THE NEW
performer.

... UNBEATABLE PRICE / PERFORMANCE RATIO
The Model 7000 Universal Counter / Timer

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

Triplet performance... a tough act to follow
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, motorcycle 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 cares 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 $33.95 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.
Beckman brings a new dimension to hand held Digital Multimeters

True RMS capability at an affordable price

Now you can measure the exact power content of any signal — regardless of waveform. Beckman delivers the new TECH™ 330 multimeter with true RMS capability and many more fine performance features for just $210.

Unlike most multimeters calibrated to read only the true power content of sine waves, the TECH 330 extends its true RMS capability to give you accurate readings of both sine and non-sine waveforms.

True RMS makes a significant difference in accuracy when measuring switching power supplies, flyback power circuits, SCR or TRIAC controlled power supplies or any other circuit generating a non-sine signal.

The TECH 330 also accurately measures the entire audio band up to 20 kHz. But that's not all you can expect from Beckman's top-of-the-line multimeter.

You also get 0.1% basic dc accuracy, instant continuity checks, 10 amp current ranges, a separate diode test function, 22 megohm dc input impedance, and an easy-to-use rotary switch.

With so much capability in hand, you'll be able to depend on the TECH 330 for a long time. That's why Beckman designed it tough enough to go the distance.

Enclosed in a rugged water-resistant case, the TECH 330 can take a 6-foot fall onto concrete and still perform up to spec. And to further ensure reliable, trouble-free operation, the TECH 330 gives you 1500 Vdc overload protection, RF shielding, 2000-hour battery life, gold switch contacts, and fewer electronic components to worry about.

Add another dimension to your world of electronics. Visit your Beckman distributor today for more information on the TECH 330 and Beckman's complete line of digital multimeters, starting at $120.

For your nearest distributor, or a free brochure:

CALL TOLL FREE
24 HOURS A DAY, 7 DAYS A WEEK
1-(800)-821-7700 (ext. 517)
in Missouri 1-(800)-892-7655 (ext. 517)

BECKMAN
CIRCLE 47 ON FREE INFORMATION CARD
SPECIAL FEATURE
49 ELECTRONICS IN YOUR NEXT CAR
Microprocessors now make it possible for your car to tell you what's wrong with it. Martin Bradley Weinstein

BUILD THIS
41 AUDIO SIGNAL RESTORATION UNIT
Hear your records and tapes as you've never heard them before. Joseph M. Gorn

60 DO-NOTHING BOX
Does "nothing" like you've never seen it done yet. Noel Nyman

63 UNICORN-1 ROBOT
The first step on the road to radio control. James A. Gupton, Jr.

TECHNOLOGY
4 LOOKING AHEAD
Tomorrow's news today. David Lachenbruch

16 SATELLITE TV NEWS
The latest happenings in an exciting new industry. Gary H. Arlen

55 IDENTIFYING UNMARKED IC'S
Every IC has a "signature" that sets it apart from other types. An ohmmeter and a piece of paper will let you classify the contents of your junk box. Kenneth H. Recorr

70 HOBBY CORNER
More on Light Mystery No. 2, some reader ideas and some reader questions. Earl "Doc" Savage, K4DS

VIDEO
67 VIDEODISC SIGNAL PROCESSING
How laser videodisc signals are encoded and decoded. Len Feldman

84 SERVICE CLINIC
About sweep-circuit timing problems. Jack Darr

86 SERVICE QUESTIONS
R-E's Service Editor solves technicians' problems.

RADIO
45 SHORT WAVE JAMMING DEVELOPMENTS
International broadcasts are still frequently plagued by jamming. Here's what's happening now. Stanley Leinwoll

76 COMMUNICATIONS CORNER
How to suppress harmonic radiations effectively. Herb Friedeman

AUDIO
52 ALTERNATE MEANS OF DISTORTION REDUCTION
A new system for minimizing distortion without having to resort to negative feedback. Len Feldman

EQUIPMENT REPORTS
24 Keithley Model 169 DMM
26 A-P Products Hobby-Blox
32 Hickock Model 216 Translator Tester
36 Gold Line Model 1139 Power Supply
37 Sony ICF-6700W Receiver

DEPARTMENTS
14 Advertising and Sales Offices
110 Advertising Index
90 Computer Market Center
14 Correction
111 Free Information Card
22 Letters
89 Market Center
74 New Products
80 Radio Products
6 What's News

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 video 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.

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.

Simulated TV picture

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.


© 1981 MAGNAVOX CONSUMER ELECTRONICS CO

CIRCLE 48 ON FREE INFORMATION CARD
Encyclopedia on one disc?

Dr. 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.

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 66.6 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 pereance, 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 franchise.
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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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.
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...

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:

NRI Schools
McGraw-Hill Continuing Education Center
9999 Wisconsin Ave
Washington, D.C. 20016

Learn at home at your convenience.
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. Terrell, Cincinnati businessman, has become the master framerisher of Hamilton County, with a population of around 877,000.

Each of the Tronis 2000 territorial franchisees 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 Tronis 2000 and former publisher of Electronics Technician/Dealer. “And today independent operators, rightly or wrongly, often mean consumer mistrust.”

The concept that Tronis 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 Tronis 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 SelectTV 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 videocassette. Viewers of SelectTV 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 SelectTV 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."

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

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 after-sale 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.
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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 in Fig. 1 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 Photo of Bo Derek copyright 1979 by Orion Picture Company

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.
NEW CM-600 SOLDERLESS PROTOTYPE BOARD

CM-600 is a unique system for solderless construction of circuit prototypes, useful to both engineers and hobbyists. The CM-600 is a neoprene board 4¾" (114mm) x 6" (152mm) with 2280 holes on .100" (2.54mm) centers. Standard components including DIP's are mounted by simply inserting leads into the holes in the long life neoprene material. Interconnections are easily made using 20 or 22 AWG (0.8 or 0.65mm) wire jumpers. Positive contact is assured by the elasticity of the hole, which compresses the leads together. To remove components or leads, simply pull out. This facilitates easy circuit changes making it ideal for breadboarding experimental circuits. CM-600 also features numbered rows and columns for easy reference.

Accessory Kit RW-50 contains 50 pcs of AWG 20 (0.8mm) insulated jumper wires of assorted lengths from ¼" (13mm) to 4" (100mm). Both ends are stripped and bent 90° for easy insertion. In stock directly from

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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 computer 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 Chaparral 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.)

Cable News Network, the all-news channel (Satcom 1, 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.

GA RY ARLEN  CONTRIBUTING EDITOR
Hand-held computer power is here!
An autoranging DMM breakthrough from B&K-PRECISION.

B&K-PRECISION's new microcomputer controlled Model 2845 is a major advance in digital multimeter technology. At a price comparable to ordinary manually operated units the 2845 brings microcomputer intelligence to a handheld portable DMM. When applied to a circuit, its computer selects the range providing maximum resolution without the slow "hunting" action characteristic of many bench-type autoranging DMM's.

The 2845 is certainly the most user oriented hand-held DMM available. No other DMM can match its speed and simplicity of operation. With tilt stand, large display and optional AC power adapter, it becomes a remarkable inexpensive bench DMM.

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MAIL TODAY!
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 operation.

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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 56 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 Zener diodes 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

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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 1000 volts full-scale. Accuracy on the DC ranges is 0.25% of reading + 1 digit. Accuracy on AC is 0.75% of reading + 3 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 2000 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 1/4 X 7 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 1/2 X 9 1/2 X 10 1/2 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

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A P Products Hobby-Blox Solderless Breadboarding System

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 X 3.12 inches and the shorter tray is 3.7 X 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 X 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
The Sinclair ZX80.
A complete computer—only $199.95 plus $5.00 shipping.

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We've packed the conventional computer onto fewer, more powerful LSI chips—including the 80A microprocessor, the faster version of the famous Z80. This makes the ZX80 the world's first truly portable computer (6½" x 8½" x 1½" and a mere 12 oz.). The ZX80 also features a touch sensitive, wipe-clean keyboard and a 32-character by 24-line display.

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ZX80's advanced design features.

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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 X 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.

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**Hickok Model 216 Transistor Tester**

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 basic 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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**LM-3.5A at a glance.**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Spec</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Volts</td>
<td>1 to 1,000, 4 ranges</td>
</tr>
<tr>
<td>AC Volts</td>
<td>1 to 7,500, 4 ranges</td>
</tr>
<tr>
<td>Kilohms</td>
<td>1 to 10,000, 5 ranges</td>
</tr>
<tr>
<td>AC/DC Current</td>
<td>1 mA to 10 A, 4 ranges</td>
</tr>
<tr>
<td>Polarity Selection</td>
<td>Automatic</td>
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<tr>
<td>Readout</td>
<td>0.3&quot; Red LED</td>
</tr>
<tr>
<td>Size</td>
<td>1.9&quot; H x 2.7&quot; W x 4.0&quot; D</td>
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<tr>
<td>Weight</td>
<td>9.2 oz</td>
</tr>
<tr>
<td>Power</td>
<td>3 type AA rechargeable</td>
</tr>
<tr>
<td>Price</td>
<td>$165.85</td>
</tr>
</tbody>
</table>

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

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ac voltage
dc current
ac current
resistance
diode test
conductance (1/R)
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ac voltage
dc current
ac current
resistance
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35
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 will not.

