union are jammed. In addition, Radio Free Europe programs in Bulgarian, Czechoslovak, and Polish are jammed. Radio Free Europe programs in Hungarian and Romanian are not. Deutsche Welle programs in Bulgarian are jammed and Voice of Israel broadcasts to the USSR in Russian, Hebrew, and Yiddish are jammed, as are People's Republic of China transmissions to the USSR in the Russian language.

On August 20, 1980, the Russians resumed jamming of the Voice of America, BBC, and Deutsche Welle. The resumption of jamming, after seven years, was generally thought to be due to growing labor unrest in Poland, and the Russians' fear that it could spread to the Soviet Union. BBC and Deutsche Welle programs in Russian were affected. Voice of America broadcasts in Russian, Ukrainian, Uzbek, Armenian, Latvian, Lithuanian, and Estonian were hit by noise jammers and *Mayak* jammers.

sions of power limitations, limiting the number of frequencies per transmission, protection ratios, and the gradual introduction of single sideband to the broadcasting service.

Evidently, rational planning in the face of jamming is a paradox. In addition, jamming against broadcasters such as the BBC and Voice of America can resume at any time, since the USSR has demonstrated in the past that it can turn jamming on and off like a faucet.

The United States is eager for the BC-WARC to succeed because this country firmly believes in the rational, equitable use of the high-frequency broadcast spectrum. It is a certainty, therefore, that U.S. planning for WARC-83/84 will emphasize the technical standards and planning necessary to a successful conference. However, it would be naive to assume that the ugly specter of jamming does not loom over the Conference, or that it will not be a major impediment to its successful conclusion.

At WARC-79 the United States expressed its grave concern about jamming by entering a formal reservation when it signed the Final Acts of the Conference. This reservation states:

"The administration of the United States of America, calling attention to the fact that some of its broadcasting in the high-frequency bands allocated to the broadcasting service is subject to willful harmful interference by administrations that are signatory to these Final Acts, and that such interference is incompatible with the rational and equitable use of these bands, declares that for as long as this interference exists, it reserves the right with respect to such interference to take necessary and appropriate actions to protect its broadcasting interests. In so doing, however, it intends to respect the rights, to the extent practicable, of administrations operating in accordance with these Final Acts." **R-E**

What's News

New software systems to spur office automation

Lack of integration is possibly the greatest weakness in the present rapid automation of office systems. Too often many of the benefits of partial automation are not realized. For example, a word processor may be obtained, but remain isolated from existing automated facilities, such as machine dictation, telephone, and facsimile.

By the mid-1980's, reports Frost & Sullivan, Inc., international business research reporters, that piecemeal approach to business automation will be replaced by general systems offering a broad and integrated range of facilities: text editing, report formatting, teleconferencing, mail calendar, on-line data access, statistical analysis, dictation, telephone services, document and information retrieval, dictionary, and other services.

Hardware components for such systems, says F & S, are already available. Software is the primary bottleneck. Three fundamental challenges must be faced by software for future automated office systems: adaptability to changing user needs, suitability to extensive customization, and conformability to existing office practices (rather than vice versa).

New fusion-reactor concept

Hope for an earlier solution of the problem of nuclear fusion is being held out by scientists of the University of Wisconsin. Their new conceptual nuclear reactor design—which is yet to be tried out experimentally—is called WITAMIR (Wisconsin Tandem Mirror). They believe that WITAMIR has many advantages over TOKAMAK, the Russian design up to now considered the most promising.

The new concept calls for a magnetic confinement vessel as long as a football field and roughly ten yards in diameter. Magnets would be positioned along the length of the chamber, and several extra coils placed at each end to reduce plasma leakage.

It is those extra coils, which create electrostatic and magnetic potentials that hold the plasma in the long central tube, that give the new concept an advantage over earlier ideas. "It is the first tandem mirror design that could produce electricity cheaper than a Takomak, and be easier to build and maintain," according to Gerald Kuchinski, leader of the University of Wisconsin's fusion-research program.

ELECTRONICS IN YOUR NEXT CAR

Electronic self-diagnostics are taking the guesswork out of auto repair, and that should make you, and your mechanic, a lot happier.

MARTIN BRADLEY WEINSTEIN

THIS IS THE FINAL INSTALLMENT IN OUR series on electronics and automobiles. This month we'll take a look at how electronics are helping carmakers design-in self-diagnostics that aid the service and repair operations every car eventually requires.

An interesting concept in auto service is being developed at the General Motors Service Development Center at Warren, MI. When you buy a new car, the selling dealer installs a small, inexpensive radio transmitter that sends out a signal with your personal code.

When you reach the dealership and drive up to the service garage, a receiver reads the code. The garage door is opened and the code is passed to a computer where your service records are stored.

By the time your car is in the door, the service technician knows who you are and has a complete service record of the car, including a flag on any recalls. The computer terminal even prints out your repair order, saving another aggravating delay.

That personalized code, by the way, would be your vehicle's VIN (*V*ehicle *I*dentification *N*umber). New Federal requirements are increasing it from 13 digits to 17. There may be an added benefit in transmitting that code: it would make police recovery of stolen vehicles much easier. Unfortunately, it would also make computerized ticketing for such offenses as speeding a technological breeze.

Check engine

A new telltale signal (idiot light) is showing up on car dashboards. It reads CHECK ENGINE, or something very close to it (Fig. 1). James G. Vorhes, General Motors Vice President in charge of Consumer Relations and Service, explains why it's there:

"The *Computer Command Control* system (see Fig. 2—editor) has been on most of the GM gasoline-engine automobiles in California since the start of the 1980 model year and will be on nearly all cars sold in this country in the 1981 model year. It's the largest new use of computer controls in the history of the industry and we will be prepared for it.

"One of the most exciting features of the system is its ability to automatically diagnose the cause of any malfunction. We have designed-in an extremely high degree of reliability. Like all systems, it can malfunction. But, unlike other systems, it will help diagnose itself.

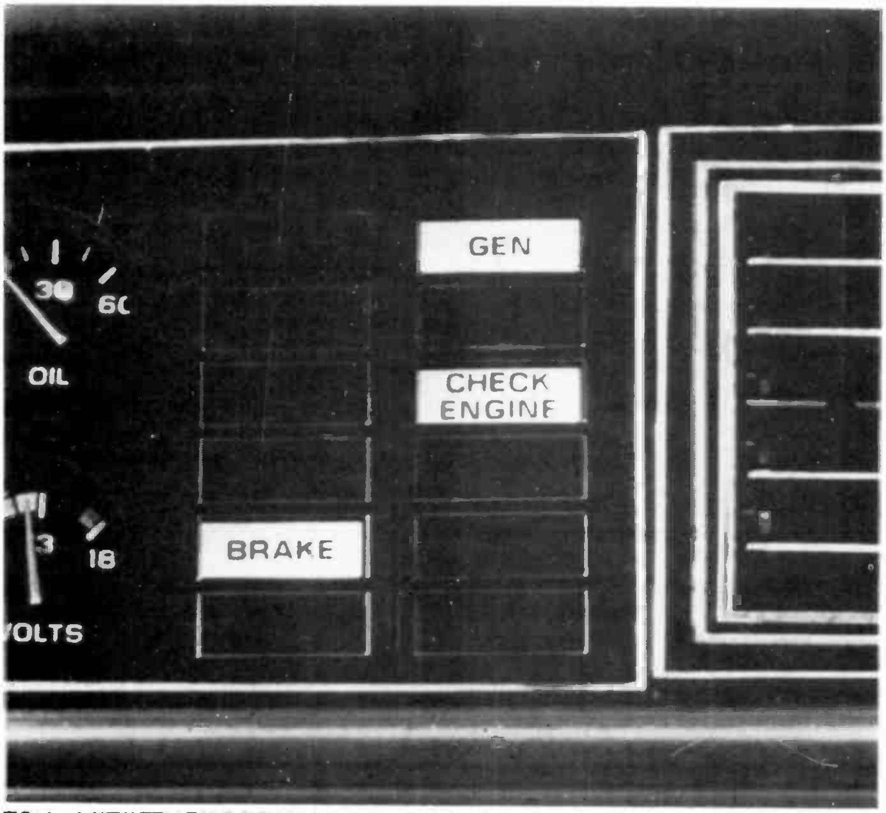


FIG. 1—A NEW TELLTALE SIGNAL informs motorists of a malfunction. It's part of GM's new Computer Command Control system.

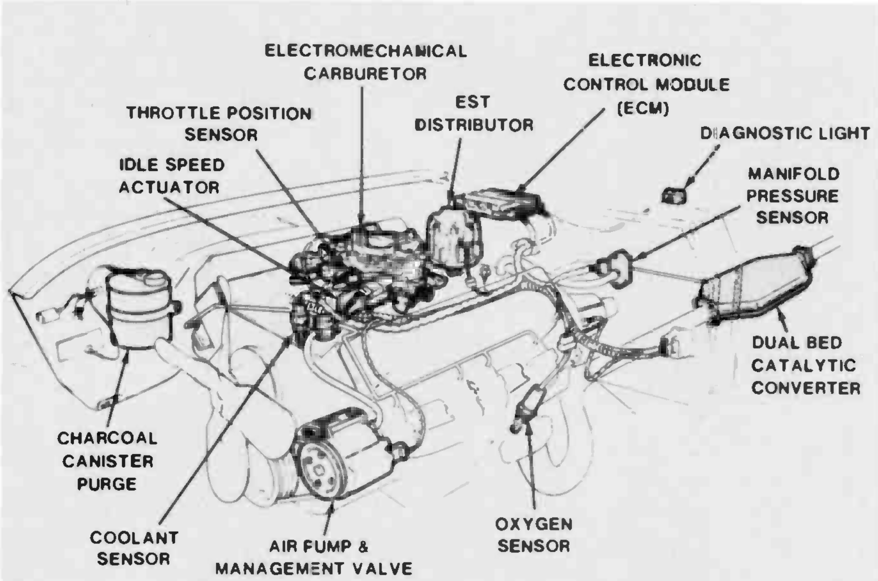


FIG. 2—KEY FEATURES of GM's Computer Command Control system. It is offered on nearly all of their 1981 cars.

"Mechanics will not have to become electronic engineers to work on the system. In fact, there will be no need for expensive computer testers. All a mechanic will need is an ordinary dwell meter, a test light, some jumper wires, a vacuum source, a tachometer, and a digital voltmeter. Most shops already have this equipment. Any qualified technician who can work on current engines will be able to fix one equipped with the system."

The CHECK ENGINE light is there to aid both the motorist and the mechanic. When it lights, indicating a malfunction, the motorist will still be able to drive the car in for service. Once there, the *Computer Command Control* system tells the technician which system may have the problem by flashing a code. Then the technician goes through a simple factory-provided diagnostic routine to determine whether the component, a wire, or a connection is at the root of the problem.

Self-test at Ford

"Self-test in its various forms is going to reduce diagnostics to the very simple goal of determining which part is bad. We, the industry, are headed that way."

That's the forecast of Walter Doelt, the fellow at Ford in charge of this area. **Radio-Electronics** was privileged to enjoy an exclusive interview with Mr. Doelt dealing with a wide range of subjects relating to the role of electronics in designing a car for serviceability. Ford's commitment to microprocessors is very strong.

"They provide the best economic approach to providing the widest degree of freedom in control strategy, and to very flexible control systems. The key is mandated performance requirements versus drivability."

Mandated performance requirements include emission and fuel economy goals, both in terms of government regulations and corporate marketing and design objectives.

Mr. Doelt continued:

"When implemented with a microprocessor, you can freeze the basic design early in the design cycle, then work the calibration in software later."

Ford has been working to reduce the component count in their various on-board systems (engine control, dashboard, etc). Systems that used seven or eight IC's in 1978 were down to four in 1979, two in 1980, and should be down to one in the near future. Since the majority of failure modes are in the interconnections of IC's, single-IC microprocessors are very popular.

The 6800 series (6809, etc.) is used for Ford's advanced *Electronic Message Center* dashboard. The 8048/8049 series is used for engine control where continuous timing is not required. The company also uses a number of custom circuits in integrated control systems (ignition, carburetion, fuel metering, and carburetor feedback) in their top-of-the-line models. Motorola, Intel, Toshiba, and Texas Instruments are among Ford's suppliers.

For example, 1980 models sold in California included a new feedback carburetor design using an Intel 8048; earlier designs used a number of discrete analog IC's and devices. By incorporating the 8048, Ford was able to include a limited self-test feature.

Lead times

One important point about new developments is that it takes time to incorporate them. For example, 1981 model year cars were introduced in October of 1980. The pilot runs of those cars began in July 1980. The control units to go into those pilot production vehicles had to be built by late March 1980. So the microprocessors had to start as silicon slices way back in December of 1979, with design requirements frozen even earlier. But each year brings more advancements.

STAR performance

One of the most intriguing aspects of the Ford self-test system is the way the under-hood microprocessor "talks" to the service technician: it uses a digital code of ½-second pulses, ½-second apart, with two seconds between digits.

That pulse timing was decided on to let any service technician read the code with just a VOM. But there's a nice alternative called STAR (*S*elf-*T*est *A*utomatic *R*eadout) shown in Fig. 3. That handheld, calculator-sized gadget translates the pulses and displays the result on a two-digit LED readout. The self-test sequence can be initiated from a front-panel pushbutton. A readout of "11," for example, translates to "test complete, everything normal."

The STAR costs about $70. They're being built for Ford by the Hickok Electrical Instrument Company. Hickok also sells an inexpensive DMM to Ford for their service technicians.

One feature of the Ford self-test system is that it's designed so all systems test the same way, no matter which model is being examined. There are also a number of universally-applicable manual test operations.

For example, a testing unit will read the voltages at various sensors through a selector switch. The switch setting, selected sensor and anticipated voltages are the same from vehicle to vehicle. Another example is that any vehicle's self-test sequence will, at a given point, call for an EGR (*E*xhaust *G*as *R*ecirculator) flow of 30%, then check the position sensor on the throttle body. At other points, hydrocarbon and carbon monoxide exhaust tests will be performed, both at idle and, with the engine unloaded, at some higher RPM.

Testing on demand in that way is well within the capabilities of both engine and electronic technology. Just beyond is the goal of full-time testing, where a car monitors its own performance periodically during normal driving.

Noise and interference

The biggest problem EMI used to cause in a car was noisy radio reception. But today, with multiple microcomputer systems and miles of harness wire on board, anti-EMI measures are a high priority in design.

Communication links between modules are designed for very low impedance. Modules are housed in metal enclosures, with both the top and bottom grounded. Measurements from analog sensors are performed ratiometrically to make them less sensitive to power-supply variations. Sensor wires are very carefully routed, especially around ignition areas. Diode and capacitor buffering is used on all I/O lines. Roll-off filters block higher and lower frequency signals. And the buzzer has become obsolete.

FIG. 3—SELF-TEST AUTOMATIC READOUT, or STAR, translates a diagnostic pulse string into an easily read fault code.

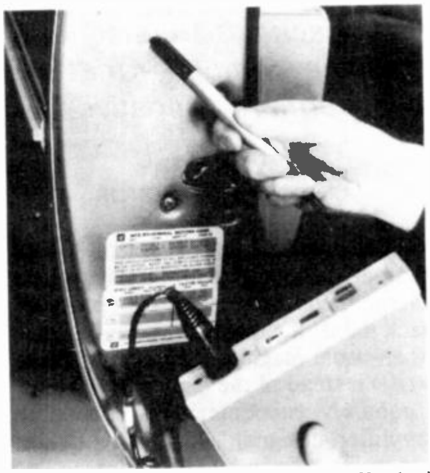


FIG. 4—THE VIN (Vehicle Identification Number) can be written as a bar code that may be read by a portable data terminal.

Buzzers created tremendous noise problems, generating harmonic-filled spikes with hundreds of volts in them. Now they're being replaced with electronic tone and chime generators that, surprisingly, cost about the same

Ford and others are taking a serious look at fiber optics as a possible answer to many noise problems but, in Walter Doelt's opinion, they won't be incorporated until there is some significant improvement in the cost of material, the cost of terminations, and the performance of optoelectronic links.

Another area being explored is the digitization of position sensors. That permits both noise reduction and the reduction of wiring through time-division multiplexing.

In the near future, non-volatile RAM will be used more and more, especially since it permits alterable test criteria as improvements are developed. Also, the lower cost of momory is going to permit designers an enormous increase in program lineage, with 10K chunks of ROM replacing each 1K available today.

One important question is what happens in the fail-fail mode? What if the computer crashes so badly that it can't even yell for help? The answer is that all systems are designed so that in any event of computer failure, the car keeps going. Those "baseline conditions" may keep the engine running, but there's no way the driver can fail to notice that there is a problem. The car bucks, surges, gurgles, and wheezes like a sick hippo. And yes, that "reduced drivability" is also designed-in.

GM developing the TOUCH

The theory is that explaining a problem is the biggest part of solving it, or, as expressed in a recent GM press release, "... once a symptom is accurately described, there is one set of most probable causes." Either way, the idea has led to a system being developed by GM called TOUCH (*T*ouch-*O*perated *U*niversal *C*ommunications *H*elper).

TOUCH is a computer system that asks a customer questions about his problem, and uses each answer to formulate either a new question or a "hunch" as to what the problem might be. And it can even be used when the repair facility is closed.

The customer could, for example, drop his car off at night. TOUCH might look very much like a 24-hour banking terminal. If the car is making a noise, TOUCH might ask where it's coming from and display a picture or diagram of the car to help the customer describe the location. It could ask what the noise sounds like, prompting the customer with either descriptive words, recorded sounds, or a sound-effects generator. Then it might ask if the noise happens all the time, or just when climbing a hill, coasting to a stop, turning a corner, or whatever.

Then, if the customer has described a squealing sound that comes from the front of the car during turns for example, TOUCH would print out a repair order telling the technician to check the power-steering pump belt for slack. You put your keys in an envelope and TOUCH takes them, gives you a receipt, and tell you when your car should be ready.

More future goodies

That 17-digit VIN we mentioned earlier appears in more places this year, and it will appear on still more in the future. GM is translating it into a bar code so it can be read by wands and portable data terminals (Fig. 4). In addition to helping identify cars being recalled for various reasons, the service history of an individual car, and even the identification of its owner, the VIN is important in recovering stolen cars. As it appears on more and more major components—such as engine blocks, frames, and glass—it makes it easier for law enforcement operations to locate

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ANTI-NEGATIVE FEEDBACK FOR HI-FI AMPLIFIERS

High levels of negative feedback can actually add to dynamic distortion. Here's a look at a totally new amplifier that uses power MOSFET's and eliminates conventional negative-feedback circuits.

LEN FELDMAN
CONTRIBUTING EDITOR

WHEN NEGATIVE FEEDBACK WAS FIRST used in an audio amplifier, back in the early days of vacuum tubes, it seemed as though it would be the panacea for all audio-distortion problems. Add 20-dB of negative feedback to any old amplifier having a harmonic distortion level of 10% and presto, the distortion drops to 1.0%. Add another 20 dB to that, for a total of 40 dB, and distortion is reduced by another whole order of magnitude, to 0.1%. Of course, with each addition you lose 20 dB of gain or so, but that's easily made up by adding extra stages of amplification that are not all that expensive.

The age of solid-state electronics made the application of high levels of feedback even more attractive to design engineers. After all, the transistor is not the most linear of amplifying devices (and is therefore better suited to switching applications than it is to linear audio-amplification service), and feedback could be used to cover a multitude of sins. Unfortunately, as engineers found out much later, it could also introduce new sonic aberrations to audio amplifiers—defects that were not apparent from static single-tone bench measurements but were definitely audible when the amplifiers were called upon to amplify real-world music signals. By now, all of us have read about transient intermodulation distortion, and other forms of dynamic distortion, that are aggravated through the use of inordinately high amounts of negative feedback.

It is not surprising, therefore, that many manufacturers of audio equipment, both here and abroad, have been addressing the problems associated with negative feedback and finding ways to eliminate those problems. Some companies, such as Lux Audio and Onkyo have come up with double feedback loops, the first of which is of lower -than-usual magnitude (typically, 30 to 40 dB instead of the higher 60 to 80 dB commonly encountered in solid-state amplifier designs), while the second, generally referred to as a servo-DC feedback loop, addresses the problem of feedback in the infrasonic region. That helps to stabilize DC-amplifier designs, reduce DC drift, and act as a subsonic filter all at once.

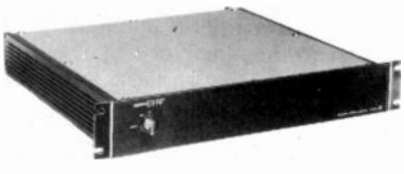

FIG. 1—MONAURAL power amplifier, the *model TA-N900* from Sony does not use negative feedback.

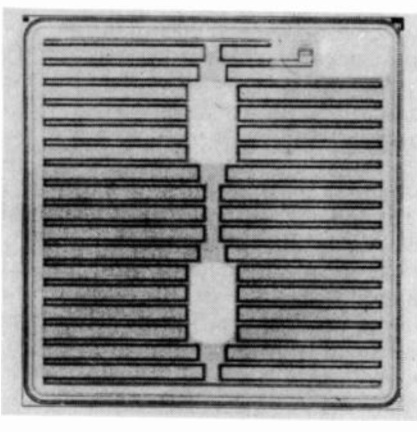

FIG. 2—HIGHLY-MAGNIFIED view of the new MOSFET chip.

Still other companies, such as Sony Corporation, have taken a different approach. At the recently held Tokyo Audio Fair, they introduced a new high-quality monaural power amplifier, called the *model TA-N-900*, pictured in Fig. 1. That amplifier uses an entirely new circuit that eliminates the conventional negative feedback circuit used in other amplifiers. One of the developments that makes it possible is the new 2SK173 power MOSFET recently developed by Sony. Figure 2 shows a highly magnified view of the chip used in the construction of that power MOSFET while in Fig. 3 we see a cross-sectional diagram.

Similar to a standard FET, a power MOSFET has a high input impedance and low storage time. It is characterized as having a wide area of safe operation and high reliability. The double diffusion type power MOSFET developed by Sony also has a very high gain and a high maximum rated voltage of 210 volts. As can be seen in Fig. 3, the drain of the MOSFET is at the same potential as the case so that there is no increase in capacitance between the drain and heat sink (when used as a source follower) and no degradation in frequency response.

A simplified partial schematic diagram of the amplifier circuitry is shown in Fig. 4. The first predriver stage consists of a differential-input double-cascode bootstrap circuit, using junction FET's and bipolar transistors. It has been designed so that high-frequency distortion caused by non-linearity of the FET's is reduced to minimum limits and also to achieve thermal stability through the use of a cascode-connected

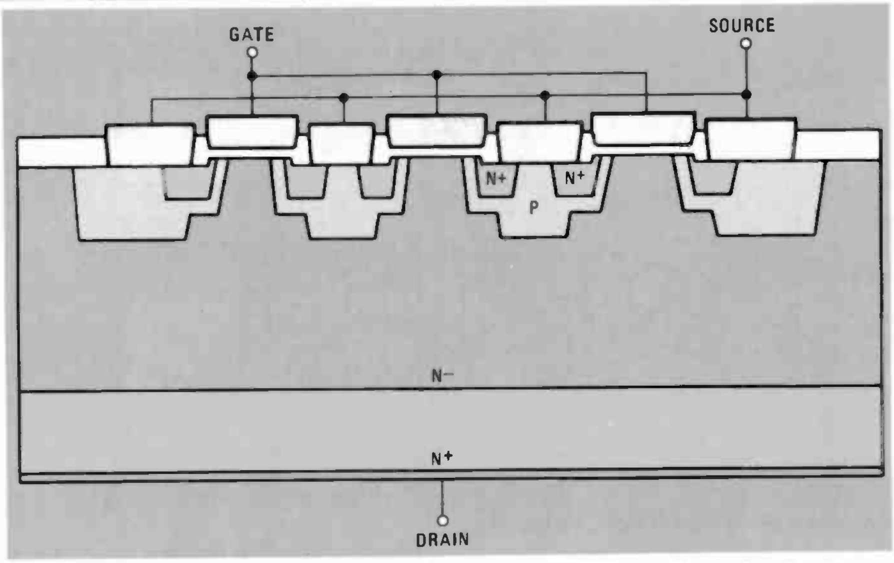

FIG. 3—CROSS-SECTIONAL diagram of the 2SK173 power MOSFET recently developed by Sony.

current-mirror load and finally to improve power-supply ripple-rejection characteristics.

The second stage consists of a cascode bootstrap inversion-amplifier using a bipolar transistor. It provides good linearity and, like the first stage, features high power-supply ripple-rejection characteristics. The final stage of the prepower stages is a complementary emitter follower single-ended push-pull output circuit. All stages up to that point have light loads and are isolated from the speaker load and the power stage, so that there can be virtually no problems caused by reactive output loads. As a result, negative feedback can be used around those stages without affecting power-stage performance.

The power-output stage itself is a source follower single-ended push-pull output circuit using four of the new power MOSFET's connected in parallel. The driver stage has a distortion-reduction circuit that compensates for the nonlinear characteristics of the output devices. The power MOSFET's operate in the Class A mode.

As can be seen in Fig. 4, there is no negative-feedback loop from that power stage to the pre-power/driver stages. Despite the lack of an overall loop-feedback circuit, the amplifier is able to achive remarkably low distortion figures less than 0.05% THD at 200 watts output into 8-ohm loads and less than 0.05% IM distortion for the same output. The 200 watts rating applies to all load impedances from 8 ohms down to 2 ohms. In the direct-coupled mode, frequency response remains flat from DC to 100 kHz, −3 dB. Damping factor, normally one of the first parameters to suffer in the absence of high amounts of loop feedback, remains a high 50 (referred to 8 ohms) and slew rate is an impressive 150 volts-per-microsecond.

Pulse-locked power supply

Since a power amplifier is called upon to transfer high levels of currents into a

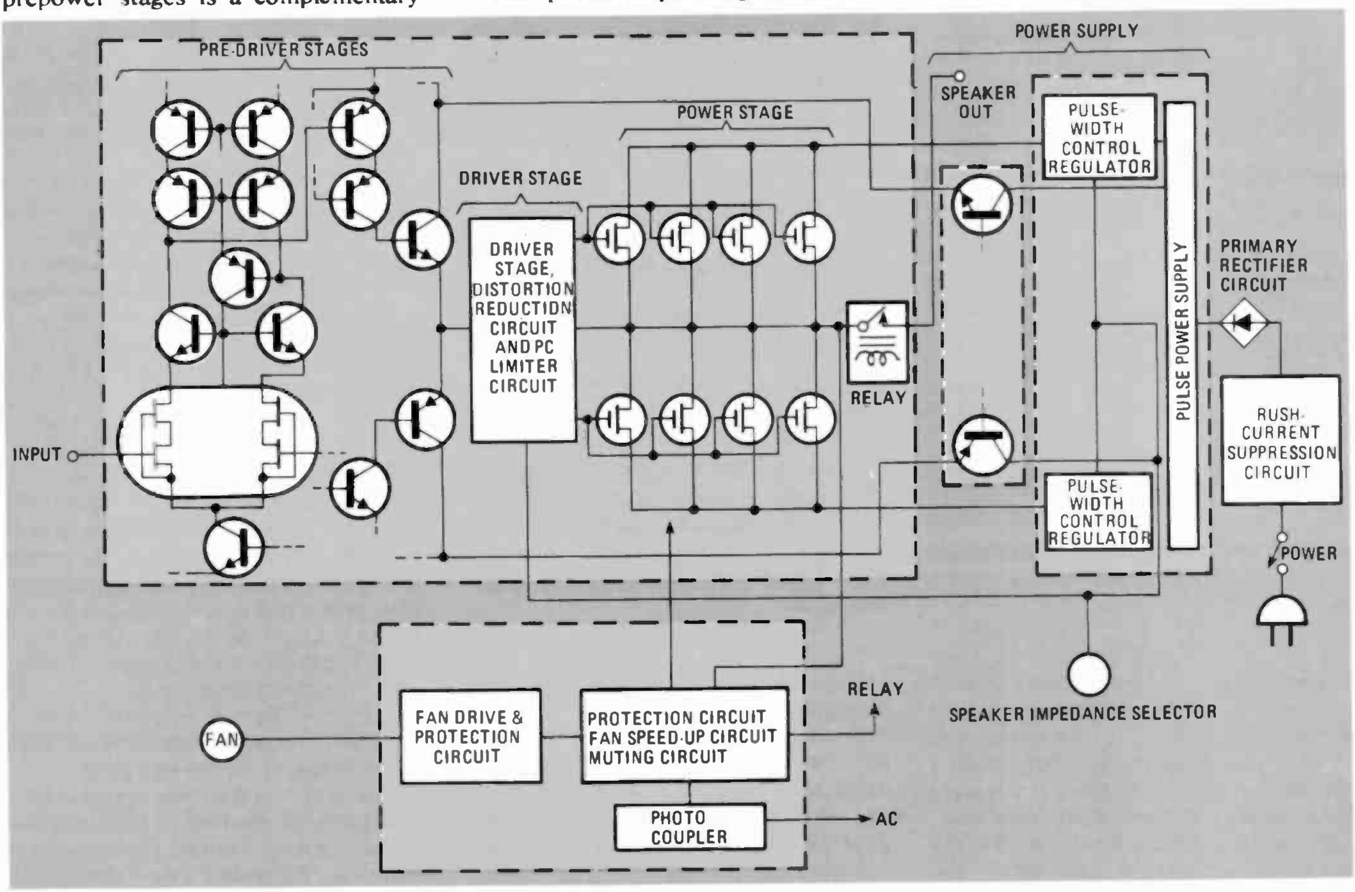

FIG. 4—THERE is no negative-feedback loop in the *model TA-N900*, as can be seen in this simplified schematic of the amplifier circuitry.

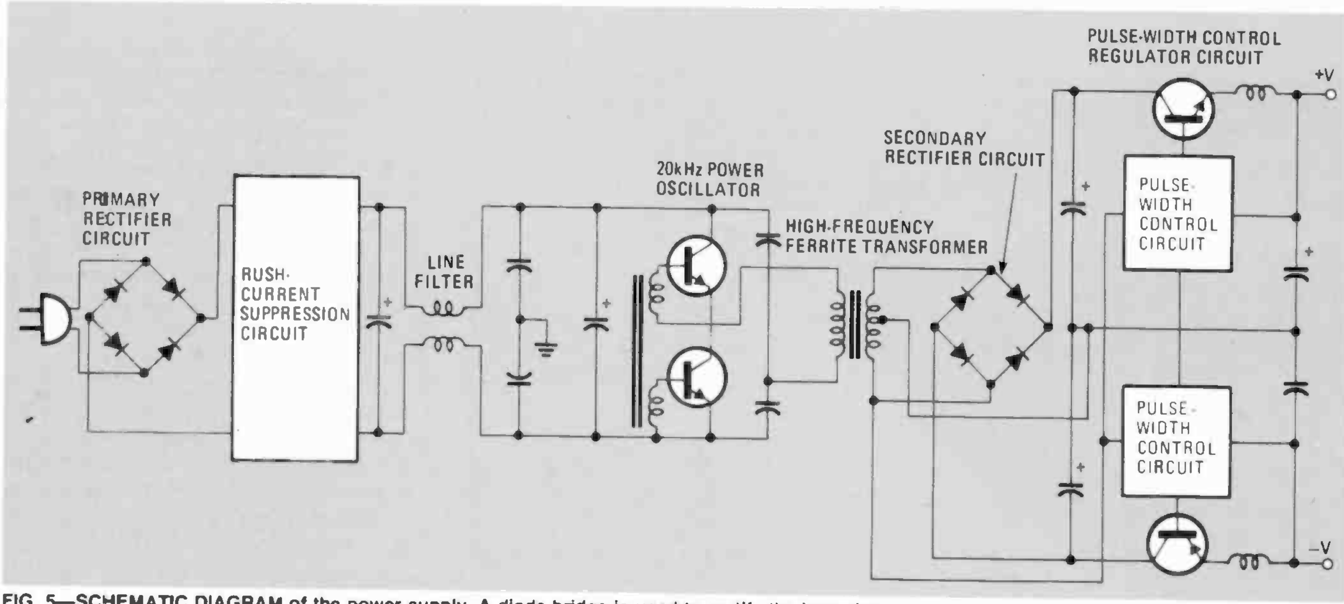

FIG. 5—SCHEMATIC DIAGRAM of the power supply. A diode bridge is used to rectify the incoming line voltage.

