Radio-Electronics®

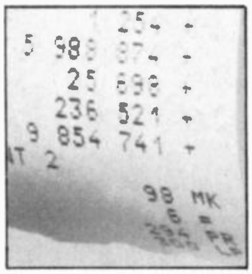
DIGITAL HI-FI FOR THE 1980's

$1.25 JUNE 1980

Television—how it all began
Improved automotive voltage regulator
How to interface an A/D converter
Satellite-TV reception pitfalls
Build a professional drum synthesizer
Eavesdrop on secret shortwave messages

Olivetti Break-through

The world's smallest electronic printer will never run out of paper, ink or batteries thanks to Olivetti, JS&A and some incredible new technology.



The new pocket-sized Olivetti calculator slides open to unveil one of the most advanced printing heads ever developed.

It's a major breakthrough. That calculator shown above is the most advanced printing calculator in the world.

SLIP TOP PRINTER

The new Olivetti Logos 9 is only 1" x 2½" x 4⅝"—smaller than many cigarette packages. It has a full 12-digit liquid crystal display with add mode and full-floating or fixed position decimal.

To turn the unit into a printer, you simply slide up the top of the unit to expose the world's smallest and one of the most precise printing heads. The printing head prints letters and numbers, identifies each entry and even clearly separates groups of three whole numbers for easy readability.

PLENTY MORE

If its size and printing head are breakthroughs, so is its paper system. The paper is loaded in special cartridges with enough paper per cartridge for 1300 entries. All you do is simply pop a cartridge into the bottom of the unit each time you change rolls. It's the most convenient way ever designed to change a roll of paper for a printing calculator.

But if you're like most Americans, you'd be concerned about paper supply. Where do you get those special cartridges, and how do you know if you can get them years from now?

That's where JS&A comes in. A 32-roll supply—all you'll ever need for three full years—is only $16. That's enough paper for 41,000 entries or approximately 52 line entries each working day for three full years.

But even more important, within one year stationery stores will stock the cartridges, and we predict that the Olivetti cartridge will become a standard in the industry.

NO INK CARTRIDGES

The paper is a new type that looks exactly like conventional paper. But the paper, when struck, leaves a clear sharp image without the use of ink. So there's no messy cartridge required and no space needed to store one. You'll never need ink again.

The rechargeable batteries last for 8,000 lines when you use just the printer and 80 hours using just the liquid crystal display. The batteries can be recharged 500 times, so theoretically the batteries should last for 300 rolls of paper, or more than nine times the life of your paper supply. The batteries can also be easily replaced.

POWERFUL COMPUTER

The features looked great. The world's smallest size, the paper roll convenience, the no-ink system, the battery life and the large 12-digit liquid crystal display were enough to convince us, but would the new Olivetti be considered a toy? Then we learned about its computational power and features which we feel are better than many of the most professional full-featured printing calculators.

Speed It's the world's fastest small printer with a speed of 2.1 lines per second. The unit also has a buffer so if you enter data faster than the unit, it will still print out each entry.

Memories The Logos 9 has two separate memories. One is an accumulating memory, and the other is a fully independent memory. And the display and printer indicate which memory is on the paper tape.

Printing Head The totally new printing head is a semi-alpha numeric system which labels all entries with letters to indicate the entry. For example LP is list price and CNT means item count.

Clock The unit is so complete, Olivetti even threw in a digital clock function. Your unit will display accurate time when the 12-digit display is not in use.

Gross Margin It automatically computes everything from gross margins to discounts and retail pricing. You just enter your percentage mark-ups in its memory, and it will automatically compute the results while retaining the formula and percentage in memory.

Plus More It has automatic round off, letting you select which figure to round off to. You can add a column of figures and then average your calculations automatically. The full-information liquid crystal display will tell you everything from when you're in the printer mode to whether you have something in memory and in which memory.

The technological breakthroughs in the Logos 9 were possible because Olivetti was able to eliminate the many interface components between the integrated circuit and the printing head. This was all made possible because Olivetti designed the entire system, not just a few of the components as is the case with most calculators.

So there it was. Great features, great convenience and great value for only $89.95 complete with batteries, charger and 90-day limited warranty. For $16 more, you can get 32 cartridges—all the paper you'll ever need for three years or for $10 more you can get 16 cartridges. So impresed are we with the Olivetti Logos 9 that we are making the following offer:

FREE TRIAL OFFER

We urge you to test the Olivetti Logos 9 now. Order one for our 30-day no obligation trial. See the clear and easy-to-read paper tape and display. Use it as a pocket calculator, and carry it in your briefcase wherever you go. Experience the convenience of always having a printing calculator there whenever you need a permanent record of your transactions.

After 30-days of actual use, decide if you want to keep it. If you do you'll own the smallest, most advanced and convenient pocket printing calculator in the world. If for any reason you're not completely satisfied, simply return your unit within 30-days for a prompt and courteous refund, including your $2.50 postage and handling. You can't lose.

Olivetti selected JS&A to exclusively introduce this exciting new product. With its solid-state design and high quality printing mechanism, the Olivetti should not require service. But if service is ever required, Olivetti maintains a convenient service-by-mail center as close as your mailbox.

To order your unit for our trial, simply send your money order or personal check for **$89.95** plus $2.50 for postage and handling (personal check orders, allow 20 days to clear our bank) to the address below, or credit card buyers may call our toll-free number below. Add $16 for 32 paper cartridges or $10 for 16 cartridges. (Illinois residents please add 6% sales tax.)

Who would have imagined a printing calculator this small and this convenient with this much computational power just a few months ago? The Olivetti Logos 9 deserves your test. Order one at no obligation, today.

JS&A PRODUCTS THAT THINK®
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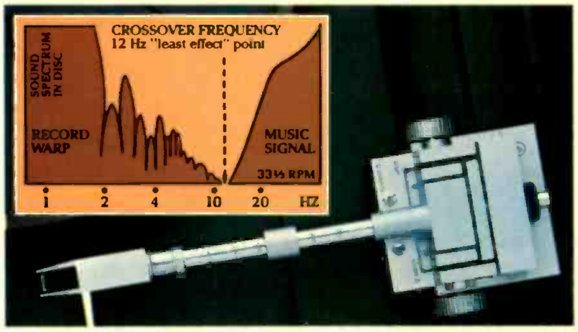
Yamaha's PX-2 linear tracking turntable. A class of one.

Yamaha's new PX-2, the flagship of a remarkable new series of turntables from Yamaha, is destined to become the new standard of the audio industry. It is a masterpiece in the art of music reproduction. Totally in a class by itself.



One of the major performance advancements on the PX-2 is Yamaha's unique optimum mass straight tonearm assembly. This design concept is Yamaha's direct challenge to the industry trend of low-mass tonearms. Among the most significant benefits of optimum mass is that it specifically addresses two of the most critical elements of music signal tonal quality—tonearm resonant frequency characteristics and high trackability with a wide range of cartridges. Tonearm mass is such a critical element in sound reproduction (especially in the low and high frequency ranges) that Yamaha has designed this optimum mass tonearm to insure its resonance frequency is at the "least effect" point. (See graph.) As a further benefit, the vast majority of available cartridges can be effectively matched with the Yamaha tonearm. Even MC types.

But the optimum mass tonearm is only one factor that puts the PX-2 in a class by itself. There's much more. Like an extraordinary 80dB S/N ratio, with incredibly accurate tangential tracking—constantly monitored by an opto-electronic sensor. The PX-2 is also a study in durability with its solid, anti-resonant monolithic diecast aluminum base. And the combined effect of the hefty platter and the heavy-duty DC motor depresses wow and flutter to below 0.01%.

Yet with all this performance, the PX-2 is deceptively easy to operate. All the microprocessor-activated controls are easily accessible—without lifting the dustcover.

The balance of the turntables in our new line (the P-750, P-550, P-450 and P-350) all incorporate this same optimum mass tonearm philosophy. Each will set new standards for performance per dollar invested.

Visit your local Yamaha Audio Specialty Dealer for a personal test of our remarkable PX-2 and the other superb turntables in our new series. You'll hear music that's truly in a class by itself.

For more information write us at Yamaha, Audio Division, P.O. Box 6600, Buena Park, CA 90622.

*Yamaha cartridges shown (MC-1X and MC-7) on both models are optional.

YAMAHA

CIRCLE 26 ON FREE INFORMATION CARD

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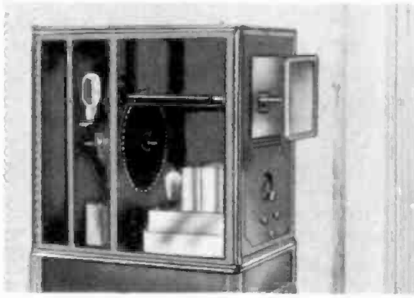
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

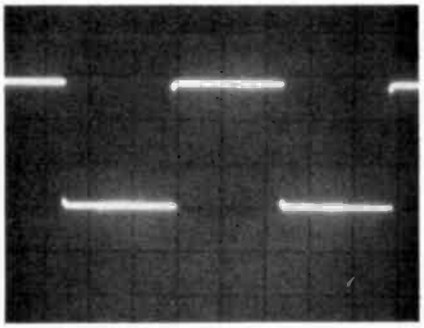
JUNE 1980 Vol. 51 No. 6

ON THE COVER

This unique function generator uses phase-locked-loop technology to overcome many of the shortcomings of commercially-available units. Frequency stability is supurb. Sine, square, and triangular waveforms are provided via a 50-ohm output jack. The generator also has a separate set of outputs to drive TTL loads.



TELEVISION—from the drawing board to a reality. Shown above is the Jenkins Projection Radiovisor, developed in 1931. For a look at the history of television, turn to page 43.



DIGITAL AUDIO for the 1980's. The squarewave response of Toshiba's PCM recorder shows the improved performance of this new audio technology. For the rest of the details, turn to page 63.

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looking ahead

Super-satellites: A new domestic communications satellite with double the capacity of any in existence or planned has been proposed to the FCC by Southern Pacific Communications. SPC has asked for approval to operate three satellites with the equivalent of 48 transponders each and says it could start service by 1982. SPC is basing arguments for its system on more efficient use of available orbiting spots, which now are becoming scarce. Existing domestic satellites are operated by AT&T, Western Union and RCA, with Hughes Communications also seeking to operate a bird. SPC said its system would involve an investment of about $196 million and would operate on both 4-6 and 11-14 GHz bands.

Zenith joins RCA: The grooved-capacitance videodisc system began to look like an American standard when Zenith announced it would adopt the system, developed by RCA. Zenith said its first players would be on the market around mid-1981, and it would be manufacturing its own players in 1982. The initial players for Zenith's market entry will be supplied on a private-label basis by RCA, which earlier had announced it would start marketing its own players early in 1981. Zenith's proposed price for the players—under $500—was the same as RCA's. Zenith said it chose the system because it has mass-market potential at a reasonable price.

Zenith thus becomes the second of RCA's major business rivals to join with it in agreements involving the capacitance videodisc system—the first was CBS, which will press discs for the system. The incompatible Philips/MCA grooveless optical system is already on the U.S. market, the discs being sold by MCA and players by Magnavox (at $775). And this month, Pioneer Electronics will market a player compatible with the Philips/MCA standards. The Matsushita-JVC Video High Density (VHD) grooveless capacitance system so far is still at the starting gate, with no firm adherents.

Phony videotapes: The video boom has spawned a small flood of counterfeit blank cassettes. Most of them from Taiwan, these tapes are packaged in authentic-looking Beta cassettes, but they're loaded with computer tape instead of properly formulated videotape. Some of these have been seized by authorities, but others have found their way into stores. It's very easy to avoid being duped into buying this new "white-box" rip-off. Just insist on tape with recognizable brand names on the box—either tape or equipment manufacturer names. The phony stuff which has been coming in so far generally carries unheard-of brands.

Stereo sound for TV: Whether television deserves stereophonic sound is still hot subject for debate. Japan already has a multi-channel sound system for television, uses it for both stereo and dual-language audio tracks. Japanese home VCR's now are beginning to appear with dual sound tracks to take advantage of the new sound service. The FCC is currently conducting an inquiry into multi-sound channels on TV and the EIA has a technical committee looking into the matter of future standards. AT&T Long Lines has equipped its intercity network interconnections for a switchover to stereo sound when and if.

Stereo also has become a hot subject in the videodisc field. The MCA/Philips optical disc system now on sale in the U.S. has a provision for stereophonic sound and output jacks for attaching to a home stereo sound system. Other proposed disc systems also feature stereo sound. RCA surprised most observers when it announced that the initial version of its disc system would ignore stereo—both on discs and players—because they would initially be attached to color TV sets capable only of reproducing monophonic sound.

Sound quality of home videocassette recorders is poor, to put it mildly. But now a tape-programming company called Media Home Entertainment proposes to get around all that by releasing videocassettes with stereo sound. How's it done? Simply—musical videocassette releases are accompanied by audio cassettes with a stereo soundtrack. A beep recorded on the videocassette tells the viewer exactly when to push the PLAY button on the cassette deck to synchronize the stereo track with the video performance.

Flat-panel TV: There seem to be renewed efforts in flat-panel TV using conventional picture-tube-like approaches featuring the phenomenon of cathodoluminescence. RCA Laboratories in Princeton, NJ, has been working in this direction since 1973 and says it feels that this area is the most promising it has investigated, and it could result in a commercial product in the "mid-to-late 1980's."

RCA is aiming at a panel 4 to 5 inches thick by 50 inches in diagonal measurement, with all television circuits (including sound and loudspeakers) within the picture frame. It calls its approach "modular guided-beam technology," or as its scientists explain it, "collapsing a picture tube into flat geometry." As envisioned, the panel has a relatively conventional phosphor screen and shadow mask. A 40-inch-long cathode runs along the base of the panel. The screen is divided into 40 one-inch vertical modules, each 30 inches high and separated from the adjacent one by a vertical electrode. RCA so far has built a developmental prototype of a 5-by-10-inch segment of the display. Its goal is a manufacturable panel with quality equal to that of a color picture tube at a reasonable cost.

Another television manufacturer—GTE, maker of Sylvania, Philco, and Saba TV sets—is working in a somewhat similar direction. As reported here (**Radio-Electronics**, November 1978), GTE is working with a team of former Zenith engineers to develop large-screen gas-discharge tubes suitable for color TV displays. Besides the fact that both companies are working in the field of cathodoluminescence, RCA and GTE have something else in common—they're both hoping to start with large displays 35 to 50 inches in diameter, obviously aiming at market segments where they hope to have advantages over Japanese Manufacturers.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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FLUKE®

Facts from Fluke on low-cost DMM's

Conductance: What it is, and what it can do for you.

We've often referred to conductance as the "missing function" in DMM's – the capability so many of you have wanted in a DMM but couldn't find until we introduced the 8020A Analyst.

Since its introduction, the Fluke 8020A has become the world's best-selling DMM. And four more low-cost models with conductance ranges have been added to our line. But you'll still find this function only on Fluke DMM's.

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Here the 8020A is being used to check leakage in a teflon pcb. With a basic dc accuracy of 0.1% and an exclusive two-year warranty, this seven-function handheld DMM has made hundreds of new troubleshooting techniques such as this possible, and more are being discovered every day.

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RE 6/80

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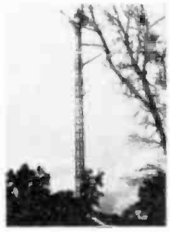
TV Broadcasting

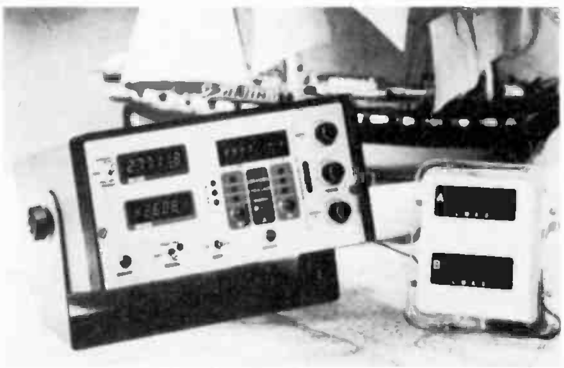


Antenna Systems

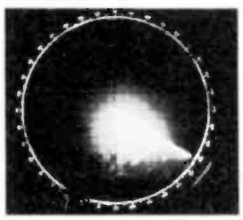
TV Tape Recorders

Aviation Communications & Navigation Systems

Marine Communications



Direction Finders, Loran



Radar

No other home-study course gives you such complete, professional training in so many fields of communication. No other gives you the actual bench training with kits and demonstration units specially designed for learning. Only NRI gives you the thorough preparation and training you need to achieve professional competence in the wide world of communications.

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Learn at your own pace, right in your own home. There's no need to quit your job or tie up your evenings with night classes. No time or gas wasted traveling to school...NRI brings it all to you. You learn with NRI-pioneered "bite-size" lessons and proven, practical "power-on" training.

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You also build and keep for use in your work a transistorized volt-ohm meter and digital CMOS frequency counter. NRI even gives you special lessons to get your Amateur License so you can go on the air with your VHF transceiver.

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CB Radio

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In all, you get 48 lessons, 9 special reference texts, and 10 training kits...the training you need to become a professional. And NRI includes training for the required FCC radiotelephone license examination. You pass or *your tuition will be refunded in full.* This money-back agreement is valid for six months after the completion of your course.

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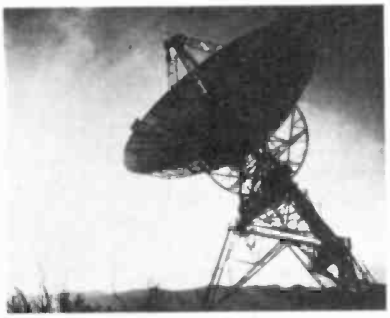
Aircraft Guidance & Landing Systems

AM & FM Broadcasting



Microwave Relay

what's news

Electronic painkillers are now implantable

Electronic pain-killing devices are not entirely new. Neural stimulators that are attached to the patient's skin are being sold at the rate of 40,000 per year. Their action is not understood—it is believed they may stimulate the brain into producing anti-pain chemicals, or that the minute currents from the stimulators may serve to block transmission of pain impulses along nerve fibers.

These "transcutaneous" stimulators are inefficient—less than ten percent of the applied energy reaches the affected nerves—and the patient has to be attached to a power supply. One instrument (Meditronic) is implantable, but still requires an external power supply.

Now comes Pacemaker Systems, of California, with an instrument that uses electrodes attached to the nerves affected, connected to a small unit implanted in the abdomen. This contains a rechargeable battery and a radio receiver that rectifies radio waves beamed to it from outside the body to recharge the battery.

The device will be costly, says the manufacturer, about $10,000 as compared to $500 for a transcutaneous stimulator—plus installation costs. The equipment is expected to be on the market within a year.

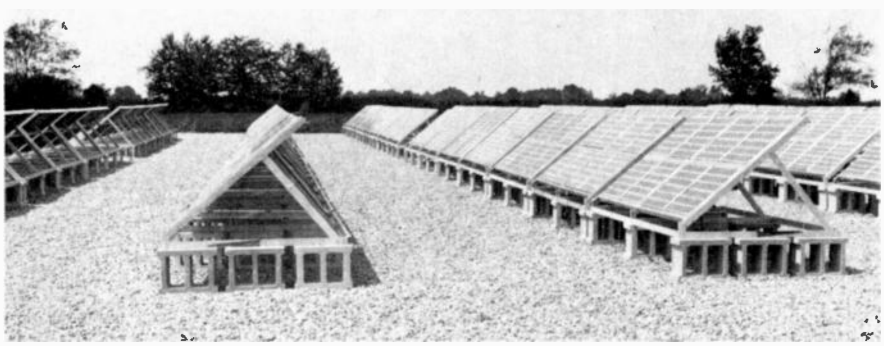
Sun supplies all power for Ohio broadcast station

Radio station WBNO (1520 kHz, daytime) of Bryan, Ohio, switched to solar power last August, and has been broadcasting on the sun's energy every sunny day since. The local power utility fills in during bad weather. Peak power of 15,000 watts is supplied by a system of 36,000 photovoltaic cells, manufactured by the Solarex Corp of Rockville, MD.

The experimental project is a joint effort of WBNO and the Lincoln Laboratory, Massachusetts Institute of Technology. It is being carried out and funded under a Department of Energy contract.

A daytime radio station is exceptionally well adapted to study of solar-powered systems because of its constant and predictable load, and because its operation is roughly coincident with daylight hours. A station with ground-based guys supporting its antenna towers, like WBNO, also has ample ground space for a solar array.

It is expected that, over a year's time, the photovoltaic system will supply from 70 to 90% of the energy required, the rest being supplied by the local utility.



WBNO RADIO'S SOLAR PANELS face due south and cover about one-third acre. Cables leading from each panel connect to the computer-control center where the power is distributed, first to the AM transmitter, then to storage batteries. Any surplus power is used for station lighting, teletype machines, the AM console, etc.

No pressure on auto dealers buying cars without radios

The Custom Automotive Sound Association (CASA), representing American manufacturers, importers, distributors and installers in the automotive sound industry, after communications with American Honda lawyers, has notified Honda dealers throughout the country that their shipments will not be reduced nor delayed if they order new cars without radios. This was in response to reports that Honda dealers were being told that their deliveries might be affected if they did not purchase optional radios through American Honda.

American Honda stated last June: "Honda automobiles will be shipped to the United States and to Honda dealers without radios. Dealers will be free to install whatever radios, if any, they and their customers decide on." Honda's attorneys state that Honda dealers have not been pressured to purchase Honda radios, and that if statements to that effect were made, they were strictly against company policy.

CASA has been instrumental in negotiating with manufacturers to roll back any policies that include radios as standard equipment in new cars. It sponsored an anti-trust suit against General Motors and settled successfully out of court. Chrysler and Toyota have also amended their radio-standardization policies. Discussions are continuing with Volkswagen, against whom a suit was filed last year.

Sylvania picture tubes now guaranteed for life

Replacement picture tubes may now be purchased with a lifetime warranty that provides for free replacement of any tubes with defects in workmanship, materials, or construction, GTE announces.

All Sylvania *Color Bright* and *All New* brand tubes sold after January 1, 1980 are included in the new policy, which warrants the tube for as long as the buyer owns the set in which it is installed. (Labor and other costs associated with tube installation are, of course, not included in the warranty.)

Among the tubes offered with the lifelong warranty are 15 types that can be used to replace more than 440 of the most popular industry types.

World's longest antenna may go into action soon

The long-proposed ELF (Extremely Low Frequency) system for communicating with submarines at considerable depths may be under way again, the *New York Times* reported in its "Science Times" section last winter.

The system calls for underground antennas in the order of hundreds of miles long, and almost the only areas in the United States where the earth formation is suitable are in Michigan and Wisconsin. A number of citizens' groups and political organizations in those states feared that radiation from such antennas might be hazardous, and protested. President Carter, on his election, deferred ordering the system into operation.

A later study, by the National Research Council, has shown that such fears are unfounded. That, plus the fact that with international tensions, naval commanders see "a growing urgency in the need for a deep-water communications system" leads to the feeling that the project will shortly be funded.

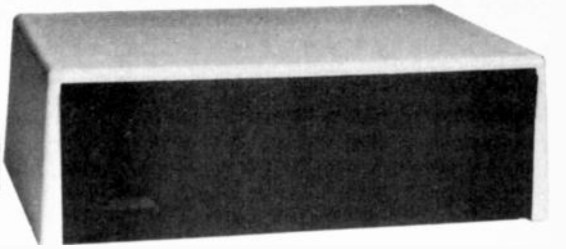
The ELF system operates on a frequency of 73 Hertz. (It is interesting to note that the Michigan-Wisconsin protesters did not propose to ban 60-Hertz power lines, which are right out in the open and produce voltage fields hundreds of times greater than anything the ELF antennas could possibly put out.)

The antenna length is 130 miles (much shorter than originally planned). Signals from the system can be read by submarines while submerged "hundreds of feet," down.

continued on page 14

Burglar Alarm Breakthrough

A new computerized burglar alarm requires no installation and protects your home or business like a thousa,d dollar professional system.

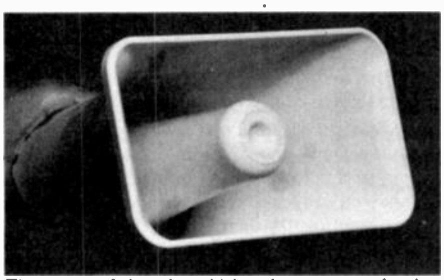


The Midex security computer looks like a handsome stereo system component and measures only 4"x 10½"x 7."

It's a security system computer. You can now protect everything—windows, doors, walls, ceilings and floors with a near fail-safe system so advanced that it doesn't require installation.

The Midex 55 is a new motion-sensing computer. Switch it on and you place a harmless invisible energy beam through more than 5,000 cubic feet in your home. Whenever this beam detects motion, it sends a signal to the computer which interprets the cause of the motion and triggers an extremely loud alarm.

The system's alarm is so loud that it can cause pain—loud enough to drive an intruder out of your home before anything is stolen or destroyed and loud enough to alert neighbors to call the police.



The powerful optional blast horns can also be placed outside your home or office to warn your neighbors.

Unlike the complex and expensive commercial alarms that require sensors wired into every door or window, the Midex requires no sensors nor any other additional equipment other than your stereo speakers or an optional pair of blast horns. Its beam actually penetrates walls to set up an electronic barrier against intrusion.

NO MORE FALSE ALARMS

The Midex is not triggered by noise, sound, temperature or humidity—just motion—and since a computer interprets the nature of th motion, the chances of a false alarm are very remote.

An experienced burglar can disarm an expensive security system or break into a home or office through a wall. Using a Midex system there is no way a burglar can penetrate the protection beam without triggering the loud alarm. Even if the burglar cuts off your power, the four-hour rechargeable battery pack will keep your unit triggered, ready to sense motion and sound an alarm.

ARRIVE HOME SAFE

There's personal danger in arriving home and finding a burglary in progress. And, if you surprise the burglar, you risk the chance of serious injury. With the Midex 55 protecting your home, you can open your front door with the confidence of knowing that no burglar lurks inside.

When the Midex senses an intruder, it remains silent for 20 seconds. It then sounds the alarm until the burglar leaves. One minute after the burglar leaves, the alarm shuts off and resets, once again ready to do its job. This shut-off feature, not found on many expensive systems, means that your alarm won't go wailing all night long while you're away. When your neighbors hear it, they'll know positively that there's trouble.

PROFESSIONAL SYSTEM

Midex is portable so it can be placed anywhere in your home. You simply connect it to your stereo speakers or attach the two optional blast horns.

Operating the Midex is as easy as its installation. To arm the unit, you remove a specially coded key. You now have 30 seconds to leave your premises. When you return, you enter and insert your key to disarm the unit. You have 20 seconds to do that. Each key is registered with Midex, and that number is kept in their vault snould you ever need a duplicate. Three keys are supplied with each unit.

As an extra security measure, you can leave your unit on at night and place an optional panic button by your bed. But with all its optional 'eatures, the Midex system is complete, designed to protect you, your home and property just as it arrives in its well-protected carton.

The Midex 55 system is the latest electronic breakthrough by Solfan Systems, Inc.—a company that specializes in sophisticated professional security systems for banks and high security areas. JS&A first became acquainted with Midex after we were burglarized. At the time we owned an excellent security system, but the burglars went through a wall that could not have been protected by sensors. We then installed over $5,000 worth of the Midex commercial equipment in our warehouse. When Solfan Systems announced their intentions to market their units to consumers, we immediately offered our services.

COMPARED AGAINST OTHERS

In a recent issue of a leading consumer publication, there was a complete article written on the tests given security devices which were purchased in New York. The Midex 55 is not available in New York stores, but had it been compared, it would have been rated tops in space protection and protection against false alarms—two of the top criteria used to evaluate these systems. Don't be confused. There is no system under $1,000 that provides you with the same protection.

YOU JUDGE THE QUALITY

Will the Midex system ever fail? No product is perfect, but judge for yourself. All components used in the Midex system are of aerospace quality and of such high reliability that they pass the military standard 883 for thermal shock and burn-in. In short, they go through the same rugged tests and controls used on components in manned spaceships.

Each component is first tested at extreme tolerances and then retested after assembly. The entire system is then put under full electrical loads at 150 degrees Fahrenheit for an entire week. If there is a defect, these tests will cause it to surface.

PEOPLE LIKE THE SYSTEM

Wally Schirra, a scientist and former astronaut, says this about the Midex 55. "I know of no system that is as easy to use and provides such solid protection to the homeowner as the Midex. I would strongly recommend it to anyone. I am more than pleased with my unit."

Many more people can attest to the quality of this system, but the true test is how it performs in your home or office. That is why we provide a one month trial period. We give you the opportunity to see how fail-safe and easy to operate the Midex system is and how thoroughly it protects you and your loved ones.

Use the Midex for protection while you sleep and to protect your home while you're away or on vacation. Then after 30 days, if you're not convinced that the Midex is nearly fail-safe, easy to use, and can provide you with a security system that you can trust, return your unit and we'll be happy to send you a prompt and courteous refund. There is absolutely no obligation. JS&A has been serving the consumer for over a decade—further assurance that your investment is well protected.