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 on 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 output of the filter); third, as that sequence of events has uniquely identified 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.

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**EQUIPMENT REPORTS continued from page 32**

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**Gold Line Model 1139 Base Station Power Supply**

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 06896), 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.

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**CIRCLE 104 ON FREE INFORMATION CARD**
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 1N3400 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-sunk. 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 X 3 X 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.

Sony ICF-6700W
General Coverage Receiver

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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sound quality, hobby-class radio receivers. One of the better models is the ICF-6700W.

The military-style cabinet measures 18 × 7½ × 9 inches. Selectable upper or lower sideband, AM, and CW modes are available from 53.29 to 13.7 MHz (the receiver skips 10.4 to 11.3 MHz) with FM coverage from 87.5 to 108 MHz.

A narrow/low 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 signal overload on SSB.

The FM fidelity is very good, with the AM signal 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 adapter nor 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, but because the receiver offers a calibrated shortwave dial and the user is entirely dependent upon the digital readout.

Frequency stability of the receiver is excellent. Single sidereal reception is quite acceptable, although dial setting is touchy. There is no fine-tuning control, 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 the on/off switch seems to maintain position of extreme accuracy. A proper preselcer 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 a push terminal (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 broadcast 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.
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HI-FI NOISE FILTER/Range Expander

Bring out the best in any recording with this combination noise filter/dynamic range expander.

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 (Audio Signal Restoration Unit).

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.

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 attenuates 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-Munsen 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
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.

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 1:2.2 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 connect this unit is duplicated on the unit itself, so owners of cassette or open-reel tape decks need not worry about losing it.

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/decay 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. 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.
not expanding such
low -bass region is not
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. 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, R11, R19, R21, R22, R51 — 100,000 ohms
- R2-5, R102-R105, R21, R23, R24, 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, R112, R107, R112 — 200 ohms

#### Resistors

- R225, R233, R313, R413, R504 — 560 ohms
- R227, R257 — 120 ohms
- R301, R401, R526, R536 — 1500 ohms
- R311, R411, R525 — 12,000 ohms
- R505 — 470,000 ohms
- R511 — 910,000 ohms
- R512, R515 — 22,000 ohms
- R516, 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, %
- Mylar
- C501 — 3.3 μF, 35 volts, electrolytic
- C4, C104, C205, C212-C214 — 0.02 μF, 10%, Mylar
- C203 — 0.001 μF, 10%, Mylar
- C206, C208 — 0.003 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, electrolytic
- C601, C602 — 1000 μF, 25 volts, electrolytic
- C603-C607 — 0.1 μF, ceramic disc

### Diagrams

#### Fig. 8

**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.**

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### Semiconductors

- D201-D204, D206-D210, D501-D513, D515-D517 — 1N4148
- D516-3.3-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 — 7410 dual audio preamplifier
- IC12, IC13 — 78L12A 12-volt positive voltage regulator
- L201, L202 — 0.8 mh coil
- R102 — 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.

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**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 SSS, 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.

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contined on page 110
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
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.

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. Satura-
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 jamming 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-
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 un jammed, 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 temporary. On August 21, 1963, 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...
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.

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 is 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 tach 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, dash-board, 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 dashboards. 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
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 (Self-Test Automatic Readout) shown in Fig. 3. That hand-held, 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 (Exhaust Gas Recirculator) 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 unladen, 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 ratio-metrically 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.

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 memory 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 buckles, 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 (Touch-Operated Universal Communications Helper).

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 report 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...
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 sub-sonic filter all at once.

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-cascade 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
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 achieve 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 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.

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**Pulse-locked power supply**

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

low power supply that offers extremely

N900.

The

an

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 identi-

fied as the 20-kHz power oscillator

generates a 20-kHz squarewave signal

using four high-power switching trans-
sistors in an oscillator circuit that sup-

plies 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-fre-

quency losses. Compared with trans-

formers that can handle conventional

power supplies (operating at 50 or 60

Hz), this transformer can be constructed

with fewer windings that, in turn, re-

sults in an extremely low internal impe-

dance. The secondary rectifying circuit

shown in Fig. 5 rectifies the 20-kHz out-

put, using high-speed diodes, to con-

vert the voltage into positive and nega-

tive DC. Finally, the pulse-width con-

trol 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 sense-type constant-

voltage supply is provided for low-level

stages (including the driver stage), com-

pletely 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 impe-

dance of 8.4, or 2 ohms. The impedance

switch simply controls the voltages pro-

duced by the pulse-locked power supply

continued on page 87
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 $\times 100$ 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.
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
The fact that flip-flop change state never more than zero, usually indicates logic out-
ings those signature. DTL.

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 5: 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 Vcc either directly or through some resistance. When reading forward resistance from substrate to Vcc (+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 Vcc terminal.

A LOGIC-FAMILY TREE

Mention is made in this article of the RTL (Resistor-Transistor Logic), DTL (Diode-Transistor Logic) and TTL (Transistor-Transistor Logic) 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" (Low-power Schottky) TTL, the latter being even faster and having a lower power consumption, at a small sacrifice in drive capability.
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 you to 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 digital.

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 markings to go by—then the only alternative is the IC signature.
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.

Although that is a clever modern way of doing nothing, the Erasable Programmable Read-Only Memory (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 when 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.
Using an EPROM to control a "do-nothing" box allows for more than just sequential operation. LED's can be made to circle clockwise, counterclockwise, 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 Strum 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 eighth selects whether the line or circle is displayed.

I used the least-significant data bit, D0, to select the display. Logic-1 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 D0 selects the circle. The choice of 1 or 0 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, D0 goes to 0 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 ad-

![Circuit Diagram](image)
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 D0 IC5 output controls Q2 and Q3 through inverters. A logic 1 from D0 will cause Q3 to conduct and the LED's in the circle will light. A logic 0 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. 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

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TABLE 4

| 8 | 1000 |
| 9 | 1001 |
| A | 1010 |
| B | 1011 |
| C | 1100 |
| D | 1101 |
| E | 1110 |
| F | 1111 |

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 0, but since it does not reset latch IC1-b, the cycling repeats.

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

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

continued on page 87
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 (Dual Tone Multi-Frequency) 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.

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-
ic, 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 paralleled 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 1/8-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 airlines!

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.

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

**TABLE 1**

<table>
<thead>
<tr>
<th>IC No., Pin No.</th>
<th>Key No.</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC1, 1</td>
<td>1</td>
<td>Both wheels, forward</td>
</tr>
<tr>
<td>&quot;&quot;, 2</td>
<td>2</td>
<td>Both wheels, reverse</td>
</tr>
<tr>
<td>&quot;&quot;, 3</td>
<td>3</td>
<td>Left wheel, forward</td>
</tr>
<tr>
<td>&quot;&quot;, 4</td>
<td>A</td>
<td>Left wheel, reverse</td>
</tr>
<tr>
<td>&quot;&quot;, 5</td>
<td>4</td>
<td>Right wheel, forward</td>
</tr>
<tr>
<td>&quot;&quot;, 6</td>
<td>5</td>
<td>Left &amp; right arm solenoids</td>
</tr>
<tr>
<td>&quot;&quot;, 7</td>
<td>6</td>
<td>Body rotate, right</td>
</tr>
<tr>
<td>&quot;&quot;, 8</td>
<td>B</td>
<td>Body rotate, left</td>
</tr>
<tr>
<td>IC2, 1</td>
<td>7</td>
<td>Left shoulder, up</td>
</tr>
<tr>
<td>&quot;&quot;, 2</td>
<td>8</td>
<td>Left shoulder, down</td>
</tr>
<tr>
<td>&quot;&quot;, 3</td>
<td>9</td>
<td>Right shoulder, up</td>
</tr>
<tr>
<td>&quot;&quot;, 4</td>
<td>C</td>
<td>Left arm, up</td>
</tr>
<tr>
<td>&quot;&quot;, 5</td>
<td>D</td>
<td>Left arm, down</td>
</tr>
<tr>
<td>&quot;&quot;, 6</td>
<td>E</td>
<td>Right arm, up</td>
</tr>
<tr>
<td>&quot;&quot;, 7</td>
<td>F</td>
<td>Right arm, down</td>
</tr>
<tr>
<td>&quot;&quot;, 8</td>
<td>G</td>
<td>Right arm, down</td>
</tr>
</tbody>
</table>

**TABLE 2**

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

**PARTS LIST—RELAY-DRIVER BOARD**

All resistors 1/4 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.