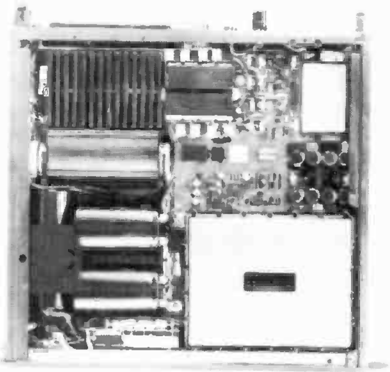

FIG. 6—INTERNAL VIEW OF THE *model TA-N900* amplifier.

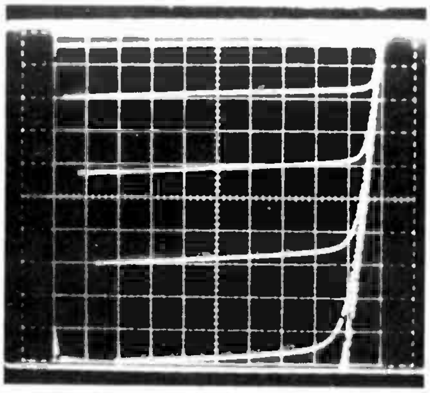

FIG. 8—TRANSFER CURVE for the 2SJ54 (P-channel) power MOSFET.

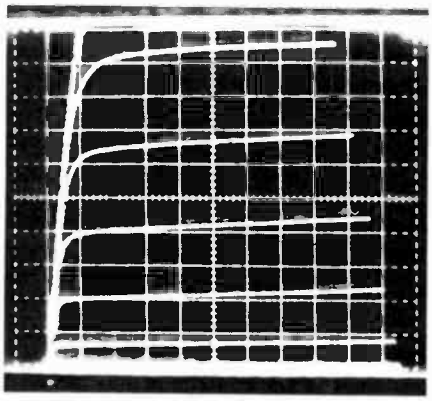

FIG. 7—TRANSFER CURVE for the 2SK173 power MOSFET.

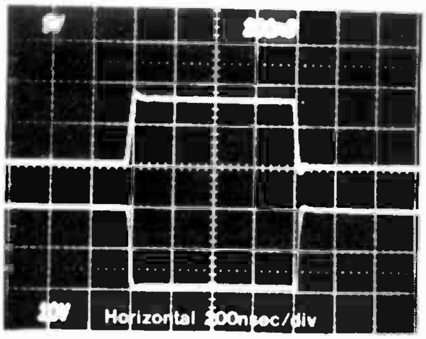

FIG. 9—INPUT and output waveforms for a 625-kHz signal.

speaker load, the power supply of such an amplifier plays an important role in the overall design. In the *model TA-N900*, Sony chose to use a pulse-locked power supply that offers extremely good regulation, low output impedance, low hum and noise levels, as well as other advantages. A diagram of the power-supply circuit is shown in Fig. 5. The circuit rectifies incoming line voltage directly, by means of bridge-connected diodes. The section identified as the 20-kHz power oscillator generates a 20-kHz squarewave signal using four high-power switching transistors in an oscillator circuit that supplies the needed power to the converter transformer.

Because that transformer handles a high frequency signal of 20 kHz, it can use a ferrite core that has low high-frequency losses. Compared with transformers that can handle conventional power supplies (operating at 50 or 60 Hz), this transformer can be constructed with fewer windings that, in turn, results in an extremely low internal impedance. The secondary rectifying circuit shown in Fig. 5 rectifies the 20-kHz output, using high-speed diodes, to convert the voltage into positive and negative DC. Finally, the pulse-width control circuits shown in Fig. 5 sense the positive and negative DC potentials that are applied to the final stage of the power amplifier and control the pulse width of the 20-kHz signal to maintain the output voltage at a constant level for both positive and negative supplies. The filter capacitors are 22,000 μF units that are incorporated at the output of the power-supply circuitry to insure that the amplifier can handle high-level transient signals without difficulty.

An independent series-type constant-voltage supply is provided for low-level stages (including the driver stage), completely separate from the pulse-locked power supply so that there can be no interference from the power-output stage to the low signal-level stages.

Referring once more to Fig. 4, there is a protection circuit that senses and monitors the DC voltage of the power amplifier, the temperature of the power MOSFET's, and the load impedance. That protection circuit will cut off the output should either the connected load (speaker) or the power amplifier approach operational limits.

The amplifier is equipped with a speaker-impedance switch that allows the speaker to be driven in the most efficient and stable manner possible, regardless of whether is has an impedance of 8.4, or 2 ohms. The impedance switch simply controls the voltages produced by the pulse-locked power supply

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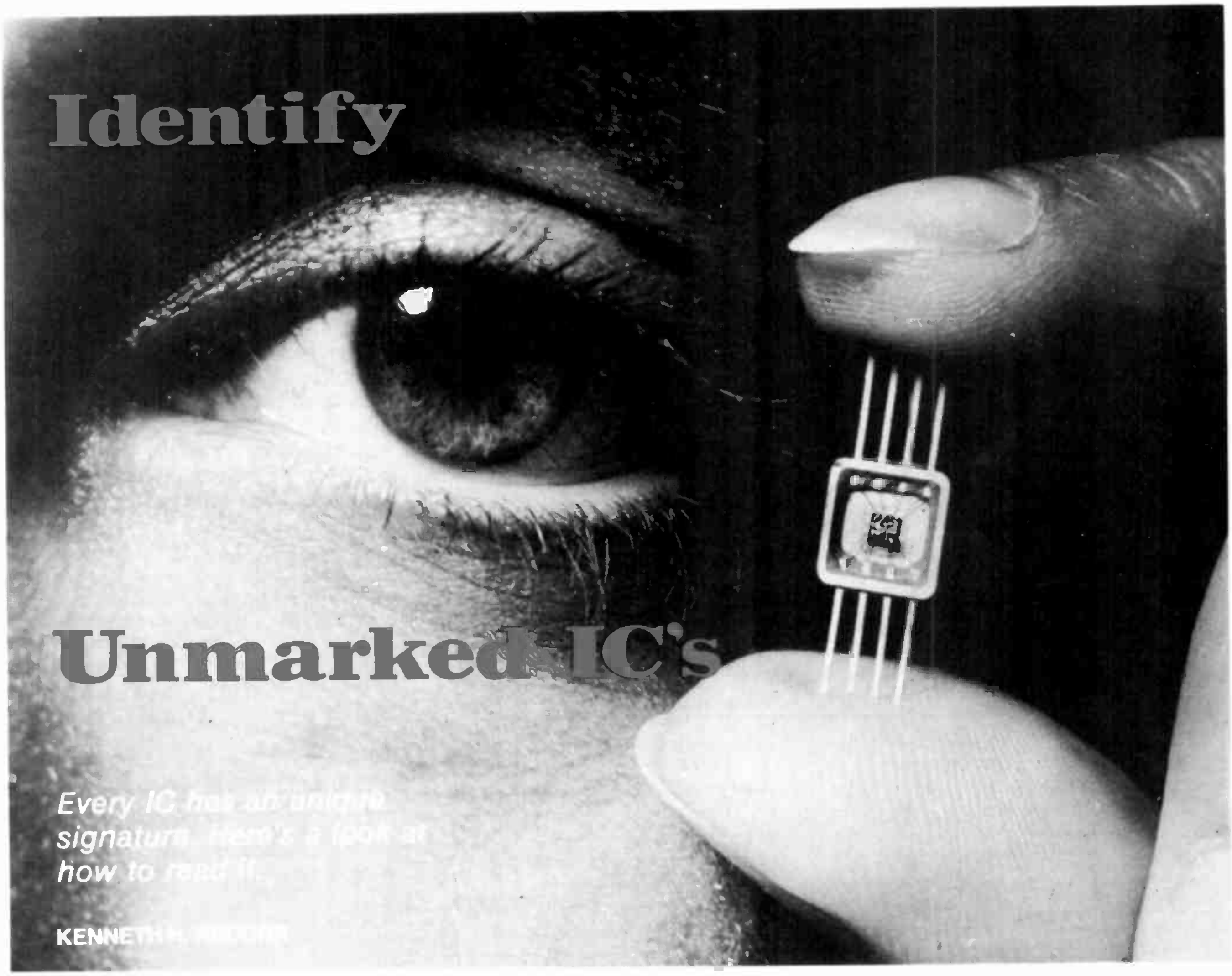
Identify Unmarked IC's



Every IC has an unique signature. Here's a look at how to read it.

KENNETH H. [illegible]

TEMPTED TO BUY THAT GRAB BAG LOADed with unidentified IC's? Go ahead—those IC's have a signature that will tell you what pins are probably outputs. From there on it's easy—a few voltage measurements, some current measurements, and you should know what you've got. You should even be able to determine if the device is defective. So grab your trusty ohmmeter and get ready to record your first IC signature.

An IC signature is an array of resistance readings derived from the IC and displayed in an organized way. The ×100 range of an ohmmeter is used. (Be sure you know which ohmmeter lead is positive; some ohmmeters change polarity when switching from volts to ohms.)

The signature is obtained by recording the resistances between all terminal pairs of the IC. Use the form shown in Fig. 1. Connect the ohmmeter's positive lead to pin 1, and move the negative lead sequentially through the remaining pins. Record the measured resistances across the top row of the signature chart. A resistance measurement of over several hundred thousand ohms does not convey very much useful information, so there is no need to record it—put a dash through the box instead.

Move the positive lead to pin 2 and fill in the second row of the chart by moving the negative lead to pin 1, 3, 4, ..., etc. Continue in the same manner until every row of the signature chart is completed. If this is done properly, you should have as many rows in your chart as there are pins on the IC.

The steps that follow show how to use the completed signature to identify your IC.

Step 1: Examine the chart and circle each terminal-to-terminal resistor—you can tell which ones those are because each purely resistive connection between two terminals reads approximately the same in both directions.

For example: In Fig. 2 there are 12 circled boxes, 6 above the diagonal and 6 below. The circled number in Row 5, Column 3 has its mirror image on the opposite side of the diagonal in Row 3, Column 5. The resistance is 7K ohms in both directions and it is therefore a terminal-to-terminal resistance. That is noted to the right of the chart (Fig. 2), along with the other resistance values and identified as step one. The remaining terminal pairs show grossly different resistance measurements in opposite directions, indicating the presence of one or possibly several semiconductor junctions in the path.

It is highly unlikely that a TTL IC, or for that matter any linear IC, would contain 6 identically valued terminal-to-terminal resistances. (Maybe the IC is RTL or DTL?)

Step 2: Disregard all circled boxes and scan the signature to locate the row with the lowest resistance readings—Row 4 in this case. That uniquely identifies pin 4 as the substrate connection of the IC or, in other words, the most negative terminal of the IC.

Scan across Row 4 for the lowest uncircled reading—in this case it is the 750-ohms reading in Column 11. That tells us that pin 11 is the V_{CC} terminal of the IC. Record those numbers in the place provided at the right of the chart—Step 2, Fig. 2.

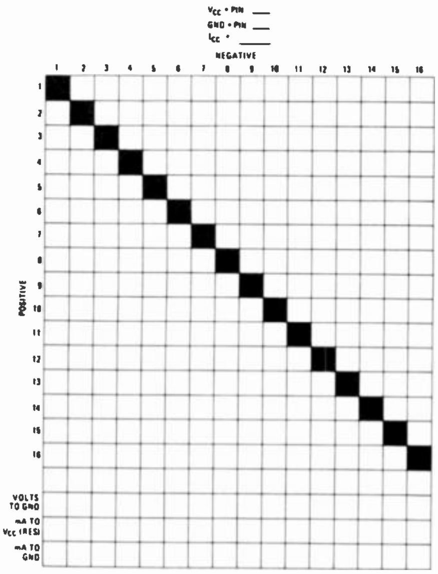


FIG. 1—THIS FORM is used to record all resistances between terminal pairs of the unknown IC.

The other uncircled low-resistance readings in the ground row usually identify transistor collectors; i.e., output terminals. That is an important clue to be used later.

Step 3: Before proceeding to the identification of other terminals we measure I_{CC}. Apply a low voltage, say 3.6 volts (RTL supply voltage), to the IC through a 100 mA milliammeter. The positive voltage goes to the V_{CC} terminal (in this case pin 11) and the return connects to the IC substrate (in this case pin 4).

To protect the IC and the equipment, place a 120-ohm resistor in series with the current meter. A dead short in the IC will only draw 30 milliamps. Remove the resistor and re-connect the current meter only when it is clearly safe to do so. Most standard TTL gates draw between 2 to 4 mA. Thus, a quad NAND or NOR would draw 12 to 15 mA. In the case at hand, there was no current flow at all. DTL or TTL would have shown some current—so again the evidence suggests RTL.

A third clue: If there is a normal current flow, raise the voltage to 5 volts, measure, and record I_{CC} in the space provided at the right of the signature chart.

Step 4: Remove the milliammeter and apply the selected voltage directly between the V_{CC} and ground pins. Measure volts-to-ground, mA-to-V_{CC} (through a 330-ohm resistor) and mA-to-ground for each pin of the IC. Record the measured values in the rows at the bottom of the signature chart.

The "volts-to-ground" row generally identifies all inputs and outputs. Voltages from about 2.2 volts up to the applied voltage indicate outputs in the high state (for a logic chip). Thus, pins 3, 5, 8, and 14 are likely candidates for output terminals. (You will recall in step 2 that

V_{CC} = PIN 11
GND = PIN 4 } 2
I_{CC} = 0 WITH ALL INPUTS OPEN AND NO LOADS APPLIED } 3
NEGATIVE

POSITIVE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		—	3.2	3.3	6.5	—	—	6.5	—	—	2.3	—	—	6.4		
2	—		3.25	3.3	7.0	—	—	7.0	—	—	3.3	—	—	7.0		
3				—	7.0	—	—	7.0	—	—	1.6	—	—	7.0		
4	—	—	.83		.83	—	—	.85	—	—	.75	—	—	.85		
5	—	—	7.0	—		—	—	7.0	—	—	1.6	—	—	7.0		
6	—	—	7.0	3.5	3.5		—	7.0	—	—	3.4	—	—	7.0		
7	—	—	6.4	3.3	3.25	—		6.4	—	—	2.3	—	—	6.4		
8	—	—	7.0	—	7.0				—	—	1.3	—	—	7.0		
9	—	—	6.0	3.2	6.0	—	—	3.1		—	1.7	—	—	6.0		
10	—	—	5.9	3.1	5.8	—	—	3.0	—		1.4	—	—	5.7		
11	—	—	3.75	—	3.7	—	—	3.7	—	—		—	—	3.7		
12	—	—	5.9	3.0	5.8	—	—	5.8	—	—	1.38		—	3.0		
13	—	—	6.0	3.1	6.0	—	—	6.0	—	—	1.7	—		3.0		
14	—	—	7.0	—	7.0	—	—	7.0	—	—	1.3	—	—			
15																
16																
								3.6V APPLIED								
VOLTS TO GND	—	—	3.6	GND	3.6	—	—	3.6	—	—	V_{CC}	—	—	3.6		
mA TO V_{CC} (RES)	1.4	1.4	—	GND	—	1.4	1.4	—	1.4	1.4	V_{CC}	1.4	1.4	—		
mA TO GND	—	—	1.0	GND	1.0	—	—	1.0	—	—	V_{CC}	—	—	1.0		

3 TO 5 = 7KΩ
3 TO 8 = 7KΩ
5 TO 8 = 7KΩ
3 TO 14 = 7KΩ
5 TO 14 = 7KΩ
8 TO 14 = 7KΩ } 1

RTL } 5
MC717P } 8

3, 5, 8, 14 - OUTPUTS
1, 2, 6, 7, 9, 10, 12 AND 13 - INPUTS } 4

3 GOES LOW WHEN 1 OR 2 OR BOTH GO HIGH.
5 GOES LOW WHEN 6 OR 7 OR BOTH GO HIGH.
8 GOES LOW WHEN 9 OR 10 OR BOTH GO HIGH.
14 GOES LOW WHEN 12 OR 13 OR BOTH GO HIGH.
DEVICE IS QUAD, 2 INPUT NOR GATE IC. } 6

7

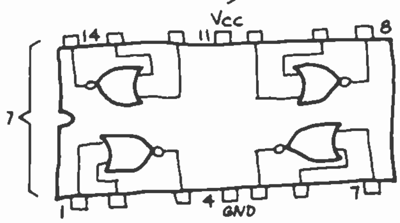


FIG. 2—COMPLETED SIGNATURE CHART for the unknown IC. It turned out to be an quad, 2-input NOR gate.

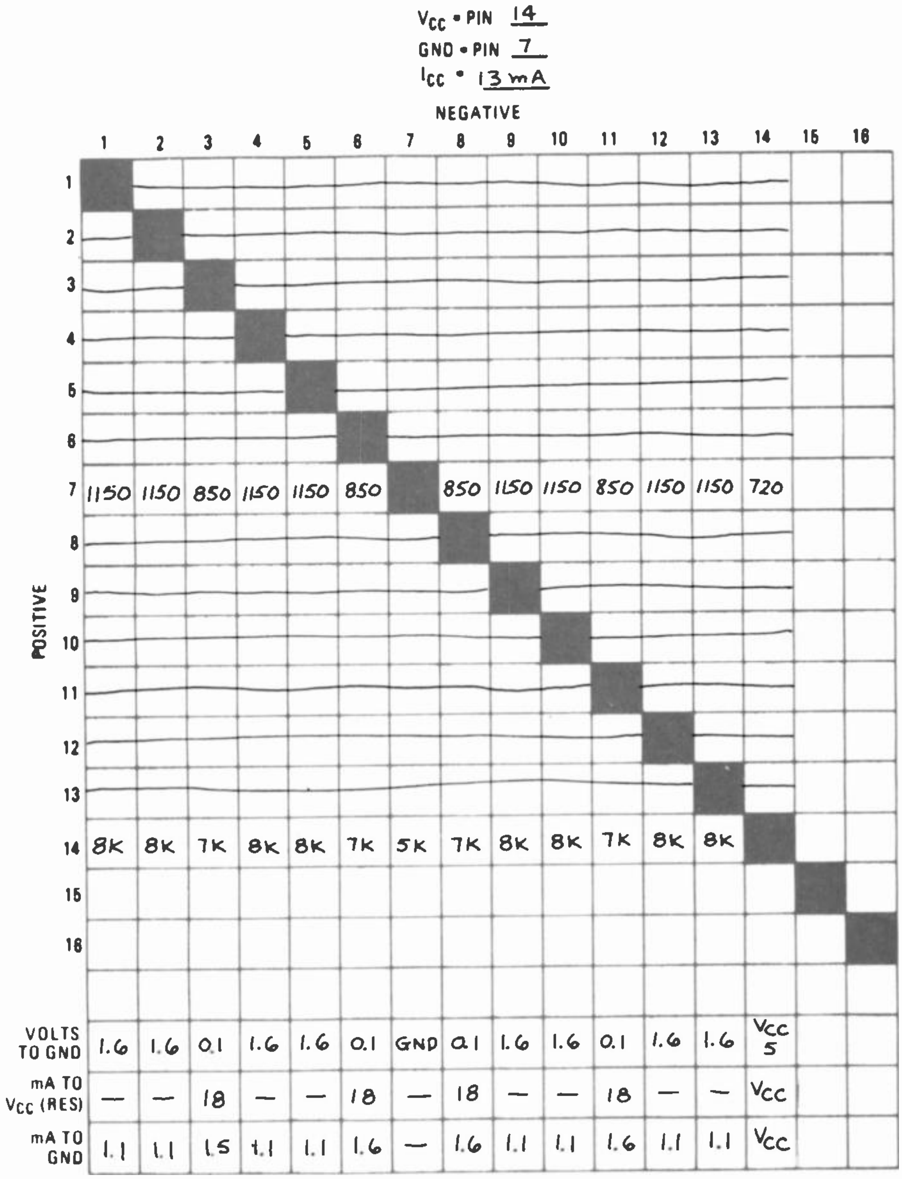


FIG. 3—SIGNATURE CHART for a TTL 7400 IC. All but a few TTL IC's have this typical two row signature.

those are the same terminals that were suggested as outputs by their low readings in Row 4.)

A voltage less than 0.2, but greater than zero, usually indicates logic outputs in the low state. None of those appear in Fig. 2.

Now is the time to remove and reapply power to the IC. Do that several times, each time comparing the voltage at each suspected output to its original recorded value. Often a flip-flop will reveal itself by changing the state of one or more of its outputs. A simple gate will never change state in response to that little trick. The IC in Fig. 2 did not change state so I assumed it was not a flip-flop.

Voltages from about 1.8 down to 0.8 usually indicate TTL or DTL inputs. The fact that there are no such voltages in the "volts-to-ground" row of Fig. 2 was certainly a surprise to me, but it did lead to a pretty solid conclusion: If the IC is not defective, then it is not TTL or DTL.

Currents in the low state should read 10 to 20 mA when measured between the output and V_{CC}. Currents in the high state can read anywhere from 2 to 30 mA when measured between the output and ground if the IC is TTL. As an example of a typical TTL signature, Fig. 3 shows the signature chart for a 7400 TTL IC.

Input currents for RTL, DTL and TTL fall between 0.8 mA and 2.0 mA. In Fig. 2 all the probable inputs draw 1.4 mA referenced to V_{CC} and nothing referenced to ground. That verifies that they are inputs and shows they are active (draw current) when the input is pulled high. RTL is active-high. DTL and TTL are active-low. Since their appear to be twice as many inputs as outputs, the chart suggests that our IC is a quad gate of some sort. It is reasonable to conclude that pins 1, 2, 6, 7, 9, 10, 12 and 13 are inputs.

The bottom row of the chart shows the outputs provide only 1 mA to ground despite the fact that the voltage measured at those terminals is 3.6. That suggests an internal pull-up resistor connected to the output terminal (see Fig. 4). If that is so, and the device is a quad gate (which seems very likely), there should be four identical resistors to V_{CC}—one from each output. And that implies we should read twice the pull-up resistor value between any two outputs. In that case, the circled 7K values in the signature point to 3.5K pull-ups in each output. With a V_{CC} of 3.6 volts applied, grounding any output through the current meter should cause a current flow of just about 1 mA. And that's what we got! List the outputs and inputs on the signature chart.

Step 5: The symmetrical pattern of resistances in the signature and the strong evidence for four independent outputs with logic-level voltages pretty much rules out any linear IC. Resistive pull-ups could be DTL, but DTL inputs are active-low and our IC is active-high. After reviewing all the evidence I felt there was absolutely no doubt that this device was RTL. That conclusion was recorded in Fig. 2.

Step 6: We now manipulate the inputs and observe the output responses to determine what kind of logic device we have.

With V_{CC} applied, we connect a voltmeter from ground to a terminal thought to be an output. Ground the inputs one at a time, noting the change, if any, in the metered output. If that output does not change state for any grounded input, repeat the procedure, this time connecting one input at a time to V_{CC} instead of ground. In this example it happened that pin 3 went low when either pin 1 or pin 2 was pulled high (to V_{CC}). None of the other outputs responded to changes in pin 1 or pin 2. This indicates that pins 1 and 2 are inputs to one gate whose output appears on pin 3. That procedure is continued until all inputs and outputs are related in some way. Truth tables can be consulted to identify the gates. This device turned out to be a quad, 2-input NOR gate.

The relationships between the inputs and outputs and the conclusion as to the type of device I was dealing with are listed in Fig. 2 as step 6.

Had the device not responded at all to any of the above techniques, I would have tried exercising two, or even three, inputs at a time and I would have begun to search for a possible "enable" or "inhibit" input. The more complicated devices require a little ingenuity and some intelligent guesswork.

Step 7: Use the results of step 6 to draw the schematic of the IC. At that point the device could be used in the average hobby project without needing to know anymore about it. But, if you feel compelled to assign a number to your IC, its time to consult the IC data books. That's what I did.

Step 8: It took quite a while to locate a

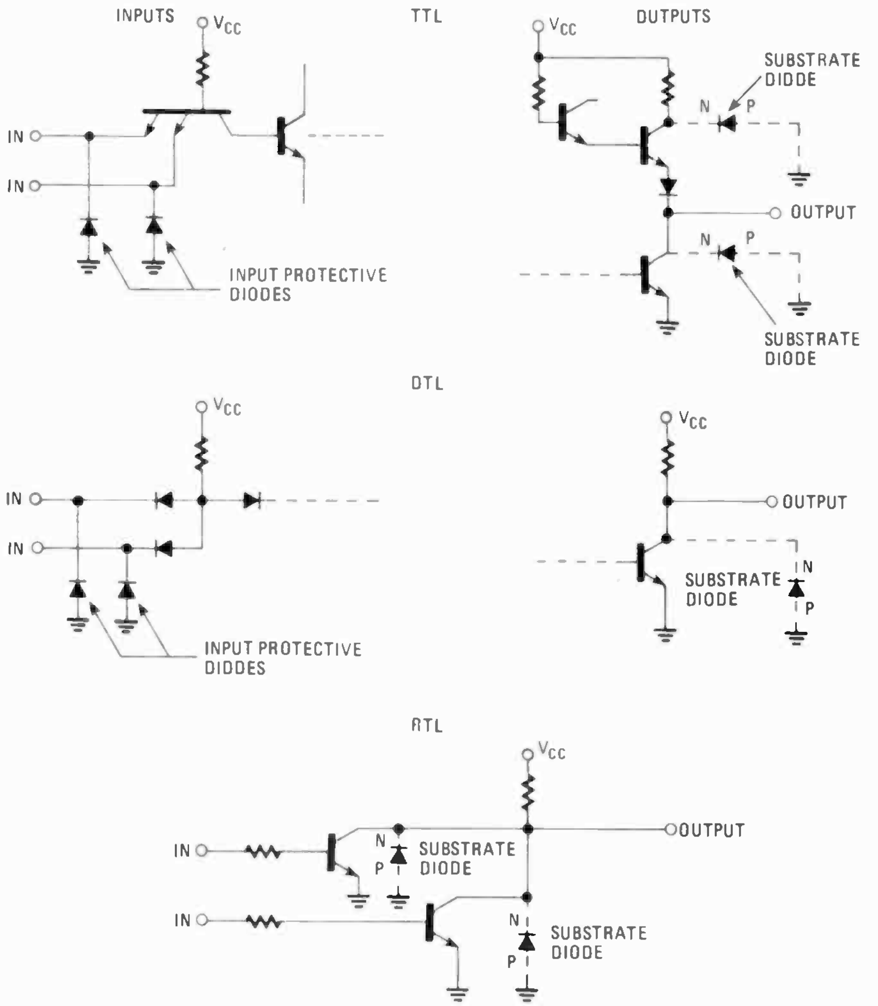


FIG. 4—LOGIC input and output circuits. Use these circuits along with your resistance measurements to determine the logic family of the unknown IC.

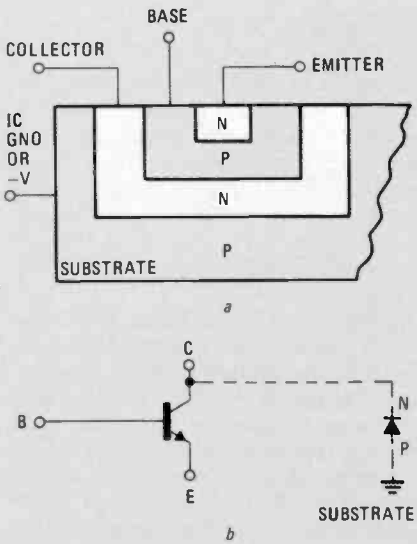
WHAT MAKES THE IC SIGNATURE POSSIBLE

Practically all IC outputs, linear or digital, are formed from transistor collectors. All NPN collectors are imbedded in a P-type substrate that is designated ground (−V for linear IC's). As shown in the accompanying diagram, the collector and substrate form a P-N junction that, like any other diode, conducts well in one direction and poorly in the other.

Connecting an ohmmeter from substrate to collector in the forward direction (positive lead to substrate) will cause the ohmmeter to indicate between 500 and 900 ohms. Other diodes in the same IC will read between 950 and 1300 ohms. Actual resistance values will vary with the type of ohmmeter and the degree of doping in the IC, but the IC outputs will always give the lowest readings.

Thus it is possible to locate every output terminal on an IC. The row containing all those low-resistance readings will be the ground (−V) row.

In every IC there are usually several transistors whose collectors are connected to V_{CC} either directly or through



some resistance. When reading forwaro resistance from substrate to V_{CC} (+V in linear IC's), that multiplicity of paths will give a lower reading than any other terminal on the IC.

Thus it is possible to identify the V_{CC} terminal.

A LOGIC-FAMILY TREE

Mention is made in this article of the RTL (*R*esistor-*T*ransistor *L*ogic), DTL (*D*iode-*T*ransistor *L*ogic) and TTL (*T*ransistor-*T*ransistor *L*ogic) families. Of the three, TTL is the only one that is still in common use, but a look at its predecessors is worthwhile. (Refer to Fig. 4.)

As advances in technology have made it possible to construct more complicated devices on a silicon chip, we have been able to take advantage of their sophistication to create faster and more elaborate logic families.

All three of those logic-families IC's work by causing their output transistors to go into saturation (a condition where no amplification takes place—only conduction) but differ in the way input signals are processed to bring about that state.

RTL was the first IC logic-family to find widespread use. Each input line going to the output transistor contains a resistor. Its purpose is to reduce the amount of current consumed by the device and to isolate the logic-gate inputs. The input voltage passed through the resistors drives the output stage into saturation, making the collector voltage of the output transistor drop and causing the output to go "low."

The resistors, though, slow down the switching speed of RTL devices because they increase the time needed to charge and discharge the input capacitance of the output transistor.

Typically, RTL has a switching speed on the order of 50 nanoseconds and operates from a 3.6-volt supply.

The next step in IC evolution was DTL. That family substitutes diodes for the resistors used in RTL. The diodes provide better isolation at the inputs and, because of their low forward resistance, make it possible for DTL circuits to switch more rapidly than their RTL equivalents.

DTL has a typical switching speed of 25 nanoseconds and requires a four-volt supply.

Finally, TTL uses multi-emitter transistors in the input stage. The base-collector junction of those transistors is never fully off, meaning that a state of saturation can be reached considerably more quickly than with either RTL or TTL.