To order your system, simply send your check in the amount of **$199.95** (Illinois residents add 5% sales tax) to the address shown below Credit card buyers may call our toll-free number below. There are no postage and handling charges. By return mail you will receive your system complete with all connections, easy to understand instructions and a one year limited warranty. If you do not have stereo speakers, you may order the optional blast horns at **$39.95** each, and we recommend the purchase of two.

With the Midex 55, JS&A brings you: 1) A system built with such high quality that it complies with the same strict government standards used in the space program, 2) A system so advanced that it uses a computer to determine unauthorized entry, and 3) A way to buy the system, in complete confidence, without even being penalized for postage and handling charges if it's not exactly what you want. We couldn't provide you with a better opportunity to own a security system than right now.

Space-age technology has produced the ultimate personal security computer. Order your Midex 55 at no obligation, today.

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what's news

continued from page 12

Practical fusion reactor not before year 2010?

The ultimate in a clean and reliable nuclear fuel—consumed in a fusion reactor—will not be attainable in this century, nuclear engineer Robert Conn of the University of Wisconsin told a recent meeting of the American Association for the Advancement of Science. (Fusion reactors have been sought as an almost-answer to the problems of radiation and pollution associated with fission fuels.)

Present research on fusion reactors has been directed toward deuterium and tritium (heavy forms of hydrogen) fuels, but the ultimate goal of fusion research is to achieve fusion with ordinary hydrogen, Mr. Conn told his audience.

Temperatures of 100 million degrees or higher are required for fusion. At those high temperatures, fuel atoms separate into a *plasma* of nuclei and electrons, in which fusion reactions can occur. That plasma must be contained in a magnetic field to keep it from hitting reactor walls, cooling, and stopping the fusion.

Tritium-deuterium requires the lowest temperature of any fuel to start a reaction, and can be contained in the weakest magnetic field. But tritium, in particular, has serious disadvantages: It is hard to produce and is in itself radioactive. Ordinary hydrogen is readily available from water and produces few radioactive neutrons when it fuses. But it needs much higher temperatures and requires stronger magnetic fields.

Conn noted that success in tritium-deuterium research is important in the study of hydrogen fuel. Once a self-sustaining tritium fusion reaction is attained, very high temperatures will be available for studying the properties of plasmas at temperatures approaching those that are needed for hydrogen fusion.

He estimated that a demonstration tritium-deuterium fusion reactor could be in operation by the year 2000. Hydrogen-based fusion reactors will not be built for at least another decade.

ISCET Library opens again—ancient schematics available

The ISCET Technical Library is open for business at a new location. The Library was the dream of Henry Golden, CET, who built up the reservoir of out-of-print information. A serious illness in April 1979 left him unable to operate the library. ISCET chairman George Sopocko, CET, packed up the materials and took them to Chicago, where, after months of cataloging, they are again available.

Service technicians needing copies of "unobtainable" technical data may obtain them from the new address. The basic search-and-copy fee is $2 for the first two pages—50 cents for each additional page. Address George Sopocko, 5631 Irving Park Road, Chicago, IL 60634 (phone 312-545-3622).

George says he has a good supply of schematics for older TV and radio sets and "a fairly good selection of diagrams for shortwave and amateur radios and for radio and TV test equipment."

For further information about the International Society of Certified Electronic Technicians, or to contact the CET test administrator in your area, write to ISCET, 2708 West Perry St., Fort Worth, TX 76109, or call 817-921-9101.

Electron microscope inventor elected to Hall of Fame

Dr. James Hillier, former Executive Vice President and Chief Scientist of RCA, has been elected to the National Inventors Hall of Fame, for his development of the electron microscope. The National Inventors Hall of Fame was established in 1973, by the National Council of Patent Law Associations in cooperation with the U.S. Patent Office.

Dr. JAMES HILLIER

While a graduate student at the University of Toronto, in the years 1937 to 1940, Hillier and a colleague, Albert Prebus, designed and built the first successful high-resolution electron microscope in the Western Hemisphere. In 1940, he was invited by Vladimir Zworykin (who was elected to the National Inventors Hall of Fame in 1977) to come to the United States and work as a research physicist for RCA. Within a few months he had designed the first commercial electron microscope to be made available in the United States. During the next several years he continued to develop techniques which would extend the capabilities of the instrument and to develop new methods of biological specimen preparation.

Dr. Hillier was named general manager of the RCA Laboratories in 1957, and became successively Vice President, Vice President RCA Research and Engineering, Executive Vice President, RCA R & E, and in 1976, the year before his retirement, Executive Vice President and Senior Scientist.

Dr. Hillier has received 41 U.S. patents and is the author of more than 100 technical papers.

COMSAT, Sears, are planning joint satellite TV service

COMSAT General Corporation and Sears, Roebuck and Co. have engaged in discussions of a possible joint project for providing satellite-to-home subscription television service. The proposed venture plans to offer high-quality programming nationwide for a fee. Subscribers would receive the service by roof-top antennas. The new service would require approval by the Federal Communications Commission.

Superconducting cyclotron for Michigan State University lab

Michigan State University and the United States Department of Energy (DOE) have signed a $25.7 million contract for establishing a National Superconducting Cyclotron Laboratory on the MSU campus. Completion is expected in 1984.

A cyclotron speeds up the nuclei of atoms to velocities of tens of thousands of miles a second. Held in a circular orbit by strong magnetic fields, they whirl through the instrument in gradually increasing spirals, then are released like a stone from a sling, to impact other nuclei. The flying wreckage from the resulting collisions gives scientists valuable information about the structure of matter.

The superconducting magnets for the MSU cyclotron are wound with a special alloy of niobium and titanium and are immersed in a bath of liquid helium at a temperature approaching absolute zero (−456°F). That reduces the resistance of the coils practically to zero, allowing fantastic magnetizing currents to flow. One of the magnets to be used is already built and tested. It has a lifting force of 900 tons.

Former cyclotrons could accelerate the nuclei of only the lightest elements. The new superconducting type will be able to hurl the heaviest atomic nuclei in an accurate, concentrated beam at their atomic targets. Scientists expect thus to gain new types of information not obtainable from the older cyclotrons.

The new laboratory will contain two cyclotrons operating in tandem. The first, operating at 500 million electron volts (500 MeV) will feed its accelerated nuclei to the second, rated at 800 MeV, which will propel them to still higher speeds.

The facility will be used by visiting scientists as well as by faculty members of Michigan State University. R-E

Brainchild

Yesterday — Remember the first Heathkit Analog Computer (1957)? Or the Heathkit Single-Sideband Transmitter (1958)? How about the Heathkit Multiplex Adapter for FM stereo reception (1960)?

Each was a ground-breaking innovation for its day. Each was a Heathkit brainchild.

Today — Today's brainchildren include the popular Heathkit All-In-One Computer, a complete computer system with disk storage, smart terminal, two Z80 microprocessors — all in one compact unit.

Also rising fast, the Heathkit Screen Star, a new projection TV that brings together the best in video technology to create the sharpest color picture ever on a six-foot diagonal screen.

Heath imagination applied to microprocessor electronics created the Heathkit Weather Computer. It monitors current weather, tracks changes, stores data — and puts it all at your fingertips.

Tomorrow — Tomorrow's brainchild, like today's and yesterday's, will combine the newest and the best in electronics to create a new state-of-the-art.

On the drawing boards right now are new designs for amateur radios, audio components, computers, color TV's, test instruments and new educational programs — all in easy-to-build, money-saving kits. They'll be appearing soon in Heathkit Catalogs and at Heathkit Electronic Centers. It's one catalog you don't want to be without.

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GX-379

CIRCLE 22 ON FREE INFORMATION CARD

editorial

Toy manufacturers aren't playing games

On the surface, the 1980 Toy Fair in New York was a routine affair. Manufacturers displayed their fall and Christmas product lines to dealers and reps. What wasn't routine about the event were the toys themselves. By far, there were more "electronic" toys seeing the light of day than ever before. In fact, they stole the show.

The hottest-selling electronic toys are the sports variety. These include Baseball, Basketball and Football. Several manufacturers were showing these toys, which included an LED display, sounds, automatic score keeping, and more. Hand-held versions of the arcade games were also exhibited. Using liquid-crystal displays, these mini-versions mimicked their CRT-based big brothers with such games as *Space Invaders* and *Wipeout*. Of course, there were many more toys, including casino games, radio-controlled cars, and even a radio-controlled two-wheel motorcycle.

From my point of view, the real show stoppers were the innovative toys. These included a voice-actuated car that accepted such commands as STOP, GO, LEFT and RIGHT. How about a programmable car? Using an 8-key keyboard, you can, for example, program it to go forward for 3 seconds, turn right for 1 second, left for 2 seconds, reverse for 4 seconds and stop. Then, after placing the car on the floor and pressing the START button, it's fascinating to watch the car execute the program. Admittedly, it's not a giant leap forward in terms of technology, but it is certainly a giant step for the toy industry.

At the show, I managed to interview Garth A. Clowes, President of Entex Industries, Inc. (one of the larger manufacturers of electronic toys). He stated that the semiconductor manufacturers have been very cooperative in helping him develop new products and that he was looking towards developing an in-house engineering capability that will include designers, software programmers, and technicians.

As the present trend toward electronic toys continues, it will prove to be a boon to both the toy industry and the electronics industry. It will affect not only the battery manufacturers, but the electronics industry as a whole. It looks as though another perfect match has been born in Silicon Valley.

Art Kleiman

ART KLEIMAN
MANAGING EDITOR

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next month

JULY 1980

Build An Environmental Control System

Energy-efficient thermostat monitors indoor and outdoor temperatures; then controls your heating, ventilating, and air-conditioning systems.

Build a Raceway Video Game

You can pretend to be an *Indy 500* race driver without ever leaving the comfort of your armchair after you build this video game.

All About Vertical-MOS

High-power semiconductor technology produces devices with near-ideal characteristics. Here's a look at how vertical-MOS devices work.

Bass Response vs. Enclosure Size

Hi-fi speaker systems keep getting smaller. Here's a look at how the size of the enclosure affects bass response and some of the trade-offs that are made when designing speaker systems.

PLUS:

Build A Synthesized Function Generator-Part 2

Coax vs. Twinlead For Your TV Antenna

How To Connect An A/D Converter To A Microprocessor.

Hobby Corner

Communications Corner

Service Clinic

letters

ENERGY ALTERNATIVES

Congratulations on your editorial, "Energy Alternatives—Research and Development" (November 1979 issue) in regard to a need for a much greater funding commitment toward the development of photovoltaic solar cell technology. Indeed, the good news is that major breakthroughs are being made in solar cell technology. The bad news is that even solar cells may have a waste-disposal problem. According to one D.O.E. (*D*epartment *O*f *E*nergy) official, "the compounds used in 'doping' photovoltaic cells, such as cadmium, arsenic, gallium, and indium may pose health risks if not handled properly."

As a suggestion, we should renew our national commitment to further space exploration, and "space industrialization" in particular, to help solve down-to-earth energy problems. There are several reasons for that:

1. Outer-space offers a large supply of clean energy with the "solar power satellite" alternative.
2. Outer-space offers a low-gravity environment for new and unique industrial processes.
3. Space engineering may continue to pay off high dividends in terms of appropriate "spinoff" products—such as *consumer items* that help home owners directly reduce their energy bills (as with the NASA "power-chopper" device).
4. The vastness of outer-space would provide a safe place for the disposal of industrial wastes.
5. Most important: Space exploration offers Americans the hope of a new frontier, essential to human growth and economic development.

With a strong commitment toward space industrialization, we may someday see photovoltaic solar cells being produced very inexpensively for use on earth and in outer-space.

PAUL JUSTUS,
Mission, KS

OOOOOOOOOOPS!

The schematic for "Not Just Another Digital Clock", on page 62 of your February issue, has an error in it. The emitter of transistor Q1 should not connect to the emitter of transistor Q8. It should connect to the common connections of all the LED's.

DERALD D. NYE,
Longmont, CO

You're absolutely right. What's missing is a jumper on the PC board. The holes are there, but the jumper isn't. Many thanks for calling it to our attention. Editor.

In the February 1980 **Radio-Electronics** article covering versatile switching regulators. I found an error in determining the maximum duty cycle of the system when using the NE5560. The correct ratio for determining the maximum duty cycle is R2/R1 plus R2, as stated in the Signetics Data Manual.

JEFFREY M. RABOLD,
Mansfield, OH

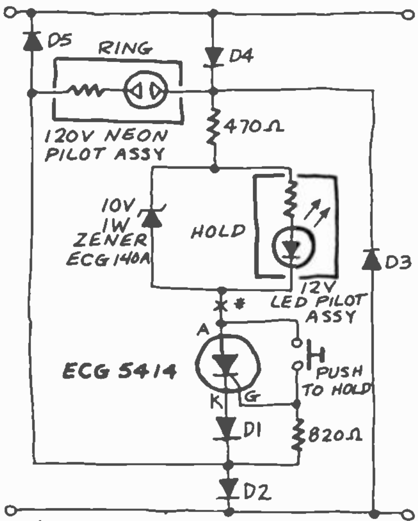
You're so right!—Editor.

MUSIC ON HOLD

I read the article, "Music on Hold," by Jules Gilder, in your November 1979 issue, with much interest and would like to make some constructive suggestions.

First: As it is described, the unit will not work on many phone systems—namely, those that employ switching methods that cause the line voltages described to be reversed in polarity upon connection of the calling number to the called number. Diodes D2 through D5 in Fig. 1 perform the required switching function, to allow the basic circuit to peform properly, regardless of the polarity.

Second: The device resistance is too high for many phone systems. To hold the line properly, the device must have a low enough resistance actually to access the line if the phone were in the hung-up mode. Normally, that would require a value of 1000 ohms or less to be placed across the line—or whatever value of resistance would be required to reduce the 48 volts normally present on the line to approximately half that value.



* BREAK HERE TO INSERT TRANSFORMER WINDING. D1-D5 SWITCHING DIODES; 1 AMP, 600 PIV, SILICON

FIG. 1

With typical 48-volt, 70-mA systems, the resistance would be 800 to 850 ohms. Mr. Gilder's circuit would not be capable of such a low resistance without additional circuitry to prevent damage to the LED. I

Continued on page 24

Continued from page 22

have accounted for that problem in the enclosed diagram through the use of a LED pilot-lamp assembly shunted by an appropriate Zenér diode. The series resistance of 470 ohms produces a total device resistance of 850 ohms. A neon 120-volt pilot-lamp assembly is included to indicate incoming calls, in the event that the phone-ringer is switched off. We have employed the described circuit for some time, with excellent results.

Third: While our circuit does not employ an audio-injection feature, it would be compatible with Mr. Gilder's idea. Should a transformer be include in the circuit, the DC resistance of its wiring should be measured; and that value should be subtracted from the 470-ohm series resistor.

BRUCE L. MACKEY
Cortland, NY

Mr. Mackey is correct. The music-on-hold circuit will, indeed, fail to operate on any telephone system that employs switching methods which cause the line voltages to be reversed in polarity upon connection of the calling number to the called number.

His second suggestion looks as if it will work well, although I have not experienced any difficulties with the resistance value indicated. His approach, however, will certainly work on systems that I have encountered, and on systems that require lower hold resistances.

JULES H. GILDER

SUPER AMPLIFIER

Here is additional information on two subjects relating to my article "Super Audio Amplifier" in the December 1979 issue: the substitution of an alternate circuit for the D1300A not readily available RCA diodes used in my amplifier; and the availability of a transparency for the printed circuit board. Here goes:

1. Two diodes connected in series may be replaced with a single transistor connected in the "amplified junction" configuration. Or any number of series-connected forward-biased diodes may be replaced in the same fashion. See Fig. 2. Use a power transistor (or medium dissipation) in order to realize the high junction-to-case thermal conductivity needed for temperature-sensing, and in order to have a convenient means for mounting on the same heat sink as the output devices whose temperature is to be sensed.

The equivalent circuit, using a transistor, has an advantage over the series-connected diodes. It can be adjusted to give a crossover bias of a precise value. Resistor R2 is made larger in value to reduce crossover bias current, and vice versa. Select a value that produces exactly 135 milliamps of power-supply current drain from the amplifier at idling (quiescent) conditions. Resistor R2 should never be so low in resistance as to cause thermal runaway (in other words, not less than one-third of the value of R1).

2. The printed circuit board is not available but a duplicate transparency of the printed circuit board, one-to-one scale factor, is available for $5.00, postpaid in the USA from Daniel Talbot, 1 Dean Street, Hudson, MA 01749.

DANIEL B. TALBOT
Hudson, MA

TRS-80 BREADBOARD

I really enjoyed the November, 1979 issue of **Radio-Electronics**, especially the TRS-80 breadboard article and the Telco article. Keep them coming.

There was one flaw in the TRS-80 breadboard article. It stated that the Level I TRS-80 cannot be used to control I/O devices. That is not true. Although Level I BASIC cannot access I/O, you can do so by using machine language. By means of either T-BUG or the Editor-Assembler, Level I users can write programs to use with the breadboard project.

It appears that the music-on-hold project can do much more than the music-on-hold feature. You may even be able to connect it to your TRS-80 cassette interface, allowing you to get out of having to buy an expensive modem/acoustic coupler.

These are just a few ideas your readers can play around with. I hope they interest you. **R-E**

COLIN PRINGLE,
Dallas, TX

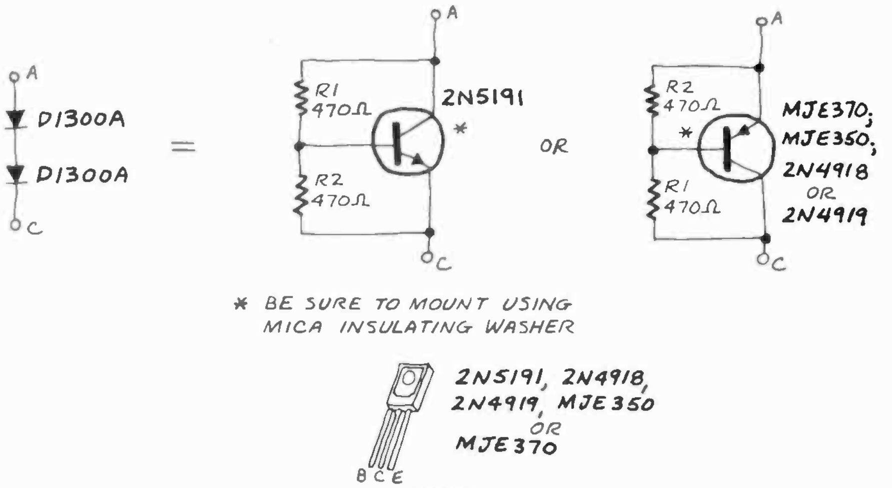


FIG. 2

- Spring-loaded, pure brass coil contact pin assures solid, corrosion-free cable connection.
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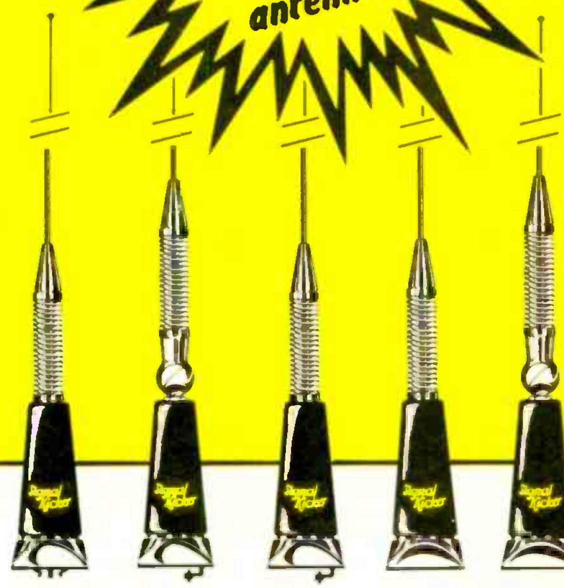

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Roof	Trunk lip	Trunk lip with swivel	Combo. trunk & roof	Combo. trunk & roof with swivel

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satellite tv news

Saga of Son-of-Satcom III

Ever since RCA Americom's Satcom III disappeared from sight last December, each week has brought new ramifications to the problem of what the cable TV industry will do about the loss. The 24-transponder satellite was supposed to become the primary bird for cable TV programming, with all of its transponders allocated for such services; Satcom I would have become the Second Cable Network, with about a dozen additional services. Now amidst promises, threatened lawsuits, make-goods, and a number of other activities, the situation has temporarily been sorted out.

Satcom I will remain the main cable bird until a replacement for Satcom III is launched next year. RCA has also made arrangement with AT&T for use of Comstar D2 as an "emergency replacement" with 11 transponders to be used for cable programs. Then the colorful Ted Turner, who is supposed to begin his Cable News Network in June, threatened to sue RCA for $34 million in order to make sure the all-news channel was aboard Satcom I. RCA capitulated and bumped one of its data communications customers off Satcom I to make room for Turner, with the possibility that the only other full-functional transponder on that bird may also be shifted to cable TV programming. (Originally it was believed that RCA would move all its data customers to the AT&T satellite and keep the cable TV programming on Satcom I and II. But since the AT&T transponders are "pre-emptible"—that is, AT&T can quickly bump off customers if it needs the circuits—the data customers balked at the arrangement.) What all that means is that if you're tuned to a cable programming being sent via the Comstar D2 satellite, it's possible that the show could be interrupted suddenly.

Meanwhile, RCA is completing its plans for what to do about its future facilities. As it stands now, the original launch date for Satcom IV in June 1981 now becomes the target for what is being called Satcom III-Replacement. That bird will become operational in October 1981. The new Satcom IV is slated to go up that same month, and then become operational in February 1982. Both launches will be aboard Delta rockets (rather than the Space Shuttle as had once been hoped). RCA says that the Son-of-Satcom III and Satcom IV will have technical improvements over the current models, including spare on-board amplifiers and higher-power amplifiers. RCA also says it wants to improve the in-orbit restoration facilities for failed transponders, and in addition plans to upgrade 18 of the 24 transponders on Satcom IV to 5.5 watts and the other 6 transponders to 8.5 watts instead of the traditional 5 watts of power.

Complete earth station deregulation

The FCC has removed all regulations from receive-only satellite earth terminals—an action that clears the way for smaller dishes and for considerable cost savings on the construction of TV receive-only earth stations and other downlinks. The FCC move means that the price of earth stations could drop by about 50% within a year. Among other things, the ruling permits use of dishes smaller than 10-foot diameter and allows anyone to put up a TVRO dish without obtaining legal and technical approval from the FCC (although, presumably, zoning and other local building ordinances must continue to be satisfied). In its ruling, the FCC warned that it is not giving the green light to satellite-signal pirates—and underscored its continuing efforts to enforce all the rules dealing with theft of service (Section 605 of the FCC regulations).

Among the people most pleased by the earth-station deregulation were executives of Mutual Broadcasting, which planned to move ahead immediately with its radio/satellite network, and cable-TV industry leaders who foresee even greater use—and less expense—of widespread satellite/cable networks. In its decision, the FCC left the door open for earth-station owners who want to be licensed. Such individuals and companies may seek FCC clearance to assure that they are avoiding any radio-frequency interference from terrestrial facilities. If you want an FCC license for your TVRO, the licensing period has been extended to five years (from the previous three years). Earth stations currently under FCC licensing policies (mostly cable-TV system's dishes) will continue to operate—but when the current permits expire, there will be no FCC requirement that they be renewed.

The prices keep coming down

Complete turn-key earth terminal facilities are now hovering in the range of about $3,500—down from about $4,000 last summer. According to experts in the world of private earth terminals, further price drops are likely—probably shaving another $700 per package by this summer. Antenna prices seem to have bottomed out at $750 for a 10-foot dish. The next item to drop in price will be low-noise amplifiers, with a 50% price reduction—into the $500 to $600 range. Tunable 24-channel receivers are also likely to fall in price from the $1,800 level; experts believe that prices this summer may be as low as $1,300 to $1,500—based on prototypes shown at last February's Satellite Private Terminal Seminar.

Sounds from the skies

While most of the attention about satellite broadcasting has been focused on television, radio is coming on strong, and promises to grow even bigger as more audio signals take to the skyways. National Public Radio is due to put its nationwide network into service this spring; significantly on the fall day last year when the first handful of NPR stations started picking up satellite feeds, another new network was also starting up: RKO General, which operates radio stations in several major markets (including New York, Boston, and Washington), began its first feeds on that date (all land-linked for now). RKO's plans call for a network of affiliates nationwide—and eventually most of them will be linked by satellites. The RKO web features youth-oriented programming, in addition to news and lifestyle features, and company engineers are actively exploring small-dish satellite equipment for use at each affiliate.

Of course, Mutual radio network—the nation's largest, with well over 800 affiliates—is actively building its satellite network. The major wire services, Associated Press and United Press International, plan to send their radio newscasts directly to some local radio stations via satellite (as well as the signals that transmit the ticker-tape news reports). Meanwhile, ABC radio is advancing its plans to send newscasts and other features to affiliates of its four networks via a digital signal transmitted from satellites. And even the cable-TV/satellite networks are dripping with audio services: At least four high-fidelity music services are transmitted on sidebands aboard the RCA satellite carrying cable shows, including a disco-music channel, and classical-music feeds. (One of the four is Chicago's WFMT, the nation's first radio superstation.)