**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 1/4-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).
Here's how the picture and sound are transferred from the disc to your TV set in the new laser videodisc system.

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...
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 than 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 the 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.

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.

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

continued on page 83
When analyzing simple circuits, be careful not to overlook the obvious.

Earl "Doc" Savage, K4DS, 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](image)

The answer to No. 1, of course, is that the voltages and currents cannot be equal if the brightnesses 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).

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](image)

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
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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 actu-
ate 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
The unique space age digital multimeter with transistor gain (hFE) measurement capability should be the only multimeter you own.

Ora Electronics has offered in the past many fine Digital Multimeters (D.M.M.'S). We still sell the famous D.M.M.'S such as Beckman, Fluke, Hickok, and others. We have always followed the advance in technology used in D.M.M.'S, and we always wanted to supply our many good customers with the most ideal Multimeter, at a price they can afford. In the past we had to sell good, but expensive Multi- meters, expensive but "fast" Multimeters, and plain "cheap" Multimeters.

WE FOUND IT!

Several months ago, a famous Test Equipment Manufacturer, walked in to our head- quarters with a Prototype of a Digital Multi- meter. We were very impressed it had almost everything we wanted plus a bonus, the only question remaining was "how expensive is it?" When we heard the answer, a big smile ap- peared on our faces. After several improve- ments we are proud to offer it. After you read the features (and price) I am sure you are going to order one or more, of these fine D.M.M.'S that we call the "UniVolt".

LCD DISPLAY.
The unit has a 3.5 Digit liquid crystal display. The sharp digits are 14mm high and have a viewing angle of 140°.

HIGH ACCURACY.
The basic D.C. accuracy of the UniVolt is 0.5% of reading +1 digit, which makes it one of the more accurate instruments in its class. The input impedance is very high, 10 mega-Ohms (10,000,000) Ohms, which helps in measure- ments of low voltage and high frequency sig- nals.

MEASUREMENT RANGES.
The UniVolt has D.C. voltage range of 100uV to 1000V in five steps, A.C. voltage range of 100mV to 1000V, current measurement range of 100mA to 10A (DC) and resistance range of 1 to 2,000,000 Ohms.

CONTINUITY & DIODE TEST.
A fast and accurate continuity test mode utilizes a built-in buzzer to indicate continuity. The same mode is used to check diodes and their approximate forward voltage.

EASE OF OPERATION.
The UniVolt is small, it measures 6½" x 3½" x 1¼". It's light weight, only 9.87 oz. including battery! It utilizes push buttons, for easy one-hand operation and the front panel has a unique color coding for reduced errors.

OVERLOAD PROTECTION
The unit has an extensive overload protection on all ranges. On D.C. current ranges it uses a 5A GMA type fuse. A spare fuse is supplied with the unit at no extra cost.

MAINTENANCE FREE
The heart of the UniVolt Multimeter is a 40 pin L.S.I. chip; the Intersil ICL710G. This space ages chip has proven to be one of the most sophisticated and reliable micro-electronic cir- cuit in use, it is supported by minimum amount of external parts, which are over specified to insure failure safe instrument. Of course, Ora Electronics stands by this instrument and guar- antees it for one year (See specific warranty information).

OTHER FEATURES
It uses one 9 volt carbon battery (included), which last approximately 200 hours of con- tinuous use. Its sampling time is 0.4 seconds, operating temperatures of 30°F to 104°F, and operating humidity of less than 80% R.H.

BONUS!!
We left the best to the end. The UniVolt DT-810 has something unique. It has a transistor gain (hFE) measurement mode! This unique feature enables you to measure hFE values of 0-1000 of either P.N.P. or N.P.N. transistors.

SPECIAL PRICE
We had originally decided to sell the unit for $119.95, but in order to promote the new advancement in D.M.M. design, represented by the UniVolt, for a limited time only you can buy this incredible unit for only $99.95 including: standard red & black test leads, a fresh 9v carbon battery, a spare 0.5A GMA type fuse and an instruction manual.

FREE CASE
We have worked long on the UniVolt project and we hate to see scratches or bad looking units. So we decided to go all the way, when you buy the UniVolt DT-810 Multimeter (and for a limited time only) we will give you absolutely free a hard vinyl leatherette, carrying case, with felt padding and a compartment for your test leads. The regular selling price for this case model CC-01 is $8.00.

ACCESSORIES AVAILABLE.
The only two accessories available are: UP-11, hFE probe with special plug and 3 color coded alligator clip, and the UP-12 I.C. clip adaptor, which will help you hook your multi- meter to any I.C. pins. (You can buy both probes for only $6.00, but only when you purchase the UniVolt DT-810 now.)

ORDER NOW!
It's very easy to order your UniVolt DT-810 multimeter. Send $99.95 (California residents add 6% sales tax) plus $2.50 delivery charge to the address below, if you want the optional accessories, please add $6.00 (California resi- dents add 6% sales tax). A cashier check or money order will help speed your order. Credit card holders (master card or visa) can call our toll free number (800) 423-5336, in California it's (800) 382-3663. C.O.D. orders will be accepted, but you must pay by cash or money order and a C.O.D. charge of $1.40 will be added. If you decided to buy another brand of Multimeter, please call us too, we carry many other types of multimeters and test equipment at low prices.

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RADIO-ELECTRONICS 
74

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-outputs output level, sine-wave distortion less than 1%, squarewave TTL and CMOS logic levels, and triangle and sine-wave 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 +12, +15, -5, -12, -15, 750 mA maximum load.

PROGRAMMABLE ELECTRONIC THERMOSTAT, the Comfort Zone, is the only electronic thermostat on today's market that offers triple 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's 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 Snappack fuse block series 6BF, features neon indicator lamps that light when a 3AG fuse blows. (The 3AG fuse is very 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, prepackaged 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-
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 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 $8.95. — 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 ohmmeter. 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.

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

Finally, there is a magazine that speaks to the beginner.

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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.

![Figure 1: Schematic of the filter.](image)

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 1/4-wavelength transmission-line stub, shown in Fig. 1 just ahead of the antenna connector J301.

The stub is an electrical 1/4-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 1/4-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 1/2-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...
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COMMUNICATIONS CORNER
continued from page 76

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 generated!

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 3/8-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.

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MARCH 1981

79
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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 $99.95—Avanti Research and Development, Inc., 340 Stewart Avenue, Addison, I 1101.

TRANSCIEVER, 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 threemode, 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 without 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 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 high-quality, 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 1/4-24 threadbase-loaded whips or, with an adapter (furnished), 1/4-28 thread. Cable 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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MARCH 1981
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.
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power with continuous (CW) carrier and automatic-
ically displays the peak power when in the SSB
mode in ranges of 0-250 W and 0-500 W.
The price of the model AT2500 is $598.00.
—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, with-
out ringing, oscillation, or Instability. The band-
width 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 tun-
ing eye that lets the operator see when he has
filtered the signal he wants to.
The Varifilter is priced at $139.95.—Kantron-
ics, 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 every-
thing in one section and make the transi-
tion 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 cir-
cuits, and Unicorn-1 will be able to cut its
apron strings.

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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 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

continued from page 69
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 recognized 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 oscillator time-constant involves all of the components: the secondary winding, the capacitor, and the resistors. All of those should be checked.

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 scope 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.

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.

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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 traced 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-W

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CIRCLE 33 ON FREE INFORMATION CARD
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 audio 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 increased 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.

Reducing Distortion

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 2SI54 (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

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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 alias 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 (Service Order Scheduling) 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 efficiency saving everybody time and money.