Switching speeds for simple TTL IC's are frequently under 10 nanoseconds. TTL uses a five-volt supply.

While it is still possible to find RTL and DTL IC's on the surplus market, the TTL family is now the dominant one. Its two most common forms are standard TTL and "LS" (*L*ow-power *S*chottky) TTL, the latter being even faster and having a lower power consumption, at a small sacrifice in drive capability.

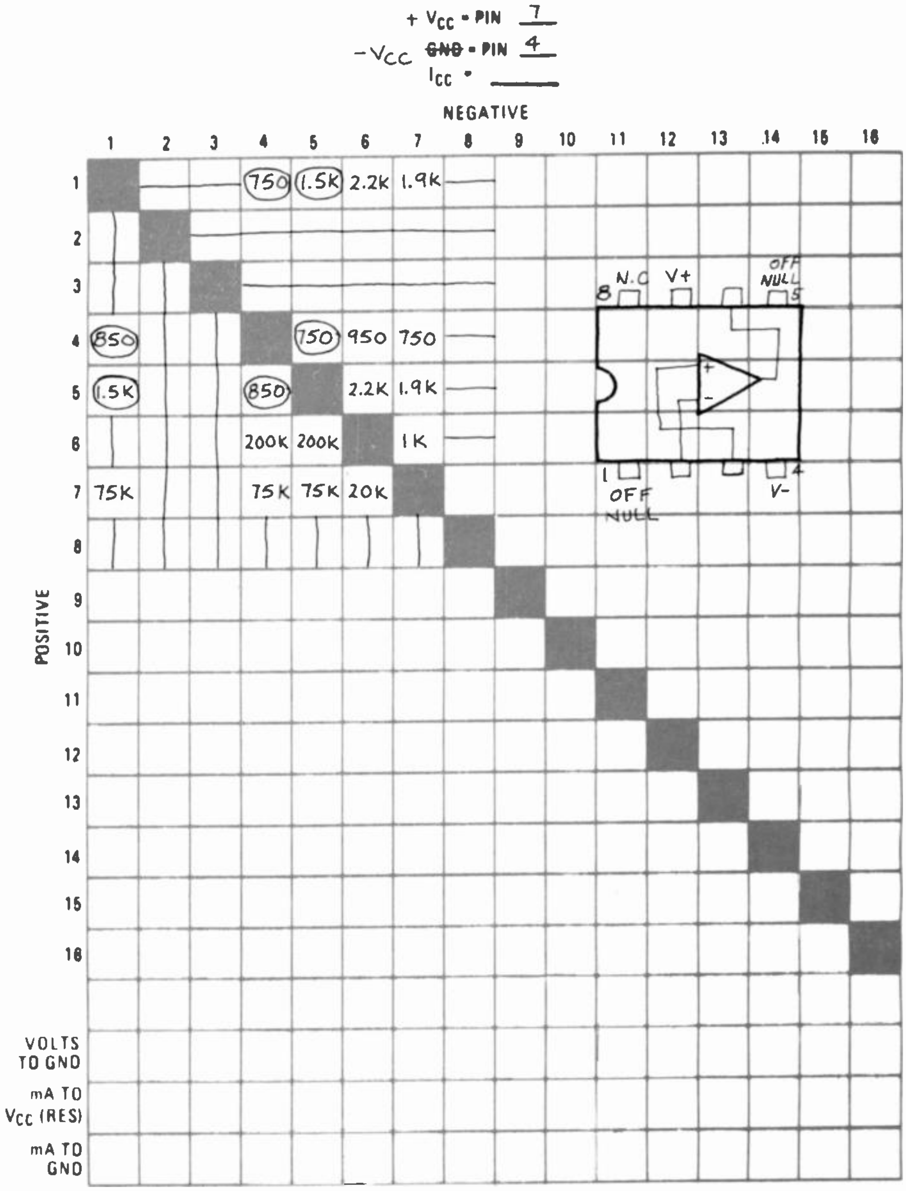


FIG. 5—LINEAR DEVICES can also be identified using the signature chart. This is the signature of a 741 IC.

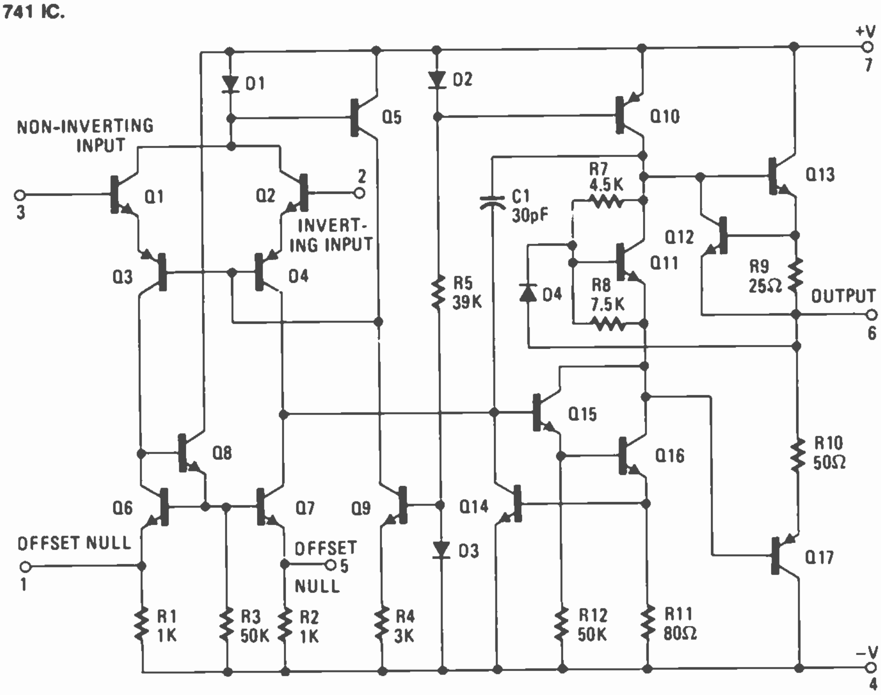


FIG. 6—PIN-OUT for the 741 IC is shown in this schematic diagram. There are 1K resistors between each offset-null terminal and −V.

Motorola IC book containing RTL data sheets. The electronics department at the local college was good enough to let me look through their copy. If you need that kind of assistance, let me urge that you make the local college your first stop. I wish I had—it would have saved a lot of time.

The Motorola book had 256 pages of RTL data—whew! Fortunately the plastic-case style of my IC eliminated two of the three RTL sections. The index of the remaining section listed only two IC's that were quad 2-input NOR gates. The collector pull-up resistors of the first IC type were nominally 640 ohms. The collector resistors in the second IC type were nominally 3.6K. *Bingo!* (We guessed 3.5K in step 4—not bad!).

The device is without a doubt an MC 717P/817P and all the information on that data sheet applies to this IC. I am unable to differentiate further between the 717P and its higher-performance counterpart the 817P. Since the safer move is to assume that the more restricted temperature range applies, I declared the device to be a Motorola RTL IC, type MC717P.

Those techniques work on linear devices as well as digitals.

For example: A signature of an 8-pin DIP 741 op-amp is shown in Fig. 5. Note that the low-resistance row still identifies the substrate, −V, for an op-amp, and also that the lowest reading in that row identifies +V. The only other uncircled reading in row 4 is 950 ohms in column 6, identifying pin 6 as the output terminal.

Figure 6 shows the 741 schematic with the 8-pin DIP pin-out. Note the nominal 1K resistors from each offset-null terminal to −V. The circled resistances in Fig. 5 illustrate some interesting facts about IC resistors: They do not always read the same in both directions—750 ohms one way, 850 ohms the other (pins 1 and 4, and 5 and 4), and they may deviate quite a bit from nominal (1K). Nevertheless the offset-null-terminals are clearly identified.

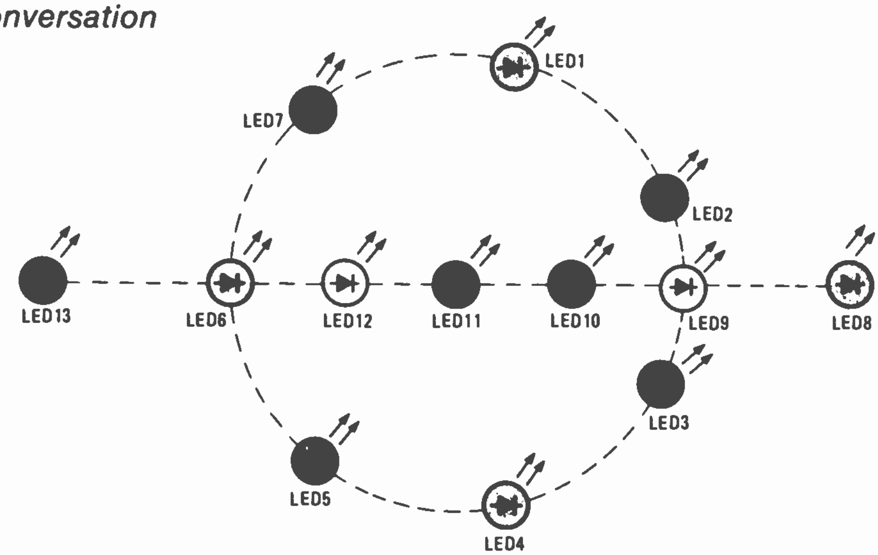
The op-amp inputs are almost impossible to identify from a signature, but the information already obtained is enough to identify the IC in the data books.

I highly recommend that all those interested in identifying IC's read Olson and Zevnik's excellent article in the January 1980 issue of **Radio-Electronics**, "How to Identify Unmarked IC's." The article is filled with useful suggestions for getting advance information from the PC board.

The smart tinkerer uses all the clues he can get. But when there aren't any advance clues—when there is no PC board—when there are no marking to go by—then the only alternative is the IC signature. **R-E**

BUILD THIS

This up-to-date version of an old favorite makes an amusing conversation piece, and a great project!



NOEL NYMAN

THE STATE-OF-THE-ART OF DOING NOTHING

A POPULAR CONSTRUCTION PROJECT some years ago was the "do-nothing" box: one or more neon lamps that flash one-at-a-time either randomly or in sequence. The basic circuit is a relaxation oscillator based on the neon-lamp characteristic of firing at about 65-volts. Figure 1 shows a one-lamp flasher. The capacitor charges at a rate determined by the R-C constant. When the neon trigger voltage is reached the lamp flashes, discharging the capacitor and the cycle repeats. Figure 2 shows circuits with more lamps.

To get the lamps to fire in sequence requires careful *mismatching* of the lamps. Because neon lamps characteristics change as they age, the sequential firing may deteriorate after a while. For more information on neon flashers, see the October 10, 1958 engineering issue of *Electronics* magazine.

The popularity of that circuit was probably due to the bright display that "moves" with no moving parts (remember that was twenty years ago). The parts were cheap and easy to obtain and the power supply was simple. Because of the low current required you could even run it from batteries (expensive ones).

Integrated circuits and LED's have upgraded the "do-nothing" box considerably. A simple sequential circuit of ten LED's requires only two IC's as shown in Fig. 3. That circuit can use inexpensive batteries, fires sequentially, and the clock frequency is easily changed.

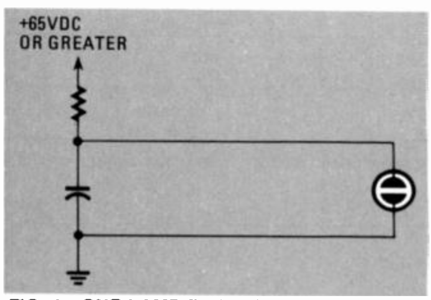


FIG. 1—ONE-LAMP flasher fires when the neon trigger-voltage is reached.

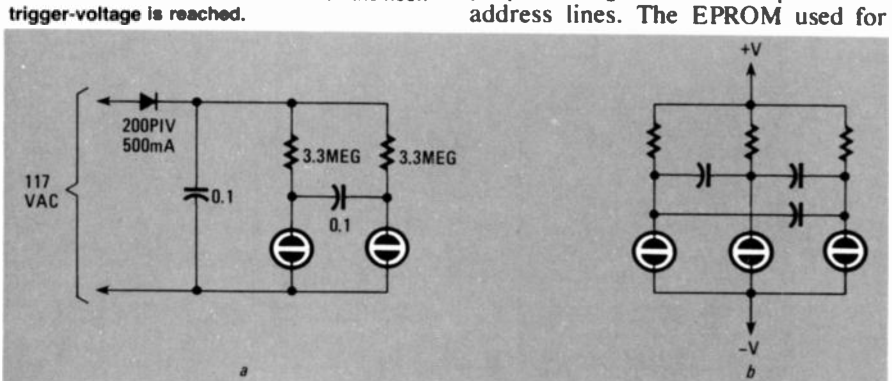


FIG. 2—MULTILAMP flasher circuit. The neon lamps must be carefully mismatched if they are to fire in sequence.

Although that is a clever modern way of doing nothing, the *E*rasable *P*rogrammable *R*ead-*O*nly *M*emory (EPROM) has made it obsolete also. In case you're unfamiliar with them, EPROM's are field-programmable IC memories that retain their stored information even with circuit power turned off. The programmed information appears on output lines when the appropriate logic levels are placed on address lines. The EPROM used for this project can store up to 2,048 eight-bit words (16,384 bits) if it's a 2716, or up to 1024 eight-bit words (8,192 bits) if it's a 2758—which is really half of a 2716.

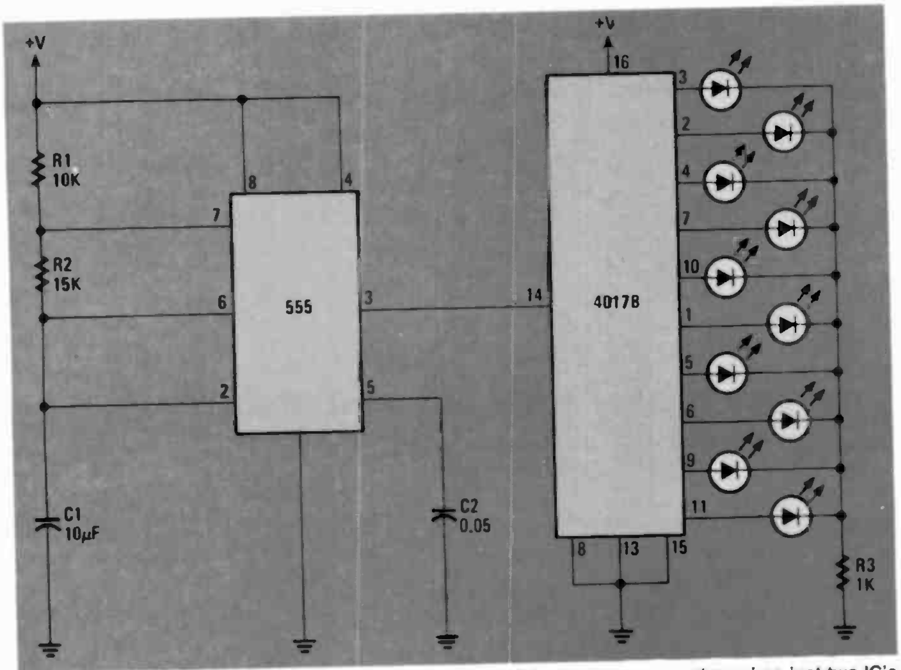


FIG. 3—THIS simple "do-nothing" circuit will light ten LED's in sequence and requires just two IC's and a few discrete components.

eighth selects whether the line or circle is displayed.

I used the least-significant data bit, DØ, to select the display. Logic-1's at the other seven data bits will light the corresponding numbered LED's. As an example, Table 1 shows the program for lighting each LED in turn clockwise around the circle. The 1 in DØ selects the circle. The choice of 1 or Ø for the circle is arbitrary and is determined by how you wire the circuit. Table 2 shows a more complex program. The first seven steps circle the display counterclockwise. In step eight, DØ goes to Ø and the 1 at D2 lights LED2 in the line display. In the remaining steps the dot moves to LED1, then lights the line from right to left leaving the LED's on as it moves.

Most of us don't have EPROM-programming equipment. For a small fee, EPROM's can be programmed by various sources. Check with your local parts supplier or write to EPROM manufacturers. Also, some of the advertisers in the back pages of **Radio-Electronics** can program EPROM's.

Your program will have to be submitted in a form that programming machines can read. Punched paper tape and punched cards are common media, although mark-sense cards may be used by some sources if you don't have access to punch equipment. Check with the programming service for format specifications. In some cases, you may need to write your program in hexadecimal. Each hex digit represents four data bits, so two hex digits will represent the data at each EPROM address. A conversion table is shown in Table 3, and Table 4 shows the hexadecimal equivalent of the program from Table 2.

Check your program before submitting it! One bit with the wrong value will throw the entire sequence off. An EPROM pre-programmed with variations of both circle and line displays is

TABLE 1

D7	D6	D5	D4	D3	D2	D1	DØ
Ø	Ø	Ø	Ø	Ø	Ø	1	1
Ø	Ø	Ø	Ø	Ø	1	Ø	1
Ø	Ø	Ø	Ø	1	Ø	Ø	1
Ø	Ø	Ø	1	Ø	Ø	Ø	1
Ø	Ø	1	Ø	Ø	Ø	Ø	1
Ø	1	Ø	Ø	Ø	Ø	Ø	1
1	Ø	Ø	Ø	Ø	Ø	Ø	1

TABLE 2

D7	D6	D5	D4	D3	D2	D1	DØ
1	Ø	Ø	Ø	Ø	Ø	Ø	1
Ø	1	Ø	Ø	Ø	Ø	Ø	1
Ø	Ø	1	Ø	Ø	Ø	Ø	1
Ø	Ø	Ø	1	Ø	Ø	Ø	1
Ø	Ø	Ø	Ø	1	Ø	Ø	1
Ø	Ø	Ø	Ø	Ø	1	Ø	1
Ø	Ø	Ø	Ø	Ø	Ø	1	1
Ø	Ø	Ø	Ø	Ø	1	Ø	Ø
Ø	Ø	Ø	Ø	Ø	Ø	1	Ø
Ø	Ø	Ø	Ø	Ø	1	1	Ø
Ø	Ø	Ø	Ø	1	1	1	Ø
Ø	Ø	Ø	1	1	1	1	Ø
Ø	Ø	1	1	1	1	1	Ø
Ø	1	1	1	1	1	1	Ø
1	1	1	1	1	1	1	Ø

PARTS LIST

All resistors ¼ watt, 5%
R1-R4—10000 ohms
R5—470,000 ohms
R6—100,000 ohms, trimmer potentiometer
R7-R13—270 ohms
R14-R16—4700 ohms
R17—390 ohms
Capacitors
C1—50 µF, electrolytic
C2—0.01 µF ceramic disc
Semiconductors
IC1—4013B dual-D flip-flop
IC2—4011B quad 2-input NAND gate
IC3—4069B hex inverter
IC4—4040B ripple counter
IC5—2716 or 2758 EPROM*
IC6—7404 hex inverter
IC7—7805 five-volt positive voltage regulator
Q1, Q4—2N4400 or other small-signal NPN-type
Q2, Q3—2N4402 or other small-signal PNP-type
LED1-LED13—jumbo red LED
S1-S3—momentary push-button switch (N.O.)
Miscellaneous: perforated construction board, IC sockets, wire, solder, etc.

***A pre-programmed 2758 EPROM showing several circle and line variations can be obtained postage paid for $25 from: Noel Nyman, MAB, P.O. Box 88568, Seattle, WA 98188**

Using an EPROM to control a "do-nothing" box allows for more than just sequential operation. LED's can be made to circle clockwise, counter-clockwise, or to alternate direction. The LED's can stay on as they circle. Opposite LED's can appear to rotate around the circle. Using a straight line, other displays can be generated. A dot can bounce from one end to the other. Lighting pairs from the ends converging on the center is another variation.

The original idea for a PROM (*non-erasable EPROM*) "do-nothing" circuit was suggested by Todd Kitajo of Almac Stroum Electronics, Seattle, WA. His design used a PROM to control two straight-line displays, one red and one green. I used LED's arranged in a line and a circle. The circle is made up of seven LED's, 51° apart. A seven-LED line bisects the circle. The circle and line share LED6. Seven EPROM data bits control the LED's and the

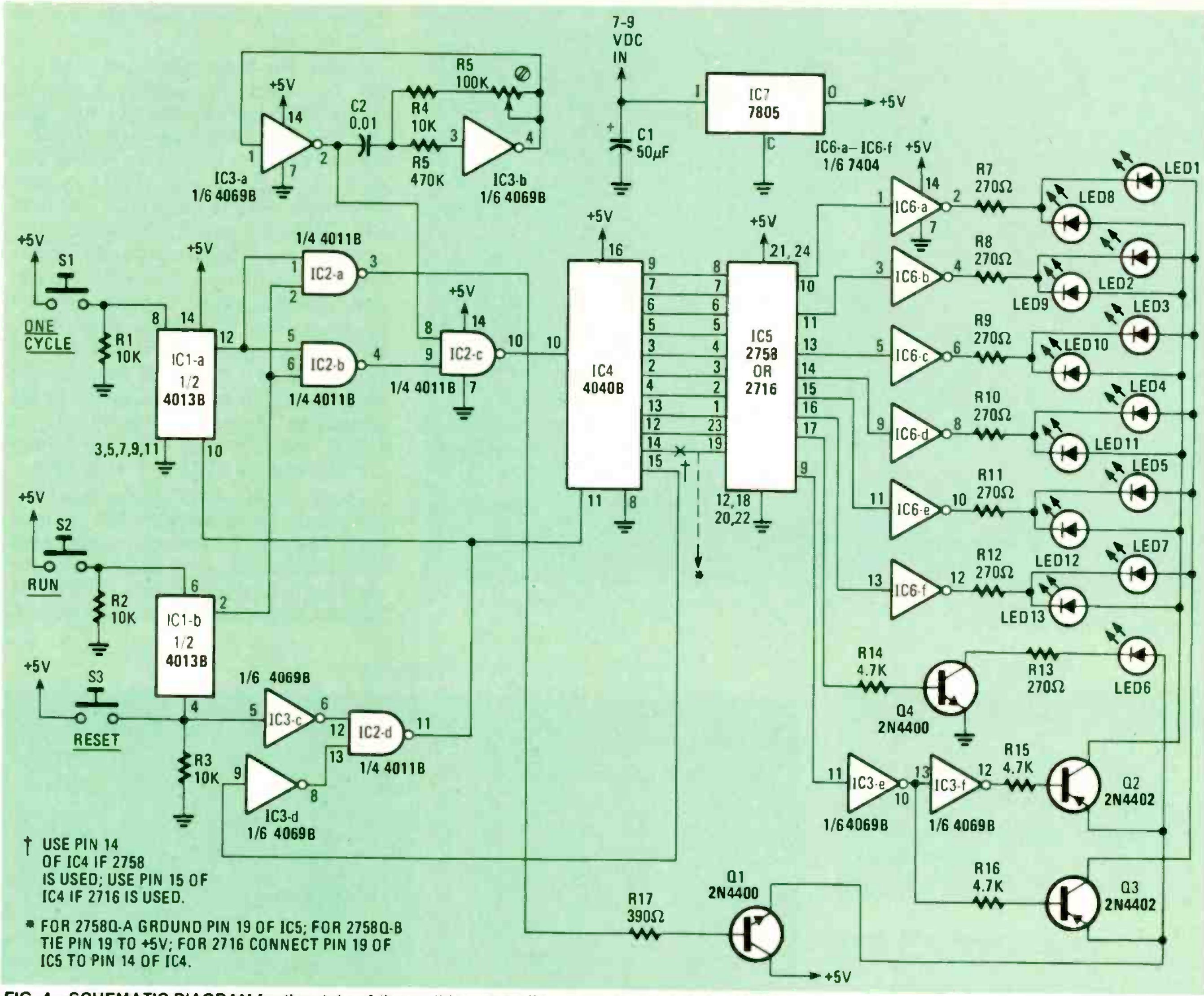


FIG. 4—SCHEMATIC DIAGRAM for the state-of-the-art "do-nothing" box. The line and circle displays share LED6.

available (see parts list).

Figure 4 shows the schematic and Fig. 5 the 2716/2758 pinout. Inverters IC3-a and IC3-b form a clock oscillator A NAND gate, IC2-c, gates the clock pulses to counter IC4. As IC4 counts, its binary outputs address each memory location of EPROM IC5 in sequence. The seven highest data-outputs of IC5 control LED's. Six pairs of LED's are controlled by inverters (TTL for high current output) and LED6 is controlled with a transistor (using a seventh inverter would waste five inverters of another IC). The 270-ohm resistors limit LED current to about 20 mA. The DØ IC5 output controls Q2 and Q3 through inverters. A logic-1 from DØ will cause Q3 to conduct and the LED's in the circle light. A logic Ø will light the line LED's using Q2.

Although an on-off switch isn't necessary, I decided to use latches to get three operating modes: RUN, ONE-CYCLE, and RESET. Pushing the ONE-CYCLE switch sets latch IC1-a, allows clock pulses through IC2-c, and switches Q1 on through IC2-a.

TABLE 3

Ø	ØØØØ	8	1ØØØ
1	ØØØ1	9	1ØØ1
2	ØØ1Ø	A	1Ø1Ø
3	ØØ11	B	1Ø11
4	Ø1ØØ	C	11ØØ
5	Ø1Ø1	D	11Ø1
6	Ø11Ø	E	111Ø
7	Ø111	F	1111

TABLE 4

81	Ø2
41	Ø6
21	ØE
11	1E
Ø9	3E
Ø5	7E
Ø3	FE
Ø4	

Transistor Q1 controls all display current and shuts off the display when the RESET pushbutton is depressed. When counter IC4 reaches a count of 512, all addresses of IC5 will have been displayed and pin 14 of IC4 will go high. That resets latch IC1-a and IC4 through IC3-d and IC2-d. If the RUN switch is depressed, IC1-b will latch and the display will operate as before. The logic-1 appears at pin 14 of IC4 and resets IC4 to Ø, but since it does not reset latch IC1-b, the cycling repeats.

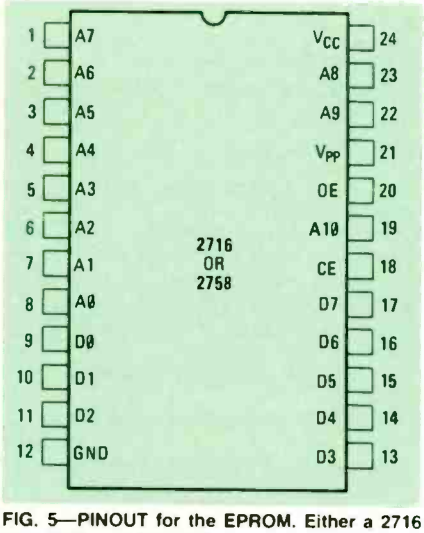
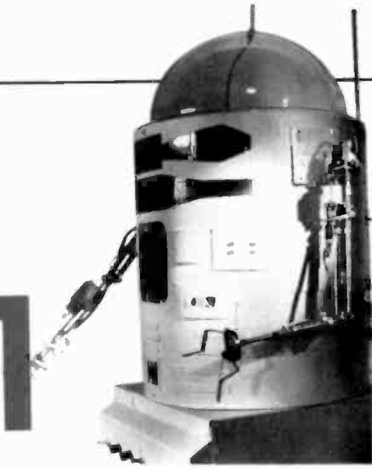


FIG. 5—PINOUT for the EPROM. Either a 2716 or a 2758 may be used.

continued on page 87

BUILD THIS

UNICORN-1 ROBOT



Part 8—Last month we began to look at a remote-control system for the Unicorn-1 robot. In this part we will continue with that system by describing our control scheme, a simple FM transmitter, and a relay-driver board.

JAMES A. GUPTON, JR.

A LOT OF THOUGHT WAS GIVEN TO HOW Unicorn-1 could be controlled remotely. A number of schemes were considered—ultrasonics (not reliable enough and not enough range); infra-red (the same, but more so), and, of course, radio. A system was even devised using model-airplane R/C equipment, but that proved to be expensive and not easily expandable to computer-control.

The system finally chosen was inspired by one used by amateur radio operators for VHF and UHF repeater control and its principles are probably familiar to most **Radio-Electronics** readers from at least one other source—the telephone company.

Before getting into the actual construction of the robot's R/C system, it might be a good idea to fill you in on this scheme, so you have an idea of the direction we're headed in.

The heart of the system is the DTMF (*D*ual *T*one *M*ulti-*F*requency) system—also known as *Touch-Tone*. A 16-key pad (shown in Fig. 65)—or a matrix of switches providing the equivalent function—is used to instruct a DTMF generator IC, in this case a ICM7206JPE, to produce a pair of tones unique to the key pressed.

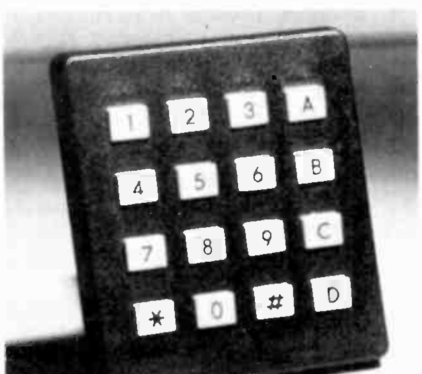


FIG. 65—A 16-KEY *Touch-Tone* pad similar to this one was used in the prototype to modulate an FM transmitter.

That tone-pair modulates an inexpensive, low-power FM transmitter operating in the FM-broadcast band. The signal is received by a standard FM broadcast-band receiver located in the robot and the tone-pairs are decoded to generate a one-out-of-sixteen control signal. That control signal is fed to a relay-driver board to energize the coils of the appropriate relays (as described in Part 7 of this series) and operate the robot's motors and solenoids.

This method will lend itself particularly well to computer control. The 16-key pad is arranged as a 4-row by 4-column switch matrix where each row generates its own tone, as does each column. The result, if the rows and columns are considered together (lined up in one row) is the equivalent of a computer *byte*—the standard 8-bit word.

A computer can output, through a parallel port, an eight-bit binary number that can represent those same switch closures. That byte can be used in place of the keypad to cause the tones to be generated, thus allowing a computer program to direct the robot's actions.

Alternatively, if the robot carries an on-board computer, the output of its parallel port can easily be translated into control signals for the relays.

Several installments will be required to describe the control system in detail. This one will talk about FM transmitters and the relay-driver board. The next will talk about the *Touch-Tone* encoding and decoding circuits, and their interfacing to the others.

Finally, we'll talk about computer interfacing and a little about programming as it pertains to robot control.

FM transmitter

This transmitter can actually be used for two purposes, although not simultaneously. In essence, it is what's commonly called an FM wireless mike. Usually it is used to transmit voices or music on an unused frequency of the FM broadcast band for personal entertainment purposes.

In that mode, using the robot's built-in amplifier and speaker (see Part 5), the robot can talk to persons in its vicinity—with a little help from the operator. In fact, if the robot carries a second wireless mike, operating on a different frequency, a two-way conversation can be carried out.

However, that is secondary to our main purpose—actually controlling the robot. (Come to think of it, though, the control tones could also be fed to the robot's amp and speaker, making him sound a little like good old *R2-D2*.)