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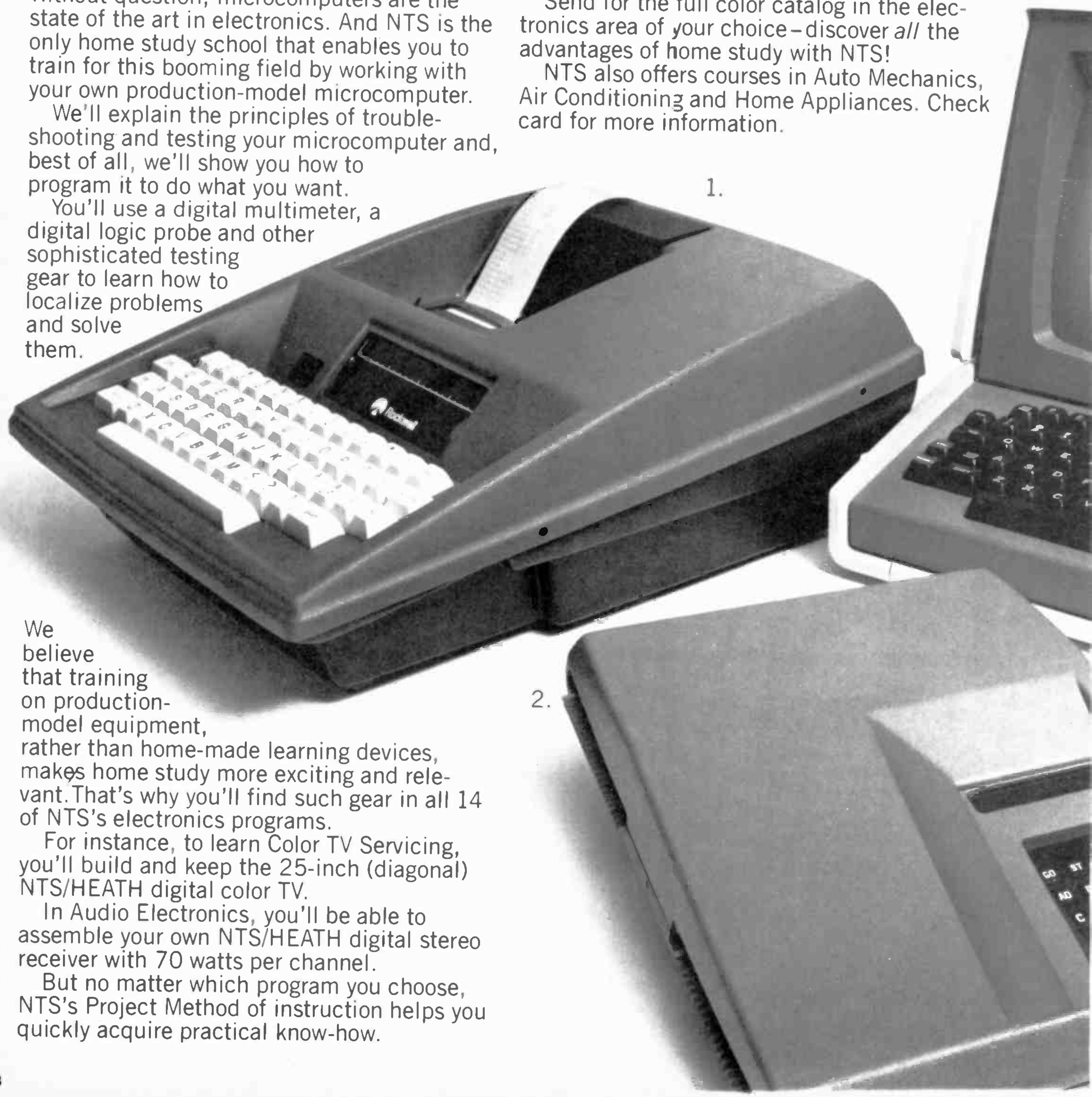

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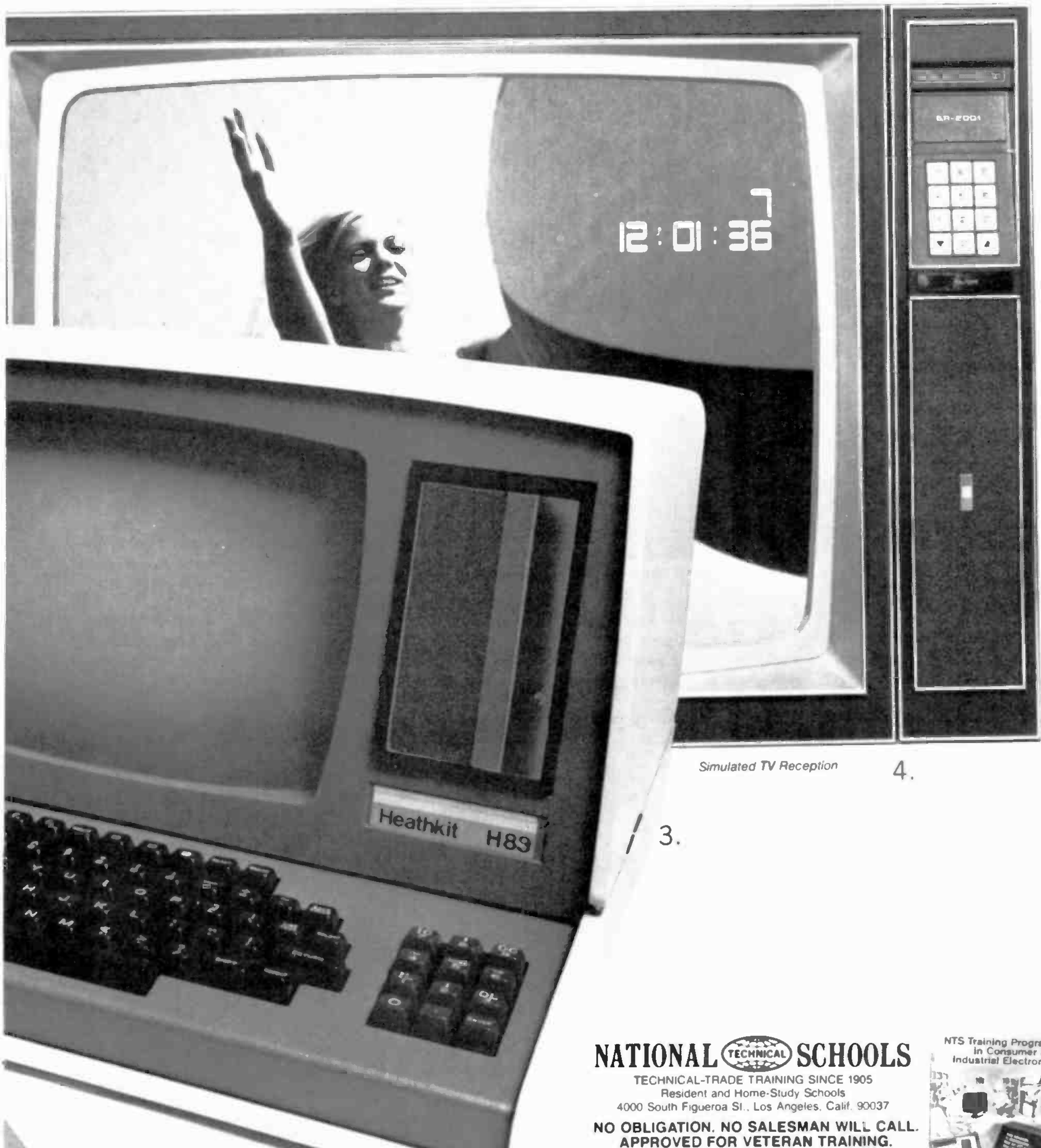

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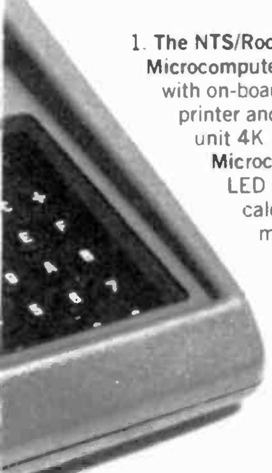

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equipment reports

Global Specialties Corp. Model 3001 Digital Capacitance Meter

BACK IN THE HEYDAY OF RADIO SERVICING (in the '30's), no respectable service bench would have been complete without some form of a capacitor tester. However, over the next 30 years or so the popularity of such devices seemed to drop off until they were seldom considered when purchasing test equipment for most shops. For whatever reason, the popularity of capacitance-measuring equipment has recently taken a huge leap in the plus direction and now, it would seem, no electronic service bench would be considered "up-to-date" unless it contained a capacitance-measuring instrument.

Most test-equipment manufacturers have introduced their own versions of capacitance meters and few of them operate on the principles used in the testers of the 30's. Global Specialties Corporation, 70 Fulton Terrace, New Haven, CT 06509, is no exception to the rule as they, too, have introduced what they consid-

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er the best tester available for the price. Designated the *model 3001* Digital Capacitance Meter, it is designed specifically for professional use in all phases of electronics whether that use is in servicing, production, or in the laboratory.

Ease of operation is one of the first advantages to be noticed when using the *3001*. Measuring capacitance is simply a matter of connecting the capacitor, turning the *3001* on, setting the switch to the range required and reading the capacitance. The actual value is displayed on a large 3½-digit LED display. The accuracy is 0.1% of the reading and readings can be obtained over the range of a few picofarads to 0.1999 Farad! The front panel of the unit includes an on/off toggle switch that is much easier to operate than the usual slide switches that have been finding their way into more and more test equipment. To the right of that switch is the LED display. Near the center of the panel, there is a ZERO CAL control that is used to balance out the capacitance of connecting leads, test stands, or fixtures. Farther to the right is the 9-position range switch and finally the two banana jacks that are used to connect the test leads.

Before attempting to operate the *model 3001*, it is recommended that the operator take a few moments to read over the instructions provided in the instruction manual. As with all other good test equipment, there is a wealth of

continued on page 34

Sabtronics NEW Hand-held Digital Multimeters . . .

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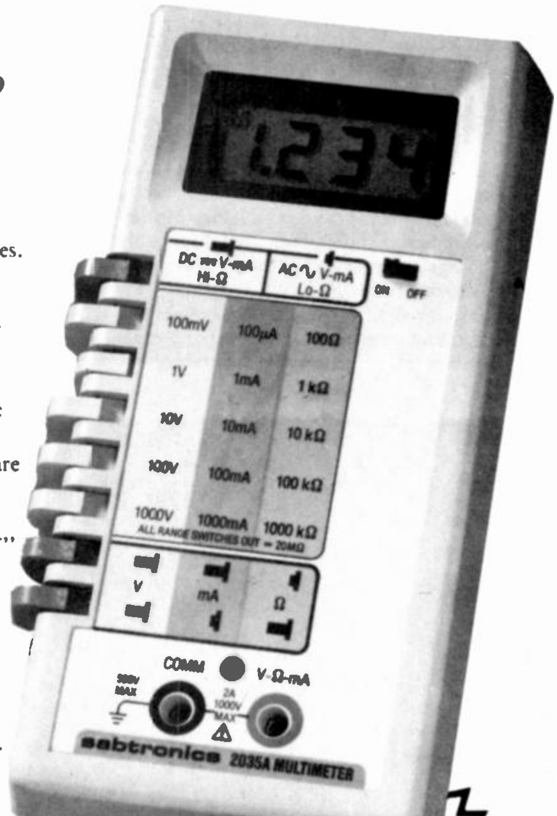

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EQUIPMENT REPORTS

continued from page 32

information supplied to assist you in the operation of the new test gear. In addition to explaining the use of the equipment, the manual also provides a recommended initial inspection to ascertain if it is operating properly when received. For those who wish to know more about the operation of the unit, a schematic diagram—as well as a functional block diagram and description—is provided. Applications, calibration, and maintenance as well as a discussion of the various capacitance-measuring techniques that have been used through the ages combine to provide the owner with a most complete manual.

The range switch is labeled with values that are representative of the center of the range chosen. For instance, in the 1 μF range, the scale will actually read out to 1.999 μF. All ranges are arranged to be in multiples of ten. They are: 1000 pF, 10 nF, 100 nF, 1 μF, 100 μF, 1000 μF, 10 mF, and 100 mF. The latter represents 0.1 Farad! (100,000 μF). In the lowest ranges where lead capacitance is an important factor, the ZERO-CAL control will null out the capacitance of the leads in use. According to the book supplied, it is possible to null out as much as 100 pF using this feature. Again, simplicity is the rule with the *model 3001*. Connect the test leads to the input jacks and leave the ends free of any capacitor. A reading of a few picoFarads should be noticed on the readout. By rotating the ZERO CAL control from end to end it will be found that at some point the display will read zero. Connecting a capacitor to the test leads at this time should provide an accurate reading. In the ranges over 1 μF, the ZERO-CAL control is disconnected and need not be adjusted since the small amount of capacitance of the leads would have a negligible effect upon the actual measurement.

The input circuitry is quite sensitive and in extreme cases, when measuring small values, it may be advisable to place the test capacitor in a metal shield enclosure that is bonded to the grounded lead of the test jacks. That will minimize the effects of surrounding interference. In the testing of this unit, we found that it made some difference in the stability of the readings obtained when the unit was moved to various portions of the test bench. That was noticeable only on the 1000 pF range when measuring capacitors of less than 100 pF.

There is no reason to expect damage to any capacitor when using the *3001* to test it as the maximum voltage used during the testing operation is about 3.5 volts (according to the manual); however, we were never able to detect that much voltage at the test terminals. While on the subject of voltages, it may be a good time to mention that Global Specialties recommend that the capacitor to be tested be thoroughly discharged before connecting it to the test leads. The unit does have overvoltage protection built into the circuitry in the form of a ½-amp fuse.

In every test, the *model 3001* came up with flying colors. It performed exactly as the manufacturer claimed it would and we were unable to discover one negative aspect to talk about. The size and shape were found to be very convenient for bench use as well as portable operation. The sample supplied came with a *model 334* Production Test Fixture that simply amounts to an aluminum baseplate containing two spring-loaded clips. The clips are connected to an 18-inch length of RG-58/U cable that connects to the *model 3001*. There are also four (4) rubber feet on the bottom to protect surfaces. In use, for such operations as sorting large numbers of capacitors, all that need be done is to insert the leads into the test fixture and read the value on the *model 3001*. In addition, the *model 335* Test Cable was supplied with the sample unit. That is also a piece of lead with two (2) alligator clips mounted at the ends to clip onto the capacitor to be tested (or the circuit to be checked). The company also makes a set of alligator clips with a banana plug attached for direct connection to the front panel jacks.

Another optional accessory available is the *model 333* Tri-Mode Comparator. This unit allows the selection of capacitors that fall within preset ranges. Those thresholds are adjustable by front-panel thumbwheel switches and three outputs are available that will correspond to Low, Good, and High.

For those who like to read specifications, here are a few as published in the operational manual. Nine ranges from 1999 pF to 199,999 μF full scale. Accuracy: ±0.1% of reading ±1 pF on 7 lower ranges; ±0.5% of reading ±1 digit on 2 upper ranges. Temperature coefficient: ±0.01%/degree C applies to all ranges. Technique: dual threshold slope integration. Excitation voltage: 3.5 volts max. Display: 3½-digit high-brightness 0.5″ character-height LED. Overange indication and underange indication. Input protection: ½-amp 250-volt fuse. Power requirements: 105-125 VAC, 50/60 Hz, 6 Watts. Size (W×H×D): 10″×3″×7″ (254×76×178 mm). Weight: 3 lbs (1.4 kg).

continued on page 38

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VIZ formerly RCA

TRIPLETT

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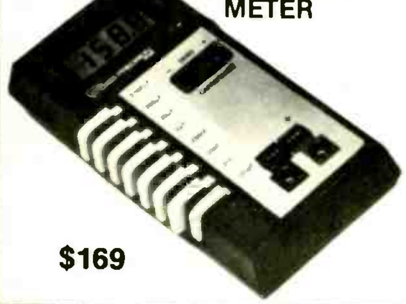

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  dc current
  ac current
  resistance
  diode test
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- 0.25% basic dc accuracy
- LCD display
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  ac voltage
  dc current
  ac current
  resistance
  diode test
  conductance (1/R)
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- 0.1% basic dc accuracy
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- Overload protection
- Free case
- Two year parts and labor warranty

Model 8024A: The Investigator

$219

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  ac voltage
  dc current
  ac current
  resistance
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  conductance (1/R)
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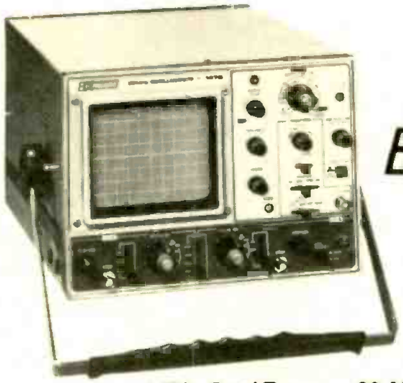

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AC CURRENT	2mA, 20mA, 200mA, 2000mA, 10A	3%
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EQUIPMENT REPORTS
continued from page 34

If you're in the market for a new state-of-the-art digital capacitor meter then you should take a serious look at the Global Specialties Corporation's *model 3001* Capacitance Meter. It may be just the item you have been looking for. The *model 3001*, including the *model 335* test cable, retails for $275. The *model 334* production test fixture retails for $21.90. The *model 333* tri-mode comparator retails for $295. **R-E**

Heathkit/Thomas Model TO-1860 Electronic Organ Kit

CIRCLE 102 ON FREE INFORMATION CARD

SOME COMPUTERNIKS LIKE TO MAKE ELECTRONIC music the hard way, by programming the pitch, duration, and timbre (and maybe more) for each note, which can take a lot of time, even for a little 16-bar tune.

If you're more interested in making music than in programming it, there's an easier way. You can build the Heathkit/Thomas *TO-1860* electronic organ. Before you say an organ is too hard to play, what with two keyboards, pedals, and all those controls, consider this: the *TO-1860* uses a microprocessor to automate just about all the tricky stuff, so that you can concentrate on just making music.

Microprocessor controlled

In this kit version of the Thomas Organ Company's *Troubadour* model, a microprocessor controls the inputs from the keyboards, pedals, and pushbutton switches. Two ROM IC's store the percussion rhythms and some fancy accompaniment patterns.

The microprocessor performs quite a variety of jobs, including sounding only one pedal note at a time by programming for low-note preference, generating the lower octaves from the 12 top-octave frequencies, and controlling the rhythm ROM's. It also controls the accompaniment features by putting them on multiplexed lines, and then using a 1-MHz clock to help pick out the right signals at the right time, so that the keyboard notes, pedal notes, and the special features all sound only when they're supposed. to.

Even if you can't read music

For people who can't read music, the organ provides a combination of color-coded keys and lettered keys, that are illuminated from underneath by fluorescent lamps when you push the *Color-Glo* switch.

Several books of music are provided, in which the color-coded music is written so that if you can already read notes, you play it that way, and if you can't, then you look at the letter printed inside each note in the melody, and play it on the matching key of the top keyboard.

The music staff behind the notes is colored to show which of three chords you should play on the lower keyboard. Colored plastic chips underneath the keys are lit up, showing which keys make up which chords.

Once you learn how to play the keys according to letters and colors, you can try the pedals. You need only three to start with, and they're also color-coded.

Microprocessor Does The Work

To do anything fancier than described so far would be difficult for a beginner. But the *TO-1860* contains a microprocessor that automates most of the difficult keyboard fingerings and pedal-playing, such as walking bass, strum, arpeggios, etc.

By depressing one of the FEATURES buttons above the keyboard, the microprocessor does the hard work letting you play some very fancy music with only two fingers and a toe. Some of the features even play the pedal note for you.

The CHORD MEMORY feature will play, for instance, a C-chord when you press the C key in the special octave on the lower keyboard. At the same time, the corresponding pedal note for that chord is played, without your toe touching a pedal.

Rhythm features

Nine pre-programmed drum-rhythm patterns, ranging from waltz to rock, are controlled by switches. The FANCY FINGERS switch adds a pre-programmed accompaniment that's different for each of the nine rhythms. You can use that as an accompaniment to your one-finger melody, instead of the chord memory.

Four ACCOMPANIMENT PRESET switches provide unique voices (piano, guitar, banjo, harp) that play in rhythm along with whatever drum rhythm has been switched on.

The automatic STRUM feature will strum whatever particular notes you hold down with your left hand, within that special lower-manual octave.

A switch on the volume-control pedal permits playing arpeggios, which will sound harp-like.

Inside the organ

A master oscillator drives an IC called the top-octave synthesizer that divides the top frequency in order to generate the twelve notes of the top octave.

The two LSI rhythm IC's are ROM's that contain bit patterns for the nine rhythms, walking bass and fancy-fingers coding.

The microprocessor turns the manual and pedal notes, and the various features, on and off at the right times.

The microprocessor IC, designed by Thomas Organ Co. and custom-made by AMI, is proprietary.

Building the organ

Construction of the Heathkit/Thomas organ is greatly simplified by virtue of the fact that the nine major circuit boards have already been prewired and tested for you. The organ cabinet is fully assembled, the wiring harnesses are precut and color-coded, and several switch units are preassembled.

So what do you build? You assemble the pedals and the switches they activate, the fluorescent-light circuits, the stereo amplifier, and the two keyboards. You install all of them in the cabinet, along with the nine preassembled boards and switch units, the two speakers, and the reverb unit.

Once you get the organ working, you can switch off the loudspeakers and use headphones, if you're a beginner, or are bashful, or play late at night.

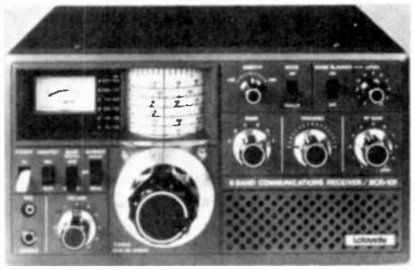
Stereo input/output jacks are provided for recording your music, or for playing a duet with previously-recorded tapes.

The three music books that come with the organ show you 36 combinations of the ten solo and five accompaniment *voices*. Many are quite striking, such as *Huge Theater Organ. Hollow Liquid Tibia, Calliope,* and *Honky Tonk Piano.*

You can play the Heathkit/Thomas organ with just the two keyboards, the pedals, and the 15 voice stops. But the fun really begins when you let the microprocessor and the ROM circuits help with making fancier music, by adding a rhythm accompaniment and a walking bass, or playing single-finger chords, or the strum, or the arpeggio or . . .

You'll need months to discover all the combinations of voices and features that are possible with this organ, which is even more of a bargain now at the new price: $1495; originally it was $1750. Write to: Heath Company, Benton Harbor, MI 49022. **R-E**

Lafayette BCR-101 General Coverage Receiver



CIRCLE 103 ON FREE INFORMATION CARD

RECENTLY, A LARGE SAMPLING OF MODESTLY priced general-coverage communications receivers has been marketed. Most of those receivers have been in the $300-$700 range. Now, Lafayette (111 Jericho Turnpike, Syosset, NY 11791) offers a general-coverage receiver for only $249.99. Can it compete? Let's take a look.

The *model BCR-101* tunes from 170-400 kHz, and 0.53-30 MHz (with some extension to about 31 MHz). It does not feature a digital-frequency readout as do the more expensive units, but it does have an accurately calibrated bandspread dial.

The main frequency display is on a printed drum. Calibration points are marked every 500 kHz, with the bandspread dial filling in every 5 kHz.

The receiver may be powered directly from 120 VAC, or by an external 12-volt battery supply (specified as 13.8 volts for mobile

EQUIPMENT REPORTS

continued from page 39

installations). Current drain is less than 500 milliamps on DC.

The superheterodyne circuitry is double conversion above 3.5 MHz (with IF's of 2.15 MHz and 455 kHz), and shortwave sensitivity is better than 1 microvolt.

Switchable selectivity may be adjusted for 6-dB down at either 8 kHz or 3 kHz. The audio output is 2 watts into 8 ohms, rated at 10% harmonic distortion at full output.

Image-rejection specifications look unusually good for a low-cost radio: 50-70 dB down on all ranges. Our on-the-air tests confirmed the low image response.

The *BCR-101* is unusually compact. Measuring 12 × 7 × 9½-inches, the receiver weighs 13 pounds.

A dual-50/500 kHz crystal calibrator is a welcome feature. It permits accurate tuning on all ranges, with its harmonics detectable well through the highest tuning range of the receiver. We found the absolute calibrator frequencies to be slightly off, but an internal alignment of the calibrator could easily correct that problem.

The beat-frequency oscillator is continuously adjustable between upper and lower sidebands to help optimize signal reception. A noise-blanker circuit is provided for electrically-noisy environments.

A separate RF GAIN control permits the user to reduce gain for reception of signals that might cause overloading. A tracking control is used to peak the RF sensitivity of the receiver on each range.

Front-panel jacks are provided for tape recording and playback, and headphones or external speaker. The *BCR-101* contains a husky 5 × 2-inch oval speaker.

Rear-apron connections are provided for external battery power, external antenna, oscillator output for direct frequency-counter measurement, and tape input for playback.

Our tests

Although there is a strong tendency for manufacturers to label low-cost receivers "communications" receivers, they are *not*; they are strictly for non-demanding hobby listening. If I were in a remote outpost somewhere, and my survival depended upon communications, I would not want to depend on a low-cost general-coverage receiver. That is not to say that the *BCR-101* is incapable of reasonably good performance. It gives an excellent accounting of itself—when it's viewed in proper perspective.

The IF-selectivity skirts are quite wide. There is hardly any rejection in adjacent frequency interference when switching to the NARROW mode. The noise blanker should work better. When adjusted as critically as possible, the reduction in electrical pulse noise is barely perceptible. True noise blankers are exceptionally effective against sharp-risetime pulse noise.

The calibrated bandspread dial is remarkably accurate. Although calibration points are provided every 5 kHz, it is possible to interpolate frequencies to within 2 kHz or better when the main tuning dial is accurately set. Unfortunately, the main tuning-drive mechanism is quite sloppy, with severe slippage and backlash. Critical adjustment is quite a chore. The bandspread dial is much better, but is functional only above 3.5 MHz.

The *BCR-101* has excellent sensitivity, certainly as good as anything else we have heard in the low-price range. Large-signal handling characteristics leave something to be desired, however. The receiver becomes completely unglued in the evening listening hours when the bands are really open. Sharper IF filters would certainly have helped here. Reducing the RF gain control is of some assistance.

Short-term frequency stability of the *BCR-101* is quite good. After a short warmup period, CW and SSB signals are easily adjusted and very readable. Mechanical stability is excellent. It takes a substantial rap on the cabinet to wobble the dial setting.

The tracking control is essentially a trimmer for peaking the RF and mixer stages. Unlike a preselector, there is no possibility of peaking the control on an image frequency by mistake. When the control is peaked, it is on the proper range. We liked that feature.

The AGC is quite fast, resulting in severe pumping when the RF gain control is reduced during strong CW or SSB signal reception. Audio quality is excellent—voice tapered for communications reception.

A special comment on the low-frequency range. Even with a short antenna connected, we were able to receive an unusually large number of low-frequency stations. That certainly will be appreciated by the low-frequency DX'ers.

The operating manual is very comprehensive. It includes detailed circuit diagrams, PC layouts, parts locations, alignment and calibration steps, and user hints. It is an outstanding manual to accompany such a modestly-priced radio. **R-E**

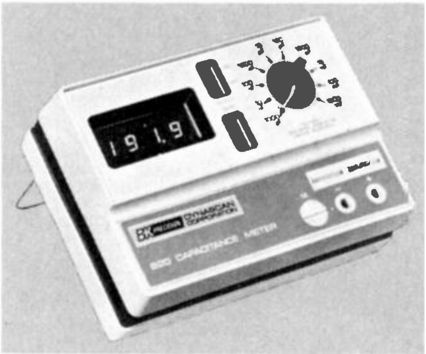
Catch the fastest C-meter under $200 ...the autoranging 830

It's happened again. B&K-PRECISION was the first company to offer a lab-quality C-meter for under $150, now we're first with autoranging for under $200. The new Model 830 autoranging capacitance meter is fast, accurate and built with famous B&K-PRECISION dependability.

The 830 offers features that are tough to match at any price, such as 0.1 pF resolution, large 3½ digit LCD display and fuse protection against charged capacitors. Basic accuracy is 0.2%, much greater than the tolerance of most capacitors.

Ease of operation is another strong suit for the 830. On the production line, even untrained workers can be quickly instructed on proper operation, making the 830 ideal for component sorting and selection. If capacitors to be measured are limited to a narrow value range, the "range hold" capability of the 830 can freeze it onto one range—an added time saver. This feature, along with the fast reading time of the instrument, makes the 830 especially valuable for incoming inspection applications. On the engineering bench, the 830 is an excellent means of pre-testing critical capacitors.

For applications suited to manual ranging, B&K-PRECISION offers the 820 at an even lower cost. In fact, for the cost of some autoranging units, you could almost purchase both the 820 and 830! The 820 also provides 0.1 pF resolution. With full 4-digit LED display, readings extend to 1 Farad.



With either B&K-PRECISION C-meter, you can measure unmarked capacitors . . . verify capacitor tolerance . . . measure cable capacitance . . . select and match capacitors for critical circuit applications . . . sample components for quality assurance . . . measure complex series-parallel capacitor networks . . . accurately set trimmer capacitors . . . check capacitance in switches and other components. Both instruments have front-panel lead insertion jacks for fast in-out testing.

Optional accessories for the 830 and 820 include a rechargeable battery pack, AC charger and carrying case. For more information, see your local distributor and see why B&K-PRECISION is now the leading supplier of digital capacitance meters.

B+K PRECISION DYNASCAN CORPORATION

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Canadian Sales, Atlas Electronics, Ontario

Model 820 $140
Model 830 $199

CIRCLE 54 ON FREE INFORMATION CARD

TELEVISION

A HISTORICAL LOOK AT TELEVISION

Television technology is progressing at a rapid rate—but the major advances were really made years ago.

KATHY GOFORTH

IN 1929, WHEN THE FIRST ISSUE OF **Radio-Electronics**—then *Radio-Craft*—took up the discussion of an infant technology called television, the consensus at the neighborhood tavern (where television would eventually find its first mass audience) was that communication had reached its zenith with radio. To the general public of 50 years ago, the idea of sending moving images through space seemed the impossible dream of over-optimistic engineers. Today Americans alone own as estimated 146 million television sets—more than the number of telephones, refrigerators, automobiles, or bathtubs. TV has moved from the impossible to the indispensable. A viewing audience, including some who once considered video communications as remote a notion as a spaceship to the moon, already looks back a full decade to the time when it watched, from the comfort of the living room sofa, that first human step on the moon.

But astonishing as television's future is certain to be, its phenomenal success story already lies in the past—in the drama of its early development, the quantum leap from mechanical to electronic, and the metamorphosis from black-and-white to color. The subplots to the tale include global neglect through two world wars, a perpetual and frustrating lag between theory and workable hardware, a series of lively disputes over uniform standards, and an out-and-out battle between two early color systems.

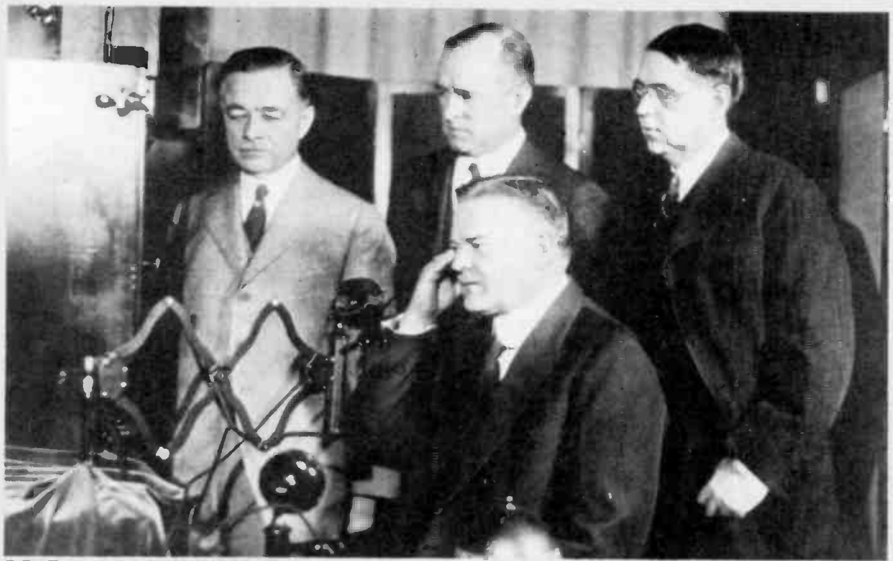
The beginning

The story begins at that unidentified moment in the distant past when man first hatched the dream of extending human vision beyond the limitations of location. But television's practical history begins only about 100 years ago, with the discovery of the early principles needed to make it possible. By 1929, milestones already included the 1873 discovery of the photoconductivity of selenium and the idea of scanning a picture's elements in rapid succession, line by line and frame by frame, with reliance on the persistence of human vision—proposed about 1880. That important theory established the possibility for single-wire transmission and led in 1884 to the patent by German scientist Paul Nipkow of a complete television system characterized by the spirally-perforated rotating disc. The Nipkow disc, as it came to be called, would be used in one form or another in all workable television systems until the advent of electronic scanning.