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MICROWAVE antenna for MDS complete with hardware, type N connector $49.95. SIGNAL ELECTRONICS, 4027 18th Avenue, Brooklyn, NY 11218

LASER handbook with burning, cutting, Ruby Reds, Co’s, complete plans, books, and parts. Send $4.00 to FAMCO, dept re, box 1902, Rochester, New York 14605

AUTOSOUND Fuzzbutter! Electronic components! Send 30s in stamps for catalog. POWER ELECTRONICS, 15206 Blackstone, Dalton, IL 60149

RECONDITIONED test equipment. $1.00 for catalog—JAMES WALTER TEST EQUIPMENT, 2697 Nickel, San Pablo, CA 94806

CHEMICALS, apparatus, project books, wide selection. Catalog $1.00 sent to: PIONEER Ltd. Ind. 144 Hughley St., Nashua, NH 03060

SATELLITE TV—the most complete single report—for novices or pros $7. SCOTT PALMER, 9062 Andrews Drive, Burke, VA 22015

TELEPHONE bugged? Uncle listers! Don’t be Watogusted! Latest countermeasures $1.00. NEGEYE ENGINEERING, Pennsboro, WV 26415

"The Intelligence Library" technical secrets. Books on Electronic Surveillance, Lock-Picking, Demolitions, Covert Sciences, etc. One dollar. (refundable) MENTOR PUBLICATIONS, Dept. 2, 135-53 Northern Boulevard, Flushing, NY 11354

RESISTORS V/W, V/W 5% carbon films 32 es. No minimums, 1% metal films. Send for details. Bulk pricing available. JR INDUSTRIES, 5834-C Swan Creek, Toledo, OH 43614

TEST equipment lowest prices BAK Leader, Hitachi, Viz, Beckman, OK Tool, Blender Tongue, RCA parts transistors others, write call collect L.I. Electronics, 981 Sunrise Highway, Bayshore, NY 11706. 516-696-3560

PRINTED circuit board—double sided epoxy, approximately 2.5 sq.ft., min. size 6"x12", $5.00 plus $2.00 postage and handling; send certified check or money order. Illustrated information on request. DYNAMIC INFORMATION TECHNOLOGIES LTD., P.O. Box 4089, Vancouver, B.C. Canada V6B-326

GRAPHIC EQUALIZER

TWELEVE channels $100.00 kit still available; see May 1978 R.E cover story or write: SYMMETRIC SOUND SYSTEMS, 912 Knobcone PL, Dept. R, Loveland, CO 80537

BUSINESS OPPORTUNITIES

MECHANICALLY inclined individuals desiring ownership of Small Electronics Manufacturing Business—without investment; Write: BUSINESS E-B, 82-R, Brighton 11th, Brooklyn, NY 11235

NEW tax loopholes discovered. Everyone eligible. Free sample newsletter. Write: ULC, Box 179-CU, Clarkston, GA 30021

PROJECTION . TV . . Make $200.00+ per evening as Projectionists . . Easy . . Results equal to $2,500 projectors . . . Your total cost less than $15.00 . . . Plans & dealer’s information $14.00 . . . See further information free . . . MACROCOMMGX, Washington Crossing, PA 19697

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UNICORN-1 Robot parts. Also robot kits, plans, books, hard to find gears, motors, metal stock, plastics. Everything you need for your robot projects. Send $3.00 for year’s subscription to catalog and Hobby Robotics Newsletter. ROBOT MART, 19 West 34 St., New York, NY 10001

CB RADIO

GET more CB channels and range! Frequency expanders, boosters, speech processors, interference filters, VOX, how-to books, plans. Catalog $1. CB CITY, Box 31500RE2, Phoenix, AZ 85046

COMPUTER PARTS

1C’S: 2114L-2’s, $3.75; 4116-2’s, $4.00; 2708’s, $6.50; 2716’s, $10.00; 74L5280’s, $1.50; 74LS374’s, $1.50; CCS 18K5MHz RAM board, A&T, $250.00; TEG Box 64086, Va Beach, VA 23464

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$55.00 puts your ad in this space in front of 197,223 active Radio-Electronics readers. To place your ad write Computer Market Center, Radio-Electronics, 200 Park Avenue South, New York, New York, 10003. Address telephone inquiries to 212-777-6400. Frequency rates are available.

RETAILERS

An ad for your computer store in this space in Radio-Electronics COMPUTER MARKET CENTER puts you in touch with our computer audience. They use microcomputer equipment for both business and personal interests. For further details call 212-777-6400.

## COMPUTER SUPPORT CENTER

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**NEW LOW PRICES**  
Z8000/10 (P) 2.5 MHz 24.85  
Z8000/11 2.5 MHz 24.85  
Z8048 CPU 2.5 MHz 4.95  
Z8050 CPU 2.5 MHz 6.35  
Z8051 CPU 2.5 MHz 8.85  
Z8080A 5.35  
Z8080B 5.35  
Z8080C 5.35  
Z8085 3.85  
Z8085A 3.85

### MICROPROCESSOR CHIP SETS

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>8080CPU</td>
<td>4.95</td>
</tr>
<tr>
<td>8080A</td>
<td>5.35</td>
</tr>
<tr>
<td>8080B</td>
<td>5.35</td>
</tr>
<tr>
<td>8080C</td>
<td>5.35</td>
</tr>
<tr>
<td>8085</td>
<td>3.85</td>
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<tr>
<td>8085A</td>
<td>3.85</td>
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### EPROM'S

<table>
<thead>
<tr>
<th>Part No.</th>
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<tbody>
<tr>
<td>2708</td>
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<tr>
<td>2708A</td>
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<tr>
<td>2708B</td>
<td>2.18</td>
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<tr>
<td>2708C</td>
<td>2.18</td>
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### MOS MEMORIES

**MOS Static RAM's**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Price</th>
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<tbody>
<tr>
<td>2114</td>
<td>1.65</td>
</tr>
<tr>
<td>2114A</td>
<td>1.65</td>
</tr>
<tr>
<td>2114B</td>
<td>1.65</td>
</tr>
</tbody>
</table>

### LOW POWER

**4K (1024 x 4) 300NS**  
2114 2.95  
2114A 2.95  
2114B 2.95

### T75100-1785 Single 5V Supply

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Price</th>
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<tbody>
<tr>
<td>2114</td>
<td>1.65</td>
</tr>
<tr>
<td>2114A</td>
<td>1.65</td>
</tr>
<tr>
<td>2114B</td>
<td>1.65</td>
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</tbody>
</table>

### ULSI-101A

**Special 3.55**  
40 KHz Single 5V Supply

### IC MOS RAM

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>5101</td>
<td>3.55</td>
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### RS5404

**4K (1K x 1) 5NSS 16 NS**  
5101 7.05

### Shift Registers

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Price</th>
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<tbody>
<tr>
<td>5101P</td>
<td>3.55</td>
</tr>
<tr>
<td>7447P</td>
<td>3.95</td>
</tr>
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<td>7447PC</td>
<td>3.95</td>
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### LINEAR I.C.'S

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Price</th>
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<tbody>
<tr>
<td>LM324</td>
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<tr>
<td>LM358</td>
<td>1.75</td>
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<td>LM386</td>
<td>2.35</td>
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### Dual-In-Line—Low Profile—1.C. SOCKETS

**CONTACTS**  
**PACKAGE**  
**PRICE**

<table>
<thead>
<tr>
<th>PIN</th>
<th>PRICE</th>
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</thead>
<tbody>
<tr>
<td>16</td>
<td>1.00</td>
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<tr>
<td>20</td>
<td>1.25</td>
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<tr>
<td>24</td>
<td>1.50</td>
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### OPTOELECTRONICS

| LED220  | 1.25   |
| LED232  | 1.50   |
| LED242  | 3.25   |
| LED282  | 3.75   |

### Displays

<table>
<thead>
<tr>
<th>Part No.</th>
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<tbody>
<tr>
<td>FRN357</td>
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<tr>
<td>FRN500</td>
<td>4.65</td>
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### ISOLATORS

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<tr>
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<th>Price</th>
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<tbody>
<tr>
<td>6003</td>
<td>1.95</td>
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<tr>
<td>6003P</td>
<td>1.95</td>
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### SCR's and TRIACS

<table>
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<tr>
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<th>Price</th>
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<tbody>
<tr>
<td>2SC5470</td>
<td>2.50</td>
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### Bi-Fet Op Amps

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Price</th>
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<tbody>
<tr>
<td>TLE1070</td>
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<tr>
<td>TLE2070</td>
<td>1.45</td>
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### Metal Can Small Signal

<table>
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<tbody>
<tr>
<td>2N1461</td>
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### Transistors

<table>
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<tr>
<td>2N3904</td>
<td>1.75</td>
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### Plastic Power Transistors

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N2222</td>
<td>1.75</td>
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</tbody>
</table>

### Super Special Voltage Regulators

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>7805</td>
<td>1.75</td>
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### TTL

<table>
<thead>
<tr>
<th>Part No.</th>
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<tbody>
<tr>
<td>74LS12</td>
<td>1.75</td>
</tr>
</tbody>
</table>

---

**MAIL ORDERS SHOULD BE SENT TO:**
U.S.A. P.O. Box 1035 Framingham, Massachusetts 01701  
Phone Orders & Inquiries: (617) 875-0557  
CANADA & EUROPE 320 Norfolk Street, Westfield, Quebec HAP 2K5, Canada  
Foreign customers please remit payment on an International bank draft or international postal money order payable in U.S. dollars.  
Prices are in U.S. dollars. Minimum Order: $10.00  
Add $3.00 to cover Postage & Handling  
CIRCLE 32 ON FREE INFORMATION CARD
4x16 MEMORY BOARD with 64 IC chips (2102) in sockets. Super deal at $50 the complete board.