A schematic for a wireless mike is shown in Fig. 66. No foil pattern is given, since the circuit can be easily constructed on perforated construction board. Suitable FM transmitters are also available from a number of companies who advertise in **Radio-Electronics**.

Transmitter construction

If you build your own transmitter, it can be constructed on a piece of perfo-

PARTS LIST—FM TRANSMITTER

All resistors ¼ watt, 5%
R1, R2—1 megohm
R3, R6, R9—8200 ohms
R4—330 ohms
R5—470,000 ohms
R8, R11—15,000 ohms
R12—3900 ohms
R13—220 ohms
R14 (optional)—390,000 ohms
Capacitors
C1, C3, C4, C6—5 µF, tantalum
C2—0.1 µF, ceramic disc
C5—10 µF, tantalum
C7, C11—0.01 µF, ceramic disc
C9—5-15 pF, variable (E.F. Johnson 274-0035-005 or equivalent)
C10—7 pF (approx.), ceramic disc
L1—see text
L2—see text
Miscellaneous: construction board, high-impedance microphone, solder, wire, etc.

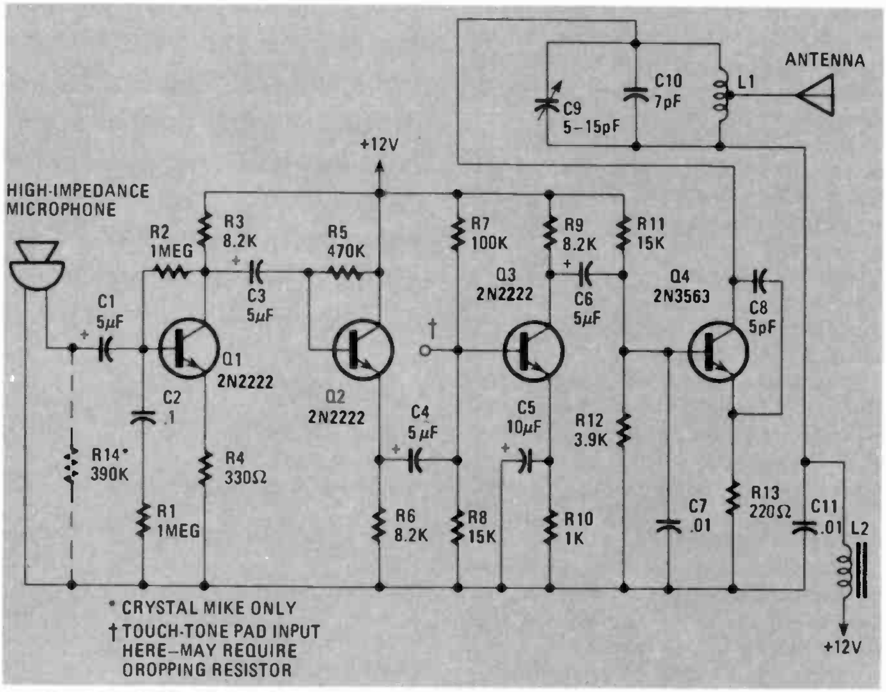


FIG. 66—SCHEMATIC DIAGRAM for the FM transmitter. Value of dropping resistor R14 may range from several hundred kilohms to two megohms or more.

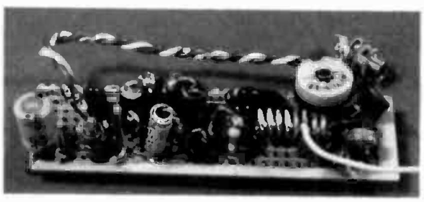


FIG. 67—PROTOTYPE TRANSMITTER built on a small piece of board. Any construction technique may be used.

rated construction board or on a prototyping board. A prototype transmitter, built on a piece of board about 1 × 4 inches, is shown in Fig. 67. Wire-wrap or point-to-point wiring techniques can be used. Keep the leads as short as possible—lead length begins to get critical at these frequencies (80-108 MHz).

The transmitter shown in the schematic, and most of the ones available as kits, are intended to be modulated by a high-impedance microphone. (If you intend to use a crystal mike, be sure to include resistor R14.)

If you are going to use the transmitter only with the *Touch-Tone* pad for control purposes, the first two stages—Q1 and Q2—can be omitted, and the output of the tone-generator IC applied to the base of Q3, since its output level is much higher than that of a microphone, and not as much amplification is needed. In fact, you probably will have to add several hundred kilohms of resistance to attenuate the tones so they do not overdrive the transmitter and cause distortion.

Best results with the homebrew transmitter were obtained when tantalum capacitors were used where values of five and ten µF were needed. The tuning capacitor, C9, should have a value such that, when it is parallelled with C10, the total capacitance does not exceed 22 pF. A good place to look for something to use as C9 is in a junked portable FM radio.

Coil L1 is made using eight turns of No. 16 copper wire. Its outside diameter is ¼-inch and the total length of the coil is 0.6 inches. Coil L2 consists of 12 turns of No. 30 wire (wire-wrap wire will do nicely) closely wound around a quarter-watt resistor of the highest value you have on hand (it should be at least 100K). The ends of that coil can be soldered to the resistor leads, which, of course, then become the leads of the coil.

The antenna lead is soldered to the third turn of L1, counting from the 12-volt end of the coil. The antenna itself can be either a fancy telescoping type, or simply a piece of stiff wire. Since we are deliberately *not* trying to obtain maximum efficiency, the length of the antenna is not critical—about ten inches seems to work well.

Locate the antenna right at the transmitter, which can be mounted inside the command console if you like. It is not necessary to feed the antenna with coaxial cable—it can be connected directly to the output of the transmitter. What is important, though, is that the antenna be insulated from the case containing the transmitter, if that case is metallic, to prevent it from shorting out to ground.

The frequency of the transmitter can be affected by the antenna. It should be as rigid as possible and, more important, because of capacitance effects, it should be as far away from possible contact with your body as possible. Keep that in mind when you are tuning the transmitter, especially if the transmitter and antenna are mounted on the case containing the keypad and tone encoder.

The best section of the FM band for your use is probably the bottom—around 88 MHz. Tune your receiver to a clear spot in that area and turn up the volume so you can hear some background hiss. Then, using an insulated—or plastic—screwdriver, *slowly* adjust C9, or its equivalent, if you assembled a kit, until the hiss is blanked out. That will indicate that you are receiving your transmitter's carrier. Be patient—the tuning process is critical. It may also be necessary for you to stretch or compress L1 slightly to get into the right portion of the band. Before you fire up the transmitter, you should be aware of the FCC regulations governing the use of such devices. Those regulations may be summarized as follows:

- The use of such devices for personal surveillance is illegal!
- The range of such devices is limited to 100 feet. Do not attempt to extend that range through the use of higher power or more efficient antenna systems—use only what you need! Improve your *receiver*, if necessary.
- Do not attempt to use the transmitter below 88 MHz or above 108 MHz. The former may interfere with commercial two-way radio services; the latter with aircraft communications. Do not use the transmitter anywhere near commercial airlanes!

To be safe, make sure the signal begins to fade out about 90 feet from the transmitter. If it is too strong at that range, shorten the antenna or reduce the input power. That will not only keep you out of trouble, but will ensure that you can clearly observe—and control—the robot's actions before it does something to embarrass you.*

In the next part of this series we'll go into detail on connecting the tone genera-

*Due to the difficulty in obtaining positronic brains, Isaac Asimov's Three Laws of Robotics do not apply here, and we have to use our own judgment, rather than rely on the robot's.

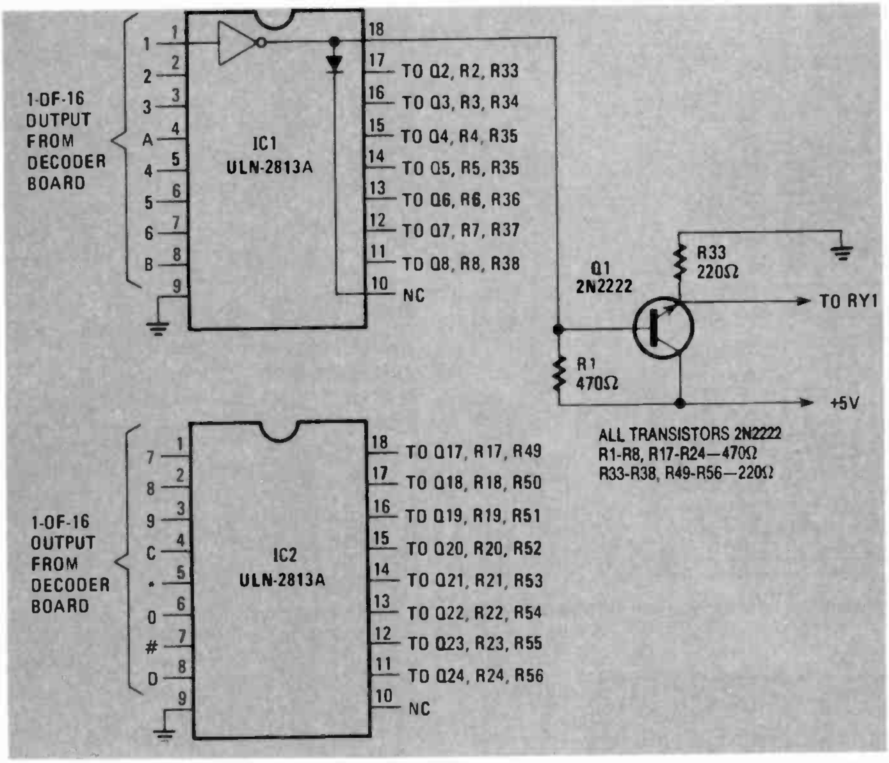


FIG. 68—SIMPLIFIED SCHEMATIC of the relay-driver board. Only one section is shown as all others are the same.

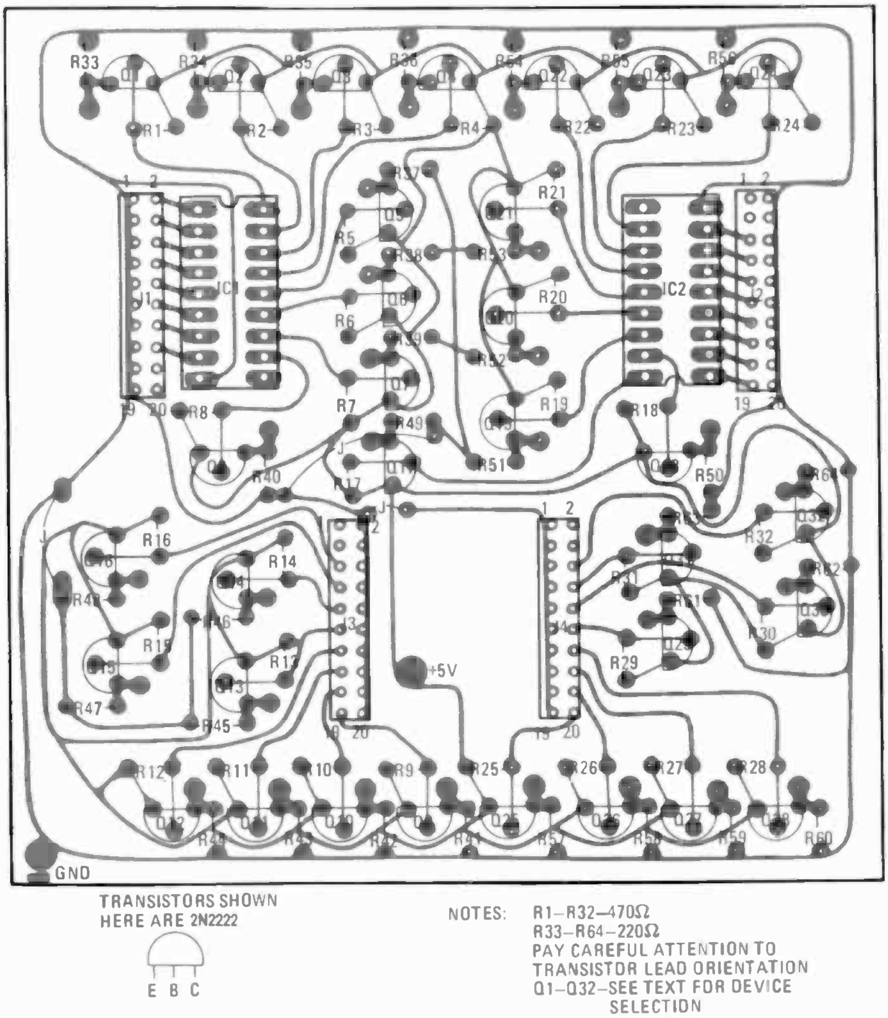


FIG. 70—PARTS PLACEMENT diagram for the relay-driver board. If 2N2222 transistors are not handy, almost any other type may be used.

tor to the transmitter, and the tone decoder to the receiver (and to the robot).

Relay-driver board

A portion of the relay-driver board circuit is shown in Fig. 68. There is really very little more to it than that—the same circuit, for all intents and purposes, is repeated 32 times.

A foil pattern for the relay-driver board is shown in Fig. 69, and the parts-placement diagram in Fig. 70. Don't be put off by its complexity, though. Initially, we'll use only half of that board—each relay will have its own output from the ULN-2813A driver IC and its own transistor. The balance of the board is reserved for future use—primarily when it becomes necessary for the robot, when it gets its on-board computer, to respond to stimuli from its environment. It can also serve to provide other control functions if a more sophisticated control system is used, and suggestions for that will appear in a future part of this series.

Jacks J1 and J2 will be used to connect the relay-driver board to the decoder board.

Here's how the circuit works: The ULN-2813A is an inverting octal driver. What that means is that it has eight identical sections; and when a logic-high signal (about five volts) from the decoder board is applied to the input of one of the sections, the output of that section goes to a logic-low state (zero volts, or ground) and will act as a ground for any voltage that is applied to it.

When an output of the IC goes "low," it causes its associated transistor to be saturated. That allows five volts to pass from the collector and out the emitter to the coil of the relay assigned to that transistor, causing the relay contacts to close. That's all there is to it.

Although IC pin and function assignments are arbitrary, Table 1 shows a suggested arrangement for use with a 16-key *Touch-Tone* keypad.

Because we are limited to 16 on/off control signals, several of the robot's original functions temporarily have had to be eliminated or combined. For example, we can no longer beep the horn, and both end-effectors now operate simultaneously.

Regaining those lost functions will be easy under computer control and later we'll present a couple of ideas for some simple logic circuits that will allow the 16 radio-control channels to provide more than 16 functions.

Construction of the board is straightforward. The 2N2222 transistors were used because they were handy. As Fig. 71 shows, almost any transistor can be used—you can see four different types there. If you have PNP—say, 2N2907—instead of NPN transistors, the only change that has to be made is to insert the transistors in the board backwards—the emitter goes where the collector would

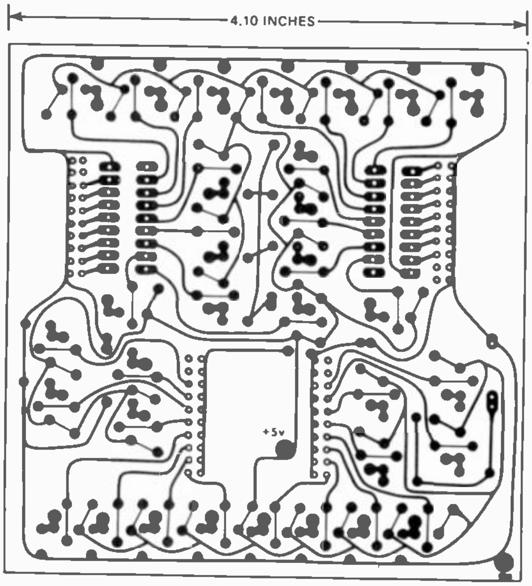


FIG. 69—FOIL PATTERN for the relay-driver board. Only half the board will be used at this time, with the rest reserved for expansion.

PARTS LIST—RELAY-DRIVER BOARD

All resistors ¼ watt, 5%
R1-R32—470 ohms
R33-R64—220 ohms
Semiconductors
IC1, IC2—ULN-2813A inverting octal driver (Sprague)
Q1-Q32—2N2222 or equivalent NPN-type; 2N2907 or equivalent PNP-type (see text for details)
J1, J2—20-pin, double row, header connector (AP Products AP923862-R or equivalent)
Miscellaneous: PC board, 22/44-finger prototyping board (Radio Shack 276-154 or equivalent), two 22/44-pin sockets (Radio Shack 276-1551 or equivalent), 18-pin IC sockets, mating connectors for J1 and J2, 20-conductor ribbon cable, hardware, wire, etc.
A PC board for the relay driver board is available from PPG Electronics Co., Inc, 14663 Lanark St., Van Nuys, CA 91402. (213) 988-3525. Price is $9.95 plus $1.00 for shipping and handling. CA residents add 6% tax. MC and Visa accepted.

TABLE 1

IC No., Pin No.	Key No.	Function
IC1, 1	1	Both wheels, forward
" , 2	2	Both wheels, reverse
" , 3	3	Left wheel, forward
" , 4	A	Left wheel, reverse
" , 5	4	Right wheel, forward
" , 6	5	Left & right arm solenoids
" , 7	6	Body rotate, right
" , 8	B	Body rotate, left
IC2, 1	7	Left shoulder, up
" , 2	8	Left shoulder, down
" , 3	9	Right shoulder, up
" , 4	C	Right shoulder, down
" , 5	*	Left arm, up
" , 6	0	Left arm, down
" , 7	#	Right arm, up
" , 8	D	Right arm, down

TABLE 2

Transistor	Relay No.	Finger No.
Q1	RY3, RY5	R, 6
Q2	RY4, RY6	M, 3
Q3	RY3	R
Q4	RY4	M
Q5	RY5	6
Q6	RY19, RY20	18, 4
Q7	RY1	20
Q8	RY2	17
Q17	RY9	P
Q18	RY10	L
Q19	RY11	7
Q20	RY12	2
Q21	RY15	N
Q22	RY16	8
Q23	RY17	5
Q24	RY18	1

be, and vice-versa. The resistor placement can stay as shown.

Installation

After the relay-driver board has been completed, it is piggy-backed onto a 22/44-finger board like the one that was used for the relay board, using ¼-inch spacers. Make positively sure that the two boards are electrically isolated from each other.

The emitter (output) of each 2N2222 transistor is connected to a finger on the piggy-back board. You can use wire-wrap wire for that. The most straightforward way is to use the same finger number (or letter) as that which is connected to pin 16 of the appropriate relay on the relay board (See Table 2).

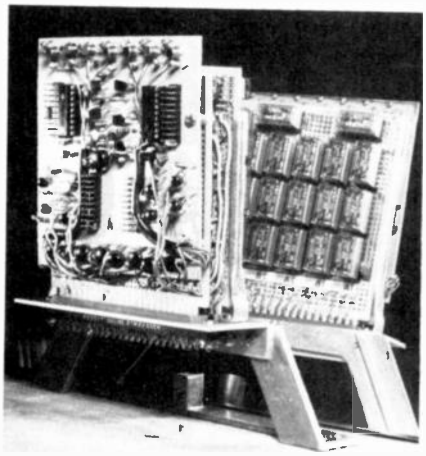
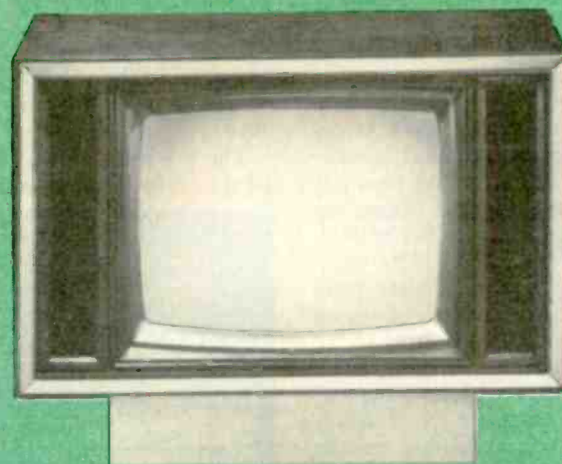


FIG. 71—THE RELAY-DRIVER BOARD is mounted parallel to the relay board, seen reflected in the mirror.

A 22/44-pin edge connector is mounted parallel to the one for the relay board (refer to Fig. 71) and, assuming that you have followed the wiring scheme described above, connections are made between like-numbered pins on the driver-board socket and the relay-board socket-

continued on page 82

Here's how the picture and sound are transferred from the disc to your TV set in the new laser videodisc system.



LASER VIDEODISC
How the Video Signal is Processed

LEN FELDMAN

MUCH HAS BEEN WRITTEN ABOUT THE makeup of the three videodisc systems currently vying for acceptance in the marketplace. There are laser optical discs favored by Magnavox, Pioneer, and others, capacitance-pickup grooveless discs, proposed by JVC, Matsushita, and General Electric, and capacitance-pickup groove-type discs developed by RCA. In the case of the optical and capacitance videodisc systems so far proposed, we have seen many diagrams of how tiny "pits" or dark and light spots in the disc tracks will be carrying the encoded information. But little has appeared in the literature as to just what that information is, how it is encoded, and what the circuitry needed to decode it will be like, once you get past the question of pickup format.

The Magnavox Consumer Electronics Company has prepared an excellent booklet about their model *VH-8000* Videodisc Player in order to familiarize technicians and others with their laser disc system as well as with playback circuitry. While the booklet deals with all aspects of the optical-laser videodisc player's operation, our concern here will be only with the signal-processing circuits that handle the signals picked up by arrays of photo-sensitive diodes that catch the laser-beam reflections from the surface of the spinning disc.

To understand the circuit descriptions that follow, we must know just what sort of signals are contained in the

laser-disc tracks themselves. The intelligence that is encoded on the videodisc is the combination of three different FM signals:

1. An 8.1-MHz FM signal modulated with composite video, including chroma.
2. A 2.3-MHz FM signal modulated with Channel-I sound.
3. A 2.8-MHz FM signal modulated with Channel-II sound.

Figure 1 shows those three signals in the frequency spectrum. Each sound carrier (the videodisc contains two independent sound channels and thus has the capability, among other things, for stereo sound) has a maximum FM deviation of ±100 kHz. The 8.1-MHz video carrier has a deviation of 1.7 MHz (from sync tip to peak white) with its bandpass extending from below 4 MHz to above 12 MHz to include all sidebands. Each of the sound signals modulates the 8.1-MHz video FM to create the resultant signal that becomes encoded on the videodisc, as shown in Fig. 2.

Signal processing

A simplified block diagram of the signal-processing circuitry needed to produce the video and audio signals from the laser disc is shown in Fig. 3. The total composite FM signal from the photosensitive diodes and preamplifier module is applied to a high frequency amplifier/splitter. Frequency tuned networks separate the sound-FM signals from the video FM. The sound FM is applied to two frequency-sensitive stages: a 2.8-MHz sound demodulator and a 2.3-MHz sound demodulator. Those stages serve as ordinary FM detectors and retrieve the audio signals from their respective FM carriers. The two resulting audio signals are applied to an electronic-switch network that applies either one or both of them to the RF modulator of the player. Front-panel switches on the videodisc player determine which audio signals are heard and used.

The 8.1-MHz video-FM signal is applied to Video Demodulator I that extracts the composite video signal from the carrier. That composite signal is amplified by a video amplifier and applied to the RF modulator. Since each frame of the 54,000 frames contained on a single side of the disc is numbered, and the player is capable of displaying that number on the TV screen, the picture-number information is stripped from the composite video signal by the clipper/decoder circuit. Here, the picture-number information is decoded and converted to a picture-number video signal. That signal is also amplified by the video amplifier and

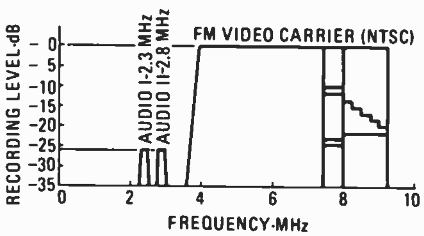


FIG. 1—AUDIO AND VIDEO signals as recorded on videodisc. One video sideband—note sync pulses and video ramp wareform—is shown at 8.1 MHz.

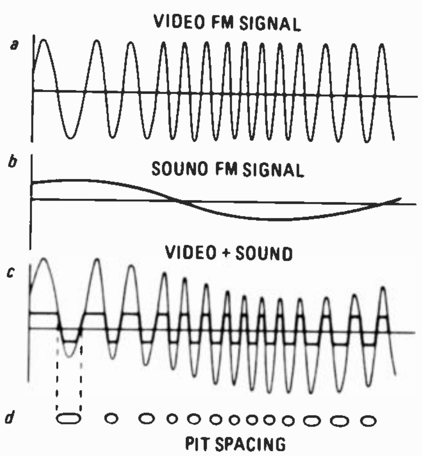


FIG. 2—RESULTANT SIGNAL created when both of the sound signals modulate the 8.1 MHz video-FM.

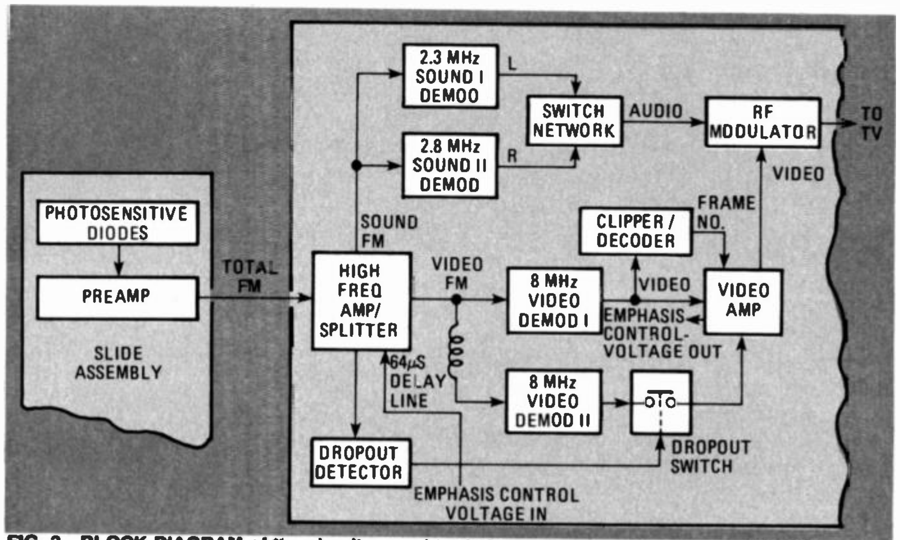


FIG. 3—BLOCK DIAGRAM of the circuitry used to derive audio and video from the videodisc.

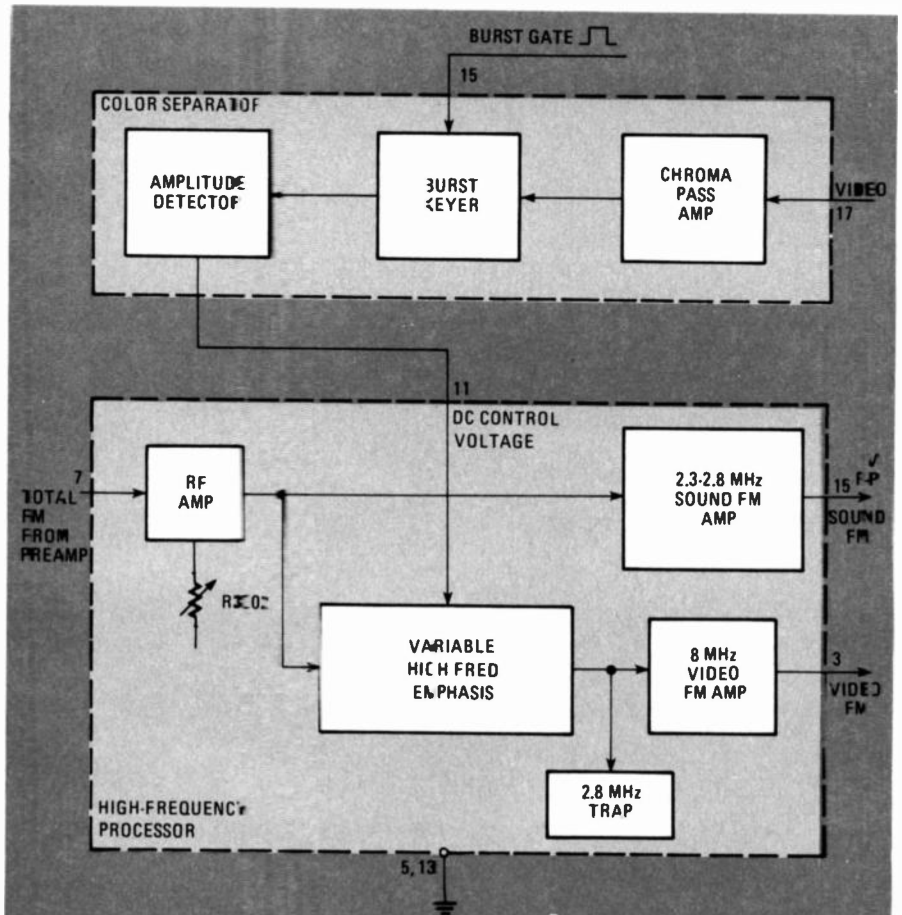


FIG. 4—DETAILED block diagram of the splitter and high-frequency signal processor. The color separator removes the color burst from the video.

applied separately to the RF modulator. The RF modulator places the audio and video onto the required RF frequencies for TV Channel 3, or Channel 4, selectable by the user. The output from the RF modulator is connected to antenna terminals on the viewer's TV set through an antenna-switch box.

The video circuitry creates a varying DC voltage that is proportional to the burst amplitude. That voltage is called the emphasis-control voltage and is applied to a high-frequency amplifier to emphasize high frequencies when operating near the inner diameter of the videodisc (where such high frequencies would tend to be more attenuated). The control is necessary because the "pits" on the surface of the disc are more closely spaced at the inner diameter of the disc.

The player is also designed to compensate for minor dropouts of information from the videodisc. A dropout, in that case, is defined as an area on the videodisc that has incorrect encoding or no encoding at all. Such a loss of encoding could be caused by physical damage to the disc after it has been used, or by manufacturing imperfections. The dropout-correction circuitry built into the Magnavox player can compensate for the loss of up to one complete horizontal line on the TV screen.

The 8.1-MHz video-FM signal is applied to a dropout-detector circuit. If a bad spot on the videodisc is encountered, the 8.1-MHz signal will be absent and the dropout detector will sense that absence.

The 8.1-MHz signal is also applied through a 64-microsecond delay line, to Video Demodulator II. Since 64 microseconds corresponds to the sweep time of a single horizontal line, when a dropout is encountered, the dropout detector activates an electronic switch that then applies the delayed, *previous* horizontal line in place of the one that has dropped out. The result on the video screen of the viewer's TV set is two horizontal scan lines with the same video information. In other words, the dropout has been filled in by repeating the previous line of video information.