1947 TELEVISION BREAKTHROUGH. Motorola introduced first black-and-white TV receiver to sell for under $200.

As early as 1897 German inventor Karl Braun had devised the cathode-ray tube, and in 1907 Russian scientist Boris Rosing reproduced crude geometrical patterns using a cathode-ray television system with a form of mirror-drum scanning at the camera end. A year later, Scottish electrical engineer A.A. Campbell-Swinton outlined a method for television using a cathode-ray tube at both receiver and camera ends—in all essentials the basis for modern TV, but an idea too advanced to be put into practice in 1908. (In 1904 English physicist J.A. Fleming had contributed the two-electrode valve; in 1906 American inventor Lee deForest had provided the grid for amplification.)

Early television research came to an abrupt halt with the outbreak of World War I, and although full-time experimentation wasn't resumed until the return of peace, by 1923 scientists in both the U.S. and England were at work on television systems using the Nipkow principle and the neon gas-discharge lamp, invented by D.M. Moore in the U.S. in 1917. In 1925 Charles F. Jenkins used such a system to broadcast silhouettes from his Washington, D.C. workshop, and in 1926 John Logie Baird in England transmitted moving pictures in halftones—scanned in only 30 lines, repeated about 10 times a second—to



FIRST PUBLIC DEMONSTRATION of inter-city television broadcasting took place in 1927. Herbert Hoover, then Secretary of Commerce, was speaking in Washington and seen on television screens at Bell Telephone Laboratories in New York.

give what might be called the first demonstration of "true" television. Baird's system formed the basis of the experimental broadcasting that began in England in 1929.

The post-war years also brought the landmark invention of the iconoscope by Vladimir K. Zworykin, a Russian scientist and recent immigrant to the U.S. The 1923 breakthrough put Campbell-Swinton's advanced theory into practice, giving the camera its "eye" and providing the final missing element needed for modern television. The crude but workable, partly-electronic TV system Zworykin developed that same year became the basis for the system used in 1939 for the first public demonstration of television, by RCA, at the New York World's Fair.

The 20's continued as a decade of enthusiastic research, and a variety of experimental television systems were demonstrated. The new technology left much to be desired, however, and even when experimental broadcasting began television made little headway toward public acceptance. Its audience remained limited to small numbers of engineers and a slowly expanding coterie of home kit-builders. The latter had a chance to become acquainted with terms such as "automatic synchronization" and "interlaced scanning" before the electron beam swept the whirling disc into discard, bringing the early period of television's development to a close. By the early 30's scientists had come to pin their hopes for improved pictures on the all-electronic systems and had turned their attention in that direction. TV's future mass audience still clustered contentedly about its radios, unimpressed by fuzzy pictures on tiny, inordinately expensive screens. And the more resolute of the home experimenters withdraw to their basements and garages to experiment with the new tubes.

Standards

It has also become apparent by this time that if television were to grow, broadcasters and set manufacturers would have to accept uniform standards. Engineers argued hotly over what those standards should be, and just what form a national television system should take, and in 1933 hearings by the FCC began in the U.S. in an effort to establish the necessary guidelines. Meanwhile, scientists and engineers continued to chalk up contributions to the growing science: Philo T. Farnsworth's electronic scanning system improved pictures; electrical engineer Allen B. DuMont streamlined the workings of the cathode-ray tube; continuing research on the electronic systems, carried out in the U.S. mainly in RCA labs, soon increased the number of scanning lines to 343. German scientists, too, were active, especially in the development of high-vacuum cathode-ray tubes, and by 1935 a regular broadcasting service had begun in Germany. A team of researchers under Isaac Shoenberg at Electric Musical Industries (EMI) in Great Britain also produced a complete and practical system based on the Emitron camera tube, and the world's first public high-definition service was launched in London in 1936—in time to broadcast the coronation of George VI over a broad area. Its 405-line standard remained the basis of the British system for nearly three decades—until 1964, when it was superceded by the 625-line standard.

French engineers had begun work on a 1,000-line system, which eventually resulted in France's 819-line standard. Japan pressed TV research in hopes of telecasting the Olympic games from Tokyo in 1940, and in April, 1939, regular television service began in the U.S. with NBC's broadcast, emanating from a transmitter atop the Empire State Building, of the opening ceremonies of the World's Fair. President Franklin Roosevelt, on hand for the occasion, became the first President to be televised. Technological capability had narrowed the gap between theory and practice, enthusiasm was fired, and the rapid development of commercial television seemed assured. Four months later, Hitler's troops assaulted Poland, and declarations of war by England and France marked the beginning of World War II and the second hiatus for television research.

In the U.S., as in other countries, the need for military preparedness led to increasingly heavy demands on industrial research, engineering, and production facilities. By the time the Japanese attacked Pearl Harbor (December 1941) virtually all U.S. electronics facilities were devoted to military projects—radar, radio, special tubes, acoustical devices, and navigational systems. What television broadcasting remained began to serve the needs of civil defense, air-raid warden training, Red Cross instructions, and war bond sales.

Network television

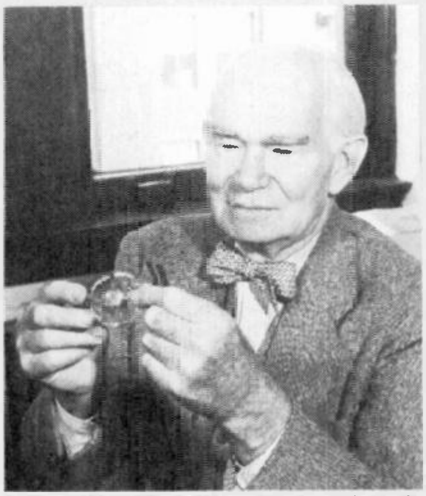
But television's crucial momentum had been gained before the war, and peacetime returned the medium was poised for unprecedented expansion. Both NBC and CBS had developed surprisingly extensive schedules of programs for the several thousand sets in use before the U.S. joined the fighting in 1941. The first official network broadcast in the U.S had come in February 1940, when a program from NBC in New York City was picked up and rebroadcast by General Electric's station in Schenectady, N.Y. At about the same time, Zenith Corp. had begun regular program service in Chicago. Parts of the 1940 Republican National Convention in Philadelphia had been televised after transmission to New York via coaxial cable, and films of the Democratic Convention in Chicago had been broadcast in New York.

Commercial television had begun officially in 1941, when both NBC and CBS were granted licenses on July 1. Standards for a commercial system had been worked out before the war by the National Television System Committee, and wartime engineering paid off in a harvest of technological advances: the image orthicon; more powerful transmitting equipment; improved picture-display techniques based on radar developments; more effective network relay techniques, and major advances in high-frequency techniques. Television celebrated the war's end and its own return to the commercial arena by broadcasting coverage of V-E Day and the Japanese surrender. An American public weary of wartime austerity, and a business world thrilled by a potential new advertising tool, both looked forward to television's widespread use.

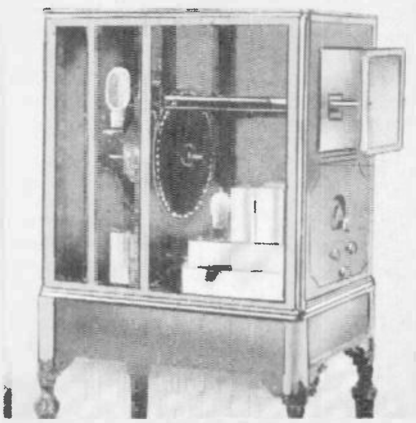
In 1946 NBC in New York linked up with Washington, D.C. by coaxial cable, creating the first real network, and RCA placed the first post-war TV sets on the market—the famed 630TS, television's equivalent to the Model T Ford, and the nation's first quantity-produced and marketed receiver, selling for $375. By midsummer, 1947, 12 broadcasting station were in operation and a larger number under construction. The same year brought the premier of Kraft Television Theater—the first regularly scheduled network drama series and the first show blessed with sufficient financial backing to ensure consistently high quality productions. The big show of 1947, however, was the first televised World Series, viewed by an estimated 3.9 million people, the majority of them in local bars, where commercial television got its test run by many consumers.

By the following year, the vote was in. Americans had taken to the idea of going to the theater and the ball park via the easy chair, and television antennas sprang up like mushrooms on the roofs of homes across the nation. The number of receivers snapped up by an eager public jumped from 136,000 in 1947 to 800,000 in 1948. Television was accepted by the service technician, and test equipment appeared. The number of stations tossing images from batwing to dipole grew with an expanding web of networks: East Coast television cities were linked to Chicago, St. Louis, Pittsburgh, Buffalo, Cleveland, and Toledo, with microwave relays adding Detroit and Milwaukee to the circuit.

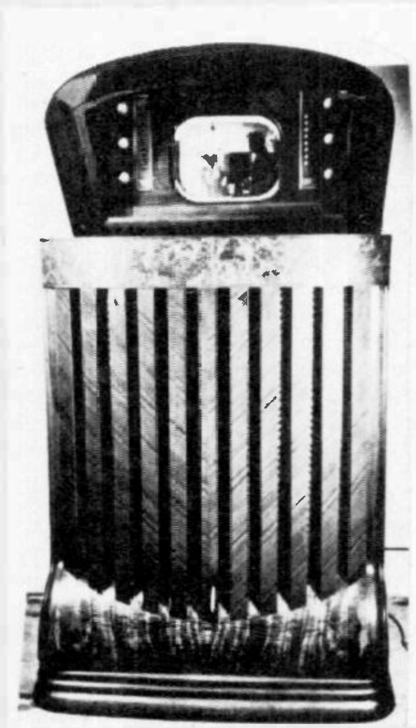
Innovations tumbled out of the labs and into the stores: "convenience" accessories such as the viewer-controlled zoom lens and the one-way mirror that made a turned-off television a decorator piece; the first portables—37 pounds light; more rugged antennas, designed to better withstand the rigors of rain, snow, and wind; directors and reflectors for more selective reception and to battle the increasing problem of interference from different stations. Television's expansion had surpassed even the most optimistic forecasts, outstripping even the phenomenal growth of the auto, moving picture, and radio industries.



LEE deFOREST holding his invention, the Audion—the first vacuum tube with a grid for amplification.



JENKINS PROJECTION RADIOVISOR, developed in 1931, used deForest's new neon-crater tube and a 1-inch scanning disc with sixty ½-inch lenses to throw a flying-spot image on the rear of the ground-glass viewing screen.



FIRST ZENITH TELEVISION was manufactured in 1939.

Color television

As a result, the problem of one station's signal interfering with another's soon grew to such proportions that, in September of 1948, the FCC declared a freeze on the licensing of any new TV stations. There had to be time to study frequency allocations and to consider the problems posed by another major innovation that sat perched on the horizon: color. Like monochrome TV, color television has its roots in a number of early experiments and in the Nipkow disc—used in threes, in this case, one disc for each of the primary colors.

The first practical demonstrations of color came in 1928 when Baird used a system of two gas-discharge tubes as light source at the receiver, one of mercury vapor and helium for the green and blue colors and a neon tube for red, along with a set of discs, an early variety of the "color wheel." In 1930, Ray D. Kell of General Electric patented a color-television system employing a double, spiral scanning disc and only two colors; and in 1931 German engineer Anronheim devised a color system using a 12-color filter disc in conjunction with a scanning disc. Experimental work on color continued in both Great Britain and the U.S. in the late 30's, and similar sequential systems using rotating color filters in the cameras and receivers were demonstrated in both countries.

The drawbacks of the mechanical approach to color TV were that it required an increased rate of scanning to avoid color flicker and it was noncompatible with existing black-and-white television. An all-electronic method proposed by others was compatible with black and white, but it was a much more difficult system than the mechanical one. In 1938, Georg Valensi of France pioneered the path to compatible color television when he patented a method enabling output from a single transmitter to be received by television sets with equipment for color and by ordinary black-and-white sets as well. His proposals were never precisely adopted in practice.

In the U.S. battle lines were drawn between variations of the two systems: CBS developed a mechanical system of whirling color wheels, synchronized at the receiver and camera ends. A transparent disc divided into three segments for the primary colors revolved before the camera, scanning the color elements of a picture and sending them to the receiver disc. The successive primaries flashed to the eye at the rate of 144 per second, and persistence of vision blended them into one. With the system's excellent picture came a counterbalance of problems, including interlacing, flicker, and fringing. Even so, and even though it was incompatible with black-and-white sets, the mechanical system offered the most promise in terms of early commercial advantage. The alternate, all-electronic system developed by

RCA's FAMED MODEL 630TS was television's equivalent to the model-T Ford automobile. The 630TS was the first post-war TV receiver and was also the first mass-produced and marketed TV receiver, selling for $375.

RCA used three lenses and three electronic systems—in effect three cameras in one—to pick up the primary colors. A sampler in the receiver, synchronized with one in the transmitter, took short samples of the composite signal at the instants of red, green, and blue peaks, using three kinescopes whose phosphors glowed in the three primary colors.

But existing projection-tube displays, and a very complex direct-view display using three orthogonal picture tubes whose pictures were combined by dichroic mirrors, lacked the convincing evidence of practicality. In 1949, the FCC gave its approval to the mechanical color system, and RCA moved with full speed to develop the final basic element in the compatible system—a single tube capable of producing full color.

In 1950, the company startled the industry with a demonstration of the shadow-mask tricolor kinescope—the reward of the most intensive single research effort in electronic to that time. The color tube was essentially the same as the one now used throughout the world.

After winning FCC approval, CBS had begun limited color broadcasting, but the mechanical color system was to be short-lived. Hit by a serious shortage of parts during the Korean conflict, the color wheel quietly whirred its way out of existence, to the relief of manufacturers and engineers alike (though a variety of the system was later used by Apollo astronauts to transmit their remarkable pictures of the moon and earth). In 1953 came the FCC aproval of the refined RCA compatible color system; and the industry sat back to let RCA and its subsidiary NBC develop and promote color TV. [Ironically, CBS held the patent on the shadow mask and RCA had to pay royalties for 17 years.—*Editor*]. RCA produced the first compatible sets in March 1954, and NBC began to try out its major programs in color.

TV growth

Television had continued to weave its way inextricably into the fabric of American society. Audiences were electrified in 1951 by the televised Senate committee hearings on organized crime. In 1952 they watched TV's first opera broadcast, the televised explosion of the first atomic bomb, and coverage of the presidential election campaign. September 1951 had brought completion of the link to the West Coast—a 3,000-mile network of 107 relay towers—and transcontinental television was now a fact. NBC's coverage of the 1952 conventions in Chicago introduced the portable RF-connected camera and the first "crash truck," a TV newsroom on wheels equipped with self-powered electronic and film cameras and its own darkroom. Cable television got its start in 1950 with the erecting of the first community antenna, in Lansford, PA.

With the imminent lifting of the FCC freeze on TV station construction, a handful of UHF stations demonstrated the technical possibilities—and limitations—of the UHF spectrum and the newly designed equipment to work in it. When the freeze ended in April 1952, with a document that supplemented the existing channels in the VHF band with 70 new channels in the UHF band, it began processing a backlog of 700 applications for new stations, granting 175 new licenses that year. Soon 377 stations were on the air, and by the middle of 1954 almost 90 percent of the country had television coverage.

The 50's also brought continued improvements: the Vidicon camera; in 1953, development of a curved shadowmask with phosphors deposited directly inside the face of the tube; in 1954 incorporation of internal pole pieces in the three electron guns of the color tube to permit each beam's independent adjustment and an increase in deflection angle; also in 1954 the development of photographic deposition of the three color phosphors. In 1958, we had the replacing of the metal envelope of the color tube by a glass one, made possible by the advent of a new frit-glass seal by Corning Glass; and in 1956 the use of videotape and the first quadruplex (4-head) video-tape recorder.

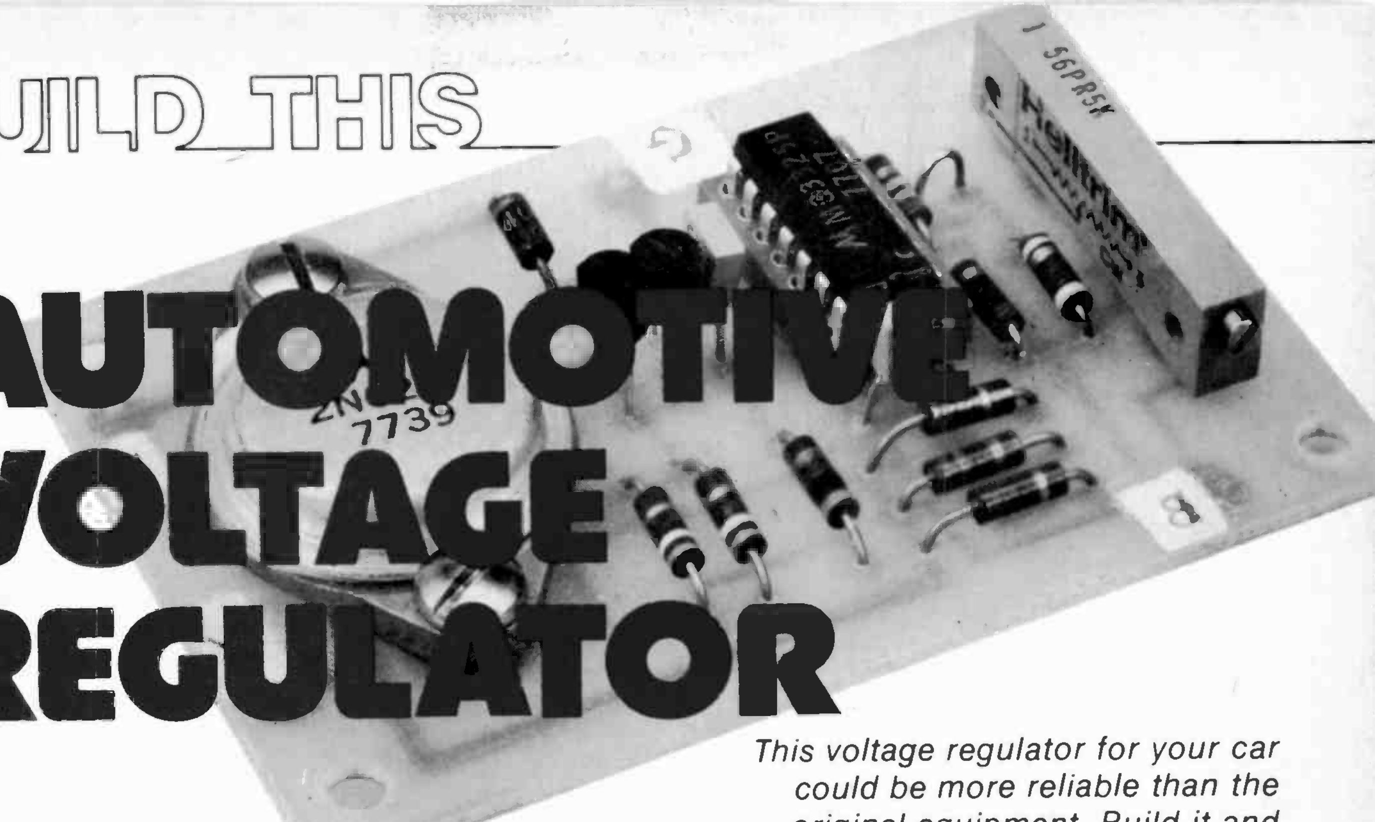
The 1960's brought the incorporation of solid-state components in color TV, new phosphors to provide brighter colors, more color programming, and an increase in popularity for color TV. NBC was broadcasting as much as 40 hours a week of color programs in 1963 (though CBS had still done little color programming and ABC virtually none), and color was becoming an important element in program costs and set sales. Experimental pay TV began on a UHF channel in Hartford, CT. At the 1964 political conventions in Atlantic City and San Francisco, new RF-connected portable cameras and control units used were much lighter than previous systems—the complete package weighing less than 50 pounds—and for the first time the camera's microwave equipment operated in the 13-GHz band, eliminating most of the noise and interference that had plagued previous microwave-link cameras.

In 1965 color television reached the elite billion-dollar category as an industry. Hand-held minicams appears at the 1969 political conventions; and the Trinitron gun was developed, reducing aberrations with its three in-line electron beams from once source and single large-diameter lens. In 1969 came the shadow-mask tube with a black-matrix faceplate, reducing back-scattered light by 50 percent.

Today countries in every corner of the globe have established privately, publicly, or government-owned television service, and acceptance of the TV screen as man's eye on the world around him is complete; the medium is destined to grow in countless and unexpected ways to accommodate the needs and satisfy the voracious curiosity of its inventers and viewers. Television has come of age, and as a maturing technology it will no doubt continue to astound and delight us. R-E

BUILD THIS

AUTOMOTIVE VOLTAGE REGULATOR



This voltage regulator for your car could be more reliable than the original equipment. Build it and keep your battery well-fed.

L. STEVEN CHEAIRS

A FEW YEARS AGO DURING A PERIOD OF excessive automobile charging-system breakdowns, I was forced to design a voltage regulator as a solution to the problem of too-frequent failures of the factory-supplied unit. My car, as are many of yours, was equipped with a solid-state module. The unit failed right after the car's warranty period expired. A replacement was purchased, for about $40.00, and installed. After a few months it also failed; again it was replaced. Again it failed after a relatively short time period.

Now, to even a thickhead like myself, it became obvious that a new approach to this problem was in order. I planned to keep the car for several years so I designed a voltage regulator that I felt would eliminate the problem in the car's electrical system. The system I designed and built is still operating without any problems. Questar later offered the unit as a kit, over one thousand units were sold, and only an occasional installation problem occurred.

Let me elaborate for a second. When the manufacturer is building an alternator and comes to the point of terminating the alternator leads for the field (rotor) and armature (stator), he is faced with three alternatives. First, ground one lead to the case and connect the other

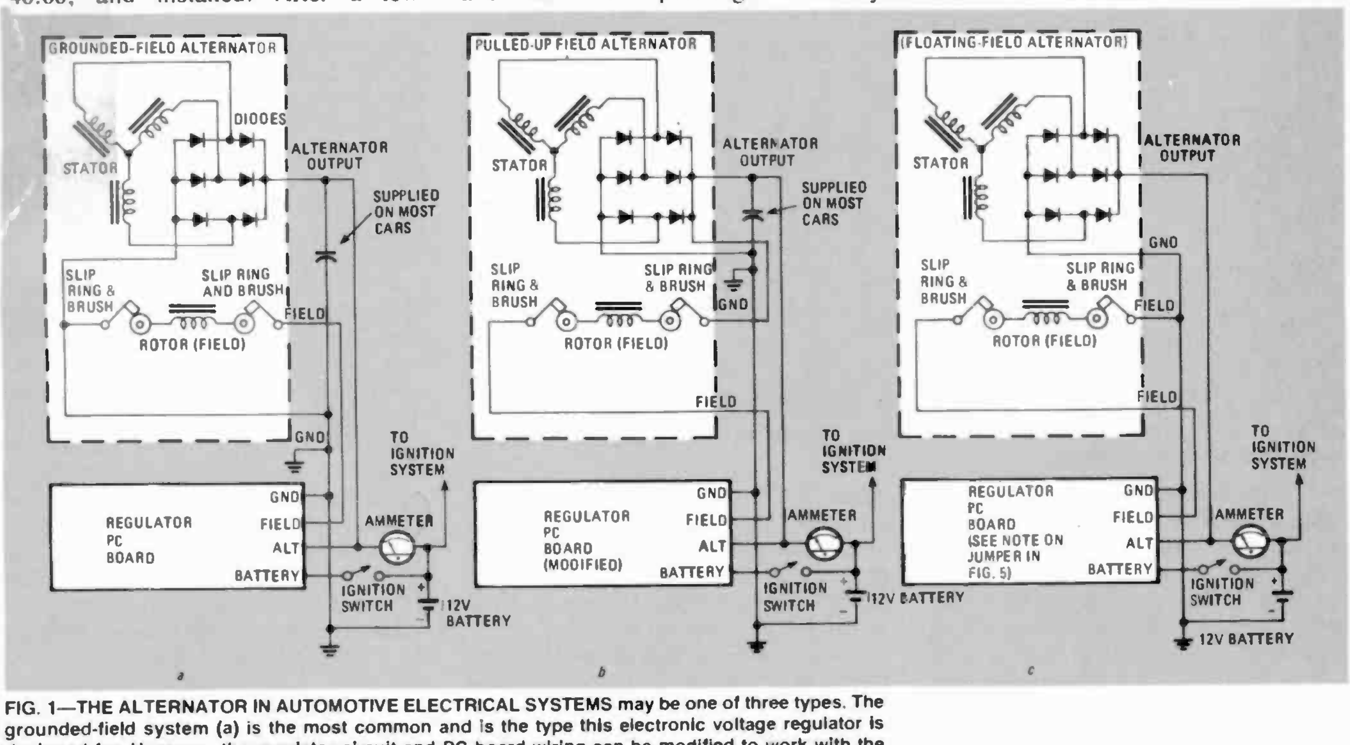


FIG. 1—THE ALTERNATOR IN AUTOMOTIVE ELECTRICAL SYSTEMS may be one of three types. The grounded-field system (a) is the most common and is the type this electronic voltage regulator is designed for. However, the regulator circuit and PC board wiring can be modified to work with the the pulled-up field (*b*) or the floating-field alternator at c. The floating-field alternator is wired as a grounded-field type at c. It may also be wired as a pulled-up field type.

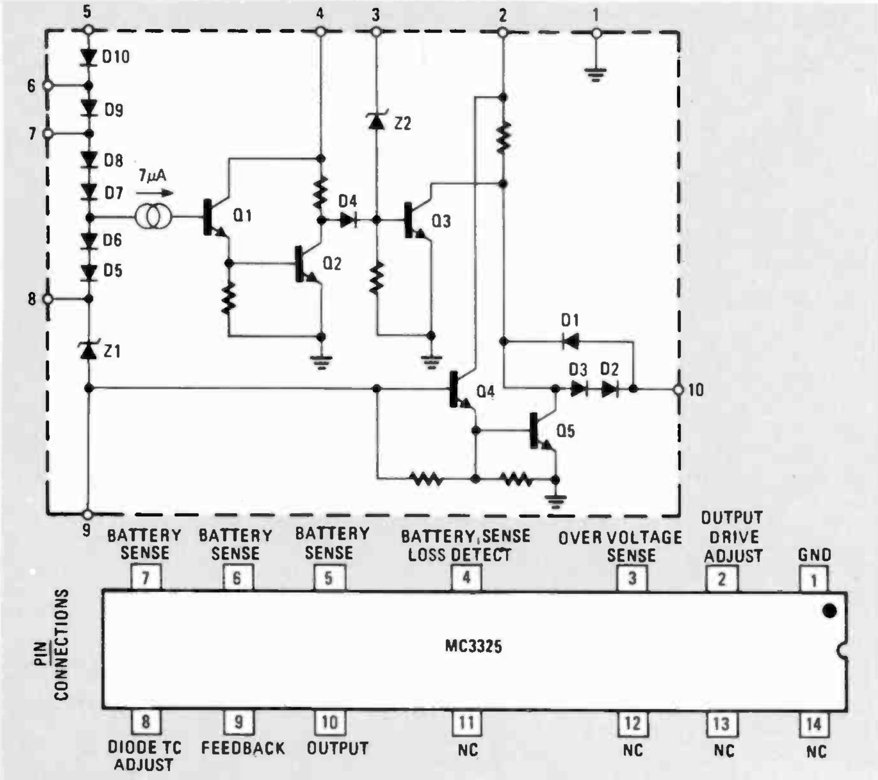


FIG. 2—CIRCUIT DIAGRAM and pin-out for the Motorola MC3352 voltage regulator IC.