$29 AUTO SECURITY SYSTEM alarm system $7.00

SANYO UHF VARACTOR TUNER 25.00
SOUND GENERATOR IC $1.00 ea 6/5.00
SHUGART FLEX DISC DRIVE 5¼ inch 150.00
SHUGART FLEX DISC DRIVE 8 inch 200.00
PORTABLE ULTRASONIC ALARM 15.00
MOTOROLA VIDEO MONITOR 12 inch 85.00
MOTOROLA VIDEO MONITOR 9 inch 40.00
The above two monitors accept composite video signal BALL VIDEO MONITOR 12 inch w/power supply $50.00
The above monitor requires comp video circuitry

DATA STATION CONSOLE w/keyboard 9 inch monitor, power supply. Logic boards broken. $80
Sond for details on this one.

TOUCH PAD solid state w/LSI chip, Bell system compatible. For computers & phones $24.00
12 VOLT GEL-CELLS 2.5 AH $14.00 5 AH $17.00
12 INCH CRT bonded face plate. New with specs. Made for computers. $35.00

WALKY TALKIES Govt surplus used condition. 47-55.4 mc range. With schematics. Govt AN/PRC-16
$25 each 2 for $45. Ant. $5 each

ASCII KEYBOARD parallel $50
RED LED's.............. 10 for $1.00
MIN ORDER $10.00
Shipping extra on all merchandise

CIRCLE 15 ON FREE INFORMATION CARD

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More CFR Spectaculars!!!

**ASCII Parallel Input**

*SELECTRIC Typewriter/Printer*

100% TRS-80 COMPATIBLE

Only $659.00

- Complete w/Printer Cable or Expansion Interface
- Completely Ready For Use
- Hi-Contrast Type Element Included
- Data Included
- Upper & Lower Case Typewriter/Printer
- Fully Formed Characters. Appr. 15 CPS
- Add $20.00 for Handling & Packaging. Pay Shipping When Delivered.

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This Month's Specials

SHUGART 801 $ Floppy Disk Drive
Used, whole untested. Data & Schematics included $2/49.00

SHUGART SA4000 $5 Mini Floppy
Used, whole untested. Data & Schematics included $2/29.00

CDC9400 (MIP-803) 8" Floppy Drive
Hard or Soft Sected. Used, whole untested. Data & Schematics Included $2/39.00

12" VIDEO MONITOR Motorola KXM-351
600 or 900 line, Tested. Model only. Composite Video Input and 110/240 VAC, 50-60 Hz. Tested, functional & guaranteed. Data & schematics included $179.00

9" VIDEO MONITOR Motorola KXM-227
Same characteristics as above 12" video. Tested, functional and guaranteed. Data & schematics included $125.00

---

Call For Our Bargain-Packed PERIPHERAL FLYER!!!
Prices are subject to change. Check all items.

---

CIRCLE 41 ON FREE INFORMATION CARD
## International Electronics Unlimited

### Ceramic Capacitors

<table>
<thead>
<tr>
<th>Value</th>
<th>Total Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2uf/35Y</td>
<td>1000 pcs.</td>
</tr>
<tr>
<td>.002uf</td>
<td>5000 pcs.</td>
</tr>
</tbody>
</table>

### POLYESTER FILM CAPACITORS

- 200V: 1000 pcs.
- 10V: 1000 pcs.

### Capacitor Kit

- 10440, 1000 pcs.
- 10450, 1000 pcs.
- 10460, 1000 pcs.

### Tantalum Capacitor Assy.

- Sea. of above
- 35.70 each

### Electrolytic Capacitors - axial

- 50V: 100,000 pcs.
- 10V: 100,000 pcs.

### Sockets - Low Profile Male Tubs

- ea 100
- ea 1000

### Transistors

- 2N3904, 2N3906: 100,000 pcs.
- 2N3906, 2N3907: 100,000 pcs.

### Diodes

- 1N4001, 1N4007: 100,000 pcs.
- 1N4007, 1N4007P: 100,000 pcs.

### Voltage Regulators

- 100% OF $25.00
- 15% OF $50.00

### Discrete LEDs

- Yellow LED

### Immediate Delivery of Quality Resistors

### Metal Film Resistors

- Low temp coeff.
- High temp coeff.

### Power Supply Kit

- Transformer Kit

### CRYSTAL CONTROLLED TIME BASE KIT

Payment by check, R.O., UPS/COG, M/C or VISA. Add $1.25 for shipping/handling in U.S. Canada and Mexico. Additional charge for UPS COD or BLUE LABEL. Other countries $1.75 - 5% of order. Total California residents add sales tax, minimum order $50.00. Local, Government orders accepted on official purchase orders.

INTERNATIONAL ELECTRONICS UNLIMITED

435 First St Suite 19
Salvage, CA 93463
805-688-2747
100 W CLASS A POWER AMP KIT

Dynamic Blas Class "A" circuit design makes this unit unique in its class. Crystal clear, 100 watts power output will satisfy the most picky fans. A perfect combination with the TA-1000 low T.M. stereo pre-amp.

Specifications:
- Output power: 100W RMS into 8 ohm
- 125W RMS into 4 ohm
- Frequency response: 10Hz - 100kHz
- C.H.D.: less than 0.008%
- S/N ratio: better than 80dB
- Input sensitivity: 1V max
- Power supply: ±40V @ 5 amp

100 W CLASS A POWER AMP KIT $119.50

TA-1000 KIT $51.95

Power transformer $18.60 each

REGULATED VARIABLE D.C. POWER SUPPLY KIT

Uses UA773 I.C. and 2N3055 power transistor as regulator. Output voltage can be adjusted from 0-30V at an internal resistance of less than 0.005 ohm ripple and noise less than 1 mV with built on board LED and audible overload indicator. Kit comes with P.C. board, all electronic components, transformer, connectors, 7 panel meter for voltage and amp, a professional look metal cabinet and instructions.

Model IR-808 D-45V D.C. 3 amp
Model IR-828 B-35V D.C. 2 amp

$69.50 per KIT

WHISTLE ACTIVATED SWITCH BOARD

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

Model 998 $4.50 each

NEW MARK III 9 Steps 4 Colors LED VU

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

IN KIT FORM $18.50

2 WATT AUDIO AMP

Pre assembled. All you need is to hook up the speaker and the wired power supply. Voltage supply from 9V to 15V D.C. measures only 2" x 3½" making it good for portable or discrete applications. Comes with hook up data

BUY 2 FOR $4.99

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 36 4-color LED (15 per channel) to indicate the sound level output of your amplifier from -36dB to +36dB. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual auto power cutout. Power supply is 5 - 12V D.C. with THD on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W.

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

TA-1000 KIT $51.95

Power transformer $18.60 each

MARK IV KIT $31.50

MARK V 15 STEPS LED POWER OUTPUT INDICATOR KIT

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

MARK IV KIT $31.50

MARK V KIT $31.50

BATTERY POWERED FLUORESCENT LANTERN

MODEL 108 R

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

$10.50 EACH

PROFESSIONAL FM WIRELESS MICROPHONE

TEST model WEM-16 is a factory assembled FM wireless microphone powered by an AA size battery. Transmits in the range of 88-108KHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case, mike is 6½" long. With a standard FM radio, can be heard anywhere on a one-acre lot!Sound quality was judged very good.

$165.00

SANYO HYBRID AUDIO POWER AMPLIFIER I.C.

Typical ratings
- Operating case temp. 85°C
- Input voltage ±15V
- Input resistance 20kΩ
- Input sensitivity +3dB
- Power band width 1KHz - 20KHz
- Frequency response 10Hz - 100KHz
- Output level ±5w
- With built in protection circuit

All units come with data sheet

PART OUTPUT (W) SUPPLY VOLTAGE PRICE
STK034 10W+10W Stereo±16V D.C. $14.50
STK034 15W+15W Stereo±20V D.C. $18.50
STK042 20W+20W Stereo±22V D.C. $22.50
STK055 25W+25W Stereo±24V D.C. $25.50
STK055 25W+25W Stereo±35V D.C. $27.50
STK070 30W+30W Stereo±42V D.C. $32.50
STK1050 100W+100W Stereo±50V D.C. $40.50

SANYO HYBRID AMP KIT $41.50 EACH

5W AUDIO AMP KIT

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

SANYO HF VARACTOR TUNER

For U.H.F. CH 14 - 83
- Tuning voltage + 14V and +28V D.C.
- Input impedance 75Ω F.B. band width 75 - 16 M.Hz.
- Noise figure 15.2 dB
- MAX Size 2¼" x 1¼" x 1¼" Supply voltage 15V D.C.
- Sound F.I. - 50.0 MHz Video F.I. - 62.5 MHz