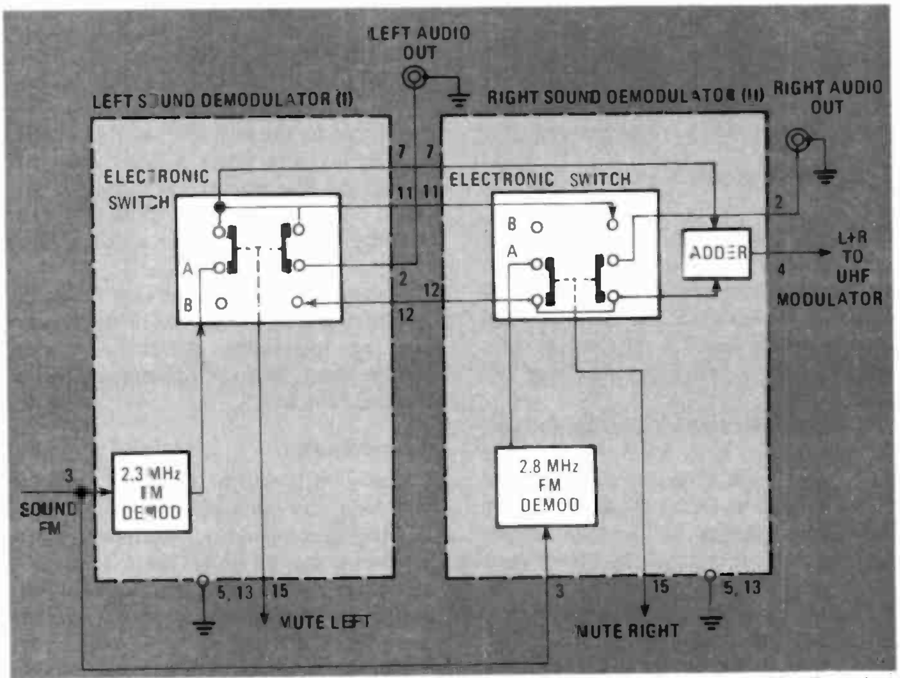


FIG. 5—SOUND SIGNAL processing modules. The sound-FM signals are processed by these two circuits.

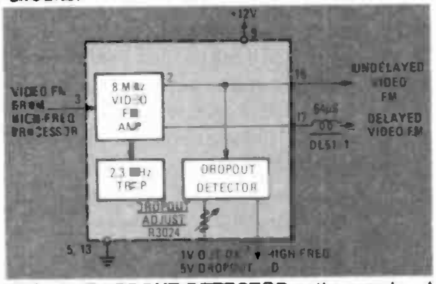


FIG. 6—DROPOUT DETECTOR activates signal restoration circuitry when it detects missing information.

A more detailed look

A more detailed block diagram of the high-frequency signal processor and splitter is shown in Fig. 4. The entire composite FM signal is applied to an RF amplifier whose gain control, R3002, is used to set the correct output level. The output of the RF amplifier is applied to the sound FM amplifier. The input of the sound FM amplifier is tuned to pass only the 2.3-MHz and 2.8-MHz sound carriers, both of which are then present at the output of the amplifier.

The color-separator circuit shown in Fig. 4 removes the color burst from the video signal by gating the burst keyer with the horizontal burst-gate pulse. The amplitude detector creates a DC voltage proportional to the burst amplitude. As that DC voltage decreases, the high-frequency response of the video amplifier increases. The net effect is to boost the high frequencies towards the inner section of the videodisc. The video FM amplifier boosts the 8.1-MHz video-FM signal. The 2.8-MHz trap removes any remaining Channel-II audio carrier at that point. Any remaining Channel-I (2.3-MHz) sound carrier is trapped out later in the signal path.

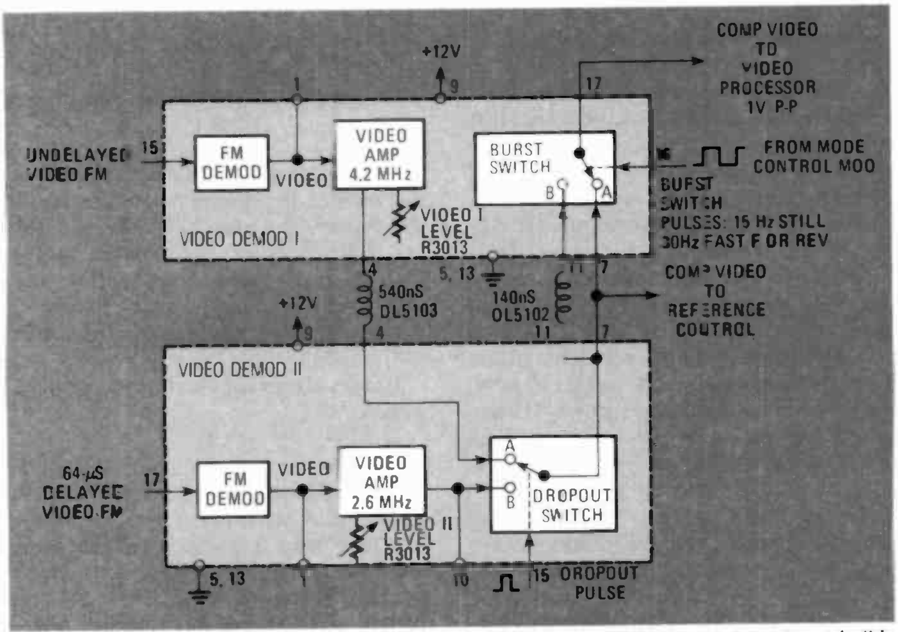


FIG. 7—VIDEO-FM and delayed video-FM are supplied to the demodulator circuit as shown in this block diagram.

Sound signal processing

The sound-FM signals are processed by two circuit modules, whose block diagrams are shown in Fig. 5. The sound-FM signal is applied to the 2.3-MHz FM demodulator on the Sound

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hobby corner

When analyzing simple circuits, be careful not to overlook the obvious.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

WELL, THE ELECTRONS HAVE SETTLED from Light Mystery No. 2 (see Hobby Corner, August 1980 issue). And those electrons were flying all over the place from California to Connecticut and everywhere in between.

Let's take another look at Don Francois' puzzle. He constructed the two circuits shown in Fig. 1 and found that the bulb brightness in one was greater than in the other.

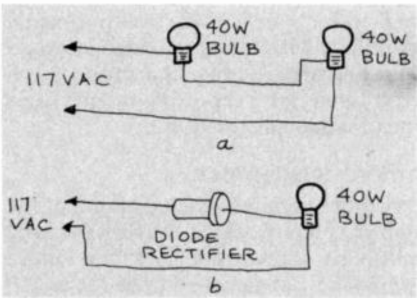


FIG. 1

Things got tough when he measured the same voltage across each bulb. And, to make matters worse, Don measured the same current in each circuit.

That puzzle can be attacked by breaking it down into three questions:

1. How can the voltages and currents be the same in the circuits shown in Figs. 1-a and 1-b?
2. Are the bulbs brighter in either circuit?
3. Why is the brightness different?

The answer to No. 1, of course, is that the voltages and currents *cannot* be equal if the brightenesses are different. All the responses that addressed that question were correct though in some cases the reasoning was fuzzy.

The voltage waveforms in the two circuits are shown in Fig. 2. The fallacy of the "equal" measurements lies in the fact that common AC meters are designed to measure sinewaves (Fig. 2-a). If the waveform is not sinusoidal, the meter gives an inaccurate reading. A DC meter also gives a false reading on pulsating DC (Fig. 2-b).

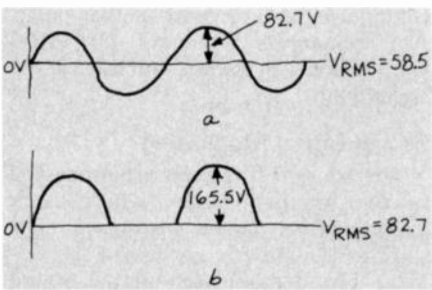


FIG. 2

We must assume that Don used a typical multimeter. If so, his readings in the diode circuit would be wrong whether he measured AC or DC. Actually, as Fig. 2 shows, the voltages and currents are *not* the same and therefore, the power (and brightness) differs.

Getting on to the question of which is brighter—That is where I got a surprise. Two readers "proved" that the bulbs in both circuits are equally bright in spite of Don's report to the contrary. And, almost half of the responses were wrong!

One sure way to find the answer is to hook up the circuits and observe the difference in brightness. Quite obviously many of you did not do that.

In fact, it appears that none of you who wrote tried the circuits. Come on, guys and gals; trying it out (experimenting) is the only way you can be sure that your reasoning is correct. Logic and computation are fine if you have all the facts and don't overlook something. Even some of the right answers were based on incomplete facts.

Sometimes things are not as simple as they first appear. Everyone remembered that the diode "cuts out" half of the AC sinewave. But did you remember that the two bulbs in series effectively divide that 117 volts AC between them? Did you remember to take into account that the circuit resistances of both circuits are *not* the same? What else did you overlook? The way to tackle any electronics problem is to use a combination of reasoning and experimentation.

Those of you who answered the question correctly used a great variety of logical and/or mathematical proofs. Three sharp readers threw in some calculus (that almost threw me—it *has* been a long time). Let me hasten to say that calculus is not necessary to prove the answer. However you did it, congratulations to you—unless, of course, it was an accident.

I have given a lot of thought to making this report on Light Mystery No. 2. Having stirred up the dust with what has been said so far, I'm going to stop short of giving you the answer. You may think that's "dirty pool" but, actually, the answers and the facts *are* above. Have fun!

A very special thanks to Don Francois for sharing that mystery with us. If you have an interesting electronic puzzle, send it along. Perhaps you too can make the electrons fly.

Speedometer

Henry Milowski of Welland, Ontario sent me a very interesting letter. It seems that the speedometer on his exercise bicycle broke and he saved some bucks by making a replacement. The basis of his design can be used to measure the rate of any rotating object.

Henry used an old DC motor as a generator that is turned by the bike tire (Fig. 3). His motor came from a discarded tape deck. The output voltage is proportional to the speed and that output is measured by the meter (a miles-per-hour scale was added). The LED protects the meter if the tire turns backwards and it also adds to the appearance.

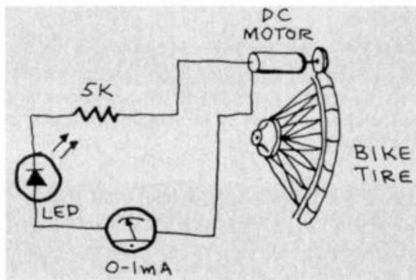


FIG. 3

You may need to change the value of the resistor depending upon the meter and motor you use. Not only will the motor be different, but the size of the shaft "wheel" pressing on the tire will determine the output range. I suggest that you start with a 10K or 20K pot in the circuit.

Thanks Henry for sharing your project with us.

Fundy

Noting Henry's Canadian address, reminds me of my summer trip around the Bay of Fundy. I guess I saw about as much as one can see there in a couple of weeks. I was duly amazed. Those 20- and 30-foot tides are all but unbelievable—

continued on page 72

HOBBY CORNER

continued from page 70

even when you are standing there looking at them. And while you're watching that awesome amount of water flow up and back every few hours, you cannot help but think how much electrical power it could generate.

You stand, watch, and dream just as countless others have done before you. Some day that potential will be harnessed. That will be something to see! (Any new ideas?)

Another clock

If there is a piece of digital equipment that has universal appeal and application, it is the clock.

Larry Neel of Cincinnati, OH has raised a question that brings forth some interesting thoughts. Larry wants a clock that normally displays local time but could give Coordinated Universal Time (GMT for you old-timers) at the push of a switch. I certainly agree that it would be better than using two clocks for hams, SWL's, and others.

I haven't had a chance to work on this problem yet but it doesn't appear to be very difficult. Why not a switchable circuit between the clock IC and the display? That circuit would add five, six, or whatever hours needed to the time before it is displayed. Or perhaps it would be easier to switch between two continuously running clock IC's.

Have any of you built a clock like that? If so, send me the info and I'll pass it along.

Reader question

E. M. Shanley of Novato, CA is looking for a control circuit to operate a piece of apparatus by radio control. The radio part is not causing him a problem—it's what comes after the receiver.

What E.M. needs is a circuit to close and latch a relay on the first pulse, and then open (unlatch) the same relay on the second pulse.

Can anyone offer any help?

Flash anyone?

Frank Eatherton of Alameda, CA is a photographer and is looking for a reliable circuit for a wireless "slave" flash control. Frank says that he is not only tired of tripping over wires, but that it can be costly when he does so and topples over a flash or camera!

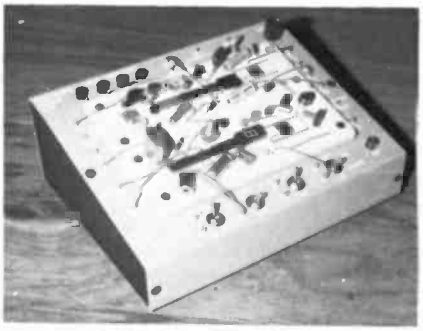
What is needed is a small unit to actuate additional flash units when the main one fires. Such a unit could operate by radio or light-control.

If you have developed a flash-control circuit, or any type of wireless control that could be adapted for flash use, send along a schematic with description of the device. Perhaps we can save Frank and other readers from damaging any more camera equipment. **R-E**

new products

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

ELECTRONIC DESIGN LAB, *model CA-16*, features a variable-function generator: frequency 1 Hz to 100 kHz variable rate, 2-volts output level, sinewave distortion less than 1%, squarewave TTL and CMOS logic levels, and triangle and sinewave for linear operation. Power supplies include 6 regulated voltages, current-limited and short-circuit proof. Noise: 20 mV under load; There is a +5-volt supply—1-amp maximum load and a +12, +15, −5, −12, −15, 750 mA maximum load.



CIRCLE 151 ON FREE INFORMATION CARD

Also featured are four LED logic-level indicators for TTL and CMOS logic, four (HI and LO) debounce toggle switches for TTL and CMOS logic, and two CMOS-to-TTL logic-level converters. Everything is at the user's fingertips and the components can be used over and over again. The *model CA-16* has been designed for engineers and technicians for testing new prototypes, modifications, circuit changes, and ideas, and is recommended as a teaching aid for students just starting in electronics. Price is $99.95.—**Cascade Labs**, 4156 South Alder Ave., Freeland, WA 98249.

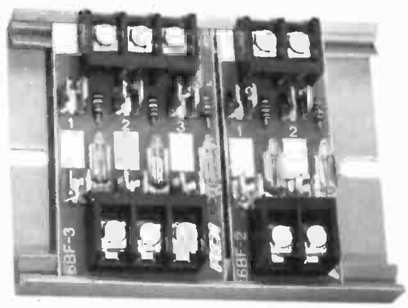
PROGRAMMABLE ELECTRONIC THERMOSTAT, the *Comfort Zone*, is the only electronic thermostat on today's market that offers triple setback, or the selection of three temperature periods in a 24-hour sequence. In addition, each day in a seven-day sequence can be programmed separately. A full week's program can be entered at one time and will repeat indefinitely until changed.

CIRCLE 152 ON FREE INFORMATION CARD

Comfort Zone has been designed for easy operation: When programming, the user rotates easy-to-use thumbwheel until the desired time and temperature settings appear on display. Pushing a key enters the time and temperature settings into the unit's memory, and an audio tone tells the user that the information has been properly entered. The previous day's program can be repeated at the touch of a key. When not being programmed, the time, temperature, and the day of the week are on continuous display.

Comfort Zone is fully automatic, but can be used manually for special periods of heating or cooling. The user may also arrange for 10-, 20-, or 30-minute bursts of heat or cold without disrupting the pre-selected program. The device is solid-state, and no additional wiring, transformers, or relays are necessary for installation. A battery protects the microcomputer's memory in the event of power failure. *Comfort Zone's* suggested list price is less than $200.00—**PCI, Incorporated**, 1145 Sonora Court, Sunnyvale CA, 94086

FUSE BLOCK, the *Snaptrack fuse block series 6BF*, features neon indicator lamps that light when a 3AG fuse blows. (The 3AG fuse is very

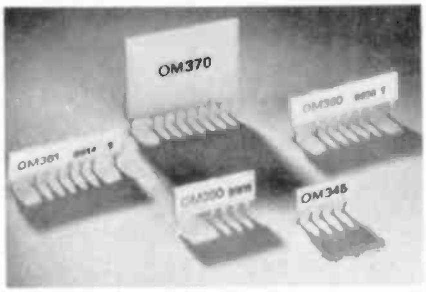


CIRCLE 153 ON FREE INFORMATION CARD

small and difficult to find when blown.) The 6BF-series fuse blocks are available in models carrying two or three fuses. Connections are made via screw terminals. The fuse clips, terminal blocks, and lamps are wave-soldered to epoxy-glass printed-circuit boards that snap-in mount in *Snaptrack* mounting channel; the modules mount easily there, along with relay sockets, edge connectors, power supplies, and other RDI control modules. *Snaptrack* requires only two fasteners per foot of track instead of two fasteners per fuse block. Rating is 10 amperes, 300 volts, with 120-volt neon lamp; the block handles 3AG fuse (1.25 X .25 in.) Price: three fuse modules, $4.35 each in 100 lots.—**RDI**, 525 Randy Road, Carol Stream, IL, 60187.

WIDEBAND UHF/VHF AMPLIFIERS, are a line of low-cost, high-performance, prepacked hybrid IC wideband amplifiers for CATV, MATV, and similar applications that has been introduced by Amperex Electronic Corporation. They operate from a 12-volt supply voltage and cover a 40- to 860-MHz frequency range. The line is produced as thin-film circuits on ceramic substrates and consists of 1-, 2-, and 3-stage types, with gain ranging from 12 dB for the single-stage amplifier to 28 dB for the 3-stage type.

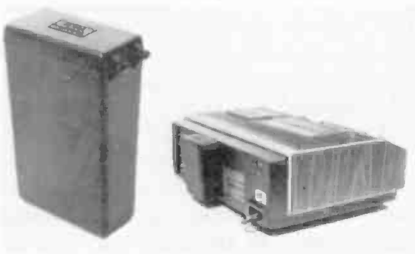
The line includes five devices: *ATF445/OM 345* has 12 dB gain and 99 dBμV output; *ATF442/OM350* has 18 dB gain and 100 dBμV output; *ATF443/OM360* has 23 dB gain, 105 dBμV out-



CIRCLE 154 ON FREE INFORMATION CARD

put; *ATF444/OM361* has 28 dB gain, 105 dBμV output, and ATF446/OM370 has 28 dB gain, 113 dBμV output. Higher gain is achieved by cascading two amplifiers. The hybrid UHF/VHF wideband amplifiers are priced as low as $3.05 each (1000 qty) for the *AFT445*.—**Amperex Electronic Corporation,** Providence Turnpike/P.O. Box 98, Slatersville, RI 02876.

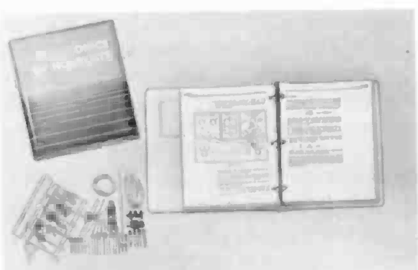
VID-KADDY offers an attractive means of storing the cords and cables at the back of your VCR unit. It is a small, simple storage case that holds the remote pause control device and cable. All that will then be visible will be the compact black



CIRCLE 155 ON FREE INFORMATION CARD

box, but the remote control can still be used easily at any time. *Vid-Kaddy* can be attached with foam tape to the back of the VCR unit in a matter of seconds. Price is $6.95.—**Video Specialties,** P.O. Box 244, Fraser, MI 48026.

HOBBYIST'S ELECTRONIC COURSE, designed for individuals with little or no previous education in electronics, is arranged in seven easy-to-understand units. The course includes the relationships among voltage, current, resistance and power, magnetism, DC and AC, transformers, inductance, reactance, and the proper use of a voltmeter, ammeter, and ohmeter. In addition, the fundamentals of rectifiers, filters, power supplies, and oscillators are covered, as well as many types of digital circuits and an explanation of how a digital computer works.



CIRCLE 50 ON FREE INFORMATION CARD

Finally, the course provides an overview of the major electronics hobbies—experimentation and construction, shortwave listening, amateur radio, R/C, personal computing, and high-fidelity audio. Twenty-six optional experiments will provide thorough hands-on experience with electronic devices. They will, however, require that the student purchase the Heathkit/Zenith *model ET-3100* Experimenter/Trainer Kit. The Hobbyist's Course is priced at $54.95; the Trainer Kit is $74.95.—**Heathkit/Zenith Educational Systems,** Dept. 350-470, Benton Harbor, MI 49022. **R-E**

communications corner

Harmonics? Here's a simple and inexpensive way to get rid of them.

HERB FRIEDMAN, COMMUNICATIONS EDITOR

THERE ARE VIRTUALLY NO NEW FRONTIERS left as far as the radio spectrum is concerned. It's no longer a matter of when devices would be introduced that could efficiently generate and amplify transmissions on the next higher slice of the spectrum but rather, it's where do we put everyone who wants to use the radio spectrum.

Until recently, no one really cared where spurious signals from transmitters were going. Early spark-gap telegraph operators actually depended on their signals taking up hundreds of kilohertz with sideband-splash, clicks, pops, and crackles. How else was anyone to know they were on the air? When the interference got too bad (because more than two stations were trying to operate within a half-megahertz of each other) the old Department of Commerce simply forced the CW operators to change from an AC high-voltage supply to DC. That created a thunderous crash of silence in which many stations could operate at the same time.

As equipment improved, so did the rules tightening control of interference. But the harmonics of broadcasting stations still fell in the VHF marine band, and FM stations couldn't have cared less about their harmonics because simply no one was operating at 170 MHz or higher. Radio amateurs had even less of a problem because, until TV came along, their harmonics generally fell within their own bands.

But today there's someone operating on virtually every frequency, and the general rule is that if your station is causing interference to the reception of any other station because of transmitter characteristics such as harmonics or spurious signals, you either fix the problem or you shut down. It is never the other station's problem. (Even amateur and CB transmitters now have strict limitations on harmonic and spurious output.)

Because of the need to squash all harmonics and spurious signals, many deep-notch filters that were formerly considered oddball, have now become commonplace in VHF and UHF transmitters. A good example of what to expect is the harmonic filter in Heathkit's *model VF-7401* two meter scanning transceiver.

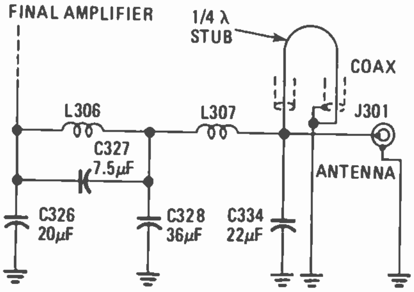


FIG. 1

Figure 1 shows a schematic of this filter. Components L306, C326, C327, C328, L307, C334 form a conventional low-pass filter used for harmonic suppression. The problem is that the L-C filter doesn't provide adequate second harmonic suppression. To cascade standard L-C filters might cause more harm than good because RF tends to seek a free path around the coils and capacitors, and really loss-free L-C filters are fairly expensive.

One way to get an inexpensive, effective filter is to short all, or actually most, of the RF to ground through a tuned line. That is precisely what's done in the *VF-7401* by a ¼-wavelength transmission-line stub, shown in Fig. 1 just ahead of antenna connector J301.

The stub is an electrical ¼-wavelength of shielded cable (coax) coiled within the transceiver. The center conductor is connected to the transmitter output at the junction of L307 and C334. The other end of the stub is shorted, with both the center conductor and shield connected to ground.

If you recall, a ¼-wavelength stub is an impedance inverter. If one end is shorted, the other end appears as a high impedance. So, at the operating frequency, the stub actually does not exist in the circuit because it appears as a high impedance in parallel with the 50-ohm transmitter load (the antenna).

At the second harmonic frequency, however, the stub is an electrical ½-wavelength. Half-wavelength stubs are impedance repeaters, often called matching transformers. At the operating frequency, what appears at one end also appears at the other. Thus if one end is a short-circuit, the other end appears as a short-circuit and the stub in Fig. 1 is actually a low-impedance path to ground for the second harmonic.

Just because we can coil up a stub made of coax cable within a small cabinet doesn't mean we must always use flexible cable. For higher-power transmitters, rigid transmission line can be used. A practical example of what to expect is the filter used by FM stations whose harmonics interfere with UHF communications. Imagine if you will, an FM station with an assigned frequency of 91.3 MHz. Its fifth harmonic falls at 456.5 MHz, a frequency in the UHF spectrum used by police and fire departments, as well as land transportation systems such as taxi services. Now the fifth harmonic might not sound like much, but if the FM station is running from 10 to 20 kW on its assigned frequency, and its antenna is about one mile from, and on a direct line with, the antenna of a taxi service, it can create all sorts of reception problems for taxis on the fringes of their service area. In an actual instance, the received fifth harmonic was 1.8 μV at the antenna terminals of a UHF receiver. It "broke" the squelch continually and just about destroyed radio communications for the taxis.

It might appear to be a contest between mismatched opponents, but remember the rule: If your gear creates interference it's your problem. The taxi service does

continued on page 78

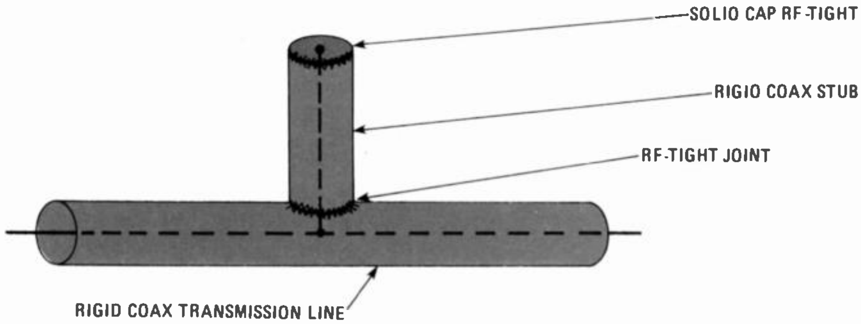


FIG. 2

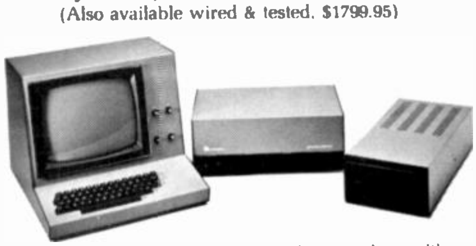
Start learning and computing for only ***$129.95*** *with a Netronics 8085-based computer kit. Then expand it in low-cost steps to a business/development system with 64k or more RAM, 8" floppy disk drives, hard disks and multi-terminal I/O.*

THE NEW EXPLORER/85 SYSTEM

Special! *Full 8" floppy, 64k system for less than the price of a mini! Only* $1499.95!

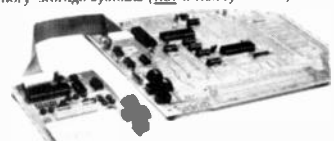
(Also available wired & tested, $1799.95)

Imagine — for only $129.95 you can own the starting level of Explorer/85, a computer that's expandable into full business/development capabilities — a computer that can be your beginner system, an OEM controller, or an IBM-formatted 8" disk small business system. From the first day you own Explorer/85, you begin computing on a significant level, and applying principles discussed in leading computer magazines. Explorer/85 features the advanced Intel 8085 cpu, which is 100% compatible with the older 8080A. It offers onboard S-100 bus expansion, Microsoft BASIC in ROM, plus instant conversion to mass storage disk memory with standard IBM-formatted 8" disks. All for only $129.95, plus the cost of power supply, keyboard/terminal and RF modulator if you don't have them (see our remarkable prices below for these and other accessories). With a Hex Keypad/display front panel, Level "A" can be programmed with no need for a terminal, ideal for a controller, OEM, or a real low-cost start.



Full 8" disk system for less than the price of a mini (shown with Netronics Explorer/85 computer and new terminal). System features floppy drive from Control Data Corp., world's largest maker of memory storage systems (not a hobby brand!)

Level "A" is a complete operating system, perfect for beginners, hobbyists, industrial controller use $129.95



Level "A" With Hex Keypad/Display.

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 advanced 8155 RAM I/O . . . all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, plus generous prototyping space.

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 . . . cassette tape recorder input and output . . . cassette tape control 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 . . . 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 to 9600 baud . . . 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 Keypad/Display 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 this version makes a perfect controller for industrial applications, and is programmed using the Netronics Hex Keypad/Display. It is low cost, perfect for beginners.

HEX KEYPAD/DISPLAY SPECIFICATIONS

Calculator type keypad with 24 system-defined and 16 user-defined keys. Six digit calculator-type display, that 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 selectable 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.

LEVEL "C" SPECIFICATIONS

Level "C" expands Explorer/85's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and card 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 that plugs into the motherboard. Just add required number of S-100 connectors.

Explorer/85 With Level "C" Card Cage.

LEVEL "D" SPECIFICATIONS

Level "D" provides 4k of 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 2k x 8 RAM IC's (allowing for up to 12k of onboard RAM).

DISK DRIVE SPECIFICATIONS

- 8" CONTROL DATA CORP professional drive.
- LSI controller
- Write protect
- Single or double density
- Data capacity: 401,016 bytes (SD), 802,032 bytes (DD), unformatted.
- Access time: 25ms (one track)

DISK CONTROLLER/I/O BOARD SPECIFICATIONS

- Controls up to four 8" drives.
- 1771A LSI (SD) floppy disk controller
- Onboard data separator (IBM compatible).
- 2 Serial I/O ports
- Autoboot to disk system when system reset
- 2716 PROM socket included for use in custom applications.
- Onboard crystal controlled
- Onboard I/O baud rate generators to 9600 baud
- Double-sided PC board (glass epoxy)

DISK DRIVE CABINET/POWER SUPPLY

- Deluxe steel cabinet with individual power supply for maximum reliability and stability.

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Beginner's Pak (Save $26.00!) — Buy Level "A" (Terminal Version) with Monitor Source Listing and AP-1 5-amp Power Supply: (regular price $199.95), now at SPECIAL PRICE: **$169.95** plus post. & insur.

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COMMUNICATIONS CORNER
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not shut down or change frequency (the FCC did not permit a change). But the FM station must eliminate the interference or shut down. The fact that the FCC might have made a mistake in assigning a UHF channel located close to the FM station, and directly on the fifth harmonic, has nothing whatsoever to do with it. The fifth harmonic goes or else!

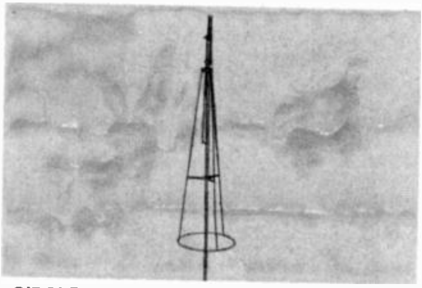
This problem can be handled by a stub serving as a harmonic filter. Figure 2 shows how it's done. The transmission line is a 50.5 ohm 3-inch rigid line that resembles a large pipe. The center conductor is copper tubing, approximately $^5/_8$-inch in diameter. A filter, of the same material and construction as the transmission line, is soldered to the line and its shield and the center conductor are short-circuited at the end by a solid air-tight cap so that there are no breaks for the RF to escape. What we end up with is a grounded, fully shielded, stub. The effective attenuation is about 60 to 80 dB.