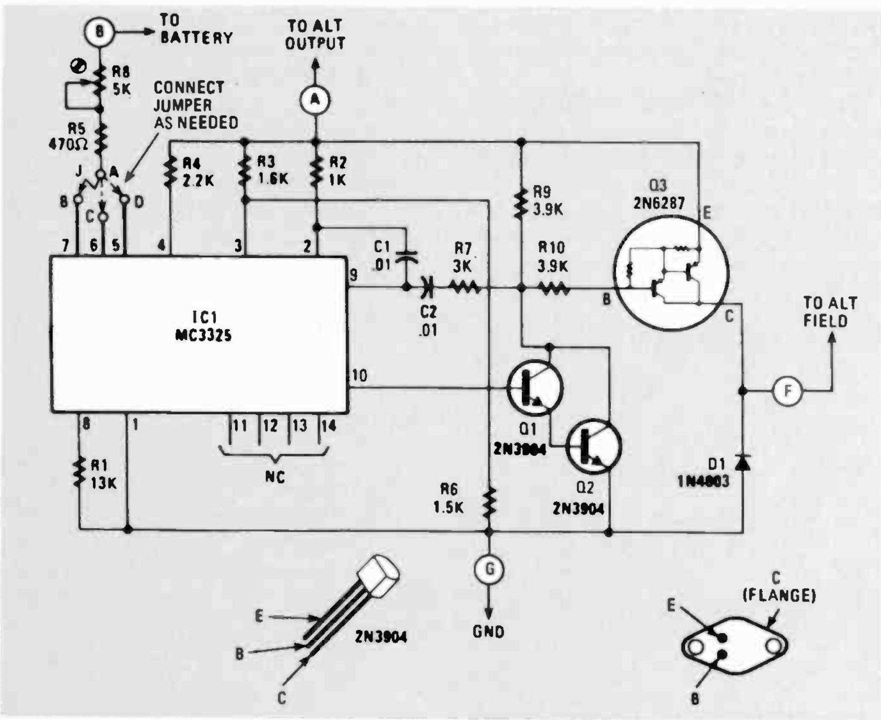


FIG. 3—SCHEMATIC DIAGRAM of the electronic voltage regulator as used with grounded-field and floating-field alternator systems.

to a terminal block, thus a grounded field system (Fig. 1-a). Second, (Fig. 1-b) connect one lead to the positive alternator output terminal and the other to a terminal block, a pulled-up field system. Third, he may simply bring both leads out (Fig. 1-c), hence floating field.

The floating-field configuration adds one terminal and for a manufacturer that could mean significant cost. The pulled-up field requires the routing of one wire to the alternator output terminal; a minor amount of extra wire is needed. The grounded-field unit is the easiest since the lead is simply attached to the case at any appropriate nearby point. *Most charging systems use the grounded-field system.*

I also chose a temperature coefficient that was optimized for my system, not necessarily the average. As the temperature varies in the engine compartment the temperature of the regulator will change. Thus, the bias levels shift. For this design, a current flow of 0.5 mA to 1.0 mA is required on the battery-sense input leg. The input resistors set a voltage level and the current level. The integrated circuit I used has three battery-sense inputs; the choice of the proper input along with external resistors set the temperature coefficient. All inputs are provided on this new design.

My auto is driven in the desert for most of the year so in my earlier design I chose a battery-voltage level best suited to this environment. Now for the fellow who lives in a cold area, a high-voltage would help his starting. Also, for the person who lives in an area that sees a fairly large-temperature fluctuation, the ability to change the battery voltage easily could be desirable.

This project is not just a modification of a three-year-old design; it is a new design which is superior to its predecessor. The new features are as described as above: 1) grounded-field operation, 2) selectable-temperature coefficient, and 3) adjustable voltage-regulation level. The previous features are also still retained: 1) high reliability from a compact solid-state design, 2) overvoltage protection, 3) automatic shutdown if the battery-sense line should be broken, and 4) a superior replacement for electromechanical and modular voltage regulators.

About the Circuit

This circuit is actually quite simple and is a good one for beginners or those who do not wish to spend the time with more complex projects. It is designed around Motorola's MC3325 voltage-regulator, IC shown in Fig. 2. However, the more advanced hobbyist will also find the completed circuit very useful. I also use the unit in a home emergency-lighting system and as a battery back-up for my home computer. The main application is still your automobile's charging system. The circuit, as shown in Fig. 3 contains one IC, three transistors, two capacitors, a trimmer resistor, and a handfull of resistors.

The IC, a Motorola MC3325 automotive voltage regulator (Fig. 2), has three battery-sense inputs (pins 5, 6, and 7) that select a tap in the diode/Zener string. The temperature-coefficient of the battery-voltage sense terminal is determined by the number of diodes used in the diode string. An approximate temperature coefficient for a diode at 1.0 mA is −2.0 mV/°C. The temperature coefficient of Zener diode Z1 is about +3.0 mV/°C. If you count from ground and sum these values a total temperature coefficient can be obtained; we have −2.0 mV for Q4 and Q5, +3.0 mV for Z1, −8 mV for D5 through D8, and an additional −2.0 mV each for diodes D9 and D10 when used. Thus the temperature coefficient will be between −9.0 mV/°C and −13 mV/°C.

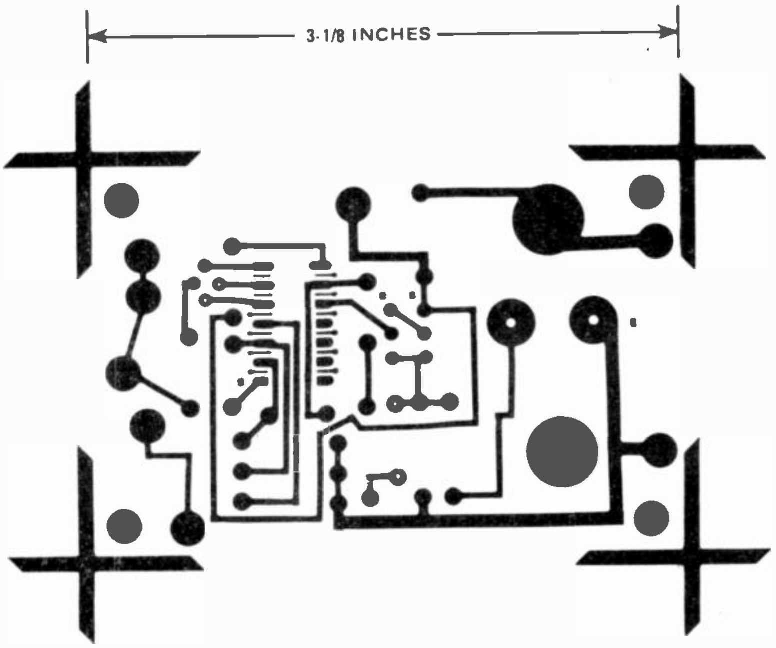


FIG. 4—FOIL PATTERN for the regulator printed circuit. The finished board measures 3-1/8 by 2-1/16 inches.

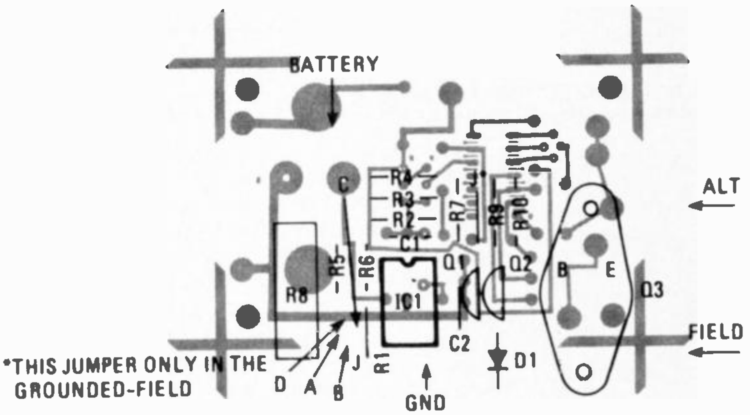


FIG. 5—PARTS PLACEMENT GUIDE for the voltage regulator. Note that the jumper between R7 and R9 is used only when the circuit is used with a grounded-field alternator. A jumper must be installed between point "A" and point "B", "C", or "D", depending on the desired temperature coefficient.

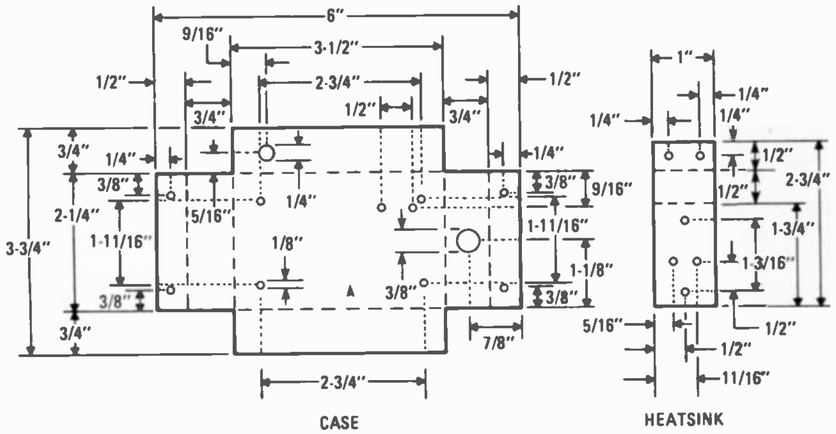


FIG. 6—THE CASE AND HEATSINK can be fabricated from easily worked tinplate or other sheetmetal. The heatsink transfers the heat generated by the power transistor to the surface of the metal case.

The complete schematic of the voltage regulator is shown in Fig. 3. Resistor R1, connected between pin 8 and ground, sets the current through the diode string between 0.5 mA and 1.0 mA. The value of R1 is directly proportional to the temperature coefficient. As the value of R1 decreases the effective temperature coefficient will decrease. The total value of the trimmer R8 and resistor R5 will determine the regulation level. Resistor R5 establishes the minimum voltage, while the maximum value of trimmer R8 plus the value of resistor R5 determines the maximum regulation voltage. The regulation voltage can be calculated from the following equation:

$$V_{reg} = \left(1 + \frac{R5+R8}{R1}\right)(8.4) + \left(n + \frac{R5+R8}{5000}\right)(0.7),$$

where n, the number of diodes in the string, is between 4 and 6 ($4 \leq n \leq 6$). Resistor R4 limits the current in case of an open battery-sense input lead. Resistor R3 is a current-limiting resistor connected between the alternator output and pin 3 of the IC. It is used along with resistor R6 to set the maximum overvoltage. The voltage at pin 3 will be about 7.5 volts, as set by an internal Zener diode. During maximum overvoltage, the current supplied to pin 3 must be between 2.0 mA and 6.0 mA; the value of R3 was chosen to insure the required current level.

Resistor R6, in conjunction with R3, sets the maximum overvoltage level. Not only does R3 set the current level for pin 3 but resistors R3 and R6 form a voltage divider used to detect an overvoltage condition. Resistor R2 determines the output-drive current of the output stage of the IC. The value chosen must provide enough current to drive the Darlington-pair (Q1—Q2) when the alternator output is at its maximum level. The Darlington-pair is formed from two NPN transistors: its function is twofold. First, it provides the required drive current to the final Darlington-type switch (Q3) and second it acts as a phase inverter. Feedback compensation is introduced via resistor R7 and

PARTS LIST

Resistors ¼ watt, 5% unless otherwise noted
R1—13,000 ohms
R2—1000 ohms
R3—1600 ohms
R4—2200 ohms
R5—470 ohms
R6—1500 ohms
R7—3000 ohms
R8—5000 ohms, 10-turn trimmer potentiometer
R9, R10*—3900 ohms
C1, C2—.01µF ceramic disc
D1—1N4003
Q1, Q2—2N3904 or equal NPN transistor
Q3*—2N6287 (Motorola or RCA) PNP power Darlington switching transistor
Q4—2N6059 or MJ1000 (Motorola) NPN power Darlington switching transistor (used only in Fig. 9 circuit)
IC1—MC3325 (Motorola) automotive voltage regulator
*R9, R10 and Q3 are not used in pulled-up field circuit

The following parts are available from Questar Engineering Co., 5412 Burntwood Way, Las Vegas, NE 89108: Kit of all parts $24.50, PC board $6.75, 2N6287 PNP Darlington $5.95 and MC3325 $2.25. Please add $1.75 for shipping and handling on all orders in the USA. Add $3.00 to all foreign orders. All COD orders incur COD charges.

capacitor C2. Capacitor C1 provides feedback from the output stage pin 2 back to the input pin 9; the total feedback is the difference of the two feedbacks' voltages. Notice that the two feedbacks are out of phase—that is, one has been inverted—thus one subtracts from the other.

The difference is applied to the base of the diode string (pin 9) and to the input of the final amplifier. This corrects for any difference between the two signals. Resistor R9 is the load for the phase inverter. The saturation current of Q1 and Q2 is 6.3 mA; 3.3 mA flows through R9. Thus 3 mA must flow from the base of the switch Q3 through R10 and into the collectors of Q1 and Q2. Of course R10 is used to set this current level. The final Darlington-configured transistor switch, Q3, is used to supply current to the alternator's field. Diode D1 is a flyback diode used as an energy return in order to prevent damage to Q3 when the inductive field load is switched on and off. In case you have not guessed; this is a switching regulator. (For more information on this type of circuit see my article "All About Switching Power Supplies" in the June and July 1979 issues of **Radio-Electronics.**)

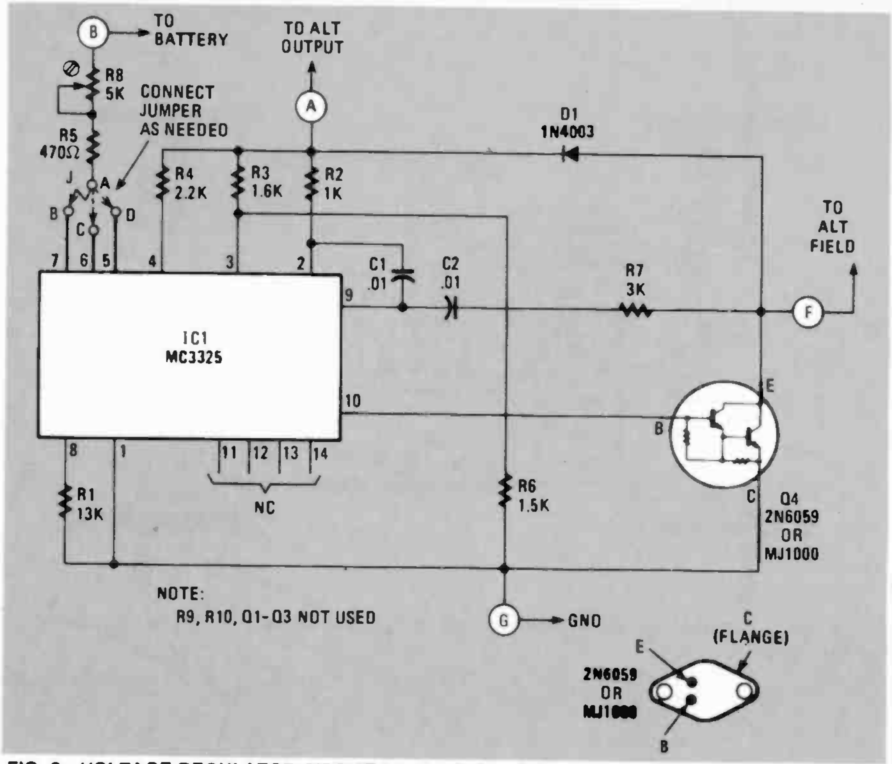
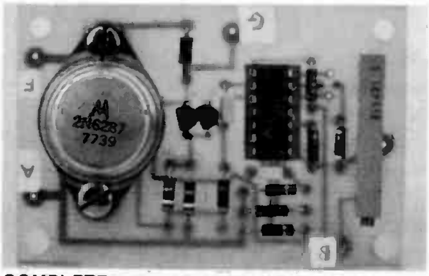


FIG. 9—VOLTAGE REGULATOR CIRCUIT for a pulled-up field alternator. The inverter formed by Q1 and Q2 has been eliminated along with R9 and R10. The driver power transistor has been replaced by a NPN type.



COMPLETED REGULATOR PC Board. Letters A, B, F and G show connecting points for alternator, field, battery and ground.

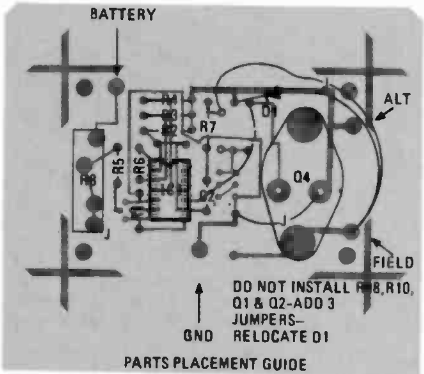


FIG. 10—COMPONENT LAYOUT used with a pulled-up field alternator. Note the three jumpers and the installation of D1.

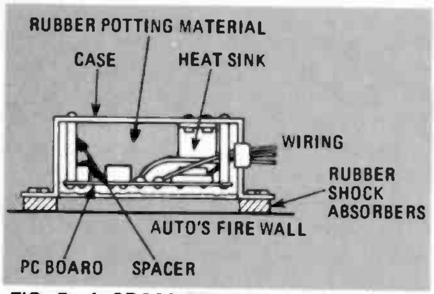


FIG. 7—A CROSS-SECTION drawing showing the shape of the case and how the PC board is suspended on four spacers.

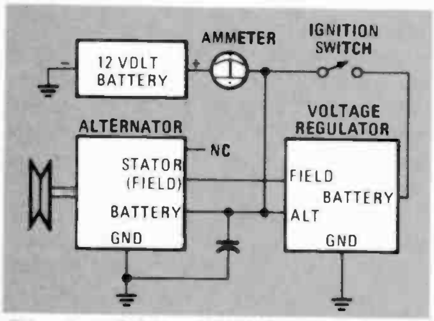


FIG. 8—TYPICAL AUTOMOTIVE BATTERY-CHARGING SYSTEM using a grounded-field alternator. Most of the wiring already exists in car's wiring. Check the connector to the old regulator; the four required interconnections probably are provided.

Construction

Since the automotive environment is quite harsh—high temperature differentials, high mechanical vibrations, and corrosive chemicals—the packaging and construction are less flexible than with most other projects. It is recommended that a printed-circuit board be used. Figure 4 provides the foil pattern for a typical PC-board layout. You may use the pattern or lay out your own board. If you wish to obtain a pre-etched and drilled PC board, Questar Engineering Company is selling it. They will also supply individual major components, or a complete kit.

As to the components required: The IC and PNP transistor, to my knowledge, may be obtained by the hobbyist only from Questar; all other components are quite common. Lay all components out on your work surface and compare them, item by item, to the parts list. If any component is missing or of a radically different value than specified, *do not* proceed until that situation has been corrected.

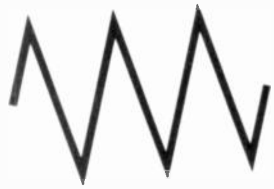
Using the parts-placement guide in Fig. 5, install the resistors, capacitors, and the trimmer. Inspect those components for proper location and solder them into place using a 40-watt iron with rosin-core solder only.

Now install a jumper for the temperature coefficient you have chosen. The choice is based on your auto environment at the point where you install the regulator. In most cases, that will be determined by trial and error—my auto installation worked best with the mid-position jumper (between R5 and pin 6).

Next install the diode, transistors, and the IC. Orientation is important for those components! Because of the environment an integrated circuit socket is not recommended. Set the pot to mid-position—about 14 volts. Temporarily wire the circuit to your car. First, verify it is operating normally; second, convince yourself that you have chosen the correct temperature coefficient. If you haven't, you can change the jumper position appropriately. Vary the pot setting and observe that the regulation level will change. Remember, if you decrease the voltage setting it will take awhile for your battery to discharge to the new level. After you have completed that step remove the circuit and install a set of permanent wires about six or eight inches long.

continued on page 85

Synthesized Function Generator



A function generator is one of the most useful pieces of equipment you can own. This synthesized unit offers professional performance at a reasonable price.

GARY McCLELLAN

THE FUNCTION GENERATOR IS A RELAtively recent piece of equipment (since the early 1960's) and has found its way to the average hobbyist's workbench. These devices are really handy for checking out audio gear, servicing other equipment, and just plain experimenting. But unfortunately, progress seems to have ignored the function generator. The generators you see today are great, but all still have crudely calibrated tuning dials that are hard to read, and most generators have some frequency drift. That may be acceptable for most purposes, but try to work with the new active filters, tone decoders, and phase-locked loops. It's tough to do if you don't have good control over the function generator's frequency, which can drift out of the passband of these devices.

Enter our SFG-or *S*ynthesized *F*unction *G*enerator project. This device is a radical departure from conventional function generators in many important ways. As you can see from the photos, gone is the squinty analog tuning dial that you always had to fiddle with. And gone, too, is the drift of conventional function generators that can cause so much aggravation when working with sharp filters. And there are other innovations, too, like the absence of a range switch—that feature is done automatically by the panel switches. And there is also a switchable digital output of different frequencies on the rear

R-E TESTS IT

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

THE SYNTHESIZED FUNCTION GENERATOR was tested in our laboratory. As expected, signal frequencies were totally accurate, thanks to the quartz crystal frequency synthesis method used in the circuitry of the device. Maximum peak-to-peak signal amplitude observed was 15 volts for the sinewave output—somewhat lower for the triangular and squarewave outputs.

As is true of most other function generators, distortion of the sinewave output was quite high. Our measured results are as follows:

Frequency	Harmonic Distortion
100 Hz	2.5%
2 kHz	2.0%
10 kHz	3.0%
100 kHz	1.3% (Bandwidth limit of analyzer)

Accordingly, we would not recommend the use of the sinewave output for distortion evaluations of audio equipment, but rather as a highly accurate source of desired audio (and super-audible) frequencies. The

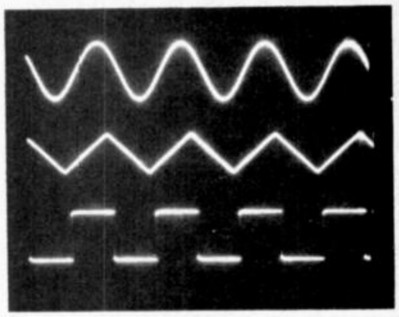


FIG. 1

sinewave source *may* be used for measuring frequency response of audio equipment, however, since levels remain constant over the entire bandwidth of the instrument. The TTL compatible signal outputs on the rear of the unit were also checked and were found to be in accordance with the author's claims and suitable for driving external logic circuitry.

Waveform outputs from the SFG were photographed in a composite photo, as shown in Fig. 1. The frequency selected for this scope photo was approximately 2 kHz.

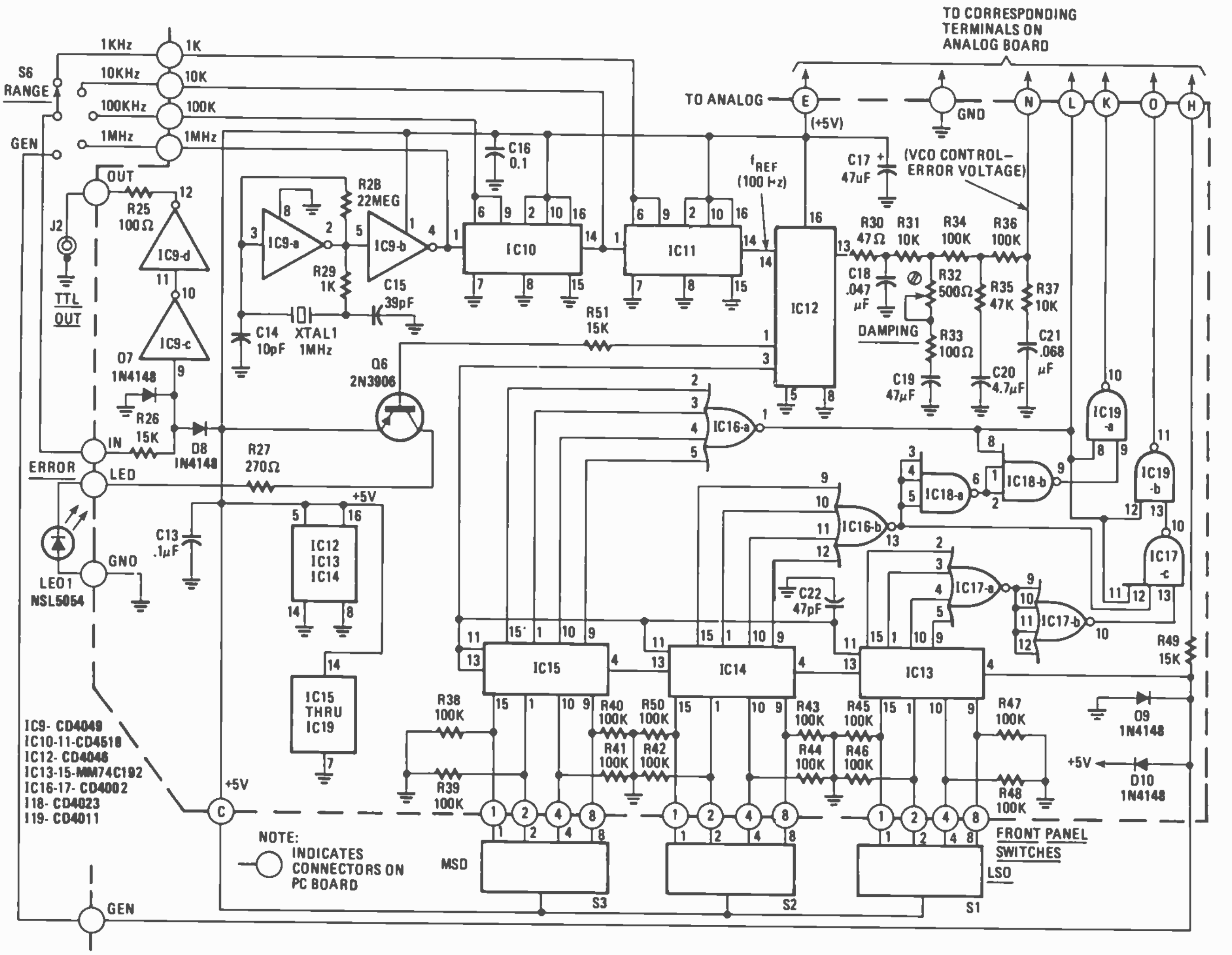


FIG. 1—SCHEMATIC DIAGRAM of the digital circuitry used in the SFG. The many output frequencies are all derived from the 1-MHz crytal and a series of programmable frequency dividers.

panel for use in running digital circuitry *independent* of the frequency the unit is set to. And if that isn't enough, this generator is crystal controlled.

You'll like the performance features of the SFG, too. All you have to do is set the desired frequency with the front-panel thumbwheel switches, select the type of waveform, and adjust the output level. There's a frequency vernier control that allows you to "fine tune" your frequency with minimal (if any) drift, too. (The photos show four thumbwheel switches. Only three are used in the SFG because output waveforms suffer when programmable output is pushed to 1 MHz.) The maximum output frequency is 100 kHz. There's an error indicator that alerts you if for some reason your frequency is off.

Not to be forgotten are two other important requirements of a function generator—namely the output waveforms and output impedance. This project offers high-quality sine, square, and triangular waveforms, plus TTL level signals from 1 kHz to 1 MHz in decade steps. The output is 50 ohms as found in the highest quality function generators. It can swing up to a 10-volt peak-to-peak signal into a 50-ohm load. If you are looking for an advanced, high-quality function generator, you are bound to like this project!

The performance of the SFG rates well with other function generators. In addition to its superior frequency stability, it produces a low distortion (adjustable to 0.5% THD) sinewave. It also generates triangular and squarewave signals on a par with the better generators. As mentioned earlier, this project features a low-impedance output (50 ohms) that is ideal for driving low-impedance loads. In fact, you can drive a speaker if desired! And with a maximum output of 10 volts peak-to-peak into 50 ohms, there should still be plenty of signal delivered to that 4-ohm speaker.

Although this is an advanced project, the cost and construction features have been optimized to make it as easy as possible to own this instrument. The cost is lower than most less-sophisticated function generators, and far lower than the least expensive commercial equivalent. In fact, the nearest commercial unit costs about $800, and this project was built for 15% of that. Wouldn't you like to have the SFG for about $60?

Inside the SFG

This project is built on two PC boards to make assembly and testing easier. Let's begin with the digital board, whose schematic is shown in Fig. 1. The signal starts with crystal XTAL1, which generates a 1-MHz reference with the aid of inverter IC9-a and IC9-b. Since the frequency of this signal is too high for the rest of the SFG, it is divided down to 100 Hz by IC10 and IC11. Each of those IC's contains a dual CMOS decade counter. In addition, the outputs of each decade are tapped off, buffered by IC9-c and IC9-d, and appear on a rear-panel switch and TTL-OUTPUT jack J2. Those signals are handy for other digital testing. Meanwhile, the 100-Hz output of IC11 drives the reference input of IC12, a CMOS phase detector. That device compares the phase of two signals and gives an output if they are different. In this case, the original signal is the 100-Hz reference from IC11, and the unknown signal derives from IC15.