SANYO UHF VARACTOR TUNER $52.50 EA

FOR DECODER BUILDERS

- Pre-Dilled PC Board
- Transformer Coils (Set of 4)
- Multi Turn Trim Pots 10K ohm
- Tunner Capacitor 6-350F
- MC1355 $2.50
- MC1356 $2.50
- MC1352 $2.50
- LM340T-15 $2.50
- MC1350 $2.50
- LM330T-15 $2.50
- NE556 $2.50
- NE556 $2.50
- NE556 $2.50
- We also have transformer capacitors set resistors set unless otherwise stated

SANYO UHF VARACTOR TUNER $52.50 EA

SANYO VARACTOR TUNER

For U.H.F. CH 14 - 83
- Tuning voltage + 14V and +28V D.C.
- Input impedance 75Ω F.B. band width 75 - 16 M.Hz.
- Noise figure 15.2 dB
- MAX Size 2¼" x 1¼" x 1¼" Supply voltage 15V D.C.
- Sound F.I. - 50.0 MHz Video F.I. - 62.5 MHz

SANYO UHF VARACTOR TUNER $52.50 EA

CIRCLE 9 ON FREE INFORMATION CARD
FLUORESCENT LIGHT DRIVER KIT

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

Price: $5.00 Per Kit

SUPER FM WIRELESS MIC KIT — MARK III

This new designed circuit uses high FET transistors with 2 stages pre amp. Transmits FM Range (88-120 MHz) up to 2 blocks away and with the ultra sensitive condenser microphone that comes with the kit allows you to pick up any sound within 15 ft. away! Kit includes all electronic parts, OSC coils, and $15.00 Per Kit

PRESS-A-LIGHT SELF GENERATED FLASHLIGHT

EXCLUSIVE!! $3.95 ea. Model T-1752. Never worry about battery, because it has nonet. Easy to carry in pocket and handy to use. Ideal for emergency light. It generates its own electricity by squeezing grip lever. Put over your hat, boat, camper or home. You may need it some time!

ELECTRONIC DUAL SPEAKER PROTECTOR

This unit will shut off when circuit damaged or over load to protect your amplifiers as well as your speakers. A must for OCL circuits.

KIT FORM $8.75 EA.

“FISHER” 30 WATT STEREO AMP

MAIN AMP (15V x 2)

Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply +5V DC included. Power band (KE 1% ± 3db) Volt. gain 53dB. 20kHz -20kHz.

Super Buy

Only $18.50

SPACE WAR SOUND GENERATOR BOARD

Brand new preassembled module for a toy factory. The board gives you 5 different selectable sound with LED light effect. Sounds include UFO take off, space gun blast, wave and space cham. 7 LEDs on the board will work with the sound. Requires 9V battery to operate. Speakers not included. SPECIAL $1.95 EACH

ELECTRONIC PIEZO BEEP BUZZER

Unique surplus 16" piezo ceramic disc on circuit board gives a distinct high freq. buzz. Unit contains an I.C., 2 caps, 6 resistors and is already preassembled. Requires 9v battery to operate. SPECIAL $1.25 EACH

2 BIT COUNTER, WARELDE PULSE ALARM BOARD

This new assembly easily converts your counter, stop watch, timer with on/off switch and alarm generator by adding a few components. We supply the data and typical applications. Requires 9v battery to operate. SPECIAL $2.00 EACH

ULTRASONIC SWITCH KIT

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

COMPLETE TIME MODULE

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

SOUND ACTIVATED SWITCH

All parts completed on a PC Board SCR will turn on relay, buzzer or flasher circuit for 2-10 sec. (adjustable). Ideal for use as door alarm, sound controlled toys and many other projects. Supply voltage 4.5V 9V DC. 2 for $3.00

REGULATED DUAL VOLTAGE SUPPLY KIT

-4 30V DC 800 uA adjustable, fully regulated by Fairchild 78M0 and 79M0 voltage regulator ICs. Kit includes all electronic parts, filter capacitors, IC, heat sinks and P.C. board. $2.50 PER KIT

AA SIZE NI-CD SPECIALS

Rechargeable batteries

LIMITED QUANTITY AVAILABLE

POWER SUPPLY KIT

0.30V DC REGULATED

Uses UA733 and ZN3055 Power TR output can be adjusted from 0.30V. 2 AMP Complete with P.C. board and all electronic parts. Transformer for Power Supply 2 AMP 24V $8.50

BI-FLASH LED RED/GREEN

2 colors in one LED, green and red. Changes color when reverse voltage supply. Amazing!

1 WATT AUDIO AMP

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

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

Incorporates brand-new D.C. outputs with a frequency response from 0Hz — 100KHz ± 0.5dB. Added features like tone delay and loudness control let you tailor your own frequency supplies to eliminate power fluctuations. Specifications: - T.M.R. less than .005%, - T.I.M. less than .005%, - Frequency response: DC to 100KHz ± 0.5dB +/R.H.A. deviation = 0.2dB + S/N ratio: better than 70dB - Sensitivity: Phone 2MV 47K/Aux. 100MV 10K - Output level: ±1V × Max. output: 15V + Tone control: bass = 10dB @ 500Hz/ treble = 10dB @ 15KHz + Power supply: ±24 D.C. ± 0.5A

Kit comes with regulated power supply. All you need is a 48V C.T. transformer @ 0.5A. ONLY $44.50

X- FORMER

$14.50 ea.

SOLID STATE ELECTRONIC BUZZER

Mini size 1" x 1\2 x 1\2. Supply voltage 1.5V-12V Ideal for Alarm or Tone Indicator

$1.50 each

FORMULA INTERNATIONAL INC.

Send $1.00 for a free detailed Catalogue

March 1981

CIRCLE 5 ON FREE INFORMATION CARD
# DISCRETE LEDS

<table>
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<tr>
<th>Type</th>
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<td>LC090</td>
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# LOW PROFILE (THT) SOCKETS

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# SOLDERTAIL (GOLD) STANDARD

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<tr>
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# 1/4 WATT RESISTOR ASSORTMENTS - 5%

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<td>3.3K</td>
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# CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

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100 VOLT MLAR FILM CAPACITORS

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</tr>
<tr>
<td>47u</td>
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22% DIPPED TANTALUM Tantalum Capacitors

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<tr>
<td>47p</td>
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MINI ALUMINUM ELECTROLYTIC CAPACITORS

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<td>47u</td>
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# DISPLACEMENT LEADS

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# WIRE WRAP SOCKET (GOLD) LEVEL #3

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# 110/220VAC AC/DC POWER SUPPLIES

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# FREEzes

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# CIRCLE 19 ON FREE INFORMATION CARD

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1355 SHOREWAY ROAD, BELMONT, CA 94002
PRICES SUBJECT TO CHANGE

PHONE ORDERS WELCOME (615) 592-8887
**Clock Modules**

12V DC AUTOMOTIVE/INSTRUMENT CLOCK

- Applications: instrument liners, airbag monitors, car audio, etc.
- Features: backlit, digital display, silenced alarm, and more.

**Microprocessor Components**

- **8080/8085 Support Devices**
- **Data Acquisition (Continued)**
- **Microprocessor Chips**

**EPROM Erasing Lamp**

Jumbo 6-Digit Clock Kit

- 6 main digits
- 3 main digits
- 6 small digits

**Regulated Power Supply**

Uses LM337K, LM7805, and LM7812. Provides a solid 10W, 5W, 12V output and 12V, 10W output with JE600 Adapter. Includes components, hardware, and instructions. Size: 3" x 3" x 2" x 2".

**JE600**

- $14.95

**JE600 Hexadecimal Encoder Kit**

The JE600 Encoder Kit provides two separate hexadecimal digits, allowing for efficient encoding and decoding of numbers. The kit includes all necessary components for assembly and operation. It is suitable for use in electronic projects and is rated for 3V, 12V, and 24V operation. The kit comes with a comprehensive user manual and is recommended for hobbyists and advanced users.

**JE610 ASCII Encoded Keyboard Kit**

The JE610 ASCII Encoded Keyboard Kit allows for the generation of ASCII codes from user inputs. The kit includes a keyboard, encoder, and various other components. It is designed for use in computer systems and is suitable for hobbyists and professionals alike. The kit comes with a detailed user manual and is compatible with a variety of platforms.

**32 National Semiconductor RAM SALE**

- MMS2900/4-16k (M141AUP1AD1)...
- JE1200A...
- JE1200B...

**JE205**

- $12.95
16K MEMORY EXPANSION SPECIAL: 8 RAMS $35!

Low power, high speed (4 MHz) dynamic RAMs, expand memory in TRS-80I/II III, and Color models as well as machines made by Apple, Eddy, Heath H89, newer PETs, etc. Add $3 for 2 or 4 points plus T-R50C conversion instructions.