As the spectrum reaches saturation on a continuing basis, the need for, and use of, deep-notch filters will become more commonplace. Keep this in mind the next time you're working on a transmitter of any sort. The little piece of extra transmission line just might be the filter that allows the rig to stay on the air. **R-E**

radio products

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

NEW 6.14 dBi GAIN omni-directional CB antenna, the *Sigma IV*, gives CB'ers the ability to transmit and receive farther than ever thought possible with an omni-directional antenna. Excellent bandwidth provides for a 1.1:1 SWR at resonance with 1.5:1 or better over all 40 channels. Unlike conventional bottom-radiating antennas, the *Sigma IV* radiates the majority of the signal from high



CIRCLE 121 ON FREE INFORMATION CARD

up on the antenna, giving an extra boost in performance. The antenna may even be mounted at ground-level—there's no need for tower or mast mounting to achieve excellence. The *Sigma IV* has an RF safety factor of 2,000 watts. Cost is $89.95.—**Avanti Research and Development, Inc.**, 340 Stewart Avenue, Addision, IL 60101.

TRANSCEIVER, *OMNI-C Series, model 546*, covers bands from 160 through 10 meters and has all nine high-frequency bands, with crystals included for seven of the nine bands. It features a three-mode, two-range offset-tuning capability with a choice of offset tuning for the receiver, transmitter, or combined transceiver. Switching is provid-

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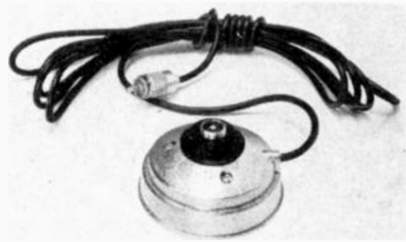
ed for selecting the standard 8-pole 2.4 kHz SSB filter, the optional 1.8 kHz 8-pole SSB filter, the optional 250-Hz or 500-Hz 8-pole CW filters, cascading them for 16 poles of filtering, or placing them in the signal path along with 450 and 150 Hz active audio filters. The *OMNI-C* also has "hang" AGC and a standard noise blanker. Price is $1189.—**TEN-TEC, Inc.**, Highway 411 E., Sevierville, TN 37862.

TRANSMITTER KIT, *model 1750 Meter Transmitter*, for the 160 to 190 kHz experimenter's band. Operation at one-watt input power and with a 50-foot maximum antenna length is allowed by the FCC with no license required. The transmitter has two parts: The main assembly contains the frequency generator, power supply, and control panel, and is located at the operating

CIRCLE 123 ON FREE INFORMATION CARD

position. The antenna-tuning assembly mounts at the base of the antenna. The transmitter is for CW operation but can easily be converted to AM. Wiring of the kit takes about an hour using simple tools. Complete assembly and operating instructions are included. Suggested retail price is $145.—**Palomar Engineers**, Box 455, Escondido, CA 92025.

MAGNET MOUNT, *model K-350*, comprises a heavy-duty, professional-grade magnet base with pre-assembled RG-58U cable and fittings to accommodate virtually all standard base-loaded or low-profile whips. The assembly will accommodate either ⅝-24 threadbase-loaded whips or, with an adapter (furnished), 1⅛-18 thread. Cable



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length is 12 feet, ample for rooftop vehicle installations, and is furnished with a pre-assembled PL-259 standard RF connector. The suggested retail price is $28.75.—**The Antenna Specialists Co.**, Professional Division, 1234 Euclid Ave., Cleveland, OH 44106.

AUTOMATIC ANTENNA TUNER, *Auto Track model AT2500* is for use with amateur, commercial, and government communications systems. It can handle power in excess of 2500 PEP over a frequency range continuous from 3 to 30 MHz,

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and the average automatic tune-up time is 15 seconds. Front-panel switch positions permit use

continued on page 82

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RADIO PRODUCTS

continued from page 80

of three coaxial antenna outputs, one long-wire antenna, and one coaxial tuner bypass. The impedance is 10-300 ohms. A direct-reading SWR meter on the front panel is calibrated from 1.1 to infinity.

The front-panel power meter displays RMS power with continuous (CW) carrier and automatically displays the peak power when in the SSB mode in ranges of 0-250 W and 0-2500 W.

The price of the *model AT2500* is $698.00.—**Bell Industries**, J. W. Miller Division, 19070 Reyes Ave., P.O. Box 5825, Compton, CA 90224.

VARIABLE FILTER, the *Varifilter* can be set to maximize one signal (peaking) or to minimize an interfering signal (notching); it works with CW (Morse), single-sideband, and AM signals, without ringing, oscillation, or instability. The bandwidth is variable from under 30 Hz to over 1 kHz.

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The *Varifilter* has its own internal power supply, which is switchable from 115 to 230 VAC, and can also run from 12 to 18 VDC. Each unit has a tuning eye that lets the operator see when he has filtered the signal he wants to.

The *Varifilter* is priced at $139.95.—**Kantronics**, 1202 E. 23rd Street, Lawrence, KS 66044.

UNICORN-

continued from page 66

et. Table 2 will also help you with that.

Because it is possible to insert the boards into the sockets backwards, we recommend that you use a marker pen or nail polish to indicate the finger-1 edge of the board and the pin-1 end of the socket. If the boards are removed and then replaced, lining up the marks will prevent embarrassing accidents.

Things to come

Because the radio/computer-control section of the robot involves so many parts, it is impossible to present everything in one section and make the transition from a cable-controlled robot to a radio-controlled one in a single jump.

The circuit described here, though, can be checked out by disconnecting the switches in the command console from the 12-volt supply, and providing them with five volts, instead. The motor and solenoid wiring inside the robot, which has served us well, can now be connected to the relays via the pins on the relay-board socket. Refer to Tables 1 and 3 in Part 7. The five-volts from the command-console switches can now be supplied, via the existing umbilical cable.

Next month we'll present the radio-control tone-encoding and decoding circuits, and Unicorn-1 will be able to cut its apron strings. R-E

LASER VIDEODISC
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Demodulator I module. The output of that demodulator is the left-channel audio signal in the case of a stereo-encoded disc. That left-audio signal is applied to the an electronic switch on the Sound Demodulator I module. The 2.8-MHz FM demodulator on the other sound module also receives the sound-FM signal and the demodulated right-channel audio signal is also applied to an electronic switch. Each switch is controlled by a DC voltage to mute the respective sound channel. The switches are shown in their normal position, with neither channel muted. In addition to passing through the electronic switch and out to the left-audio output jack, the left-audio signal passes through pin 7 of the module and into the adder circuit on the second-channel module. The right-channel audio signal is also applied to that adder circuit so that the output of the adder is an L+R audio signal. That sum signal is applied to the RF modulator to modulate the sound-carrier portion of the VHF (Channel 3 or 4) signal.

If the left channel is muted at the front panel of the player, the voltage at pin 15 of Sound Demodulator I module goes high (to 5 volts) and switches the electronic switch to position B. The left-audio signal now goes nowhere, while the right-audio signal is passed to the left-audio out jack and, through pin 7, to the adder. Thus, the right-channel audio signal is present at both adder inputs and at both rear-panel audio-output jacks.

Dropout detection circuit

The 8.1-MHz video-FM signal from the high-frequency processor module is applied to the 8.1-MHz video FM amplifier through pin 3 on the Dropout Detector Module, as shown in Fig. 6. The trap removes any residual 2.3-MHz signal present at that point from the sound carrier. The amplifier supplies two outputs: one at pin 15 and one at pin 17. The latter output passes through a 64-microsecond delay line and is therefore delayed by the time it takes for one horizontal-scan line to occur.

The undelayed video FM is applied to the Dropout Detector. The output of that stage is a voltage at pin 7. If the high-frequency signal drops out momentarily, the pin-7 output goes to 5 volts DC. The drop-out adjust potentiometer R3024 sets the actual amount of time the high frequency must be absent before the detector responds. That output at pin 7 is called the High Frequency Identification voltage because the DC-voltage level is an identification of whether or not high frequency is present. That identification voltage is used later on in other circuits.

The video-FM and the delayed video-FM signals are each applied to a demodulator module as shown in Fig. 7. Video Demodulator I module receives the undelayed video-FM signal and applies it to the demodulator stage at pin 15. The composite video output of the demodulator is present at a test point on pin 1 and is applied to a video amplifier. That amplifier has a frequency response out of 4.2 MHz. The gain of the amplifier is controlled by

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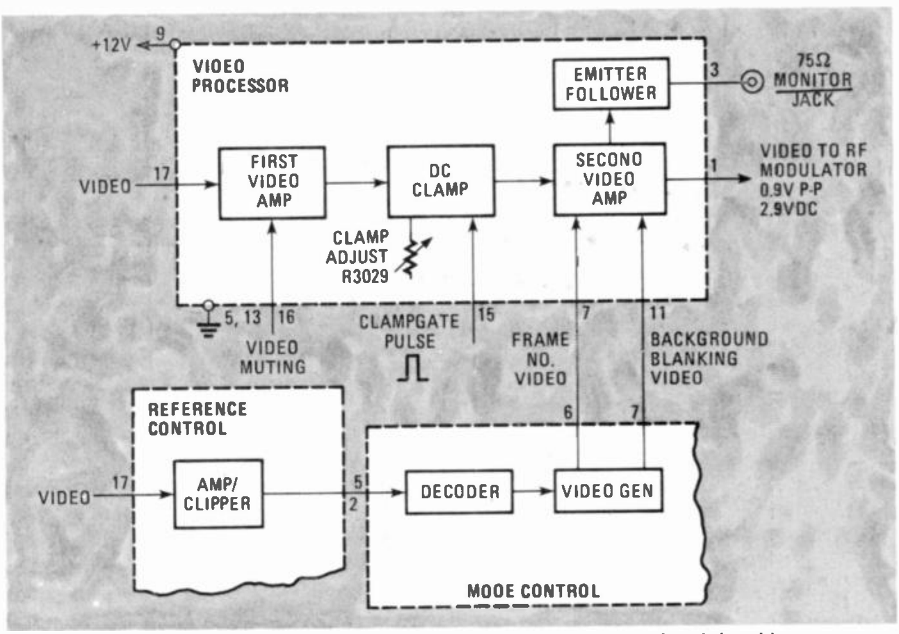

FIG. 6—A COMPOSITE video signal is supplied to the reference control and the video processor modules.

service clinic

The time constant is the key to recognizing faults in oscillator circuits.

JACK DARR, SERVICE EDITOR

AN OLD PROBLEM HAS COME UP AGAIN—incorrect time-constants in critical TV sweep-circuits. All circuits are critical, of course, but the two sweep oscillators are even more so. If the basic problem is recongized when you begin the diagnosis, it's a lot easier all around.

The symptom is that the oscillator is running, but at the wrong frequency. Vertical oscillators cause the display of two pictures, or an overlapped picture which can look almost like the first. If you see two complete pictures, but only half-height, the vertical oscillator is running at half-frequency—30 Hz. If you see two overlapped pictures, the oscillator's running at double frequency, or 120 Hz. In all cases, that is due to an incorrect time-constant in the frequency-controlling circuitry. In the multivibrator types so popular a while ago, that was an R–C time constant and resistor drift or capacitor leakage threw it off. In some of the new sets, however, oscillator transformers are coming back.

In the case that triggered this column, a *Quasar TS-938*, a two-winding transformer is used. The primary winding goes to the collector, and secondary to the base of the transistor. There is a resonating capacitor and some resistors across the secondary. That is shown in Fig. 1. The time-constant involves all of the components: the secondary winding, the capacitor, and the resistors. All of those should be checked.

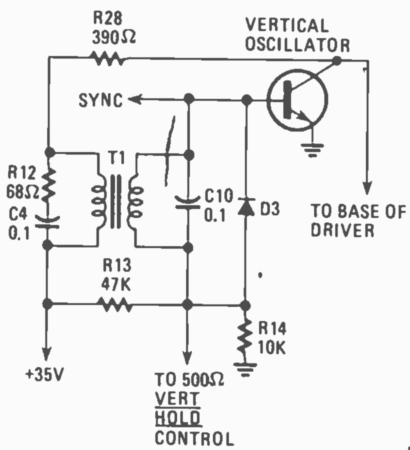

FIG. 1

The symptom here was two complete pictures. The oscillator frequency was checked on a scope and it was 30 Hz, thus the oscillator was running slow. That is a valuable clue. A low frequency tells us that one of the values is far too large so a component must have increased in value. We have three possibilities: inductance, capacitance, and resistance. It is quite impossible for an inductor to go *up* in value. The same is true for a paper capacitor. So, we can eliminate those. That leaves us with resistance. And indeed it's quite possible for a resistor to increase in value. There are three resistors used: R13 (47K ohms); R14 (10K ohms); and the 500-ohm hold control. Checking those out showed that R13 had gone up to more than 100K ohms. After replacing it, the problem cleared up. You can see the reasoning that eliminated most of the components, and left us with the only ones that could produce the indicated fault. Incidentally, the DC voltages around the stage were very close to normal so, in this case they weren't of much help. But the picture on the screen plus confirmation with the scope gave us the needed information very quickly.

In similar cases with older sets, a slightly leaky capacitor in the feedback loop (output-stage plate back through an R–C network to the input grid) can upset the time constant and cause off-frequency operation. In a great percentage of those cases, the culprit was the last capacitor in the loop going to the input grid. Here, it affected the oscillator time-constant. By the same reasoning, a leaky coupling capacitor from the sync-separator to that grid can also upset things.

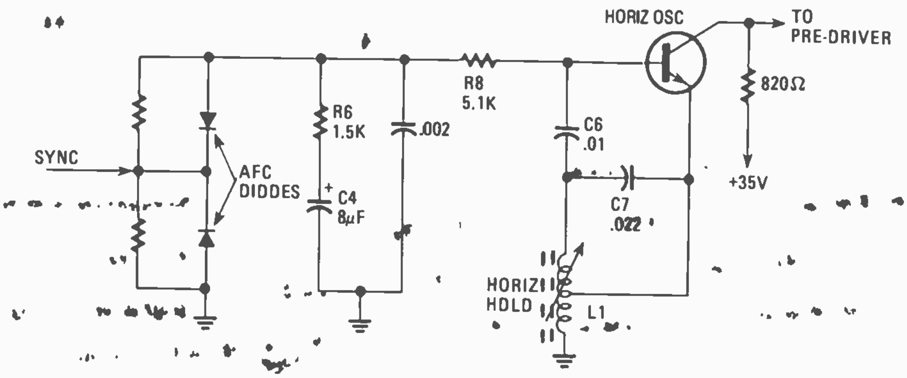

FIG. 2

And the same thing can happen in the horizontal-oscillator stages too. In the cathode-coupled (emitter-coupled) circuit, where a tapped coil is used in the grid-cathode (base-emitter) circuit, there will be resonating capacitors across the coil. There is also a coupling capacitor from the top of the coil to the input. All of those capacitors are critical. Even very small leakage in any of them can cause trouble.

The horizontal AFC circuit can cause off-frequency operation, in some cases. That can be mistaken for a time-constant problem in the oscillator. Luckily, there is a very simple test for it: Just kill the AFC, and see if you can make the oscillator run on-frequency with the hold control. If so, the oscillator is OK and you have to deal with the AFC.

You do have some time-constant circuits in the horizontal AFC, by the way. Note the filtering circuitry between the AFC diodes and the oscillator base in Fig. 2. You can get a real headache if some of those parts have gone off-value.

There is an electrolytic capacitor and that can go down in value. One function of the filter network is to remove all sync signals from the AFC-control voltage. Failure will allow the sync to get into the oscillator control, and the result will be a "mysterious" horizontal jitter. Here again, don't rely on DC-voltage readings exclusively. The scope will show you whether there is any unwanted signal on the oscillator base, and that is a key clue. **R-E**

Service questions are on page 86

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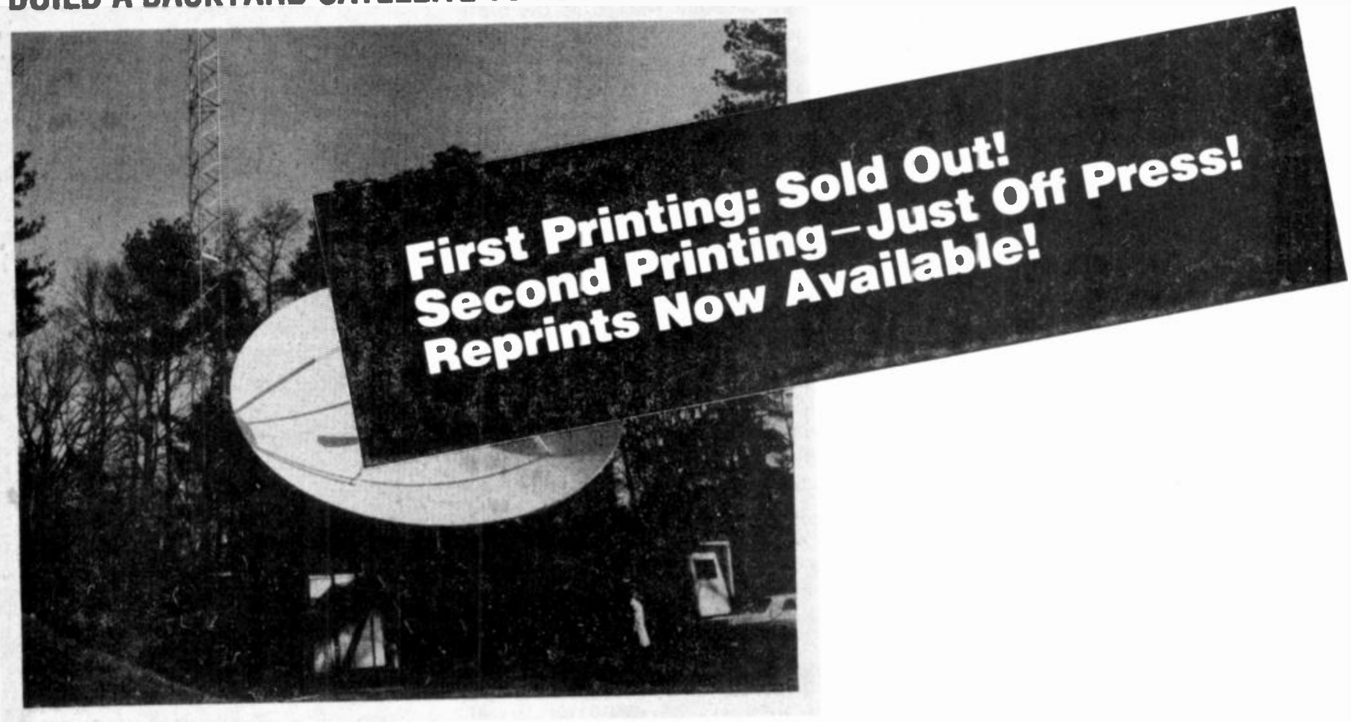

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service questions

NO HIGH VOLTAGE

This GE 15XB has no high voltage. All of the DC voltage supplies are OK. There is no collector voltage on Q253 (horizontal output); I've checked all of the things I can find, no result. Any ideas?—C.C. Rio Grande, PR.

With no collector voltage on the horizontal output transistor, you'll never get high voltage! The fuse doesn't blow, so something is open. Go to the +131-volt source and start checking from there back to the collector of Q253. You'll find it somewhere in there.

(Feedback—R269 was open. That is 10-ohm 2-watt resistor from the +131-volt source to the flyback winding. I thought I was checking R269 but it was R266!)

INTERMITTENT VERTICAL

Complaint was no vertical sweep in this RCA *EC338W*. There was just a horizontal line. Fiddling with the vertical size and vertical linearity controls brought the sweep back and the raster filled the screen. Deciding that something in there is heat-sensitive, I went to work. I found nothing conclusive; sometimes it worked, sometimes it wouldn't. But I did use up three cans of freeze spray! Finally got down to looking for odd things. There was some discoloration on the PC board near the height control. For lack of a better idea, I sprayed that area and the vertical sweep came back! Scraping the PC board clean and replacing the PC conductors from the height control to the pins with wires fixed everything.

Thanks to David A. Day of Apalachicola, FL for that one.

BREAKER TRIPS

I've got one in this RCA CTC-59XD that I can't pin down. The circuit breaker trips in three minutes. Seems to be in the high-voltage section. If I pull the MAG001 horizontal-oscillator module, the breaker stays in. Replaced MAG001 and trace SCR; no help. Where do I go from here?—V.S. Dalton, PA.

If the breaker doesn't trip for three minutes, it looks as if something is heating up and breaking down. If the breaker holds with no drive to the high-voltage section, I'll take that idea as OK. While the breaker is still holding, try spraying coolant on things around the high-voltage section. That might give you some help. We've had problems in some of those sets with driver transformer T403 breaking down.

(Feedback—Thanks! It was T403. I sprayed it with coolant and that worked. Replaced it and things are fine.) **R-E**

STATE-OF-THE-ART/DO-NOTHING

continued from page 62

Although CMOS gates are used for four IC's, the EPROM current requirements are high and the "do-nothing" box needs a regulated 5-volts at about 150 mA. I used a "battery eliminator" DC supply of the type used for calculators and cassette recorders. Those are often available inexpensively as discontinued items at surplus or discount outlets. Their regulation is poor and a 6-volt eliminator at 200 mA delivers closer to 8 volts and works well here. Batteries are an impractical power source for 150 mA.

Construction is straightforward. Point-to-point or wire-wrap will work best. A printed circuit board would be very complex because of the IC pinouts. You could substitute TTL IC's for the CMOS ones with some component changes and an increase in power-supply current. Use a small heat sink on the voltage regulator. I mounted the LED's on the circuit board and replaced the box cover with red plastic. You can mount the LED's separately or use transistor drivers and incandescent lamps instead. Whatever type of display you use, you will have a truly (for now) state-of-the-art "do-nothing" box. R-E

REDUCING DISTORTION

continued from page 54

so that the amplifier produces its rated power output for each of the selected impedances.

Layout and construction

Figure 6 shows the internal layout of the newly developed amplifier. The previously described power-supply section of the amplifier accounts for approximately half of the total cubic space inside the unit. Also visible in the photo is a highly efficient cooling system that uses a heat pipe with a related blower fan. A linear torque motor similar to the type used for turntables and tape decks, is used to drive the fan for silent operation.

Since the power stage of this amplifier does not have a negative-feedback loop, the quality of the materials used in all components—and the quality of their performance—has a close relationship to tonal quality, according to the designers of the new amplifier. The power block and the heat-dissipation fins, for example, are of extremely rugged construction. Boron nitride has been used as the material for the transistor insulators. That material has a thermal conductivity rate of the same order as metal, thereby resulting in outstanding heat conductivity and dissipation for the power devices.

Because the amplifier is monophonic, there is, of course, no risk of crosstalk between channels. Nevertheless, any interference between the first stages and the output stages will still impair tone quality. Therefore, the layout has been planned so that the signal travels the shortest possible distance from input to output.

More technically oriented readers may be interested in additional details concerning the two new power MOSFET's that play such an important part of this new amplifier design.

In Figs. 7 and 8 we have reproduced transfer curves of the 2SK173 (N-channel) and its complementary 2SJ54 (P-channel) MOSFET's while in Fig. 9 we show the input waveform and output signal obtained for a squarewave having a repetition rate of 1600 nanoseconds (equivalent to a frequency of 625,000 Hz)! R-E

CAR ELECTRONICS

continued from page 51

and shut down "chop shop" operations. It can even be used to keep the parts department from ordering the wrong part for your particular engine.

Service facilities are also increasingly dependent on thoroughly detailed engineering data from the manufacturers. Diagnostic and repair manuals are becoming much more graphic and their language more readable. But the more information that's available on each car, and the more cars, the harder it gets to store all that paper. Microfiche and other space-saving methods are being used, and a number of computer software packages are being developed.

Tools are also getting smarter. GM is developing an *Automotive Service Analyzer*, an advanced version of a cooling-system tester first developed in 1976. In its eventual form, it will be capable of diagnosing problems with air conditioning, cooling, electrical, and automatic transmission systems, and then will give repair instructions in English on an alphanumeric display.

The magic, of course, is performed by a built-in microprocessor. The tester is attached to the vehicle and the mechanic dials up the tests he wants to perform. The *Automotive Service Analyzer* walks him through a test procedure and gives him a diagnosis of the problem.

When development of the *Automotive Service Analyzer* is complete, GM will continue its policy of making technological advances like this available to qualified manufacturers of service tools and equipment, free of charge. That's how GM's SOS (*S*ervice *O*rder *S*cheduling) system—developed by GM Service Research and Delco Electronics Division—became available through several commercial computer-system companies. SOS controls the work flow in a large service organization by scheduling and routing the flow of repair orders. That helps reduce shop inefficiency saving everybody time and money.

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And if you'd like to see more of this kind of coverage, tell us that, too. That's the way electronics moves from today to tomorrow. R-E

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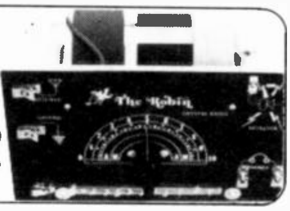

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7420N	.32	74368AN	.69	74LS96N	.59
7422N	.37	74390N	.99	74LS107N	.38
7423N	.37	74393N	1.38	74LS109N	.38
7425N	.32			74LS112N	.38
7426N	.44	74S00N	.44	74LS122N	.48
7427N	.32	74S02N	.48	74LS123N	.69
7428N	.42	74S03N	.48	74LS125N	.98
7430N	.22	74S04N	.79	74LS126N	.54
7432N	.78	74S05N	.79	74LS132N	.52
7433N	.44	74S08N	.48	74LS133N	2.85
7437N	.37	74S09N	.98	74LS136N	.44
7438N	.37	74S10N	.69	74LS138N	.59
7440N	.22	74S11N	.88	74LS139N	.59
7442N	.44	74S20N	.68	74LS145N	1.19
7445N	.89	74S30N	.48	74LS147N	2.49
7446N	.84	74S32N	.98	74LS148N	1.39
7447AN	.69	74S37N	1.87	74LS151N	.44
7450N	.22	74S38N	1.68	74LS153N	.36
7451N	.32	74S40N	.44	74LS155N	.74
7453N	.32	74S51N	.78	74LS156N	1.45
7454N	.32	74S74N	.69	74LS157N	.58
7472N	.36	74S85N	2.39	74LS158N	.52
7473N	.38	74S86N	1.44	74LS160N	.72
7474N	.38	74S112N	1.59	74LS161N	.72
7475N	.42	74S114N	1.50	74LS162N	1.65
7476N	.38	74S124N	2.77	74LS163N	.72
7483AN	.52	74S132N	1.24	74LS164N	.59
7484AN	1.36	74S133N	.98	74LS165N	1.09
7485N	.66	74S134N	.69	74LS166N	2.15
7486N	.44	74S135N	1.48	74LS170N	1.95
7490AN	.35	74S138N	1.15	74LS173N	.64
7491AN	.42	74S139N	1.25	74LS174N	.39
7492AN	.38	74S140N	1.45	74LS175N	.44
7493AN	.38	74S151N	1.19	74LS181N	2.19
7494AN	.68	74S153N	1.19	74LS190N	.89
7495AN	.54	74S157N	1.19	74LS191N	.89
7496N	.54	74S158N	1.45	74LS195N	.54
7497N	2.36	74S161N	2.85	74LS192N	.68
74100N	1.38	74S162N	3.70	74LS193N	1.24
74104N	.64	74S163N	3.75	74LS194N	2.40
74107AN	.42	74S168N	4.65	74LS196N	.88
74109N	.42	74S169N	5.44	74LS197N	.89
74110N	.45	74S174N	1.09	74LS221N	.85
74111N	.58	74S175N	1.09	74LS240N	.99
74116N	1.38	74S181N	4.47	74LS241N	.99
74120N	1.25	74S182N	2.95	74LS242N	.99
74121N	.54	74S189N	14.95	74LS243N	1.09
74122N	.52	74S194N	2.95	74LS244N	3.95
74123N	.54	74S195N	1.89	74LS245N	1.95
74125N	.52	74S201N	14.95	74LS247N	.78
74126AN	.52	74S225N	8.95	74LS248N	1.25
74128N	.69	74S240N	3.98	74LS249N	.99
74132N	.45	74S241N	3.75	74LS251N	1.45
74136N	.52	74S251N	1.90	74LS253N	.59
74141N	.85	74S253N	7.45	74LS257N	.75
74142N	2.98	74S257N	1.39	74LS258N	.59
74143N	3.44	74S258N	1.49	74LS259N	2.95
74144N	3.44	74S260N	1.83	74LS260N	.99
74145N	.67	74S274N	19.95	74LS266N	.44
74147N	1.24	74S275N	19.95	74LS273N	1.19
74148N	.92	74S280N	2.90	74LS275N	4.95
74150N	1.44	74S283N	3.89	74LS279N	.58
74151N	.42	74S299N	6.98	74LS280N	1.98
74153N	.38	74S373N	3.45	74LS283N	.89
74154N	1.68	74S374N	3.45	74LS290N	.78
74155N	.54	74S381N	7.95	74LS293N	.38
74157N	.54	74S412N	2.98	74LS298N	.99
74159N	1.68	74S471N	9.95	74LS299N	2.65
74160N	.65	74S472N	16.85	74LS320N	2.95
74161AN	.72	74S474N	17.85	74LS321N	3.95
74162N	.65	74S476N	8.95	74LS322N	4.95
74163AN	.65	74S478N	16.95	74LS323N	4.95
74164N	.69			74LS324N	2.50
74165N	.63	74LS00N	.17	74LS348N	2.95
74166N	.72	74LS01N	.17	74LS352N	1.35
74170N	2.18	74LS02N	.24	74LS353N	1.95
74172N	6.45	74LS03N	.24	74LS362N	11.95
74173N	.85	74LS04N	.24	74LS365N	.84
74174N	.67	74LS05N	.24	74LS366N	.84
74175N	.63	74LS08N	.19	74LS367N	.96
74176N	.79	74LS09N	.24	74LS368N	.96
74177N	.79	74LS10N	.19	74LS373N	1.39
74178N	1.15	74LS11N	.24	74LS374N	1.39
74179N	1.15	74LS12N	.24	74LS375N	1.95
74180N	.75	74LS13N	.25	74LS377N	1.44
74182N	.52	74LS14N	.42	74LS378N	1.19
74184N	2.95	74LS20N	.19	74LS379N	1.35
74185N	2.95	74LS21N	.19	74LS390N	1.44
74190N	.69	74LS26N	.48	74LS393N	1.29
74191N	.76	74LS27N	.34	74LS395N	1.35
74192N	.69	74LS30N	.19	74LS447N	.37
74193N	.88	74LS32N	.39	74LS490N	1.95
74194N	.88	74LS37N	.32	74LS630N	85.00
74195N	.48	74LS38N	.32	74LS631N	85.00
74196N	.79	74LS42N	.45	74LS669N	1.25
74197N	.79	74LS47N	.69	74LS670N	2.88
74198N	1.56	74LS48N	.99		
74199N	1.56				

LINEAR I.C.'s

LM301AN-8	.34	LM324N	.52	LM741CN-8	.32
LM304CH	.89	LM339N	.52	LM747CN-14	.59
LM307N-8	.29	LM348N-14	.99	LM748CN-8	.39
LM308N-8	.89	LM358N-8	.79	LM1458N-8	.42
LM308CH	.95	LM555N-8	.29	LM1488N-14	.89
LM309K	1.56	LM556N-14	.49	LM1489N-14	.89
LM310HC	1.49	LM723CH	.89	LM3046N-14	.99
LM311N-8	.59	LM723CN-14	.48	LM3302N-14	.55
LM317T (TO-220)	1.19	LM725CN-8	1.75	LM3403N-14	.89
		LM733CN-14	1.59	LM3900N	.49
LM318N-8	1.45	LM739CN-14	1.29	LM4136N-14	.99
LM318CH	1.75	LM741CH	.65	ULN2003AN	.89