When the SFG has reached the frequency it is set to, the synthesizer is said to be in "lock", and both input frequencies will be 100 Hz. Let's look closer at IC13 to IC15. Those devices are the programmable dividers that accept inputs from the front panel switches (S1–S3) and divide the signal from the VCO by the same number. Thus, if the switches are set for 100, and the VCO generates a

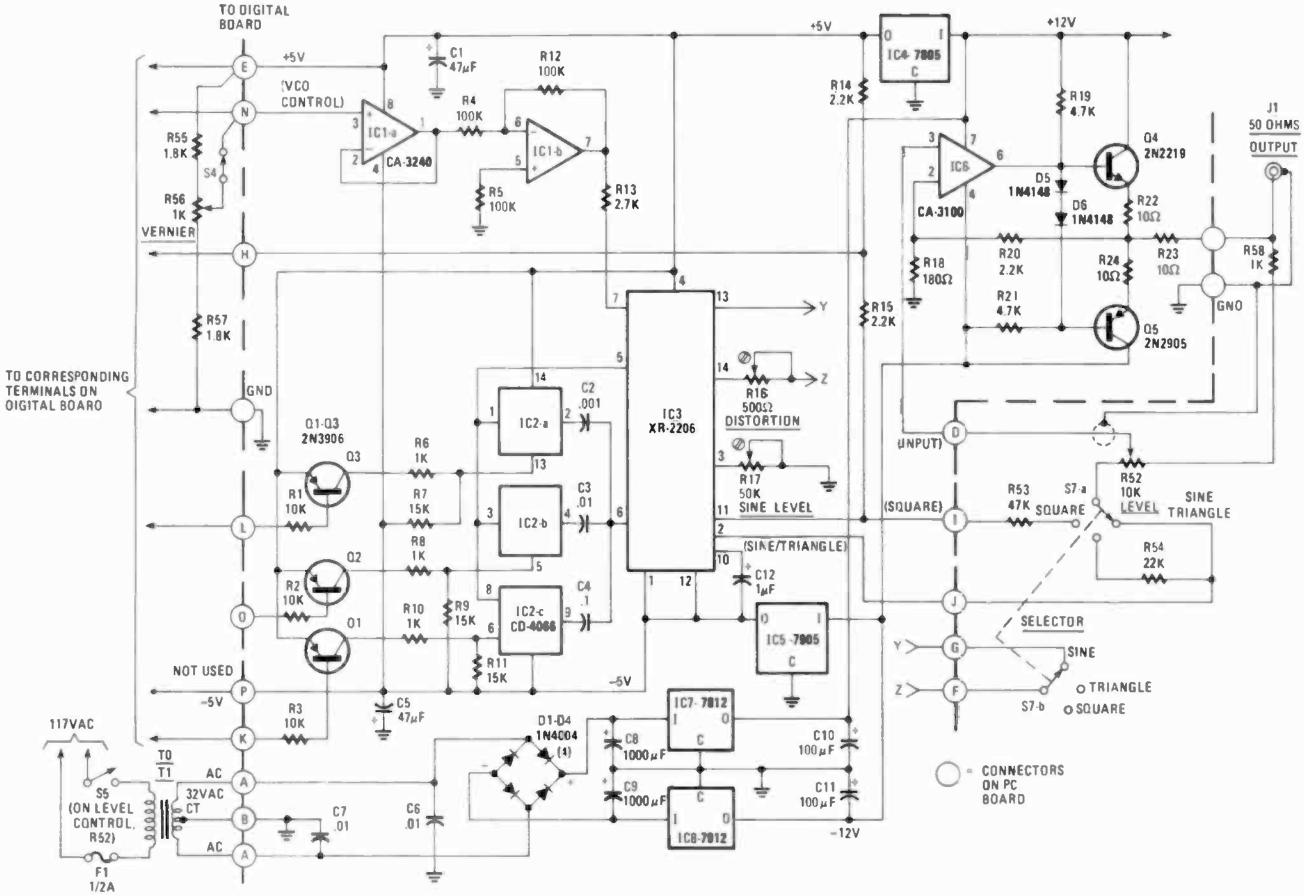


FIG. 2—THE ANALOG CIRCUITS are designed around IC3, the heart of the function generator. Output frequency is determined by a DC voltage from the digital section. Range switching is automatic.

PARTS LIST

Resistors ¼ watt, 5% unless otherwise noted
R1–R3—10,000 ohms
R4, R5, R12, R34, R36, R38-R48, R50—100,000 ohms
R6, R8, R10, R29, R58—1000 ohms
R7, R9, R11—15,000 ohms
R13—2700 ohms
R14, R15, R20—2200 ohms
R16—500 ohm trimpot
R17—50,000 ohms, trimmer (Jim-pak 840-50K or equal)
R18—180 ohms
R19, R21—4700 ohms
R22-R24—10 ohms, ½ watt
R25, R33—100 ohms
R26, R49, R51—15,000 ohms
R27—270 ohms
R28—22 megohms
R30—47 ohms
R31, R37—10,000 ohms
R32—500 ohm trimpot
R35, R53—47,000 ohms
R52—10,000 ohms, linear-taper pot with SPST switch
R54—22,000 ohms
R55, R57—1800 ohms
R56—1000 ohms, linear-taper pot with SPST switch

Capacitors
C1, C5, C17—47 μF, 6 volts, electrolytic, PC mount
C2—0.001 μF, 100 volts, Mylar
C3, C6, C7—0.01 μF, 100 volts, Mylar
C4—0.1 μF, 50 volts, Mylar
C8, C9—1000 μF, 25 volts, electrolytic, PC mount
C10, C11—100 μF, 16 volts, electrolytic, PC mount
C12—1 μF, 16 volts, tantalum
C13, C16—0.1 μF, 25 volts, ceramic disc
C14—10 pF mica
C15—39 pF mica
C18—0.047 μF, 100 volts, Mylar*
C19—47 μF, 6 volts, tantalum*
C20—4.7 μF, 6 volts, tantalum*
C21—0.068 μF, 100 volts, Mylar*
C22—47 pF ceramic disc
***Do not substitute.**

Semiconductors
D1-D4—1N4004
D5-D10—1N4148
IC1—CA3240AE dual BiMOS op-amp
IC2—CD4066 quad analog switch
IC3—XR 2206 function generator (EXAR)
IC4—7805 or LM340T-5 +5-volt regulator
IC5—7905 or LM320T-5 −5-volt regulator
IC6—CA3100EM wideband op-amp
IC7—7812 or LM340T-12 +12-volt regulator
IC8—7912 or LM320-12 −12-volt regulator
IC9—CD4049 CMOS hex inverter
IC10, IC11—CD4518 CMOS dual BCD up-counter
IC12—CD4046 CMOS Micropower phase-locked loop
IC13-IC15—MM74C192 CMOS BCD up/down counter
IC16, IC17—CD4002 dual 4-input NOR gates
IC18—CD4023 CMOS triple 3-input NAND gates
IC19—CD4011 CMOS quad 2-input NAND gates
Q1-Q3, Q6—2N3906
Q4—2N2219
Q5—2N2905
LED1—NSL5054 LED and holder

Miscellaneous
XTAL1—crystal, 1 MHz, 32 pF parallel mode, HC-6/U case
S1-S3—BCD thumbwheel switch (C&K Type 332110000, Cherry Switch Type T35-02A3 (Herbach & Rademan) or Unimax Type SF-21X3 or equal approximately $10.00 completely assembled.
S4, S5—SPST, on R52 and R56
S6—rotary switch, 1 pole, 5 positions
S7—rotary switch, 2 poles, 3 positions
I1—power transformer, 32 volts, CT, 1 amp
J1, J2—BNC connectors
F1—fuse, 0.5A with holder
IC sockets: two 8-pin, eight 16-pin, five 14-pin
Heatsinks: two TO-220, two TO-5

PC boards and plans are available. If desired, the plans can be ordered separately or combined with a set of boards. Here's how to order: SFG-1 complete set, $12.00 postpaid in U.S.A.

SFG-2 plans only, $5.00 postpaid in U.S.A.

California residents add sales tax. Foreign residents add $3.00 for shipping and handling. No COD's or foreign currency, please. Order from Technico Services, PO Box 20HC, Orangehurst, Fullerton, CA 92633

10-kHz signal, the output will, of course, be 100 Hz.

The output of IC15 drives the phase detector input, completing the programmable divider chain. Notice the 4-input NOR gates tied to IC13 to IC15? They serve as a *priority decoder*, and act as an automatic range switch, controlling the output frequency of the instrument. The outputs of NOR gates, IC16-a, IC16-b and IC17-a go low any time a non-zero number is selected by its corresponding switch. These signals then drive inverter IC17-b and gates IC18 and IC19, generating a logic output at terminals L, K and O, corresponding to the most significant digit selected. These outputs are used to select a range capacity on the analog board, which will be described shortly. Finally, back to IC12. The output of the phase detector drives a rather extensive R-C network. That network is a "loop filter" that smooths the pulses coming out of IC12 to a DC voltage in order to drive the VCO.

The reason for the complexity of the loop filter is that it not only filters, but controls the performance of the SFG. It determines how long it takes to lock on a new signal, and how stable the output signal will be. In short, it's important. A pot adjustment is provided for "damping" or for minimizing the jitter in the output as the loop tries to lock. If you are concerned about the difficulty of making this adjustment, don't worry—it takes only a moment to make with a triggered-sweep oscilloscope. That takes care of the SFG digital board.

The second half of the SFG is the analog board. Refer to the schematic in Fig. 2. Although there are fewer IC's on this board, the larger number of discrete components make it seem "busier" than the digital board. Actually, the circuitry is easy and straightforward enough to understand quickly. The DC control signal from the loop filter goes to the input (pin 3) of IC1-a, a CMOS op-amp. That device provides the high-input impedance required to minimize loading on the loop filter. You should know that any loading on the loop filter causes damping problems—jitter—making a CMOS device ideal for this application.

The second half of IC1 serves as an inverter with a gain of one. That converts the +1.5–3-volt input from the loop filter to a *minus* value of the *same* magnitude. This is necessary to operate the function generator IC3 properly. Also, another input is provided on pin 3 of IC1-a. It is used for a frequency vernier control, or for an external FM input.

Now on to IC3. This device is a standard function generator. It generates an especially high quality sine-square-triangle wave output. The sine and triangle outputs appear on pin 2, with the type of waveform selected by closing the switch between pot R16 and pin 13. This switch is part of S7, the SINE-TRIANGLE-SQUARE SELECTOR. In the sine mode (switch closed), trimmer pot R16 adjusts the shape of the waveform for minimum distortion, while trimmer R17 sets the maximum output level. Both adjustments are easy to make with an oscilloscope.

Moving on, the squarewave output appears on pin 11. Note the pull-up resistors, R14 and R15. The voltage tapped off these resistors drives IC12 on the digital board. In order to set the output frequency, three different timing capacitors (C2, C3, C4) are used, allowing IC3 to cover 10 kHz to 100 kHz, 1 kHz to 10 kHz, and 100 Hz to 1 kHz, respectively. An analog switch (IC2) selects the appropriate capacitor. Since the switch is powered by ±5-volt supplies, some logic conversion is necessary. Transistors Q1 through Q3 provide that function, and interface the outputs from the priority decoder gates to the analog switch. Next, there's a power-amplifier circuit on board to boost the signal of the function generator IC to useful levels. That's the job of IC6, a 15-MHz op-amp, and transistors Q4 and Q5. Finally, the balance of the board consists of the power supply. Standard three-terminal regulators provide a stable source of ±12 volts and ±5 volts for the circuitry. That takes care of the analog board.

SUGGESTED PARTS SUPPLIERS

IC's:
Tri-Tek, Inc.
7808 N. 27th Ave.
Phoenix, AZ 85021
(602) 995-9352

Jameco Electronics
1021 Howard Ave.
San Carlos, CA 94070
(415) 592-8097

Misc. Parts:
Digi-Key Corp.
PO Box 677
Hiway 32 South
Thief River Falls, MN 56701
1-800-346-5144

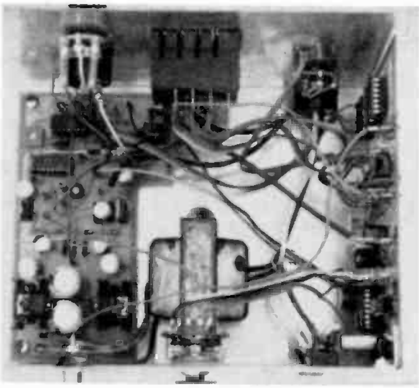
T1:
B&F Enterprises
119 Foster St.
Peabody, MA 01911

Signal Transformer
500 Bayview Ave.
Inwood, NY 11696
(516) 239-7200

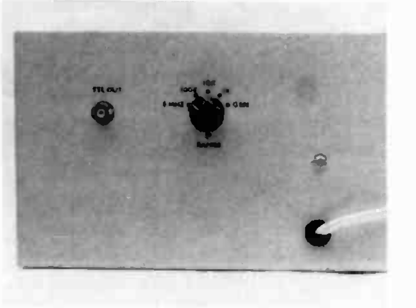
Thumbwheel switches:
C & K
15 Riverdale Ave.
Newton, MA 02158
(617) 964-6400

Jameco Electronics
1021 Howard Ave.
San Carlos, CA 94070
(415) 592-8097

Herbach & Rademan
401 E. Erie Ave.
Philadelphia, PA 19134



INTERIOR VIEW of the Synthesized Function Generator shows board and parts placement and point-to-point wiring.



REAR APRON of the SFG contains the jack for providing TTL-level signal output and rotary range switch.

The cabinet houses a few minor bits of circuitry besides the power transformer, controls, and connectors. You'll be able to see those next month when you wire up the two boards. All that the circuitry consists of is a vernier pot and switch which supply a bias voltage to the op-amp on the analog board. The pot allows adjustment of the SFG to frequencies not selectable by the switches—a handy feature. Also, there are several resistors on the SINE-TRIANGLE-SQUARE switch. Their purpose is to make the output levels of the different waveforms equal in peak-to-peak values, reducing the need to adjust the level control.

Construction

As you should know, this project consists of two PC boards and the case. So building the SFG will consist of stuffing each of the boards first, then connecting them together in the case. The work is easy if you know what you are doing and take your time to do the job.

This month we'll present the necessary information to get you started on the SFG, by assisting in the ordering of the parts and preparation of the circuit-boards. Then next month we'll describe the actual construction.

The first thing you can do on this project is to make or buy the PC boards. For your convenience, foil patterns have been provided in Figs. 3 and 4 so you can duplicate the boards. Or if desired, you can order the board set that is being made available to **Radio-Electronics** readers. Simply refer to the parts list for the name and address of the supplier. As a bonus,

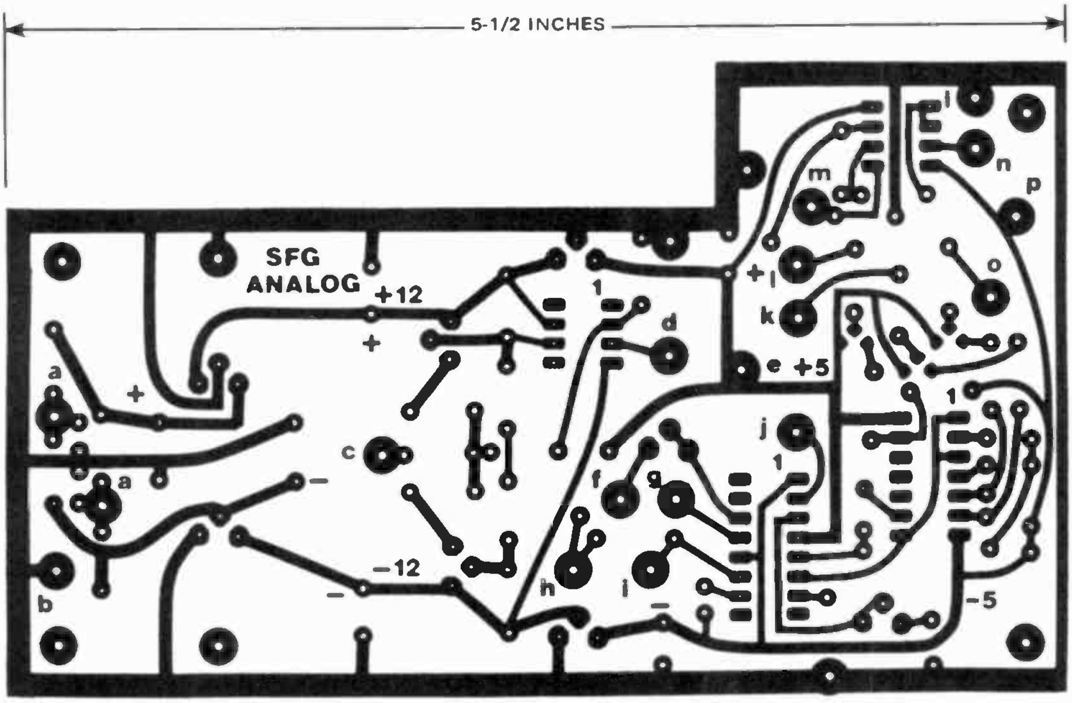


FIG. 3—FOIL PATTERN for the analog circuit board.

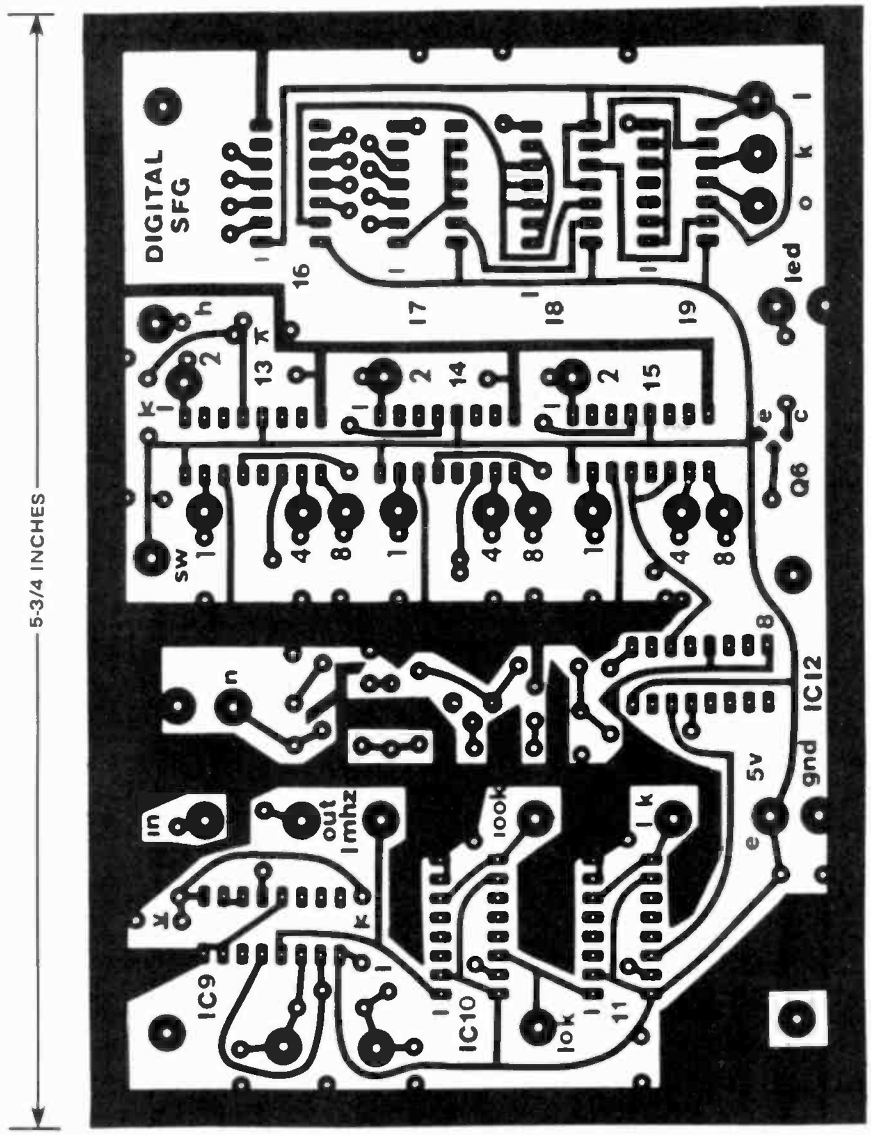


FIG. 4—FOIL PATTERN for the digital circuit board. Etched and drilled boards are available at a nominal cost. See parts list.

you'll receive a copy of instruction plans, plus operating and troubleshooting information. At any rate, the choice is yours!

The next step is to obtain the parts. That should be a fairly easy job in that no special "synthesizer products" were used in the design. All IC's are standard CMOS, with the exception of the bipolar function-generator IC. Some good parts sources are listed at the end of this article. Or, if you prefer, choose other suppliers from the classified section of this magazine, or raid your junkbox.

Now let's look at some of the parts themselves, as a few might be confusing at the store. The function generator, IC3, is from EXAR and is often seen blister-packed in stores carrying the *Jim-pak* or *CALECTRO* product lines. So you might try your local dealer for it. Power transformer, T1, may throw you at first, but it is actually one of those units used in "drugstore" stereo receivers, so you may be able to scrounge one at home. If not, try Signal Transformer, 500 Bayview Ave., Inwood, NY 11696, for a usable unit. The secondary voltage should run from 30 to 36 volts center-tapped with no load, and be capable of at least a half amp. The frequency-setting switches, S1–S3, are readily available in surplus; try a computer store. Be sure that you get one with BCD coded (e.g. C, 1, 2, 4 and 8 connections) outputs. There are plenty of those switches available from many sources if you just take time to look. As far as the rest of the parts are concerned, there should be no problems obtaining them. Just be sure to get quality devices and you'll be all set.

Next month the construction of the SFG continues with the board stuffing and installation data. The project will be rounded out with the adjustment procedure, and a "how to use it" guide. **R-E**

Connect An A/D

It's not enough simply to digitize analog information—it still has to be presented to the microprocessor to be useful. Here's how to interface the A/D converter and the CPU.

ANALOG-TO-DIGITAL (A/D) CONVERTERS ARE USED TO CONVERT analog electrical currents or voltage levels to representative digital words for use in a computer, digital instrument, or circuit containing a microprocessor. In certain control systems, for example, we might want to measure some physical parameter such as pressure, temperature, position, etc., using a transducer that produces an analog output. But the electronic instrument that processes the data produced by the transducer might be digital. The A/D converter fills the gap between the two systems.

Now that microprocessor IC's and microcomputer subassemblies are often used in control systems and other related applications, the use of A/D converters has become even more popular. Whether we are using a microprocessor as merely a small part of a larger instrument, or as a stand-alone computer that processes the data, an A/D converter is needed to supply the binary representations of the analog levels.

But no A/D converter is useful until it is interfaced to the microprocessor. That job may be as simple as plugging in an I/O (*I*nput/*O*utput) cable to a pre-existing input port on the back panel of a microcomputer. In other cases, such as when we design our own microprocessor-based projects, we will have to interface directly with the microprocessor IC and that requires a knowledge of the bus structure and microprocessor control signals.

How they work

Figure 1 shows the general block diagram for any A/D converter. There will be an input terminal for the analog signal, and a set of digital (binary) outputs. Many low-cost A/D's today are 8-bit devices and, therefore, have eight output lines, so are directly compatible with most of the common microprocessor IC's and ready-built microcomputers.

Other A/D converters, however, will have 10-, 12- or even 16-bit word lengths. Even those A/D's can be accommodated by the 8-bit machine, if the proper techniques are used.

Almost all A/D converters have two control lines, and those are used by the external circuitry or the computer. The control lines are called the *start* input and the *end-of-conversion* output, although they are sometimes given other designations. The A/D converter will remain dormant, doing nothing, until a pulse is applied to the start line. That pulse, which may sometimes be negative-going, initiates the conversion sequence. The end-of-conversion output produces a pulse that tells the external circuitry that the conversion process is finished, and that the data on the output lines is valid. In many A/D designs, the data on the output lines keeps changing and should be ignored until the EOC pulse is issued.

For synchronous operation, the start and EOC lines are separated. The external circuit will issue a start pulse and will then wait for an EOC pulse. That is the mode you would use when making only an occasional conversion. The idea is to have the microprocessor loop, or do something else, while the conversion process is taking place and then input the data when the EOC pulse is issued.

Asynchronous operation provides a continous conversion by tying the EOC and start lines together. The EOC pulse from the last conversion cycle automatically becomes the start pulse of the present cycle. In most cases, when asynchronous operation is used, an external data latch is used to hold the last valid data between EOC pulses.

Also found on continuous-conversion asynchronous, A/D's is a *status* line. That line will tell the microprocessor that the data is valid, so that input operations only occur on valid data. In a typical case, the *status* line will go low for valid data, but snaps high (indicating invalid data) during the EOC pulse.

Interfacing to a microprocessor

As in many microprocessor-interfacing jobs, there are two approaches that we can take: I/O-based and memory-mapped.

In the I/O-based systems we use the input and output instructions of the microprocessor, and that requires some form of I/O port. If we are using a ready-built microcomputer that has an unused I/O port, then the job may be as simple as connecting a cable to the port.

We may also have to interface with the bus lines inside of the computer, or directly to the microprocessor IC. In any event, we will have to provide some means to recognize the

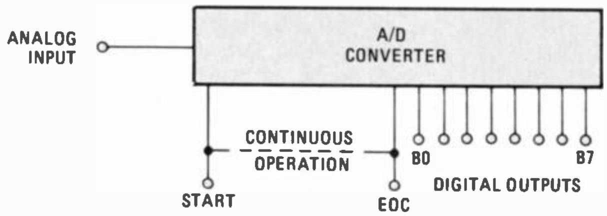


FIG. 1—TYPICAL A/D CONVERTER provides 8-bit digital representation of analog input signal. Start and EOC lines control the converter's operation.

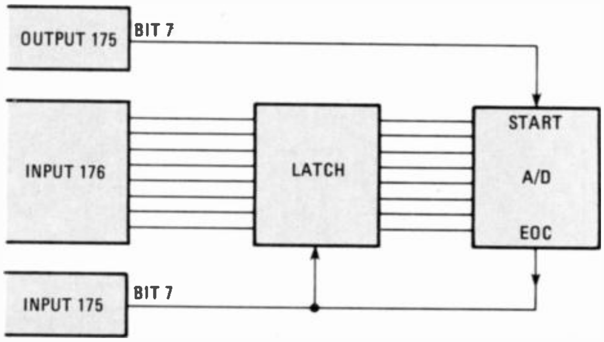


FIG. 2—I/O BASED INTERFACE requires three I/O ports. One port handles the data while the other two control the A/D converter.

Converter

JOSEPH J. CARR

microprocessor control signals, and decode the port address.

In memory-mapped systems, on the other hand, we will treat the output of the A/D converter as another location in memory. It is the usual practice to assign the A/D to a location in the upper 32K of the 64K memory range. That convention is probably the result of few microcomputers having a full 64K of memory. Some people feel that memory-mapped design is superior to I/O-based schemes.

In Fig. 2 we see a I/O-based scheme that works, even though it is costly in I/O ports. We require one entire eight-bit port for the A/D output data, and one bit each of the input and output sides of another port. In the example shown, we have assigned bit-7 (MSB) of port 175_{10} (AF_{16}) as the control signal. If bit-7 of the output side goes high, then the A/D converter sees a start command and the conversion cycle is initiated.

The EOC signal is applied to bit-7 of the input side of the same port, 175_{10}. We have designated port 176_{10} ($B0_{16}$) as the data-input port. The eight output lines from the A/D converter are connected to this port.

The operation will go something like this: we output a high on bit-7 of port 175. That begins the conversion sequence. We will then begin to look at bit-7 of input port 175_{10} to see if it goes high. The program will continue looping until bit-7 goes high. At that time, the program will input data from port 176_{10}.

A sample program is listed in Table 1. The program is written in Z-80 code, but is easily adapted for 8080, 6502, and 6800 microprocessors.

In locations 0601 and 0602 we are loading the accumulator with a value (in this case 80) that will force bit-7 high. This value is output (locations 0603 and 0604 of the program) to port 175 to become the start pulse required to initiate a conversion sequence in the A/D. But we cannot immediately expect the input data to be valid; it takes from microseconds to milliseconds for the A/D to make the conversion. Because of that, we must next loop for awhile, testing for the EOC pulse (locations 0605 to 0611). When the EOC pulse is received, *then* we may input data from port 176_{10}. In some cases, a RET statement will also be used at the end of this program, allowing the program to be used as a subroutine in a larger program.

TABLE 1

Location	Comments	Contents	More Comments
06 01	LD Add	3E	Load accumulator
06 02		80	with 10000000
		06	
06 03	OUT	D3	
06 04		AF	
06 05	IN	DB	
06 06		AF	
06 07	AND	E6	Test to find
06 08		80	EOC pulse
06 09	JP Z	CA	
06 10		05	
06 11		06	
06 12	IN	DB	Input A/D data from
06 13		BO	port 176

A program that is slightly less wasteful of I/O ports would use the same I/O port for all functions. An example of the connection scheme needed for that is shown in Fig. 3. In this case, we are *multiplexing* the port.