MA1003 CLOCK MODULE $14.95

Operates from 12V DC and includes internal timebase accurate to 0.01%. Ideal for mobile applications in car, van, or boat. Blue-green fluorescent readouts look great at night and don’t wash out during the day. Easy to make into complete clock, add two time-setting switches, hook up power, and you’re ready to go. With applications charts that show how to get the most out of your MA1003. Add $5 for matching case with mounting hardware and optical filter.

$1010111 1X RAM 4X256 540 ns 10/17.50
General purpose silicon signal diodes. 50/12
GT306 NPN darlington, gain min 17000: 25V 200 mA TO92 package 100/16.95
NPN transistor similar to 2N3906 100/7.95
PNP transistor similar 2N3906 100/8.45
4N28 opto-coupler 6 pin minidip. 5/2
SN76477 complex sound generator IC $1.25

SEND FOR OUR FREE CATALOGUE

REVIEWS: Our cat and dog, Alice at least 5”; baby daughter Alexia at 5 months. Drive under $15 and $7 handling. 32-bit and 16-bit RAMs, edge addressable RAMs. Our 32-bit edge addressable RAMs are suitable to build just about anything without notices.

16K MEMORY EXPANSION SPECIAL: 8 RAMS $35!

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BULLET ELECTRONICS

Sound Effects Kit $18.50

The B.S.O.K. is the newest sound effects kit. It features all the parts to build a programmable sound generator. The kit contains a 12"x12" board with all the components needed: 2N4077 Sound Chip, Pong board, pickups, wire, diodes, and more. The kit is an excellent introduction to electronics, and is a great project for beginners. The kit includes a complete set of instructions and a list of component values. It is an easy-to-follow project that will help you learn about electronics.

BANKRUPT Game Manufacturer

Dumps Computer-Generated Game

The Engineers designed this one. It's too costly to make! Result: Chapter XI. We bought all the parts and cut the unit as a kit for over 60% off retail!

You get:

Powerful 8055 Microl Computer
Processor Chip
Two 27s style Real RAM Chips
LED readouts
Keyboard, instructions
AC Plug transformer
1000 and program ROMs only with schematics

$39.95

Includes Case Does not include play piece

7 Watt Audio Amp Kit $5.95

SMALL, SIMPLE HYBRID IC and COMPONENT KIT ON A 2" x 2" PC BOARD. CJOP RUNS ON 120V GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3 IN THE 5 WATTS

OVERVOLTAGE PROTECTION KIT $6.95

Protect your expensive equipment from overvoltage damage. Every computer should have one! Works with any fuse or circuit breakers.

SUPER VALUE POWER TRANSFORMER

Wall made, open frame transformer with mounting ears. Built to 15 and 12 volt requirements. Can be used for any circuit. Smaller sizes are available for low voltage applications. The kit includes a complete set of instructions and a list of component values. It is an easy-to-follow project that will help you learn about electronics.

FREE CARTRIDGE KIT

Satisfaction guaranteed on all parts and kits, except for 10 days if not pleased return in original form with a note explaining the reason for refund. Included: INSURANCE FOR AMOUNT OF QUALITY VALUE is OVER $15.00.

16K MEMORY EXPANSION SPECIAL: 8 RAMS $35!

Low power, high speed (4 MHz) dynamic RAMs, expand memory in TRS-80I/II III, and Color models as well as machines made by Apple, Eddy, Heath H89, newer PETs, etc. Add $3 for 2 or 4 points plus T-R50C conversion instructions.

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Includes Case Does not include play piece

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SUPER VALUE POWER TRANSFORMER

Wall made, open frame transformer with mounting ears. Built to 15 and 12 volt requirements. Can be used for any circuit. Smaller sizes are available for low voltage applications. The kit includes a complete set of instructions and a list of component values. It is an easy-to-follow project that will help you learn about electronics.

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No Minimum Order! No Waiting! Low Prices!
All Prime Devices!

Bam! Beep! Boom! Zonk!
And More with This IC

NEW

**SN76488**
26-Pin DIP

This sound-generator IC, a handful of parts, and a little imagination can create an infinite variety of sounds! Can be controlled by a microprocessor for sophisticated multiplexing of sounds. Built-in audio amplifier drives a speaker. With data.

Reg. 6.99
Sale 6.99

**Three DC Motors**

**NEW**

Pkg. of 3

For 1½ to 6VDC. Typical no-load RPM: 3550. Long leads for easy hookup.

Reg. 3.88
Sale 3.88

**Three-DC Motors**

**NEW**

Pkg. of 10

Ideal for Speakers, Power Supplies

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Sale 19.80

**Bright Red Flasher LED**

Pkg. of 10

CMOS Timer IC and LED in One Package! 5 Hz flash rate really gets attention. Ideal for displays, even electronic jewelry.

Reg. 4.99
Sale 4.99

**Heavy-Duty SCRs**

TO-220 Cases

Reg. 9.99
Sale 9.99

**Bar-Graph Display**

**NEW**

Pkg. of 10

Companion to our LM3914 and LM3915 display driver ICs. Ten LEDs in a 20-pin DIP. With data!

Reg. 7.99
Sale 7.99

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CIRCLE 18 ON FREE INFORMATION CARD

MARCH 1981

105
SATELLITE TELEVISION

SATELLITE television...Howard/Coleman boards to build your own receiver. For more information write: ROBERT COLEMAN, Rt. 3, Box 58-ARE, Travelers Rest, SC 29690

SATELLITE spherical TV antenna easy to build from local parts for $200.00. Detailed plans $20.00, GEMINI TV, 103 Lamport Blvd., S.J., NY 10035

Satellite TV

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Sick of Network TV?

Our receiver lets you get over 75 channels of television direct from your own orbiting cable TV satellites! HBO, Showtime, super stations, sports and movies worldwide.

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GLOBAL ELECTRONICS,
P.O. Box 219-E, Maitland, Florida 32751

Satellite TV

LIMITED ED. quantity of Motorola 40-channel remote CB radios w/ microphones. These are a closeup of new D84Y 16806A radios made for 78-79 Lincoln/Mercury/Ford automobiles. Shipping is prepaid and orders received will be shipped within 24 hours. Send cashier's check or money order for $70 to GUY GRIDER CB, 225 SE 89th, Oklahoma City, OK 73149

CB EQUIPMENT

We manufacture the highest over, 3 meter radio and a voice pitch and we also sell direct. Immediate orders for $200.00. Compare details including satellite TV information on service and discount amphen. Send $1.25 for copy. JASON TENNESSE
P.O. Box 57
Cassidy, Florida 32707

CABLE TV CONVERTERS AND OTHER CABLE TV UNITS

ETCO® VIDCOR 2000 CONVERTER ELIMINATES PROBLEMS WHEN TAPING FROM CABLE TV

ETCO VIDCOR 2000 CONVERTER eliminates problems when taping from cable TV.

UNUSUAL FACTORY SURPLUS MIDDLE-BAND/CABLE BAND CABLE TV TUNER

HOT NEW IMPORT! REMOTE CONTROL 30 CHANNEL CABLE TV CONVERTER

NOT NEW IMPORT! REMOTE CONTROL 30 CHANNEL CABLE TV CONVERTER

ETCO MII WIRELESS THE ULTIMATE CABLE TV CONVERTER!

Our final offering is a complete wireless system! 

VIDCOR 2000 CONVERTER ELIMINATES PROBLEMS WHEN TAPING FROM CABLE TV

UNUSUAL FACTORY SURPLUS MIDDLE-BAND/CABLE BAND CABLE TV TUNER

ETCO GENERAL PURPOSE TUBE TESTER

ETCO VIDCOR 2000 CONVERTER eliminates problems when taping from cable TV.

QUARTER MILE WIRELESS MICROPHONE RECEPTION SYSTEM

FCC approved crystal controlled, higher frequency than radio, motorless, automatic volume control. Battery operated. Electronic audio output is 100,000 Hz. Siren-LEDs.

QUARTER MILE WIRELESS MICROPHONE RECEPTION SYSTEM

UNCOMPROMISING NORELCO ENDLESS LOOP CASSETTES

IN STOCK—THE MURAS CORDLESS TELEPHONE SYSTEMS

SALE OF QUARTZ BATTERY-OPERATED CLOCK MOVEMENTS

20 AMP REGULATED 120VDC POWER SUPPLY

CABLE TV CONVERTERS AND OTHER CABLE TV UNITS

OUR LATEST 98 PAGE ELECTRONIC CATALOG

AMERICAN ELECTRONICS
3705 W. 52ND ST. 
MINNEAPOLIS, MINN. 55416

Cable TV converters and other cable tv units.
7 DIGITS 525 MHz $99.95 WIRED

**SPECIFICATIONS:**
- **Range:** 20 Hz to 525 MHz
- **Sensitivity:** Less than 50 mV to 150 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

**PRICE:**
- MINI-100 wired, 1 year warranty $79.95
- MINI-100 Kit, 90 day parts warranty $59.95
- AC-Z Ac adapter for MINI-100 $3.95
- BP-Z Nicad pack and AC adapter/charger $12.95

**FEATURES:**
- The CT-90 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 this counter a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1 ppm accuracy - that's 0.001%! The CT-90 is the answer to all your measurement needs. In the field, lab or home shop.