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CD4002BE	.19	CD4027BE	.44	CD4069BE	.19	CD4519BE	.54
CD4006BE	.75	CD4028BE	.56	CD4070BE	.24	CD4520BE	.69
CD4007BE	.32	CD4029BE	.75	CD4071BE	.24	CD4522BE	.84
CD4008BE	.69	CD4030BE	.44	CD4072BE	.24	CD4526BE	1.25
CD4009BE	.45	CD4033BE	1.75	CD4073BE	.29	CD4527BE	1.59
CD4010BE	.45	CD4034BE	2.56	CD4075BE	.29	CD4528BE	.84
CD4011BE	.19	CD4035BE	.84	CD4076BE	.67	CD4531BE	.84
CD4012BE	.19	CD4040BE	.78	CD4078BE	.29	CD4532BE	1.12
CD4013BE	.34	CD4041BE	1.56	CD4081BE	.19	CD4539BE	.64
CD4014BE	.59	CD4042BE	.64	CD4082BE	.24	CD4543BE	1.98
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CD4017BE	.65	CD4046BE	.78	CD4093BE	.67	CD4556BE	.58
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2N1613	.29	2N3772	1.29	2N3710	.099	PN2222A	.089
2N1711	.29	2N3773	1.89	2N3904	.069	PN2907A	.089
2N1893	.29	2N6133	.56	2N3906	.069	PN5138	.099
2N2222A	.19			2N4123	.075	MPSA05	.12
2N2369A	.24			2N4124	.075	MPSA06	.12
2N2484	.24			2N4125	.075	MPSA13	.12
2N2905A	.36			2N4126	.075	MPSA56	.12
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SN7420N	.22	SN74153N	.67
SN7421N	.35	SN74154N	1.19
SN7422N	.29	SN74155N	.82
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SN7425N	.29	SN74157N	.69
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SN7429N	.45	SN74161N	.95
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CD4044	.85	74C42	1.85
CD4046	1.75	74C48	2.39
CD4047	1.25	74C73	.85
CD4048	.99	74C74	.85
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	3.95	74C107	1.19
CD4056	2.95	74C151	2.49
CD4059	9.95	74C154	3.50
CD4060	1.39	74C157	2.10
CD4066	.75	74C160	2.39
CD4069	.35	74C161	2.30
CD4070	.49	74C163	2.39
CD4071	.35	74C164	2.39
CD4072	.35	74C173	2.59
CD4073	.35	74C174	2.75
CD4075	.35	74C175	2.75
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74LS02N	.28	74LS166N	2.48
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74LS04N	.39	74LS169N	1.89
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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	1.95
74LS30N	.26	74LS241N	1.90
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74LS38N	.39	74LS244N	1.95
74LS40N	.26	74LS245N	4.95
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	.88	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	.73
74LS126N	.89	74LS368N	.73
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
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LM320T-XX*	1.25	CA3046T	1.29
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LM340T-XX*	1.25	CA3080N	1.29
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LM348N	1.85	CA3083N	1.99
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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
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LM739N	1.15	SN75453N	.49
LM741CN/H	.33	SN75454N	.49
LM741CN 14	.19	SN75491N	.89
LM747N/H	.79	SN75492N	.89
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Speech Synthesis System

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

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- Designed to be easily interfaced to most popular microprocessors
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- Male, female, and children's voices
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- Addresses 128k of ROM directly
- Communicates with static or clocked dynamic ROMs
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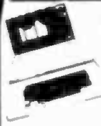
Apple II. 16K or Apple II. Plus $990



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Apple II Plus w/48K Supermod Video Modulator
Disk II w/Controller Integer Based ROM Card.
Reg. $2,220.00, ACP Price $1819.00 SAVE **$401.00**

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- Pascal Revision Kit. Adds executive and chaining capabilities to Pascal environment $65.00
- Mountain Hardware Expansion chassis. 8 more slots for Apple. Hardware or software selectable includes power supply Avail. Soon
- Smart Term Apple 80 x 24 Video Card Avail. Soon
- Symtex X-10 Avail. Soon
- Apple Silentype. With Apple Intelligent Interface Card $549.00
- NEW! California Computer Systems APPLE Clock Only $124.95
- NEW! Z-80 Softcard for APPLE CPM 2.2 & M BASIC 5.0. $325.00
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2. RTR Stock Market Analysis – Hi-Res, Trend Lines etc. $109.95
3. "Star Cruiser" – Apple II version of the number one arcade game "Galaxy" $29.95
4. "Bats Barron" – Hi-Res simulation of Western Gunfight and Skeet Shooting. Same author as Nasir $29.95
5. "Apple Tax Planner Package" $74.95
6. "Non-DOS Text Kit" $64.95
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ATARI® 800 & 400
Personal Computer System

ATARI 800 $825.00
ATARI 400 $449.00

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

Peripherals		**Education System Cassette Programs**		Spelling	35.00
Disc Drive	599.00	U.S. History	35.00	Basic Electricity	35.00
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Software - 800 Cartridges		World History (Western)	35.00	Guide to BASIC Programming	18.00
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AM/FM stereo surrounds and fills your body with sound. No earplugs. You wear it!

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The looks and functions of the expensive models at an affordable price.
NEW!
6 FUNCTIONS
- HOURS
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- SECONDS
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All in a smart silvertone metal with matching bracelet.
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Time and Date Digital Display with Backlight for Night Use.

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- Quartz LCD
- Time, Date, Seconds
- Easily Installed

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The above two monitors accept composite video signal

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80x24 or 16x64 Display. Requires only Composite Video Input and 110/230 VAC, 50/60 Hz. Tested, functional & guaranteed. Data and schematics included. . . . . $95.00 ea. Plus Shipping

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apple II/apple II plus

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- Switch from "APPLESOFT" to "INTEGER BASIC" and back again.
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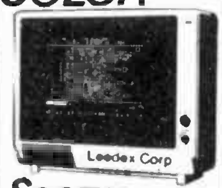

$397.00 MONITOR 13"

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SN7400N	.20	SN7440N	.22	SN74141N	.69
SN7402N	.22	SN7442N	.57	SN74151N	.65
SN7404N	.22	SN7443N	.78	SN74153N	.65
SN7408N	.24	SN7445N	.78	SN74154N	1.25
SN7410N	.22	SN7451N	.20	SN74155N	.80
SN7412N	.28	SN7454N	.20	SN74157N	.69
SN7413N	.35	SN7474N	.32	SN74160N	.95
SN7414N	.49	SN7475N	.32	SN74161N	.65
SN7416N	.29	SN7482N	1.05	SN74163N	.85
SN7417N	.29	SN7492N	.50	SN74164N	.87
SN7423N	.28	SN7493N	.48	SN74165N	.87
SN7425N	.25	SN7495N	.60	SN74174N	.95
SN7430N	.23	SN7496N	.70	SN74175N	.69
SN7437N	.29	SN74122N	.39	SN74180N	.75
SN7438N	.24	SN74136N	.95	SN74181N	1.15

video 100

$125 12"

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2708	1k x 8	5.95
	8 FOR	40.00
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apple clock/calendar

$124.95

Seconds, minutes, hours, day-of-week, month, date, & year. On board batteries with one year life. Uses MSM5832-crystal controlled.

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MSM5832 MICROPROCESSOR REAL-TIME CLOCK

$7.45

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TRS 80

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KIT CONTAINS DIP SWITCHES AND DETAILED INSTRUCTIONS

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74LS04	.26	74LS161	.85
74LS08	.28	74LS162	.95
74LS09	.26	74LS163	1.60
74LS10	.26	74LS164	.65
74LS20	.26	74LS165	.65
74LS21	.28	74LS170	1.75
74LS22	.26	74LS174	.75
74LS26	.49	74LS175	.75
74LS27	.26	74LS190	.75
74LS30	.28	74LS193	.95
74LS32	.32	74LS195	.95
74LS38	.32	74LS196	.85
74LS42	.65	74LS221	1.40
74LS48	.78	74LS240	1.65
74LS51	.25	74LS241	1.65
74LS54	.35	74LS243	1.45
74LS74	.38	74LS244	1.45
74LS75	.60	74LS245	2.25
74LS83	.44	74LS253	.95
74LS85	.95	74LS257	.95
74LS86	.95	74LS258	.95
74LS90	.69	74LS259	2.85
74LS93	.69	74LS279	.44
74LS107	.45	74LS283	1.00
74LS112	.38	74LS293	1.85
74LS113	.48	74LS298	1.20
74LS122	.48	74LS366	.95
74LS123	.95	74LS367	.55
74LS126	.69	74LS368	.55
74LS138	.69	74LS373	1.39
74LS151	.44	74LS374	1.39
74LS153	.44	74LS386	.65

APPLE EXPANSION KIT

16K Memory Add-On

MEMORY ADD-ON KIT INCLUDES INSTRUCTIONS

$39.00

MISCELLANEOUS

8038C	2.65
NE555V	.27
7905	.85
7908	.85
7915	.85
7918	.85
7805	.85
7806	.85
7808	.85
7812	.85
MC1330AIP	1.60
MC1350P	1.15
MC1358P	1.50
LM380N	1.75
NE565N	1.25
MC1458P	.50
IS410 SCR	.95
IT410 TRIAC	.95
2114 200ns	3.50
2114L 300ns	3.75
2114L 200ns	4.25
4116 300ns	4.95
4116 200ns	5.45

LOGIC PROBE KIT

BUY FIVE OR MORE FOR . . . . $16.95 each

WE CARRY Tbar SWITCHES

CONCORD COMPUTER COMPONENTS

1971 SOUTH STATE COLLEGE
ANAHEIM, CALIF. 92806

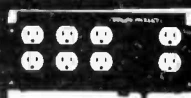
VISA, MASTERCHARGE, CHECK OR M.O. NO C.O.D. CAL. RES. ADD 6%

(714)937-0637

MINIMUM ORDER $10.00
ADD $1.50 FOR FRT. ON ORDERS UNDER $50. 5% IF OVER $50

SOROC TECHNOLOGY, INC

IQ120 $689



No "Glitches", Surges Or Interference

THE MPO117 TURNS AN ORDINARY OUTLET INTO A CONTROLLED FILTERED POWER SOURCE FOR UP TO EIGHT DEVICES

$87.50

CIRCLE 36 ON FREE INFORMATION CARD

INTERNATIONAL ELECTRONICS UNLIMITED

CERAMIC CAPACITORS

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

1pf - .050uf / .1uf

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

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

POLYESTER FILM CAPACITORS - 100V ± 10%

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

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

POLYESTER CAPACITOR KIT
5 ea of the above values $14.95

TANTALUM CAPACITORS solid dipped ± 20%

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

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

ELECTROLYTIC CAPACITORS - axial

	1-9	10-99	100-		1-9	10-99	100-
1u/16V	.13	.11	09	22u/16V	15	13	11
1u/30V	.14	.12	.10	22u/50V	16	14	1.
1u/160V	.17	15	12	33u/25V	18	16	14
2.2u/25V	14	12	10	47u/25V	18	16	14
2.2u/50V	.14	.12	10	50u/25V	18	16	14
2.2u/63V	.14	.12	10	100u/10V	18	16	14
3.3u/250V	.16	.14	.12	150u/25V	.22	20	17
4.7u/10V	14	.12	10	220u/16V	23	21	18
5u/25V	12	.10	08	220u/25V	25	22	20
10u/16V	.13	.11	.10	470u/35V	33	29	26
10u/25V	.14	.12	10	1000u/35V	89	85	80
10u/50V	.15	13	11	1000u/50V	1 00	95	90
10u/150V	.18	16	14				

SOCKETS — LOW PROFILE, SOLDER TAIL

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

TRANSISTORS

2N3904	NPN TO-92	$.25ea	10/$1.65	25/$3.25	100/$12.00
2N3906	PNP TO-92	$.25ea	10/$1.65	25/$3.25	100/$12.00
2N2222A	NPN TO-18	$.45ea	10/$3.50	25/$8.00	100/$29.50

DIODES

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

VOLTAGE REGULATORS

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

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

DISCRETE LED'S

JUMBO LED .20"dia. diffused			
Red, Clear or White	10/$1.00	25/$2.00	100/$8.00
Green or Yellow	7/$1.00	25/$2.85	100/$9.75
SUBMINITURE LED .125"dia. diffused			
Red or Clear	10/$1.00	25/$2.00	100/$8.00
Green or Yellow	7/$1.00	25/$2.85	100/$9.75

TTL

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

7400	$.18	7464	.30	74155	.50
7401	.18	7465	.30	74156	.64
7402	.18	7470	.49	74157	.60
7403	.18	7472	.32	74158	.75
7404	.20	7474	.18	74160	.70
7405	.25	7475	.49	74161	.79
7406	.20	7576	.49	74162	.85
7407	.20	7480	.35	74163	.85
7408	.27	7482	.25	74164	.85
7409	.27	7483	.58	74166	.85
7410	.18	7485	.50	74170	1.50
7415	.29	7486	.42	74173	1.25
7416	.20	7489	1.75	74174	1.05
7417	.20	7490	.59	74175	.85
7420	.20	7491	.64	74176	.70
7425	.39	7492	.59	74177	.70
7426	.35	7493	.35	74180	.35
7427	.25	7494	.59	74181	1.85
7430	.25	7495	.35	74182	.35
7432	.20	7496	.35	74189	.50
7437	.20	74105	.48	74190	1.15
7438	.13	74107	.35	74191	1.15
7440	.13	74121	.35	74192	.50
7441	.59	74122	.39	74193	.79
7442	.35	74123	.39	74194	.85
7443	.55	74125	.50	74195	.69
7444	.60	74126	.50	74196	.80
7445	.50	74132	.75	74197	.75
7446	.59	74141	.35	74198	1.40
7448	.59	74145	.50	74199	1.25
7450	.18	74148	1.25	74S200	3.75
7451	.22	74150	1.35	74279	.65
7453	.18	74151	.50		
7454	.18	74153	.35		
7460	.18	74154	1.45		

8000 (Signetics)
8263 2.95 8267 1.75 8281 .95

9000 Series
9601 .25 9602 .29

CMOS

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

4000 Series CMOS

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

LINEAR CIRCUITS

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

		LM565N	.55
		LM565H	1.39
LM300H	$ .30	LM566H	1.69
LM301CN	.28	LM566CN	1.45
LM302H	.28	LM567CN	1.19
LM304H	30	LM703H	.59
LM307CN	.32	LM703CN	39
LM307H	.40	LM709N	29
LM308CN	.45	LM709H	39
LM309H	1.05	LM710N	.45
LM309K	1.15	LM711N	35
LM310CN	.75	LM723H	59
LM310H	.75	LM723N	49
LM311CN	.39	LM733H	.45
LM318CN	1.45	LM739N	.45
LM319N	1.20	LM741CN	.29
LM320K-5	.95	LM741	29
LM320K-5.2	.95	LM741CH	45
LM320K-15	.95	LM747H	79
LM322N	.45	LM747N	69
LM324N	1.19	LM748CN	.25
LM339N	.25	LM1310N	2.50
LM340K-6	.95	LM1414N	.35
LM340K-8	.95	LM1456CN	1.29
LM340K-12	.95	LM1458CN	.55
LM340K-15	95	LM1496N	.89
LM340K-24	.95	LM1800N	2.40
LM370N	.95	ULN2208	79
LM372N	1.25	ULN2209	79
LM376CN	30	CA3046N	1.29
LM380N	1.19	CA3081N	1.25
LM380CN	.45	CA3082N	1.25
LM381N	1.75	LM3900N	.45
LM382N	1.75	LM7524N	.45
LM385K	.49	LM7525N	.45
LM386CN	.39	LM7535	.99
LM387CN	99	8038B	3.79
NE546A	1.79	75450N	.35
NE550A	1.25	75451CN	.35
LM555CN	.45	75452CN	.35
LM556N	.79	75453CN	.35
LM560N	2.95	75454CN	35
		75491N	.75
		75492N	.85

IMMEDIATE DELIVERY OF QUALITY RESISTORS Rohm

METAL FILM RESISTORS,

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

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

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

VALUES STOCKED (ohms)
Standard 1% metal film values from 10 ohm to 1/2M 1/4 watt

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 1.21M
i.e. 10.0 100 1.0K 10.0K 100K 1M etc

METAL FILM RESISTORS

METAL FILM ±1%
RN55 (R.Ohm CRB14FY) 1/8watt
Low temp coef - 50ppm/OC
.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

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

VALUES STOCKED (ohms) 1/8 watt

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	1.01K	8.25K	14.7K	25.5K	43.2K	90.9K	205K	1M
17.4	47.5	165	1.00K	1.16K	8.66K	15.0K	26.1K	45.3K	95.3K	210K	
18.2	49.9	191	1.02K	1.32K	9.09K	15.4K	26.7K	46.4K	100K	221K	
19.1	54.9	200	1.10K	1.57K	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	68.1	301	1.47K	4.87K	10.5K	19.1K	30.1K	52.3K	130K	294K	
26.1	71.5	316	1.50K	4.99K	10.7K	20.0K	30.9K	53.6K	137K	301K	

CARBON FILM RESISTORS

PRICING 1/4 & 1/2 watt

CARBON FILM ±5%
1/4watt (R.Ohm R25) .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

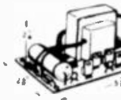
25 or more resistors - not individually packaged - mixed - specify any assortment of values $.04ea

VALUES STOCKED (ohms)

.5	3.3	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	1.	51	220	910	3.9K	16K	68K	300K	1.2M	5.1M	
3.3	1.	56	240	1.0K	4.3K	18K	75K	330K	1.3M	5.6M	
3.6	1.	62	270	1.1K	4.7K	20K	82K	360K	1.5M		

POWER SUPPLY KIT

+5V, +12V, +15V
A regulated power supply using a 115V/29V CT transformer, 3-LM340T and 3-LM120T regulators to supply the above voltages. Heat sink provided for +5V

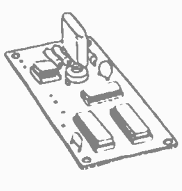


PARTS INCLUDED
Transformer
6 regulators
PC board
4 diodes
Capacitor 1000 uf
Capacitor 500 f
3 capacitors 10 uf

ea $17.50
10- 16.00
25- 15.00
+ shipping

CRYSTAL CONTROLLED TIME BASE KIT

Produces accurate 1hz, 10hz and 60hz outputs--three of the most popular frequencies for any piece of test equipment. The crystal frequency output may be tuned with a frequency counter for increased accuracy. All outputs are buffered. The input voltage range is 5-18VDC. Low power requirement permits the use of a 9V battery as the power source for a convenient laboratory unit. The completed board is designed to fit the PCB slots of Hammond case 1591DGY which IEU stocks.



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

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

Payment by check, M.O., UPS/COD, M/C or VISA. Add $1.25 for shipping/handling in U S, Canada and Mexico. Additional charge for UPS COD or BLUE LABLE. Other Countries $1.25 + 5% of order total. California residents add sales tax. Minimum order $10.00
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INTERNATIONAL ELECTRONICS UNLIMITED
435 First St Suite 19
Solvang, Ca 93463
805-688-2747

CIRCLE 29 ON FREE INFORMATION CARD

CIRCLE 5 ON FREE INFORMATION CARD

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Same day shipment. First line parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

INTEGRATED CIRCUITS

74LS00 TTL	
74LS00N	29
74LS02N	29
74LS04N	35
74LS05N	25
74LS08N	35
74LS10N	35
74LS13N	55
74LS14N	1 00
74LS20N	35
74LS22N	35
74LS28N	35
74LS30N	35
74LS33N	60
74LS38N	50
74LS74N	85
74LS75N	65
74LS90N	60
74LS93N	75
74LS95N	1 00
74LS107N	45
74LS112N	45
74LS113N	45
74LS132N	89
74LS136N	50
74LS151N	90
74LS155N	1 10
74LS157N	1 10
74LS162N	1 10
74LS163N	1 10
74LS174N	1 25
74LS190N	1 25
74LS221N	1 25
74LS258N	1 00
74LS367N	75

MOS MEMORY RAM	
2101-1	2 85
2102-1	95
2102AL	1 45
2102AN	1 65
2104A-4	4 95
2107B-4	3 75
2111-1	3 75
2112-2	2 95
2114	3 75
2114L 300ns	8 25
2114L 450ns	8 00
4116 200ns	13 50
B 4116 200ns	15 00
MM5262	40
MM5280	3 00
MM5320	9 95
MM5330	5 94
PD411D 3	4 00
PD411D 4	5 00
P5101L	8 95
4200A	9 95
82S25	2 90
91L02A	1 50
HD0165 5	6 95
MM57100	4 50
GIAY38500 1	9 95
MCM6675 1A	9 95
9368	3 50
4100	10 00
416	16 00

PROM	
1702A	4 95
2708	7 30
2716TI	18 00
2716 5 Volt	13 50
8-2716 5 Volt	89 00
2732-4	55 00
2758 4	19 50
8741A	55 00
8748	55 00
8748 8	55 00
8755A	55 00
N82S23	2 95
N82S123	6 50
N82S126	3 75
N82S129	8 50
N82S131	8 50
N82S136	8 75
N82S137	8 75
DM8577	2 90
8223	2 90

INTERFACE	
8095	65
8096	65
8097	65
8098	65
8T09	1 25
8T10	4 50
8T13	3 00
8T20	5 50
8T23	3 10
8T24	3 50
8T25	3 20
8T26	1 69
8T28	2 75
8T97	69
8T98	69

MICROPROCESSOR	
6502	10 95
6504	9 95
6522	9 95
6800	6 95
6802	11 95
6820	4 95
6850	5 95
8080A	5 95
8085A	12 95
8086	75 00
Z80	9 95
Z80A	11 95
8212	2 90
8214	3 95
8216	2 90
8224	3 15
8228	4 95
8251	6 95
8253	15 00
8255	5 75
8257	10 95
8259	14 95
1802CP plas	13 95
1802DP plas	17 95
1861P	9 50
CDP1802CD	28 95
CDP1802D	35 00
CDP1816P	7 95

RESISTORS ¼ watt 5%	
10 per type	03
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100 per type	015
1000 per type	012
350 piece pack	
5 per type	6 75

½ watt 5% per type 05

IC SOCKETS Solder Tin Low Profile PIN	1 UP	PIN	1 UP
8	15	22	30
14	14	24	35
16	16	28	42
18	27	36	58
20	29	40	57

2 level 14 pin ww 20

WIRE WRAP LEVEL 3 PIN		PIN	
14	37	24	86
16	39	28	1 00
18	57	40	1 23

CRYSTALS	
1 MHz	4 50
2 MHz	4 50
4 MHz	4 25
5 MHz	4 25
10 MHz	4 25
18 MHz	3 90
20 MHz	3 90
32 MHz	3 90
32768 Hz	4 00
1 8432 MHz	4 50
3 5795 MHz	1 20
2 0100 MHz	1 95
2 097152 MHz	4 50
2 4576 MHz	4 50
3 2768 MHz	4 50
5 0688 MHz	4 50
5 185 MHz	4 50
5 7143 MHz	4 50
6 5536 MHz	4 50
14 31818 MHz	4 25
18 432 MHz	4 50
22 1184 MHz	4 50

DISPLAY LEDS			
MAN1	CA	270	2 90
MAN3	CC	125	39
MAN72 74	CA CC	300	1 00
DL704	CC	300	1 25
DL707 DL707R	CA	300	1 00
DL727 728	CA CC	500	1 90
DL746/750	CA CC	600	1 95
FND359	CC	357	70
FND500 507	CC CA	500	1 35
FND503 510	CC CA	500	90
FND800 807	CC CA	800	2 20
3 digit Bubble			60
10 digit display			1 25
7520 Clairex photocells			39
TIL311 Hex			9 50
MAN3640	CC	30	1 10
MAN4610	CA	40	1 20
MAN4640	CC	40	1 20
MAN4710	CA	40	95
MAN4740	CC	40	1 20
MAN6640	CC	56	2 95
MAN6710	CA	60	1 35
MAN6740	CC	60	1 35

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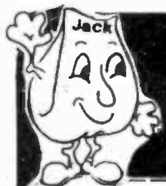

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74S86	.79	74S242	3.25	74S572*	19.95
74S112	.79	74S243	3.25	74S573*	19.95
74S113	.79			74S940	3.15
74S114	.79			74S941	3.15

* LIMITED AVAILABILITY ON THESE PROMS

CA–LINEAR

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

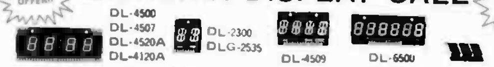
CD–CMOS

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

LITRONIX DISPLAY SALE

LIMITED OFFER!!

WHILE THEY LAST!!



MULTI DIGIT REFLECTOR ARRAYS FOR CLOCKS

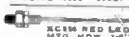
PART NUMBER	CHAR HT (IN)	POLARITY	DESCRIPTION	LIGHT OUTPUT (MCD) TYP	MIN	@mA	FORWARD VOLTAGE SEGMENT (V) TYP	MAX	CONTINUOUS FORWARD CURRENT PER SEGMENT (mA) MAX	PRICE
DL-4500 (Red) / DL-4507 (Red)	[illegible]	C.C. MPX	[illegible]	[illegible]	[illegible]					2.00 / 2.40
DLO-4507 (orng) / DLG-4507 (grn) / DL-4520A (red)	.50	C.C. non MPX	4 Digit 7 Segment With Colon And Auxiliary Indicators	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]	4.00 / 4.00 / 2.40
DL-4120A (red)	[illegible]	C.C. non MPX		[illegible]	[illegible]		[illegible]	[illegible]		4.00

MULTI DIGIT REFLECTOR ARRAYS

PART NUMBER	CHAR HT (IN)	POLARITY	DESCRIPTION	LIGHT OUTPUT TYP	MIN	@mA	FORWARD VOLTAGE TYP	MAX	CURRENT MAX	PRICE
DL-2300 (Red)	.30	C.C. MPX	7 Seg. 2 Digit D.P. Right	[illegible]	[illegible]	20	[illegible]	[illegible]	30	.99
DLG-2535 (green)	.50	C.A. MPX	8 Seg. 2 Digit	[illegible]	[illegible]	20	[illegible]	[illegible]	75	1.49
DL-4509 (Red)	[illegible]	C.C. MPX	9 Seg. 4 Digit D.P. Right	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.49
DL-6500 (Red)	[illegible]	C.A. MPX	7 Seg. 6 Digit D.P. Right	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.95
DL-6530 (Red)	[illegible]	C.A. MPX	7 Seg. 6 Digit D.P. Right	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.00
DL-3130 (Red)	[illegible]	C.A. MPX	7 Seg. 3 Digit D.P. Right	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.00

DISCRETE LEDS


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



XC556 RED LED, METAL MTG. HDW. 2-6" LEADS.

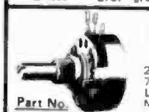
RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

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

Type	Polarity	Ht	Price	Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95	DLG507	C.A.—green	.500	1.25
MAN 2	5x7 D.M.—red	.300	4.95	DL704	C.C.—red	.300	1.25
MAN 3	C.C.—red	.125	.25	DL707	C.A.—red	.300	1.25
MAN 52	C.A.—green	.300	1.25	DL728	C.C.—red	.500	1.49
MAN 54	C.C.—green	.300	1.25	DL741	C.A.—red	.600	1.25
MAN 71	C.A.—red	.300	.75	DL746	C.A.—red ± 1	.630	1.49
MAN 72	C.A.—red	.300	.75	DL747	C.A.—red	.600	1.49
MAN 74	C.C.—red	.300	1.25	DL750	C.C.—red	.600	1.49
MAN 82	C.A.—yellow	.300	.49	DLO847	C.A.—orange	.800	1.49
MAN 84	C.C.—yellow	.300	.99	DLO850	C.C.—orange	.800	1.49
MAN 3620	C.A.—orange	.300	.49	DL338	C.C.—red	.110	.35
MAN 3630	C.A.—orange ± 1	.300	.99	FND358	C.C. ± 1	.357	.99
MAN 3640	C.C.—orange	.300	.99	FND359	C.C.	.357	.75
MAN 4610	C.A.—orange	.400	.99	FND503	C.C. (FND500)	.500	.99
MAN 6610	C.A.—orange—DD	.560	.99	FND507	C.A. (FND510)	.500	.99
MAN 6630	C.A.—orange ± 1	.560	.99	HDSP-3401	C.A.—red	.800	1.50
MAN 6640	C.C.—orange—DD	.560	.99	HDSP-3403	C.C.—red	.800	1.50
MAN 6650	C.C.—orange ± 1	.560	.99	5082-7751	C.A., R.H.D.—red	.430	1.25
MAN 6660	C.A.—orange	.560	.99	5082-7760	C.C., R.H.D.—red	.430	1.75
MAN 6710	C.A.—red—DD	.560	.99	5082-7300	4x7 sgl. dig. RHD	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7302	4x7 sgl. dig. LHD	.600	22.00
MAN 6780	C.C.—red	.560	.99	5082-7304	Overnge. char. (±1)	.600	19.95
DLO304	C.C.—orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.99
DLO307	C.A.—orange	.300	1.25	LIT-1	Photo Xsistor Opto-Isol.		.69
DLG500	C.C.—green	.500	1.25	MOC3010	Optically Isol. Triac Driver		1.25

POTENTIOMETERS



$2.95 each

2 Watt @ 70°C ± 10%
7/8" Slotted Shaft
Linear Taper
Meets Mil-R-94

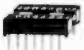
Part No.		
CMU 1021	RV4NAY SD - 102A	1K
CMU 5021	RV4NAY SD - 502A	5K
CMU 1031	RV4NAY SD - 103A	10K
CMU 2531	RV4NAY SD - 253A	25K
CMU 5031	RV4NAY SD - 503A	50K
CMU 1041	RV4NAY SD - 104A	100K
CMU 1052	RV4NAY SD - 105A	1Meg

$1.35 each

3/4 Watt @ 70°C
15 turn pot. Linear taper. Printed circuit mount.

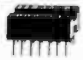
Part No.	Part No.	Part No.
830P-50ohm	830P-5K	830P-100K
830P-100ohm	830P-10K	830P-200K
830P-500ohm	830P-20K	830P-500K
830P-1K	830P-50K	830P-1Meg
830P-2K		

LOW PROFILE (TIN) SOCKETS



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

SOLDERTAIL STANDARD (TIN)



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

SOLDERTAIL (GOLD) STANDARD

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

WIRE WRAP SOCKETS (GOLD) LEVEL #3

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

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 Ohm 12 Ohm 15 Ohm 18 Ohm 22 Ohm 27 Ohm 33 Ohm 39 Ohm 47 Ohm 56 Ohm	50 pcs.	$1.95
ASST. 2	5 ea.	68 Ohm 82 Ohm 100 Ohm 120 Ohm 150 Ohm 180 Ohm 220 Ohm 270 Ohm 330 Ohm 390 Ohm	50 pcs.	$1.95
ASST. 3	5 ea.	470 Ohm 560 Ohm 680 Ohm 820 Ohm 1K 1.2K 1.5K 1.8K 2.2K 2.7K	50 pcs.	$1.95
ASST. 4	5 ea.	3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K	50 pcs.	$1.95
ASST. 5	5 ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	50 pcs.	$1.95
ASST. 6	5 ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	50 pcs.	$1.95
ASST. 7	5 ea.	1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M	50 pcs.	$1.95
ASST. 8R		Includes Resistor Assts. 1-7 (350 pcs.)		$10.95 ea.