We could use this scheme when the A/D is a continuous conversion type, and allow bit-7 to look for the status-line condition. The program could loop, as in the previous case, until it sees the status line go high. The data from the A/D converter would be applied to a latch circuit that has tri-state outputs, so as to not load the input port when two lines are connected to it. Following the EOC pulse, the data would be applied to the port, and the program should be in a condition to accept it.

If you are building from "scratch" using a microprocessor IC, or are willing to interface directly to the bus of a hobby

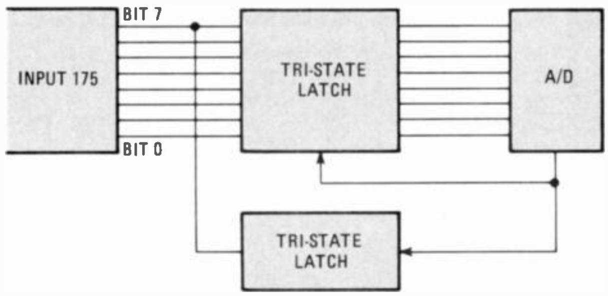


FIG. 3—ASYNCHRONOUS OPERATION of A/D converter can reduce the number of required I/O ports to one in an I/O-based interface.

computer, then it is necessary to build your own input ports. That would require an address-decoder circuit, so that the circuit would know when the program called for the A/D converter.

Address decoding

Two examples of I/O port address decoders are shown in Figs. 4 and 5. Both of those circuits may be used for either I/O or memory-address decoding.

The simplest circuit, shown in Fig. 4, uses a 7430 8-input TTL NAND gate and an inverter. The 7430 output will remain high unless all eight input lines are high. Any one line being low will keep the 7430 output high. We must, then, conspire to make those inputs high only when the appropriate address is present. Since the only address in which this condition is true is FF_{16} (11111111 in binary), we will require one or more inverters on the input lines. In the example given in Fig. 2, we wanted the data on input port 175_{10}, which is AF in hexadecimal and 10101111 in binary. Note that, in the binary representation, two bits (B4 and B6) will be low when the correct address is applied, and all others will be high. Those bits are applied to the 7430 inputs through inverters, while

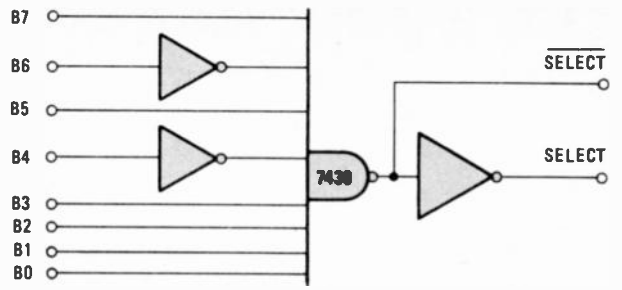


FIG. 4—SIMPLE ADDRESS DECODER can be used to decode the address of the I/O port.

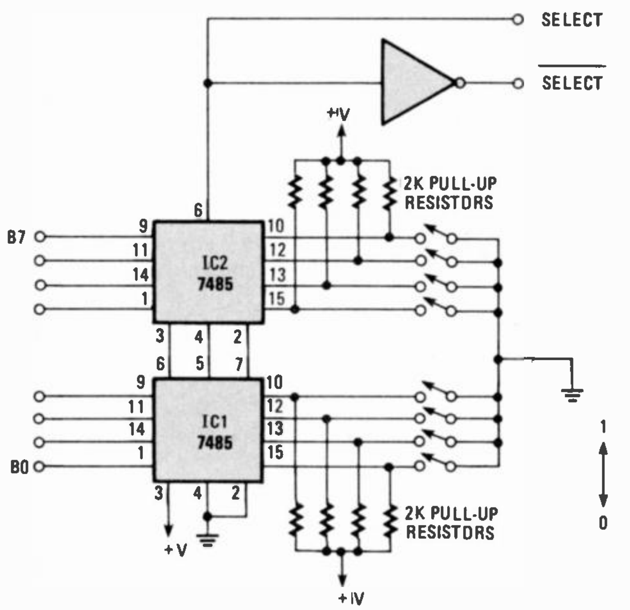


FIG. 5—ADDRESS DECODER using two 4-bit magnitude comparator IC's and a DIP switch permits easily changing the address of the I/O port.

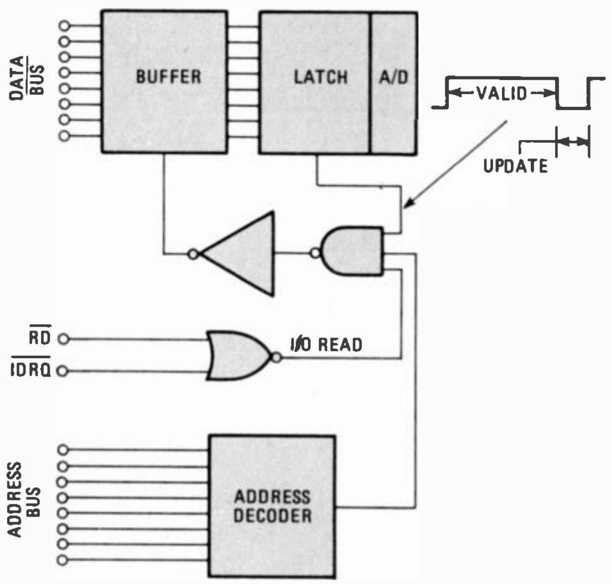


FIG. 6—DIRECT CONNECTION of A/D converter to microprocessor.

the others are connected directly. When the input word from the address bus is 10101111 (the address of port 175 in binary), then the 7430 inputs will see 11111111, so the 7430 output drops low.

The output of the 7430 is labeled $\overline{\text{select}}$. When we pass the 7430 output signal through an inverter, it is complemented to form a positive-going select signal. That signal will be used to tell us that the address is selected correctly.

The alternate approach is to use a pair of 7485 TTL four-bit magnitude comparator IC's (Fig. 5). Those TTL IC's will compare two four-bit words, and issue output signals that indicate whether they are equal, or whether one is greater than the other. They also have inputs so that two may be cascaded for eight (or higher) bit operation.

The address of the A/D is determined by eight selector switches, which in actual practice may be a DIP switch on the PC board. This address is compared with the word present on the lower byte of the 16-bit address but (B0 - B7), reflecting my use of the Z-80 microprocessor. When the lower eight bits of the address bus contains the address of the selected port, then the output (pin 6 of IC2) goes high to form the select signal.

A sample circuit for connecting the A/D is shown in Fig. 6. The A/D selected will have latched outputs, and a status line that remains high as long as the data on the output latch of the A/D is valid. During the brief period when it is updating, the status line will drop low, prohibiting transfer of the latch contents onto the data bus via the buffer.

But before the transfer to the data bus can take place, three conditions must be satisfied: the $\overline{\text{IORQ}}$ must be low, the $\overline{\text{RD}}$ line must be low (both of those lines on the Z-80 are used to indicate an I/O Request (IORQ) and a Read (RD) operation), and the address select line must be high, indicating that the input operation called for by the $\overline{\text{IORQ}}$ and $\overline{\text{RD}}$ signals will take place on the A/D converter. When those criteria are met, then the data is transfered through the buffer onto the data bus.

What we have done above is to create a microprocessor input port that is local to the A/D converter, and indeed may be on the same printed circuit board as the A/D.

In some microcomputers, the I/O cards have *data to* and *data from CPU* lines, and both *input* and *output strobe* lines. In that case, less decoding is needed. All that we need is the address decoder and the proper strobe pulse.

Memory-mapping means that the A/D converter is seen by the CPU as a memory location. Since most microcomputers do not actually have any more than 32K - 40K of the allowed 64K of RAM/ROM, we generally see the A/D converter assigned an address in the upper 32K region.

An address decoder is needed to determine when the CPU is calling for a memory-read operation. We must also use the memory-request ($\overline{\text{MREQ}}$ line on the Z-80) and $\overline{\text{RD}}$ signals from the CPU to let the A/D know that a memory-request-read has been selected.

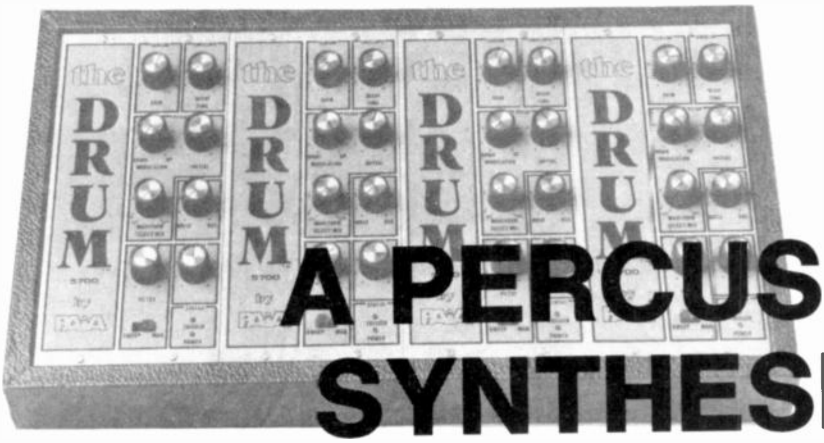
Many microcomputers have a serial-input port (and S-100 owners can buy any of several serial I/O boards), but most A/D converters have parallel output-data lines. Unless you happen to use one of the successive approximation A/D converters, which provide a serial-data output line, then you must build a serial port for the A/D converter. The easiest way to do that job is to use one of the UART chips on the market. The transmitter side of the UART receives parallel 8-bit data from the A/D, formats it according to programmed commands, and then sends it out in serial form.

The receiver side of the UART does exactly the opposite! It will receiver serial data sent by the transmitter, or sent over a serial-data communications line, and then reassemble it in parallel form. We can use the transmitter section of the UART to convert the A/D parallel output to a serial output (see *Digital Interfacing with an Analog World,* by Joseph J. Carr, TAB Books, Blue Ridge Summit, PA 17214). We can also mount the UART IC on the same board with the A/D converter.

We may also lump the topic "interfacing digital panel meters" (DPM) under the heading of A/D interfacing. The DPM is, after all, a special form of A/D converter.

Before ordering a DPM for this type of application, be sure to inquire of the manufacturer just what output coding and format are used. Some serial outputs are not sequential, and that can foul up your decoding scheme. Also find out what control signals are available. You need at least an EOC terminal, and a *start* and/or *latch output data* terminals would be handy. **R-E**

the DRUM...



A PERCUSSION SYNTHESIZER

Part 2—Full construction details as well as a detailed description of the operating controls are given in the conclusion of this project.

STEVE WOOD

LAST MONTH WE DISCUSSED THE DRUM and its theory of operation. Now, we'll go into construction. Remember that the four-channel instrument described and shown in the photos is composed of four identical drum-synthesizer modules. Although the four modules are basically identical, the summing circuit and summing amplifier are installed only on the board for channel four. The power-supply foil pattern and parts-placement diagram are in Figs. 3 and 4, respectively.

The PC board for the synthesizer modules is laid out with ease of assembly in mind. Its foil pattern is shown in Fig. 5 and parts-placement details are shown in Fig. 6 and the photo in Fig. 7. Note that everything except the six input and output jacks is mounted on the circuit board. Be sure to give the foil side of the board a cleaning before starting assembly.

Install all the passive components first, starting with the resistors, then capacitors and jumpers. Next, mount the control pots, slide switch, and the two LED's—installing them on the foil side of the board. Figure 8-a shows details of the mounting of those parts on the foil side of the board. The control pots are mounted by soldering their lugs to the pads on the PC board. The body of the pot goes into a hole that is an exact fit. The bottom of the pot is flush with the component side of the board. Pots R32 and R45 are exceptions since they have switches on them. See Fig. 8-b. Fig. 9 shows the front panel of one of the modules.

When installing slide switch S3 (Fig. 8-c), you must insulate its case from the copper foil on the PC board. Thin foam tape is ideal for the job but ordinary black electrician's tape will do. It should be placed just under the switch case, along the sides of the holes that the switch lugs will pass through.

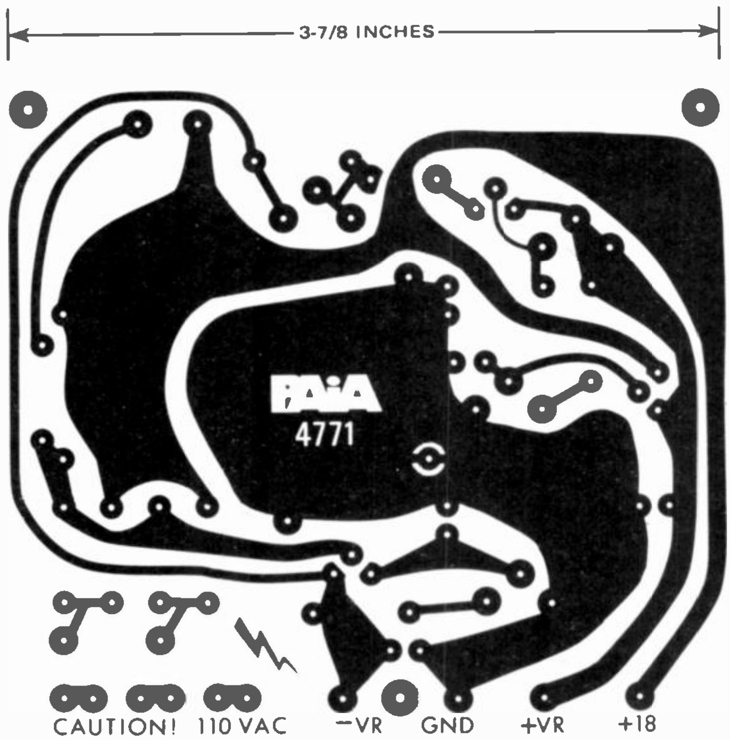


Fig. 3—FOIL PATTERN for the power supply. The power transformer is mounted on the bottom of the case, in the left-rear corner next to the supply circuit board.

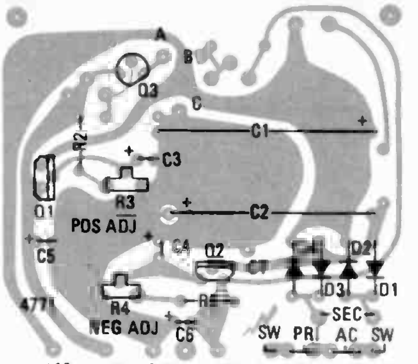


FIG. 4—POWER-SUPPLY PARTS-PLACEMENT GUIDE. The supply circuit has been simplified so some pads and circuit leads are not used.

The LED's are inserted in holes in the front panel. The panel is ⅛-inch aluminum, so alignment can get a bit tricky. It helps to crimp the leads on each LED so that when you install the panel you can work the LED's up through the holes as the panel is being set down over the bushings of the pots.

Number 22 hookup wire and some good small-diameter coaxial cable is used in making the connections between the PC board and the jacks. Figure 10-a shows how the jacks are wired. Use bare wire to connect the ground lugs (lug 2) on each jack. Start with J1, forming a small hook and anchoring the wire in lug 2. Roughly measure the distance to lug 2 on J3 and cut a piece of plastic insulated sleeving (spaghetti) to that length. Slip the tubing over the wire and pass it through lug 2 on J3. Continue around through J6, J4, J2, and J5, insulating the common ground lead between all ground lugs. Solder the connections at J5 and J6 only.

Run single-conductor wires from indicated pads on the circuit board to the proper lugs on the jacks. You will have leads from points C, E, E′, G, and U. Now, following Fig. 10-a, run lengths of coax cable from the circuit board to the jacks. Note that the shield braid always connects to a ground lug (lug 2). Wire S1, J7 and R62 as in Fig. 10-b.

When you get the four modules wired and installed in the cabinet, and wired up, turn on the power and carefully check the voltages. You'll have +9 volts at 20 mA, −9 volts at 20 mA and the POWER indicator LED should light. The TRIGGER indicator LED should flash when you strike the transducer.

Calibration

This step is a snap! Just set the controls up like this:

SENSOR GAIN	approx. 3 or 4
DECAY TIME	approx. 3 or 4
PITCH MOD.	fully CCW (down)
INITIAL PITCH	approx. 3 or 4
WAVEFORM	sine (fully CCW past detent)
MIX	osc. (fully clockwise)
NOISE FILTER	fully CCW
SWEEP/MAN	manual
OUTPUT	Midway (adjust as required)

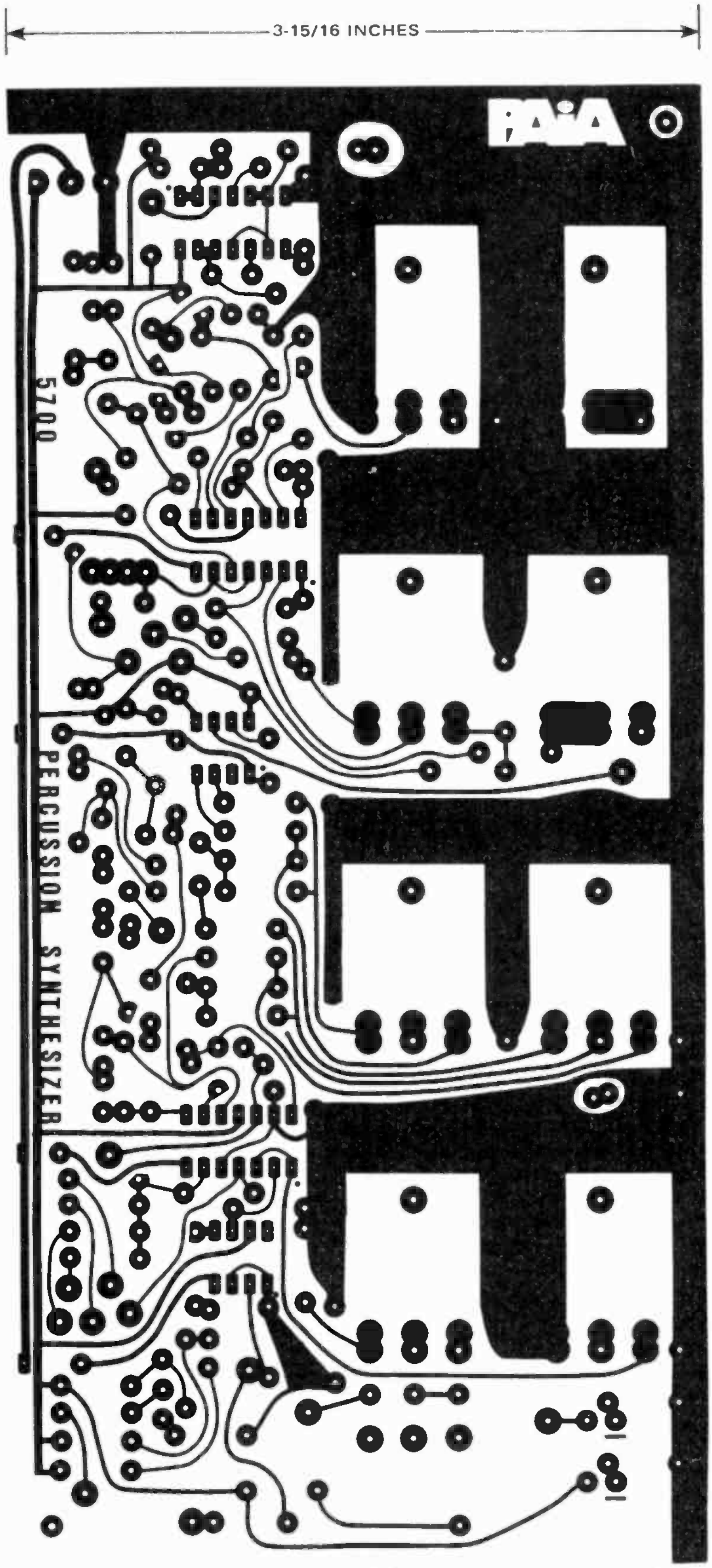


FIG. 5—PATTERN for one drum-synthesizer module. You need four modules to duplicate The Drum.

Now, strike The Drum transducer with a pencil or your finger. You should hear the pitch go down in frequency and die out in a short time.

Trigger The Drum several more times and play with the DECAY TIME control. Note that as the control is rotated farther clockwise, the downward sweep in pitch becomes slower and it takes longer for the tone to become inaudible. Leave the DECAY TIME control set at some intermediate value.

Rotate the MODULATION control from DOWN to UP. Notice that as the control is

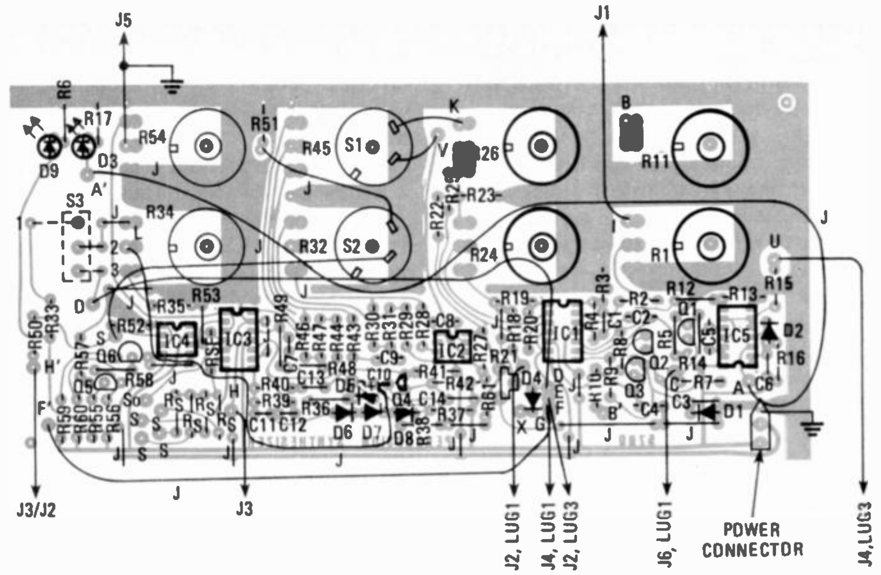


FIG. 6—HOW PARTS ARE POSITIONED on the synthesizer modules. The four R_S resistors are installed only on the module for the fourth channel. The diagram also shows jumpers and connections to off-board components.

rotated, the amount of downward pitch shift as The Drum sounds decays decreases until at some position of the control there is no pitch shift at all. Further clockwise rotation beyond this point should cause the pitch to shift up.

Set the internal trimmer R21 as follows: Rotate the MODULATION control fully CCW (DOWN), trigger the Drum and make a mental note of the pitch produced at the beginning of the downward sweep. Next turn the MODULATION control to fully CW (UP), and once again trigger The Drum. Adjust R21 so that the pitch produced at the end of the upper sweep closely matches the pitch at the beginning of the previous downward sweep. This is not a critical adjustment and may be set to taste.

Turn the INITIAL PITCH control in the clockwise direction and observe that the output pitch increases as the control is rotated. Return the control to a setting of 3 or 4.

Switch the WAVEFORM MIX control to the triangle position, just clockwise from the detent. When The Drum is triggered now, you should be able to hear a slight, but noticeable difference in the timbre, as the output changes from a sinewave to the selected triangle. If you can't tell any difference, try turning the OUTPUT level control down some and turn your amplifier volume up to compensate. As the WAVEFORM MIX control is rotated in a clockwise direction from triangle to square wave, the timbre should become progressively less "mellow." Return the WAVEFORM MIX control to the sine position.

While triggering The Drum, begin rotating the NOISE/OSC MIX control in a counterclockwise direction toward the NOISE position and observe that progressively more noise is mixed into the output. Rotate the control fully CCW past the detent and note that there is only noise in the output and no oscillator signal is present at all.

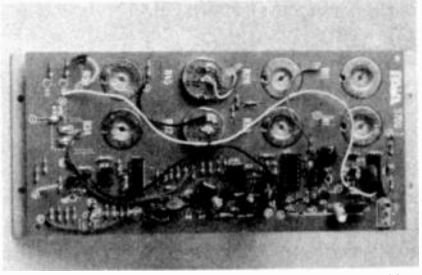


FIG. 7—REAR-VIEW of one of the modules. Use it along with Fig. 6 when you are placing parts and jumpers.

With the NOISE/OSC MIX control set fully CCW, continue triggering The Drum and observe that rotating the NOISE FILTER control clockwise causes apparent pitch of the noise to increase.

With the NOISE/FILTER control set to its mid-range position, change the SWEEP/MAN switch to its SWEEP position and note that the apparent pitch of the noise now follows the drum envelope. Also observe that with the filter in the sweep mode, the FILTER control is acting as an initial frequency control which increases the "range" of the filter sweep as the control is rotated CW.

Using the drum

The DRUM has a number of front-panel controls (Fig. 9) and jacks (Fig. 10) on the back panel. While some of them follow conventional designs, others offer control features or interface capability not found on many other percussion synthesizers. The following is a list of those controls and connectors, and a brief description of their function:

SENSOR GAIN—This control sets the sensitivity of the 5700 to the triggering signal from the sensor. If it is set too high The Drum will trigger too easily, resulting in false triggering and loss of dynamic range. Too low a setting will make The Drum hard to trigger.

ENVELOPE DECAY TIME—This control sets the decay time. The decay time becomes longer as the control is rotated clockwise.

INITIAL PITCH—This control sets the initial pitch of the VCO, which constitutes The Drum pitch source. Clockwise rotation of the control increases the initial pitch.

MODULATION UP/DOWN—This control, when set fully counterclockwise (to DOWN) causes a downward sweep of the pitch source. Full clockwise rotation (to UP) makes the pitch sweep up after triggering. Settings between those two extremes produce progressively less pitch modulation, and when the control is centered there should be no pitch modulation at all when The Drum is triggered.

WAVEFORM SELECT/MIX—This control

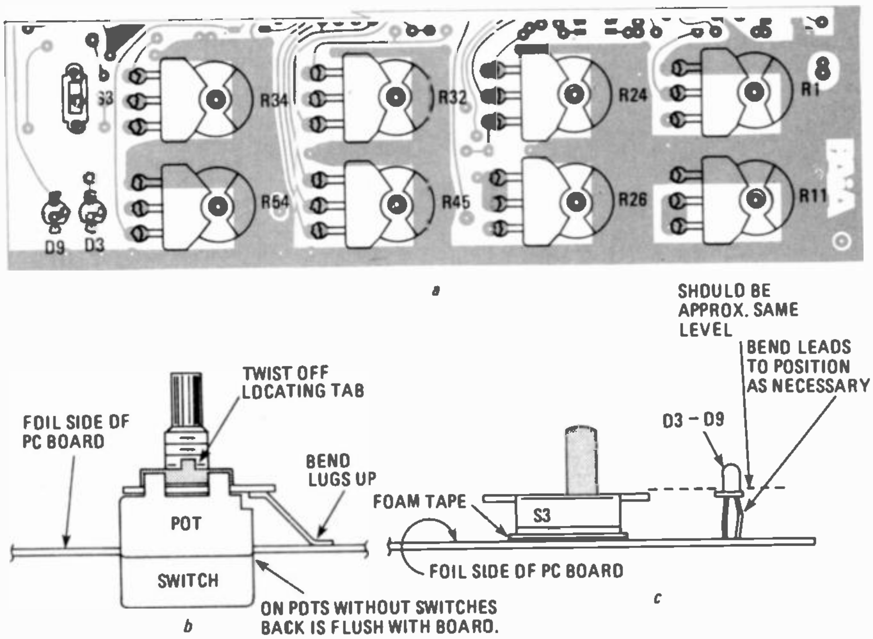


FIG. 8—HOW POTS, SWITCH, AND LED's are mounted on the PC board. Diagram at *a* shows how potentiometer lugs are soldered to pads on the PC board. Sketch at *b* shows how to shape the control lugs before soldering and *c* shows details of switch S3 and LED mountings.

allows mixing of waveforms from the VCO. Turned fully counterclockwise, past the detent, the output signal will be a sinewave. Turning the knob in a clockwise direction just past the detent produces a triangle waveform. Continued clockwise rotation of the control begins to mix a squarewave into the output until at the extreme end of the rotation the signal is completely squarewave.

NOISE/OSCILLATOR MIX—This control provides mixing between the VCO signals and filtered white noise. Full clockwise rotation will produce VCO signal only. Full counterclockwise rotation past the detent will produce an output signal

FIG. 9—THE FRONT PANEL of the 5700 synthesizer module with the codes keyed to the various controls.

of noise only. Positions between these extremes will cause the output to be a mix of both pitched signal and noise.

SWEEP/MAN—This slide switch allows the corner frequency of the filter associated with the noise source to either track the drum envelope (in the SWEEP position) or to be set to a fixed value (MAN position).

NOISE FILTER—This control sets the corner frequency of the filter when the SWEEP/MANUAL switch is in the MAN position and sets the sweep range of the filter when the switch is in the SWEEP position.

STATUS—There are two LED's on The Drum front panel. The LED labeled POWER should continuously light any time power is applied to the PC board. The TRIGGER-indicating LED will wink briefly at each triggering of the synthesizer circuitry.

OUTPUT LEVEL—Clockwise rotation increase, output signal level.