7 DIGITS 500 MHz $79.95 WIRED

**SPECIFICATIONS:**
- **Range:** 20 Hz to 600 MHz
- **Sensitivity:** Less than 25 mV to 150 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

**PRICE:**
- CT-50 wired, 1 year warranty $59.95
- CT-50 Kit, 90 day parts warranty $16.95
- RA-1 receiver adapter kit $14.95
- RA-1 wired and pre-programmed $29.95

**FEATURES:**
- The CT-50 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 this counter a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1 ppm accuracy - that's 0.001%! The CT-90 is the answer to all your measurement needs. In the field, lab or home shop.

8 DIGITS 600 MHz $159.95 WIRED

**SPECIFICATIONS:**
- **Range:** 20 Hz to 600 MHz
- **Sensitivity:** Less than 25 mV to 150 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

**PRICE:**
- CT-50 wired, 1 year warranty $59.95
- CT-50 Kit, 90 day parts warranty $16.95
- RA-1 receiver adapter kit $14.95
- RA-1 wired and pre-programmed $29.95

**FEATURES:**
- The CT-50 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 this counter a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1 ppm accuracy - that's 0.001%! The CT-90 is the answer to all your measurement needs. In the field, lab or home shop.

DIGITAL MULTIMETER $99.95 WIRED

**SPECIFICATIONS:**
- **DC/AC volts:** 1000V to 1 KV, 5 ranges
- **AC current:** 0.1 uA to 2.0Amps, 5 ranges
- **Resistance:** 0.1 ohms to 20 Megohms, 6 ranges
- **Input impedance:** 10 Megohms, DC/AC volts
- **Accuracy:** 1.0% basic DC volts
- **Power:** 4°C cells

**PRICE:**
- $345.95 Kits $34.95 Wired

**FEATURES:**
- 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. Measurement are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, over-range indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof. The DM-700 looks great, is handson, jet black, rugged ABS case with convenient retractable tilt tab makes it an ideal addition to any shop.

AUDIO SCALER

**FEATURES:**
- For high resolution audio measurements, multiplies (up to 1000)
- Multiple by 10 or 100
- 0.01 Hz resolution
- $29.95 Kit $39.95 Wired

ACCESSORIES

**PRICE:**
- Telescopic whip antenna - BNC plug $5.95
- High impedance probe, light loading $15.95
- Low pass probe for audio measurements $15.95
- Direct probe, general purpose usage $12.95
- Test bell, for CT 70, 90, MINI-100 $3.95
- Color burst calibration unit, calibrates counter against color TV signal $14.95

COUNTER PREAMP

**PRICE:**
- For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer included.
- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop $34.95 Kits $34.95 Wired

**FEATURES:**
- Sensitivity guaranteed. For 10 days, if not pleased, return in original form for refund. Add 5% for shipping charges to a minimum of $5.00. Overseas add 15% - Goods add 5% for international sales under $1,000. NY residents add 8% tax.

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107
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 pulse 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 modes 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 of the story of what takes place inside the new optical-laser videodisc 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.
The remarkable programming advantages:

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

'Excellent value' indeed!

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

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

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

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

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

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

The display shows 32 characters by 24 lines. And Benchmark tests show that the MicroAce is faster than all other personal computers.

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

The MicroAce teach-yourself BASIC manual.

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

A hardware manual is also included with every kit.

The MicroAce Kit:

- $149.00 with 1K
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Demand for the MicroAce is very high: use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. If you are unsuccessful in constructing your kit, we will repair it for a fee of $20.00, post and packing FREE. Of course, you may return your money if you are not satisfied beyond any doubt — and we have no doubt that you will be.

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CIRCLE 6 ON FREE INFORMATION CARD
**ADVERTISING INDEX**

RADIO-ELECTRONICS does not assume any responsibility for errors that may appear in the index below.

**Free Information Number**

23 AMC Sales .................................................. 106
24 AMF, Electro—Components Division ............. 104
25 ATV Research .............................................. 89
32 Active Electronics ....................................... 91
34 Advanced Computer Products ....................... 92-93
36 Advance Electronics ................................. 26,32,34-35
45 Alix Electronics Inc. .................................. 81
46 All Electronics ............................................ 102
22 American Antenna ................................. Back Cover
Ancoma ......................................................... 103
3 B & K ......................................................... 17
19 Karl Bart ................................................. 104
47 Beckman ................................................... 2
51 Bullet Electronics ........................................ 102
54 Burdex Security Co. .................................. 89
12 Byte ......................................................... 37
41 CFR, Associates Inc. .................................. 94
43 CIE, Cleveland Institute of Electronics ........... 18-21
57 Cambridge Learning Inc. ......................... 38
28 Channellock Inc. ....................................... 36
58 Chaney Electronics .................................. 106
30 Command Productions .............................. 104
49 Communications Electronics ..................... 88
36 Concord Computer Components ................. 94
37 Crystal Radio .............................................. 90
10 Dage ........................................................ 89
35 Digi-Key Corp. ........................................... 99
62 Discwasher ............................................... Cover 3
4 Etco .......................................................... 104, 106
37 Fluke ......................................................... 7
56,55 Fordham ............................................. 78,24
52 Formula International ............................ 96-97
24 Gladstone Electronics ....................... 110
58 Global Specialties Corp. ......................... 40
38 Godbout Electronic .................................. 102
43 Grantham College of Engineering .......... 88
38 Hal-Tronix ............................................... 102
63 26,25 Heath .............................................. 25,74
11 Information Unlimited ............................ 104
13 International Components ....................... 87
51 International Crystal MFG, Co. Inc. .......... 78
29 International Electronics Unlimited ......... 95
25 JS & A ....................................................... 1
19 Jameco Electronics ................................ 100-101
27 Jan Crystals ............................................. 82
30 Joe .......................................................... 89
33 Keithley Instruments Inc. ..................... 86
48 Magnavox ............................................... 5
15 Meshna Inc. ............................................. 94
6 Micro-Ace ............................................... 109
10 Micro Management Systems, Inc. ............. 110
49 NRI Schools .............................................. 8-11
20 NTS, National Technical Schools ............. 28-31
59 Neoteric ................................................... 77
30 Non-Linear Systems ................................. 33
18 O.K. Machine & Tool Corp. .................. 15
11 On Computing .......................................... 75
9 Ora Electronics .......................................... 73
16 Paccom .................................................... 83
2 Paia Electronics ........................................ 88
43 Poly Pak ................................................... 98

**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.
NEW D4 FLUID
Inherently more active against record contamination. Inherently safe for record vinyl. Preferentially absorptive formula carries all contamination off the record.

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Unique directional fibers preferentially remove fluid and contamination. D4 fabric results in clearly better cleaning, better drying and ultimately residue-free surfaces.

UNMATCHED VALUE
The Discwasher D4 System is enhanced by the durability and aesthetics of the hand-finished walnut handle. Included in the D4 System are the DC-1 Pad Cleaner and new instructions.
In one year our K40 antenna has become the largest selling CB antenna in the world!

1. It’s more expensive...
$42.50 suggested retail

And when you pay more, you expect more!

MORE PERFORMANCE:
The K40 is guaranteed to transmit further or receive clearer than any antenna it replaces. We know it will. We've tested it with 771 CB'ers just like you for one year.

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MORE QUALITY:
It's not imported. It's not made in Taiwan, Korea or Japan. It's American made in an American town. It's made with better materials that cost more and by professional people we pay more. And we designed it right here in the U.S.A.

*Including optional mounts at extra cost.

...This Antenna is so DYNAMITE you receive a ...

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.

"No ifs, ands, or buts! The K40 Antenna from American Antenna would have to be just about the best antenna around.

CB MAGAZINE: "Introduced in October, 1977, the K40 quickly became the top seller and in mid 1978 became the number one selling antenna in the nation.

...Here's what CB'ers all across the country said.

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J.H. Conit, 207 McKee, Redtop, 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."

H.R. Castro, VR8, Monserrante D-67, Salinas, Puerto Rico

PAL: "...20% better in transmission and reception than my 5/8 wave Pal Firesk." John A. Bum, Bx 446, Zelienople, PA

SHAKESPEARE: "...I've been a CB'er for three years and the K40 is the best I've ever had. Better in reception and transmission than my Shakespeare."

H. Boschert, Jr. 15 King Rd., Park Ridge, NJ

HUSTLER: "Compared to my Hustler XBLT-4, the K40 can consistently transmit 40% further and the reception was better. The K40 is the perfect way to complete a CB system."

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