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INTERSIL

Part No.	Function		Price
7045IPI	CMOS Precision Timer		14.95
7045EV/Kit*	Stopwatch Chip, XTL		22.95
7106CPL	3½ Digit A/D (LCD Drive)		16.95
7106EV/Kit*	IC, Circuit Board, Display		34.95
7107CPL	3½ Digit A/D (LED Drive)		15.95
7107EV/Kit*	IC, Circuit Board, Display		28.95
7116CPL	3½ Digit A/D LCD Dis. HLD.		18.95
7117CPL	3½ Digit A/D LED Dis. HLD.		17.95
7201IDR	Low Battery Volt Indicator		2.25
7205IPG	CMOS LED Stopwatch/Timer		12.95
7205EV/Kit*	Stopwatch Chip, XTL		19.95
7206CJPE	Tone Generator		5.15
7206CEV/Kit*	Tone Generator Chip, XTL		9.95
7207AIPD	Oscillator Controller		6.50
7207AEV/Kit*	Freq. Counter Chip, XTL		11.10
7208IPI	Seven Decade Counter		17.95
7209IPA	Clock Generator		3.95
7215IPG	4 Func. CMOS Stopwatch CKT		13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL		19.95
7216AIJI	8-Digit Univ. Counter C.A.		32.00
7216CIJI	8-Digit Freq. Counter C.A.		26.95
7216DIPI	8-Digit Freq. Counter C.C.		21.95
7217IJI	4-Digit LED Up/Down Counter		12.95
7218CIJI	8-Digit Univ. LED Drive		10.95
7224IPL	LCD 4½ Digit Up Counter DRI		11.25
7226AIJL	8-Digit Univ. Counter		31.95
7226AEV/Kit*	5 Function Counter Chip, XTL		74.95
7240IJE	CMOS Bin Prog. Timer/Counter		4.95
7242IJA	CMOS Divide-by-256 RC Timer		2.05
7250IJE	CMOS BCD Prog. Timer/Counter		6.00
7260IJE	CMOS BCD Prog. Timer/Counter		5.25
7555IPA	CMOS 555 Timer (8 pin)		1.45
7556IPD	CMOS 556 Timer (14 pin)		2.20
7611BCPA	CMOS Op Amp Comparator	5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr.	5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp.	5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp.	10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp.	10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp.	10MV	7.50
7660CPA	Voltage Converter		2.95
8069CCQ	50ppm Band—GAP Volt Ref. Diode		2.50
8211CPA	Volt Ref/Indicator		2.50
8212CPA	Volt Ref/Indicator		2.50

* INTERSIL'S EVALUATION KITS

74C

74C00	.39	74C106	.75	74C195	1.59
74C02	.39	74C107	1.89	74C221	1.95
74C04	.39	74C151	2.95	74C240	2.25
74C08	.39	74C154	3.95	74C244	2.25
74C10	.39	74C157	2.25	74C373	2.49
74C14	.75	74C160	1.69	74C374	2.69
74C20	.39	74C161	1.60	74C901	.89
74C30	.39	74C162	1.49	74C903	1.15
74C42	1.39	74C163	1.69	74C911	10.95
74C48	1.95	74C164	1.59	74C912	10.95
74C73	.79	74C173	1.39	74C915	1.69
74C74	.79	74C174	1.39	74C917	10.95
74C85	1.95	74C175	1.39	74C922	5.49
74C86	.99	74C192	1.69	74C923	5.75
74C89	6.95	74C193	1.69	74C925	7.50
74C90	1.29			74C926	7.50
74C93	1.29			80C95	.79
74C95	1.59			80C97	.79

LINEAR

LH0002CN	6.85	LM340T-5	1.25	NE570N	4.95
LM10CLH	4.50	LM340T-12	1.25	LM702H	.79
LM11CLH	4.75	LM340T-15	1.25	LM703CN	.89
LH0070-OH	6.05	LM341P-5	.75	LM709N	.29
TL071CP	.79	LM341P-12	.75	LM710N	.79
TL072CP	1.39	LM341P-15	.75	LM711N	.79
TL074CN	2.49	LM342P-5	.69	LM723N	.69
LH0082CD	35.80	LM342P-12	.69	LM733N	1.00
TL082CP	1.19	LM342P-15	.69	LM739N	1.19
TL084CN	2.19	LM348N	1.25	LM741CN	.35
LH0094CD	36.80	LM350K	5.75	MC1741SCG	3.00
LM300H	.99	LF351N	.60	LM747N	.79
LM301CN	.35	LF353N	1.00	LM748N	.59
LM302H	1.95	LF355N	1.10	LM1014N	2.75
LM304H	1.95	LF356N	1.10	LM1310N	1.95
LM305H	.99	LM358N	1.00	LM1458CN	.59
LM307CN	.45	LM359N	1.79	LM1488N	1.25
LM308CN	1.00	LM370N	4.49	LM1489N	1.25
LM309H	1.95	LM373N	3.25	LM1496N	1.95
LM309K	1.25	LM377N	2.95	LM1556V	1.75
LM310CN	1.75	LM380N	1.25	LM1800N	2.95
LM311H	.90	LM381N	1.95	LM1877N-9	3.25
LM312H	2.49	LM382N	1.79	LM1889N	3.20
LM317MP	1.15	LM384N	1.95	LM1896N	1.75
LM317T	1.75	LM386N-3	1.29	LM2002T	1.49
LM317K	3.95	LM387N	1.45	LM2877P	2.06
LM318CN	1.95	LM389N	1.35	LM2878P	2.25
LM319N	1.95	LM392N	.69	LM2896P-1	2.25
LM320K-5	1.35	LF398N	4.00	LM3189N	2.95
LM320K-12	1.35	LM399H	5.00	LM3900N	.69
LM320K-15	1.35	TL494CN	4.49	LM3905CN	1.25
LM320T-5	1.25	TL496CP	1.75	LM3909N	1.15
LM320T-12	1.25	NE510A	6.00	LM3914N	3.95
LM320T-15	1.25	NE529A	4.95	LM3915N	3.95
LM323K-5	5.95	NE531H	3.95	LM3916N	3.95
LM324N	.99	NE536H	6.00	RC4136N	1.25
LM329DZ	.65	NE540H	6.00	RC4151NB	3.95
LM331N	3.95	NE544N	4.95	RC4194TK	5.95
LM334Z	1.30	NE550A	1.30	RC4195TK	5.49
LM335Z	1.40	NE555V	.39	KB4428	4.25
LM336Z	1.75	LM556N	.99	KB4429	5.95
LM337T	1.95	NE564N	3.95	LM4500A	3.25
LM337MP	1.15	LM565N	1.25	ICL8038B	4.95
LM338K	6.95	LM566CN	1.95	LM13080N	1.29
LM339N	.99	LM567V	1.25	LM13600N	1.49
LM340K-5	1.35			75138N	1.95
LM340K-12	1.35			75450N	.89
LM340K-15	1.35			75451CN	.39

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

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

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.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

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

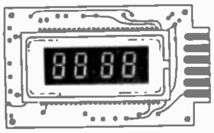
MINI. ALUMINUM ELECTROLYTIC CAPACITORS

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

CIRCLE 19 ON FREE INFORMATION CARD

National Semiconductor Clock Modules

12VDC AUTOMOTIVE/ INSTRUMENT CLOCK



APPLICATIONS:
- In-dash autoclocks
- After-market auto/ RV clocks
- Aircraft-marine clks.
- 12VDC oper. instru.
- Portable/battery powered instruments.

Features: Bright 0.3" green display. Internal crystal time-base. ± 0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete—just add switches and lens.

MA1003 Module $16.95

MA1023	.7" Low Cost Digital LED Clock Module	8.95
MA1026	.7" Dig. LED Alarm Clock/Thermometer	18.95
MA5036	.3" Low Cost Digital LED Clock/Timer	6.95
MA1002	.5" LED Display Dig. Clock & Xformer	9.95

National Semiconductor

RAM SALE

MM5290N-4 (MK4116/UPD416) . . **$4.95 each**
16K DYNAMIC RAM (250NS)
(8 EACH $39.95) (100 EACH $450.00/lot)

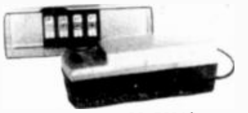
MM5290J-2 (MK4116/UPD416) . . **$6.95 each**
16K DYNAMIC RAM (150NS)
(8 EACH $49.95) (100 EACH $550 00/lot)

MM5298J-3A .... **$3.25 each**
8K DYNAMIC RAM (LOW HALF OF MM5290J) 200NS
(8 EACH $23 95) (100 EACH $250.00/lot)

MM2114-3 .... **$5.95 each**
4K STATIC RAM (300NS)
(8 EACH $43.95) (100 EACH $450.00/lot)

MM2114L-3 .... **$6.25 each**
4K STATIC RAM (LOW POWER 300NS)
(8 EACH $44 95) (100 EACH $475.00/lot)

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 $79.95

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
- 115VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE747 .... $29.95

6-Digit Clock Kit

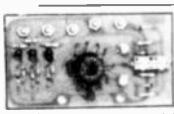
- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701 .... $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 high speed switching XFMR. 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

INS8080A	CPU	6.50
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	6.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm Element	16.95
DP8251	Prog. Comm. I/O (USART)	7.95
DP8253	Prog. Interval Timer	14.95
DP8255	Prog. Peripheral I/O (PPI)	9.95
DP8257	Prog DMA Control	19.95
DP8259	Prog. Interrupt Control	14.95
DP8275	Prog. CRT Controller	49.95
DP8279	Prog. Keyboard/Display Interface	19.95
DP8300	Octal Bus Receiver	6.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8 Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	14.95
MC6802CP	MPU with Clock and RAM	19.95
MC6810AP1	128x8 Static RAM	4.95
MC6821	Peripheral Inter Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	10.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	13.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	15.95
CDP1802	CPU	19.95
2650	MPU	16.95
IOM2901ADC	CPU—4-Bit Slice (Com Temp. Grade)	19.95
MC5002	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	16.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128 bytes RAM)	19.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	19.95
INS8900	CPU—16-Bit	29.95
TMS9900JL	MPU—16-Bit	49.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM505H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402	256-Bit Dynamic	1.95
MM5013	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	.69
MM5024N	Octal 80-Bit	9.95
MM5025N	Octal 80-Bit	9.95
2504V (1404A)	1024-Bit Dynamic	3.95
2518N	Hex 32-Bit Static	4.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Pass Filter	19.95
AF122-1CJ	Touch Tone Low Pass Filter	10.95
LM308AH	Super Gain Op Amp	1.00
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp Comp. Prec Ref. (.5ppm/C°)	4.95
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv Micro Comp (0.05% Lin.)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro Comp (0.20% Lin.)	6.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	5.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.95
2101 (8101)	256x4 Static	1.95
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	5.95
2114L	1024x4 Static 450ns Low Power	6.95
2114-3	1024x4 Static 300ns	7.49
2114L-3	1024x4 Static 300ns Low Power	7.95
2117	16,384x1 Dynamic 350ns (house marked)	4.95
4116 (UPD416)	16K Dynamic 250ns	4.95
MM2147J	4096x1 Fast 70ns	19.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.25
MM5280/2107	4096x1 Dynamic	4.95
MM5290J-2 (4116)	16K Dynamic 150ns (UPD416)	6.95
MM5298J-3A	8K Dyn 200ns (lower ½ of MM5290J)	4.95
7489	16x4 Static	1.75
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	14.95
TMS4046	1024x4 Static	14.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	9.95
TMS2716	16K EPROM (-5V, +5V, +12V)	19.95
2716 Intel (2516) TI	16K EPROM (Single +5V)	17.95
2732 Intel (2532) TI	32K EPROM	49.95
2758	8K EPROM (450ns) (Single +5V)	7.95
5203	2048 PROM	14.95
82S23 (74S188)	32x8 PROM (Open Collector)	4.95
82S115	4096 Bipolar PROM	19.95
82S123 (74S288)	32x8 Tri State Bipolar PROM	4.95
82S185	8K PROM	29.95

ROM'S

2513 (2140)	Character Generator (Upper Case)	9.95
2513 (3021)	Character Generator (Lower Case)	9.95
2516N	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

NMOS READ ONLY MEMORIES

MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen	13.50

MICROPROCESSOR MANUALS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

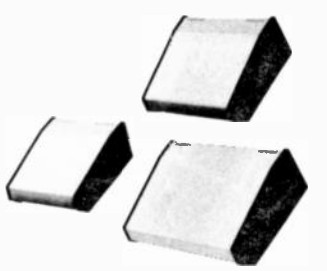
SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2661N	Communication Chip	39.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Intg	7.49
COP470N	32-Seg VAC Fluor Driver (20-pin pkg)	3.25

TELEPHONE/KEYBOARD CHIPS

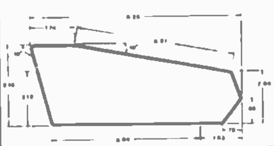
AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53190N	Push Button Pulse Dialer	7.95
MM5740N	90/144-Key Serial Keyboard Encoder	8.95

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

Spec Sheets – 25¢
Send 41¢ Postage for your FREE 1981 JAMECO CATALOG

NEW 1981 CATALOG

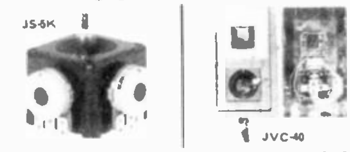
Jameco ELECTRONICS

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS – WORLDWIDE
1355 SHOREWAY ROAD, BELMONT, CA 94002
PRICES SUBJECT TO CHANGE

3/81

JOYSTICKS



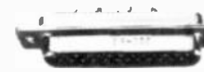
JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case ...	$5.95

AC and DC Wall Transformers

Ideal for use with clocks, games, power supplies or any other type of AC or DC application

Part No.	Input	Output	Price
AC 250	117V/60Hz	12 VAC 250mA	$3.95
AC 500	117V/60Hz	12 VAC 500mA	$4.95
AC 1000	117V/60Hz	12 VAC 1 amp	$5.95
DV9200	117V/60Hz	9 VDC 200mA	$3.25
DC 900	120V/60Hz	9 VDC 500mA	$3.95

CONNECTORS



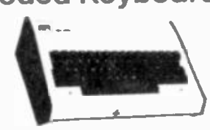
DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
★ 8 ea. MM5290 (UPD416/4116) 16K Dyn. Rams (*NS)
★ Documentation for Conversion

TRS-16K2 *150 NS **$49.95**
TRS-16K4 *250 NS **$39.95**

JE610 ASCII Encoded Keyboard Kit

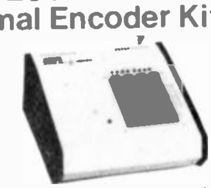


The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10 mA for operation. Features: 60 keys generate the 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. Size: 3½"H x 14¾"W x 8¾"D

JE610/DTE-AK (as pictured above) ... **$124.95**
JE610 Kit 62-Key Keyboard, PC Board, & Components (no case) .... **$ 79.95**
K62 62-Key Keyboard (Keyboard only) ... **$ 34.95**
DTE-AK (case only – 3¼"Hx11"Wx8¾"D) **$ 49.95**

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD



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

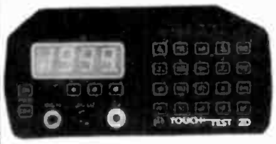
JE600/DTE-HK (as pictured above) **$99.95**
JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) .. **$59.95**
K19 19-Key Keyboard (Keyboard only) **$14.95**
DTE-HK (case only – 3½"Hx8¾"Wx8¾"D) **$44.95**

CIRCLE 19 ON FREE INFORMATION CARD

ANCRONA HAS MOTOROLA ICs

BFR90	$ 1.88	MC1355P	2.10	MC3303P	5.80
BFR91	2.42	MC1357P	1.55	MC3325P	2.10
CA3054	1.54	MC1358P	1.50	MC3340P	2.10
CA3059	3.34	MC1364P	2.01	MC3360P	1.00
CA3079	2.23	MC1372P	6.48	MC3370P	3.72
MB0101	.73	MC1373P	5.19	MC3403P	1.68
MBD102	.28	MC1391P	1.44	MC3405P	2.42
MB0201	1.03	MC1403AU	11.07	MC3408L	3.55
MBD501	1.57	MC1403UDS	4.23	MC3416L	31.42
MC664P	3.20	MC1405L	15.28	MC3423P1	1.66
MC680P	2.05	MC1408L6	2.94	MC3438L	4.33
MC830L	2.27	MC1408L8	4.64	MC3476P1	3.18
MC832L	2.27	MC1413P	1.33	MC4016P	8.52
MC835L	2.46	MC1437L	3.99	MC4024P	5.75
MC836P	1.50	MC1439L	4.62	MC4026P	3.48
MC839L	5.88	MC1439P1	3.97	MC4044P	5.75
MC839P	3.56	MC1445L	2.94	MC4558NCP1	3.18
MC840P	1.50	MC1455P1	.72	MC10109L	1.24
MC846P	1.36	MC1455UDS	1.77	MC10116L	1.24
MC848L	3.17	MC1458CP1	.68	MC10116P	.92
MC857L	2.46	MC1469G	4.24	MC10123L	2.39
MC857P	1.50	MC1488L	1.51	MC10124L	3.01
MC862L	2.27	MC1489AL	1.48	MC10125L	2.50
MC958L	4.43	MC1489L	1.48	MC10137L	5.38
MC1013P	.50	MC1489P	1.39	MC10189L	3.27
MC1302P	3.72	MC1494L	8.04	MC10195L	2.52
MC1309P	2.86	MC1495L	5.28	MC101216L	1.88
MC1310P	2.86	MC1496G	1.80	MC14412VP	15.53
MC1330A1P	1.60	MC1808P	1.36	MC14435VP	11.53
MC1349P	1.72	MC1809P	1.36	MC14457P	6.60
MC1350P	1.15	MC3062L	5.25	MC14458P	13.73
MC1352P	2.01	MC3302P	.88	MC14490VP	3.06

THE NEW NLS TECHNOLOGY TOUCH/TEST 20



TOUCH/TEST 20 comes complete with test leads, temperature probe, component test adaptor, batteries and charger unit. Order yours TODAY!

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NLS-TT20B		425
NLS-41-140	LEATHER CARRYING CASE	45

Capacitance Meter

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BUILO A WORKING OPM IN ½ HOUR WITH THESE COMPLETE EVALUATION KITS

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ICL7106EV (LCD) $34.46 ICL7107EV (LED) $78.70

Power Supplies from ADTECH POWER

Model	Vdc	Amps
APS 5-3	5	3.0
APS 12-1.6	12	1.6
APS 15-1.5	15	1.5
APS 24-1	24	1.0

1-9 $42.50 10 up $40.65 25 up $38.86

Model	Vdc	Amps
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APS 15-3	15	3.0
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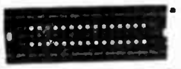

- Display Range -36dB to +5dB
- Floating or Gradual Output Indicating
- Kit includes transistors, leds, capacitors, resistors, PC Board, and silk screened metal front panel

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LM309K	1.25	78L08CP	.55	78M15CT	1.45
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LM320-6K	2.20	78L18ACP	.60		
LM320-8K	2.20	78L18CP	.55		
LM320-12K	2.20	78L24ACP	.60		
LM320-15K	2.20	78L24CP	.55		
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LM340-12K	1.35	79L15ACP	1.50		
LM340-15K	1.35	79L15CP	1.00		
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LM353-15	7.50	MC1468G	5.90		
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MRF223	18.50
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MRF314	28.91
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MRF454A	26.53
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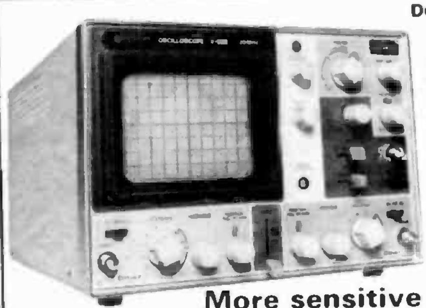

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TIL115	Transistor Coupler	1.32	1.26	1.20	1.14
TIL116	Transistor Coupler	1.32	1.26	1.20	1.14
TIL117	Transistor Coupler	1.32	1.26	1.20	1.14
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7430	.17	74123	.42	74196	.86
7432	.27	74125	.45	74197	.87
7437	.27	74126	.45	74279	.96
7438	.27	74145	.75	74325	2.25
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4.000 MHz	8.000MHz
3.000 MHz	10.000 MHz
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6.000 MHz	20.000 MHz

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200	.70	.80	1.90	9.00
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400	.09	.25	.65	1.50	6.50	9.60
600	.11	.30	.80	2.00	8.50	12.50
800	.15	.35	1.00	2.50	10.50	16.50
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200	.80	1.30	2.20
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600	1.30	1.80	4.40

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74LS05	.27	74LS157	.85
74LS08	.27	74LS160	1.00
74LS09	.27	74LS161	1.00
74LS10	.25	74LS162	1.00
74LS11	.35	74LS163	1.00
74LS12	.35	74LS164	1.00
74LS13	.60	74LS168	1.25
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74LS15	.35	74LS170	1.70
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74LS30	.30	74LS192	.90
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74LS37	.35	74LS195	.80
74LS38	.35	74LS196	1.00
74LS40	.40	74LS197	.90
74LS42	.65	74LS240	1.60
74LS47	.75	74LS241	1.60
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74LS74	.45	74LS245	2.25
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74LS107	.47	74LS290	.80
74LS112	.45	74LS293	.80
74LS113	.45	74LS365	.80
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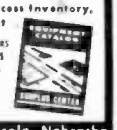

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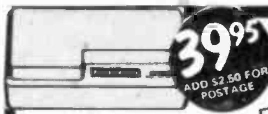

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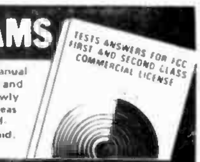

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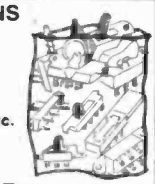

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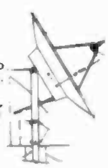

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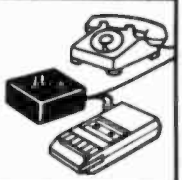

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PRICES

CT-90 wired, 1 year warranty	$129.95
CT-90 Kit, 90 day parts warranty	109.95
AC-1 AC adapter	3.95
BP-1 Nicad pack +AC Adapter/Charger	12.95
OV-1, Micro-power Oven time base	49.95
External time base input	14.95

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

SPECIFICATIONS:

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

7 DIGITS 525 MHz $99.95 WIRED

SPECIFICATIONS:

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

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

PRICES:

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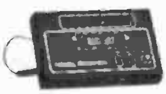
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC adapter/charger	12.95

7 DIGITS 500 MHz $79.95 WIRED



PRICES:

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

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SPECIFICATIONS:

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

8 DIGITS 600 MHz $159.95 WIRED

NEW READ RECEIVER FREQUENCY

SPECIFICATIONS:

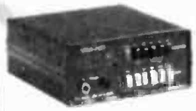
Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

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

PRICES:

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

DIGITAL MULTIMETER $99.95 WIRED



PRICES:

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

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

SPECIFICATIONS:

DC/AC volts:	100uV to 1 KV, 5 ranges
DC/AC current	0.1uA to 2.0 Amps, 5 ranges
Resistance:	0.1 ohms to 20 Megohms, 6 ranges
Input impedance:	10 Megohms, DC/AC volts
Accuracy:	10.1% basic DC volts
Power:	4 'C' cells

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For high resolution audio measurements, multiplies UP in frequency.

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- Multiplies by 10 or 100
- 0.01 Hz resolution!

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ACCESSORIES

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

COUNTER PREAMP

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

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- BNC Connectors
- Great for sniffing RF with pick-up loop

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CIRCLE 17 ON FREE INFORMATION CARD

LASER VIDEODISC
continued from page 83

R3013. Output at pin 4 is applied through a 540-nanosecond delay line, DL5103, to pin 4 of the Video Demodulator II module. Here the composite video signal is applied to point A of the electronic dropout switch.

The 64-microsecond delayed video-FM signal is applied via pin 17 to the FM demodulator stage of the Video Demodulator II module. Its composite video output is available at Pin 1 and is applied to a video amplifier. The frequency response of that amplifier rolls off at 2.6 MHz because the 64-microsecond delay line (DL5101 in Fig. 6) cannot pass signals above that frequency. As a result, dropout corrections occur in black-and-white only. The effect, however, is not noticeable on the TV screen because of the small areas of the picture involved. Gain control R3013 controls the gain of the video amplifier. The video input is applied to point B of the dropout switch and can be monitored at the test point on Pin 10 of the Video Demodulator II module.

The electronic-dropout switch therefore receives a 540-nanosecond delayed-video signal at point A and a line-delayed composite video signal at point B (64-microsecond delay). The voltage at pin 15 determines which of those signals will be applied to the electronic burst switch. When a dropout occurs, the voltage at pin 15 goes high and creates a dropout pulse for the duration of the dropout. The dropout switch, normally in position A, receives the undelayed video signal (540 nanoseconds). However, when a dropout pluse is present, the dropout switch moves to position B and receives the delayed (64-microsecond) video signal. The selected signal leaves the module at pins 7 and 11.

The undelayed video signal is actually delayed by 540 nanoseconds—the time required for the dropout circuitry to respond to the actual dropout. The actual time difference between the two types of video signals is 64 microseconds less 540 nanoseconds, or approximately 63.5 microseconds, the true scan time of one horizontal raster line.

The electronic burst switch in the Video Demodulator I module is used to maintain the 180-degree phase difference in the 3.58-MHz chroma (color) signal from frame to frame during special mdoes of operation, such as still-picture, reverse, fast forward, etc. The chroma signal is normally 180 degrees out of phase from track to track on the videodisc. That relationship is also true from frame to frame on normal TV broadcasts and its purpose is to cancel 3.58-MHz interference. However, when the same track is being played over and over again, the chroma signal would not be out of phase from frame to frame. To introduce that phase difference, the signal is therefore delayed by 140 nanoseconds during alternate revolutions when still-picture viewing is called for. That delay is equivalent to one half of a 3.58-MHz period. The electronic burst switch switches the delay line DL5102 in or out depending upon the viewing mode being used (still picture, reverse play, fast forward, etc.).

The resultant composite video signal is then fed to a Video Processor module and to a Reference Control module, as shown in Fig. 8. A video-muting input at pin 16 blanks the video signal during return of the laser beam to the inside of the disc and during initial turn-on. The video signal is also processed by the DC clamp circuit that clamps the video signal to the correct DC level.

Composite video is clipped in the Reference Control module by the amplifier/clipper stage. The resulting clipped video contains the digital code that represents the picture or frame number. That code is applied to the decoder block on the Mode Control module. A video generator actually creates the separate video signal for displaying the picture number. A video signal that provides a gray background behind the numbers on the screen is also generated by those circuits. Those video signals are then applied to the 2nd video amplifier at pins 7 and 11 of the Video Processor module and the resultant video is then applied to the Rf Modulator as well as to the rear-panel monitor jack, via an emitter follower.

As elaborate as that video and audio processing circuitry may seem, it is really only one half the story of what takes place inside the new optical-laser video disc players. Fully as much electronic circuitry (not to mention the precision mechanical system) is associated with the servo-control circuitry that performs such functions as turntable motor control, tangential-tracking mirror control, radial-tracking mirror control, slide-drive control, objective-lens control (focus) and turn-on sequence logic. All of which makes the new videodisc players an almost miraculous achievement when one considers that they don't cost much more than many audiophiles spend for a super-performing audio turntable. **R-E**

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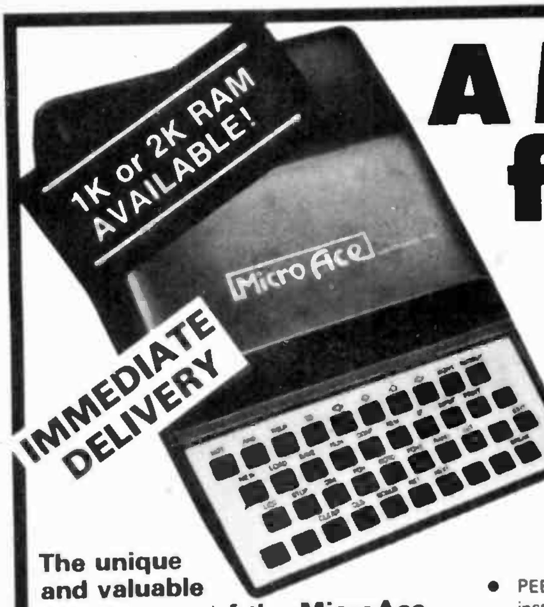

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- Variable names of any length.
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No other personal computer offers this unique combination of high capability and low price.

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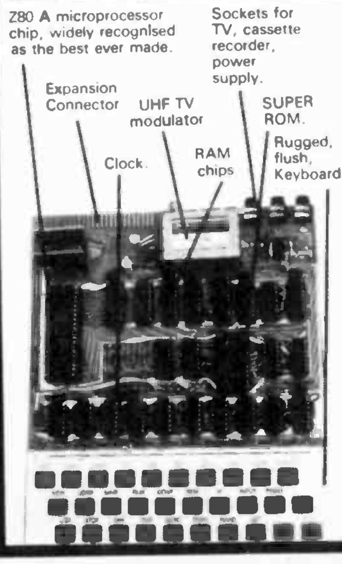

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CIRCLE 6 ON FREE INFORMATION CARD

ADVERTISING INDEX

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NOISE FILTER

continued from page 44

minimum. A further advantage provided by multiple notch-filter techniques, is that the worst possible adjustment is limited to between 8 dB and 10 dB of attenuation. If a sliding cut-off filter were used, that might not be the limit and the error induced could be intolerable.

With the ASRU, the maximum permissible error can be set by the user and the possibility of obtaining an unnatural response—where a low-frequency band might be attenuated more than a higher-frequency one—is avoided. The noise-reduction control and the spectral-tracking concept with feedback are two features that make the operation of the ASRU so effective, yet free of side effects.

Next month, we will provide the circuit details for both the noise reduction and dynamic range expander portions of the ASRU. The construction details will also be given. R-E

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*Including optional mounts at extra cost.

2. It's made better...

3. It's proven best!

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CB TIMES: "... it's not often that a product bursts onto the market scene, dominates and improves CB'ing for everyone. American Antenna and the K40 are doing it—repeated tests showed the K40 could out-perform the major competitive brands."

RADIO-ELECTRONICS: "The results of our tests showed that, in three different positions of the monitoring receiver, the *model* K40 equaled or out-performed the competitive antenna. Apparently, American Antenna's advertising is not merely Madison Avenue showmanship."

PERSONAL COMMUNICATIONS: "... an impressive 95% of the trials, the K40 out-performed the existing mobile antennas. We had to try one for ourselves.

"... in every case, the K40 either equaled or out-performed its competitor.

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...Here's what CB'ers all across the country said.

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—J.H. Collett, 207 McFee, Bastrop, LA

AVANTI: "I'm an electronic technician with a Second Class FCC license ... I was able to transmit 70% further and tune the SWR 75% lower than my Avanti."

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—H. Bachert, Jr., 15 King Rd., Park Ridge, NJ

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