Back panel jacks

J1 (INPUT)—This jack is the input from which The Drum synthesizer derives dynamics information (when and how hard the drum was struck). The input can come from the drum transducer or from a microphone or other audio transducer. For computer interface, this input can come from a digital-to-analog converter.

J2 (EXT CV IN)—This jack is an external control voltage input. When a control voltage source is plugged into this jack the envelope-follower output will be disconnected from the VCO frequency controlling circuitry and the external source will take its place. Both UP/DOWN MOD. and INITIAL PITCH controls will still be functional.

J3 (EXT SIG IN)—This jack is used to apply an external audio source directly to The Drum's VCA for percussive voicing. When used, this jack will disconnect the internal signals from the VCA and only the external signal will be passed. Unless working with extraordinarily high external signal levels, the WAVEFORM SELECT/MIX control should be kept in the sine position.

J4 (E.F./TRIGGER OUT)—This is a stereo jack that carries two output signals. On the ring or collar connector (lug 3) is the trigger output which goes high briefly each time The Drum is triggered and on the tip connector (lug 1) is a time-varying DC voltage which is the output of the A/R generator. There are numerous possible uses for those signals; for example, the envelope of one 5700 card can be routed to the EXT CV IN of a second card and the two outputs mixed to produce a dual-oscillator drum voice. To operate two drums from one sensor, take EF/OUT signal from point "X" and feed it to J1 of the second drum module.

In computer applications, the TRIGGER OUT can be used to signal the processor that the drum has been struck while the E.F. OUT is connected to an analog-to-digital converter (such as the PAIA EK-7 Dual Digitizer) to provide dynamics information in a digital form.

J5 (OUT)—This is the audio output jack. It is a closed-circuit jack that will pass the output signal to a summed output in a multi-channel system when no plug is inserted.

J6 (CANCEL)—A switch plugged into this jack will allow for disabling The Drum when not required. This is particularly useful when using the synthesizer with an existing drum set. Connect the four CANCEL jacks in parallel and then you can control the four channels with one footswitch.

Some good friends played around with a rough four-channel prototype while The Drum was under development. A surprising number of options were discovered in relation to the mounting of the transducer ranging from gluing it to an externally-mounted muffler to the obvious (taping it to the bottom of the drum head). Actually, you can put the transducer anywhere you want to: on the inside of the drum shell, or on the outside for that matter, or on a bottom head—if you have them. It doesn't care! A convenient means of temporarily mounting the sensor while searching for just the right place is to use a foam tape with adhesive on both sides. The actual mounting details will depend on your personal preference. Before you decide on a particular location, move the sensor around a bit. The results may surprise you. When the best sensor location is found, the transducer can be permanently mounted there with *Instant-Weld* or a similar adhesive. It also works out quite nicely to mount it in a practice pad (also available from PAIA).

If you don't have the transducer that's available from PAIA, you can get by with a high-impedance microphone (though The Drum's dynamic response may suffer). **R-E**

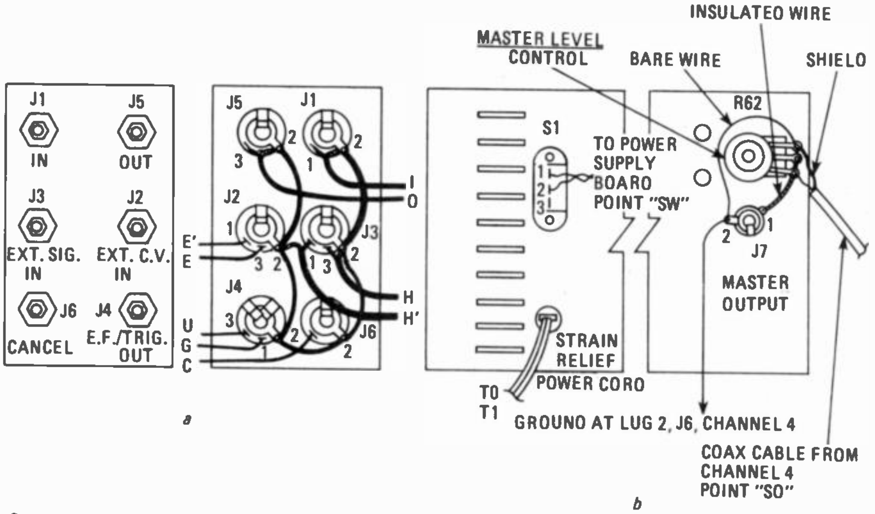


FIG. 10—HOW COMPONENTS ARE MOUNTED on the rear panel. Drawings at *a* show the jacks: how they are positioned and connected to coded points on the circuit board. Four sets of jacks are used—one set of six for each synthesizer module. The drawings at *b* show components on the ends of the rear panel.

OUTLOOK — Digital Audio For The 1980's

The introduction of Pulse Code Modulation (PCM) recording technology will soon give you truly "live" audio quality in your home. The equipment's available now.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

IT HAS BEEN OVER 100 YEARS SINCE THE phonograph record, as we know it, was first introduced by Edison in the form of a cylinder with tinfoil wrapped around it. Crude as that record was, its fundamental mode of operation was no different from that of the highest-fidelity disc recordings we listen to today. The 19th century cylinders and the high-quality vinyl long-playing records of 1980 all operate on analog principles.

The process begins with sounds reaching a microphone (or several microphones) that translates the sounds into minute, constantly varying voltages or currents. Those varying voltages or currents are then stored as program material in a variety of ways. The varying electrical signals might be applied to a magnetic-tape head that is then used to apply varying degrees of magnetization to magnetic particles imbedded or coated on a strip of tape. Alternatively, the electrical signal might be used to move a cutting stylus that creates grooves in a master recording. These grooves would have side-to-side or up-and-down wiggles in them that are a replica or *analog* of the original sound waves picked up by the microphone or microphones.

Both of those purely analog systems of sound storage have serious limitations. Even in their most advanced forms, tape and discs have limited dynamic range. Measured in dB of sound-pressure level, modern or classical orchestral music has a dynamic range of from 85 to 95 dB. Neither present-day discs nor tapes can store that wide dynamic range. Figure 1 illustrates the point. In the case of magnetic tape, if you try to record the loudest sounds of music at their correct relative amplitudes, you will exceed the magnetization capacity of the tape. Beyond a certain level the tape becomes saturated and louder signals will not cause linearly greater magnetization levels of the tape. The situation is similar to that of an amplifier that is driven into overload; the result is clipping and severe distortion.

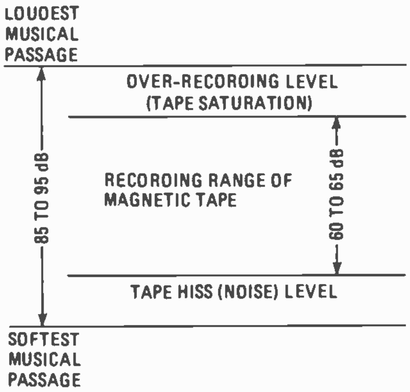


FIG. 1—DYNAMIC RANGE of magnetic recording tape is approx. 60 dB while orchestral music has a dynamic range of 85 to 95 dB.

Conversely, if you try to record the very softest musical passages they would be so low in amplitude that the magnetic pattern would be well below the residual tape hiss that is present on even the very finest tape. The same limitations apply to disc recordings. Loudest passages, if recorded as-is, would make the wiggles in the groove so great that one groove might cut through to the next. Soft musical passages would once more be buried—this time beneath the level of surface noise that is always present on a vinyl disc.

There are other problems peculiar to analog-recording methods. Wavering speed of tape or of a revolving disc leads to audible wow-and-flutter. Various kinds of distortion (particularly intermodulation and harmonic) are present during playback of either tapes or discs, often at levels that no high-fidelity enthusiast would ever tolerate in an amplifier, tuner, or receiver. When you think about it, it is quite remarkable that we have been able to store and reproduce music using analog techniques as well as we have. Still, for all of the advances made in the science of sound recording over the past century, analog recording leaves much to be desired.

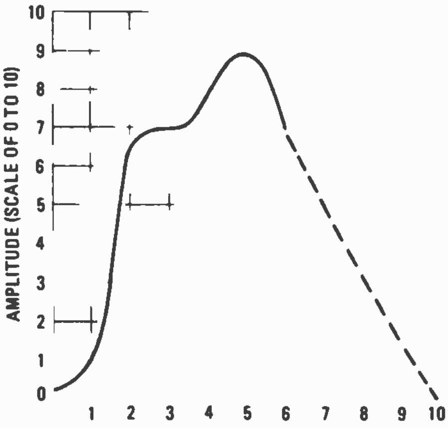
Digital recording

Much has been written in the general press, as well as in technical journals, concerning PCM (*P*ulse *C*ode *M*odulation) or digital recording. Often, journalists writing for the general press, in their excitement over the new digital-recording technique, have jumped to erroneous conclusions. There has been much talk, for example, about digital disc recordings. In fact, there is not a single digital disc recording that you could buy as of this writing. That's not to imply that there never will be. Several systems are available for creating such all-digital disc recordings. But today, when someone speaks of a "digital" disc recording what they really mean is an *analog* disc recording that has been made from a master *tape* recording that was digitally recorded. In other words, digital recording, or PCM recording as it is often called, is a reality in the world of tape recording but is not yet a marketable commodity insofar as disc recordings are concerned.

How PCM recording works

Though many people consider it to be complicated, PCM is a relatively simple technology. Consider the audio waveform shown in Fig. 2. As is true of any other continuous waveform, this one can be broken up into instantaneous levels at specific moments in time. Five milliseconds after the start of this waveform, for example, its amplitude is approximately 9 on a vertical scale calibrated from 0 to 10. The table at the right of Fig. 2 shows how we might characterize the signal at every millisecond of time, using only numbers from 1 to 10 (no fractions allowed). With such time and amplitude constraints, we won't get a very accurate representation of our original waveform expressed in numerical or *digital* form—only a rough approximation of it, as shown in Fig. 3. To get a more accurate waveform, we would have to change our approach in two ways. We would sample the original waveform much more often than every millisecond and we would break up the amplitude levels into far more than just ten increments.

For the moment, however, let's presume that the accuracy obtained in Fig. 3 is good enough for our intended purpose. The next step would be to record the numbers that we have tabulated in some convenient way onto tape. The simplest way to do that is to convert those decimal-type numbers into binary numbers, which are made up of only 0's and 1's. The binary system lends itself very well to electronic use because a "0" can be represented by an "off" or no-voltage condition in a circuit while a "1" may be represented by an "on" or positive voltage condition. Similarly, in the case of a tape recording, "0's" can be represented by no magnetization of the tape while "1's" can be recorded as a fixed-amplitude pulse. If, during playback, the tape-head reads the presence of a pulse, that's interpreted as the binary number "1", while if a stretch of tape has no signal, that condition is interpreted as a binary "0".



AT TIME	AMPLITUDE
1	1
2	6
3	7
4	8
5	9
6	7

FIG. 2—DIGITAL CONVERSION of analog signal requires sampling the amplitude of the analog signal at discrete time intervals.

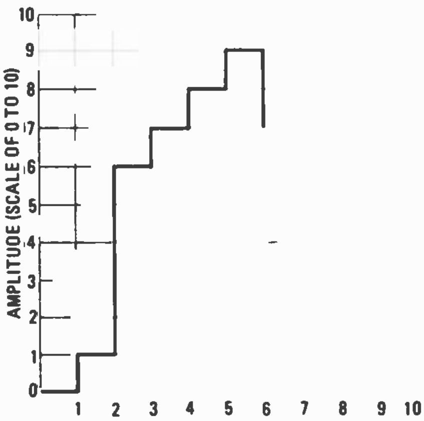


FIG. 3—DIGITAL REPRESENTATION of analog waveform shows rough approximation due to low resolution analog-to-digital conversion.

TABLE I

Decimal Number	Binary Equivalent (4-bit system)
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010

In the example of Figs. 2 and 3 we would want to express numbers from 1 to 10 in binary form. We will need a four-element code word to provide that range of numbers. In digital or PCM terminology we would call that a 4-bit system. Table I shows the 4-bit code for the more familiar decimal numbers ranging from decimal 0 to decimal 10.

To express the numbers that correspond to our sampled amplitudes of Fig. 3 (1, 6, 7, 8, 9, 7 ....) we would select the equivalent binary notations: 0001, 0110, 0111, 1000, 1001 and 0111. To record that number-code series on tape, we would apply a series of pulse and no-pulse conditions as shown in Fig. 4. So long as the positive pulse is easily distinguished (during playback) from a no-pulse condition, we have a means of recovering the coded numbers. And, if we can recover the coded numbers we can also convert them back to the approximate waveform of Fig. 3 which is, in turn, an inaccurate replica of the musical waveform of Fig. 2 with which we started.

Several clear advantages result from such an approach to signal storage. Since the tape playback head now simply has to read pulse or no-pulse conditions, tape saturation or overrecording is no longer a factor. Residual tape hiss or noise is also excluded from the recording. That's because the level of such noise is so low that it could not possibly be misinterpreted as a "pulse on" condition.

In the example cited, however, we only provided for ten distinct levels of amplitude and the distortion during playback would therefore be extremely high. Furthermore, it can be shown mathematically that with only a 4-bit system of encoding, maximum available dynamic range would be no greater than 24 dB—from loudest to softest reconstructed sound levels. For every increase of "1 bit" we can pick up another 6 dB of dynamic range, however, so that a 5-bit system would yield 30 dB, a 10-bit system would give up 60 dB (which is, incidentally, about the best we can do with conventional analog discs or tapes) while a 14-bit system would yield a dynamic range of 84 dB!

A 14-bit system will also provide up to 16,384 possible amplitude levels (2^{14}); al the way from 00000000000000 to 11111111111111! It is easy to understand how precise or refined we might be able to represent the waveform of Fig. 2, given that many amplitude levels in a 14-bit binary system. However, unless we sampled far more frequently than in the earlier example, our representation of the desired waveform would still be highly inaccurate. In any PCM or digital system, it is necessary to sample at least

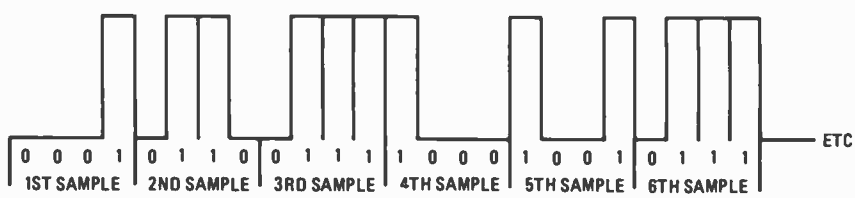


FIG. 4—PCM FORMAT is recorded on magnetic tape as the presence or absence of pulses. The PCM format shown divides each sample into a 4-bit digital word.

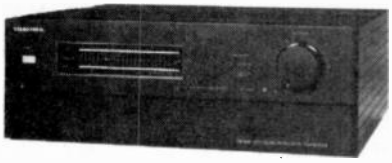


FIG. 5—TOSHIBA MODEL PCM-MARK II is a signal processor that interfaces with a video cassette recorder to provide PCM recording.

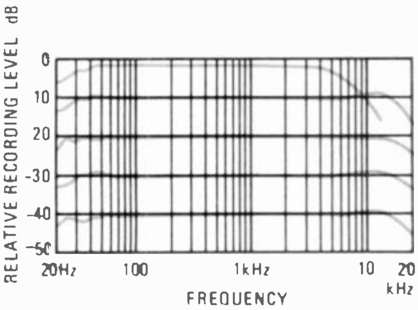


FIG. 6—TYPICAL FREQUENCY RESPONSE of analog cassette deck shows increasing non-linear response at higher recording levels.

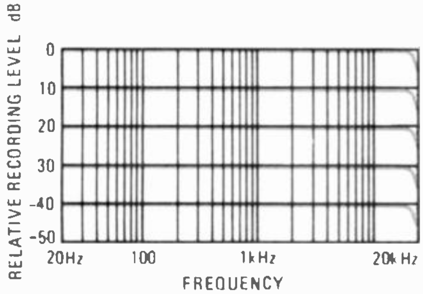


FIG. 7—FREQUENCY RESPONSE of Toshiba PCM recorder shows "ruler" flat response at all recording levels.

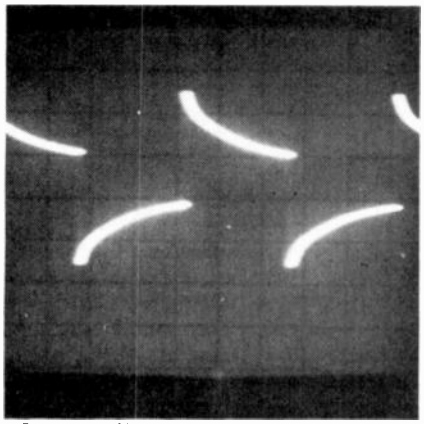


FIG. 8—PLAYBACK of low-frequency squarewave recorded on a high-quality open-reel tape deck.

twice as often as the time it takes to reproduce a single cycle of the highest frequency to be recorded. That means that if we want to be able to store and reproduce the digital equivalent of all audio frequencies from 20 Hz to 20,000 Hz we must use a sampling frequency of at least 40,000 Hz. In fact, the Electronics Industry Association of Japan (EIAJ) recently adopted standards which call for a sampling rate of 44,056 Hz in a standardized PCM format. We will look at the other aspects of this new standard shortly.

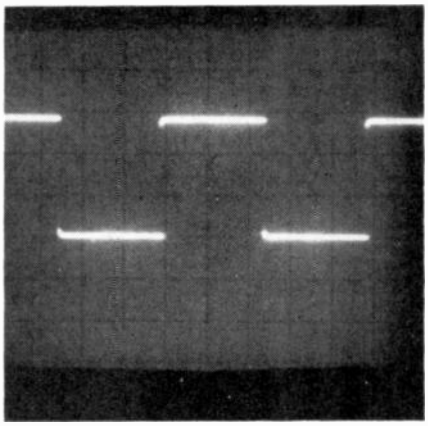


FIG. 9—SQUAREWAVE RESPONSE of Toshiba's PCM recorder shows vastly improved playback of low-frequency squarewaves as compared to Fig. 8.

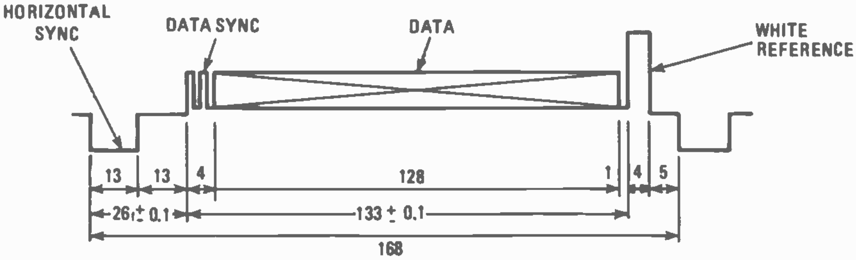


FIG. 10—EIAJ STANDARD places 168 bits on each horizontal line of the TV "picture" for recording on a video cassette recorder. The data block consists of 128 bits while the remaining 40 bits are used for the horizontal-sync pulse and the white-reference pulse.

Storing the digital information

Let's see what sort of storage capacity our tape recorder would have to have to handle this new type of PCM data. As we said, we must sample the signal being digitized 44,056 times per second. Each sample will contain 14 bits. That comes to 616,784 bits per second. But we are talking about a stereo system and, in a digital system such as this, rather than divide the tape into two tracks it is just as easy (and in fact more desirable) to interleave the digital information in a single continuous tape track—sampling first the left channel, then the right, etc. etc. That brings us up to 1,233,568 bits per second. And, as we shall see, that makes no allowance for any redundancy or error-correction code words that are found to be necessary in a PCM system.

Obviously, no present-day analog audio tape deck now used by audio enthusiasts could handle that kind of information density. Such recorders lack the bandwidth or frequency response that would be required. But there is one type of tape deck that *can* handle such bandwidths and it is one that is already found in more than one million homes in this country. You guessed it! It's the video cassette recorder, or VCR. Since these recorders must be able to record frequencies well up into the megahertz region, they constitute a natural and logical storage medium for PCM or digital audio. As the VCR market grows in this country and elsewhere, there will be more and more consumers who will own a tape transport system that is also capable of storing audio information in digital or PCM form. What those consumers would need, then, is not a complete PCM tape recorder, but rather a "black box" type of audio processor that, in the record mode, converts audio information to a standardized PCM format for application to a VCR's tape cassette and that, during playback, converts the millions upon millions of bits or pulse/no-pulse conditions read from the tape back into an analog signal. (Pioneer's recently-announced *VP 1000* laser-optical videodisc player can presently handle, in addition to the video, two channels of analog audio information. The player has been designed, however, to accept a Pulse Code Modulation adaptor which will be offered as an option at some time in the future—*Editor*).

Many manufacturers have demonstrated prototypes of such PCM audio processors at various technical and consumer electronics conventions. Among them have been Sony, Mitsubishi, Toshiba, Technics by Panasonic, JVC, and Sanyo. I have personally had an opportunity to experiment in my lab with the prototype unit from Toshiba, shown in Fig. 5. Typically, the dynamic range of this, and most other standardized PCM units, is 85 dB. Frequency response for the entire record/playback cycle is ruler-flat, from DC to 20,000 Hz, ±1 dB. Harmonic distortion is less than 0.03% referred to maximum record level and wow-and-flutter is simply not measurable!

The statement concerning frequency response really fails to tell the complete story. In the case of ordinary analog cassette decks, for example, frequency response is normally quoted for a record level of −20 dB. That is done to avoid the high-frequency saturation problems inherent in tape recording at slow speeds. Figure 6 illustrates this point. Even with a high-quality analog tape deck, response at high levels of recording is increasingly non-linear at high frequencies.

Compare these results with those obtained and shown in Fig. 7, for which the prototype Toshiba *PCM Mark II* prototype was used. Results remain flat all the way up to 20,000 Hz, regardless

continued on page 87

COMMUNICATIONS SECRET INTERNATIONAL When And Where

Numbers, numbers everywhere—and nobody seems to have any idea what they're all about. After reading this, tune in and maybe you'll come up with the answer.

ROBERT B. GROVE

"ONE-SEVEN-FOUR-TWO-SIX; TWO-THREE-nine-zero-two." The tape-recorded female voice drones on. Tuning through the shortwave spectrum, we find another station...this time in Spanish. "Cinco-nueve-tres-cuatro-uno; tres-cinco-dos-uno-seis."

Those so-called "numbers stations" populate the shortwave spectrum, following regular schedules. (See Table 1). They announce no callsign and usually transmit their cryptic one-way messages for approximately 15 minutes. The same numeric sequence is often repeated on a nearby frequency (see Table 2). [The frequencies of many more numbers stations are included in a book listing over 6,000 radio stations, their frequencies as well as what they broadcast. The book is entitled "Confidential Frequency List" and is available from Gilfer Associates, P.O. Box 239, 52 Park Avenue, Park Ridge, NJ 07656 for $6.95—*Editor*.]

Who are these phantom broadcasters? Where are they located? Perhaps most important, what is the nature of their encoded messages?

One thing is certain: They have been on the air for at least 20 years. In all that time, no one has publicly settled the enigma. Many possible solutions have been suggested: They are monetary statements for world-bank transactions; coffee-plantation price quotes; bolita scores; instructions for insurgents in foreign countries; arrival-departure schedules for agents; or...nothing at all—merely part of the psychological cold war!

While most broadcasts are made in full-carrier AM, occasional single sideband transmissions are monitored.

Voice transmissions aren't the only mode; Morse code is frequently reported with similar messages, often in three-letter groups. Some listeners have even gone to the trouble to show a relationship between the number groups and the letter groups.

TABLE 1—A BRIEF SAMPLING of the numbers stations.

FREQUENCY (kHz)	TIME (UCT)
3060	On the hour
3090	Quarter past the hour
6772	0615, 0700
6840	1025
10570, 14968	2225

TABLE 2—Some additional frequencies (kHz) recently reported by various listeners.

3178	7322
3435	7445
4670	5727
5775	7887
5812	8418

A former intelligence officer states that the Russian KGB—the secret police (formerly NKVD)—used CW five-letter Russian Cyrillic to broadcast to their posts in the USSR and elsewhere. The transmissions were in the 8-MHz region, but they identified themselves with legitimate callsigns which were registered with the ITU (International Telecommunications Union). It is very unlikely that those are the stations that are being reported.

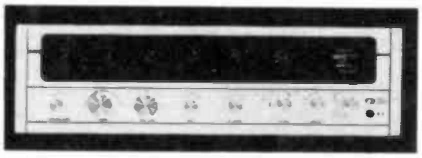
Let's examine some of the hypothetical suggestions which have been offered.

World-bank transactions: Although visitors to Latin American countries have noticed large antennas on the tops of some of the banks, it would seem unlikely that international banking would operate via a clandestine network. Such activities have never been reported among the myriad member countries, and the frequencies chosen for numbers transmissions would not support such a large geographical network. Keyboard teletype would be far more practical for such monetary transactions.

Coffee plantation price quotes: Although a rather far-out suggestion, it shouldn't be dismissed without some consideration. Frequencies chosen for the broadcasts are usually in the lower part of the shortwave spectrum, and would favor propagation throughout Central and South America. About the only reaction that can be applied here is intuitive: It doesn't seem likely.

Bolita scores: The Cuban lottery and Bolita are popular sports among Latins. Could this be an informational system providing such traffic to lottery bookmakers? Again, the answer must remain "Unlikely." It is a little too obvious.

...Or, nothing at all? While that is a distinct possibility in a world in which some things don't make any sense at all, there is considerable evidence that

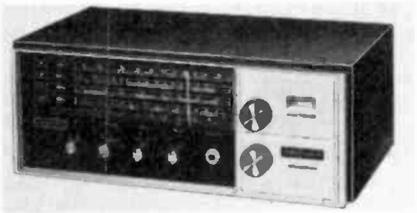


MCKAY-DYMEK MODEL DR-101 covers a frequency range between 50 kHz and 29.7 MHz.

REALISTIC MODEL DX-300 communications receiver covers a frequency range between 10 kHz and 30 MHz.

NUMBER STATIONS To Listen In

YAESU MODEL FRG-7000 covers a frequency range between 250 kHz to 29.9 MHz.



HEATH MODEL SW-717 4-band receiver covers 550 kHz to 30 MHz.

would weigh against the hypothesis. First of all, such tactics would be aimed at our intelligence organizations. Over a period of some 20 years, even with admitted bungling, U.S. Intelligence would have been able to see through such a transparent diversionary tactic.

In fact, there have been several reported cases in which the message had technical difficulties, and frantic live broadcasts were made to ensure the success of the transmission. During Hurricane Frederick, one station was apparently knocked off the air, and an alternate frequency became active for a week, apparently until repairs could be effected.

How about spies?

Yes, how about that? Although the transmission could be cryptographic training sessions (as suggested by one prominent listener with a military background) such training could be provided more easily with cassette tapes. Of course, nothing beats practical, on-the-air experience!

It would seem that after 20 years, someone would have the presence of mind to suggest using radio direction-finding techniques to home in on those "bogies." Their repeated schedules and long transmission times would make them ideal targets.

As a matter of fact, that *has* been done, and by an agency no less than our own Federal Communications Commission! One of the more classical broadcasters is the one heard on 3060 kHz at 15 minutes after the hour. Several RDF attempts have nailed that one down as being in Havana, Cuba. That has been corroborated by another intelligence agency, and also by several private hobbyists.

But other listeners, all with excellent equipment and unquestionable qualifications, have found additional "fixes" for similar stations: San Juan, Puerto Rico; Portland, Oregon; Northern Virginia; the West Coast of Florida; even London, England!

To confuse things further, many languages are reported besides English and Spanish; they include Czechoslovakian, German, and English being

PANASONIC MODEL RF-4900 is a portable communications receiver that can cover the frequency range between 1600 kHz and 31 MHz.

	5	6	7	8
1	N	A	S	O
2	6	E	M	R
3	O	B	I	D
4	T	9	3	U

15 48 27 36 26 28 17
N U M B E R S

17 45 16 45 37 18 15 17
S T A T I O N S

47 35 25 35   16 15 38   47 35 46 35
3 0 6 0   A N D   3 0 9 0

FIG. 1—The Polybius square (checkerboard or grid) uses digraphs. Each set of two numbers keys out a box in the grid. For example, 15 = N.

read by someone with a heavy European accent!

Clearly, the operation is extensive—multinational. Are they all tied together? If they are, what would be a common interest between Havana and Northern Virginia? Could those be clandestine intelligence broadcasts to foreign agents? If so, who is foreign and in which country? The more we investigate those strange broadcasts, the more paranoid we are likely to become.

Taking the content of the transmissions at face value, we would probably conclude that they are using some sort of cryptographic means of encoding. What type of code is likely? Among the easiest to use is the "one time pad." In that system, a list of letters or numbers is chosen at random to replace actual characters in the text. The pad is used only once and discarded. A new pad is used for the next message.

Listeners who have been close to intelligence work say that the one-time pad is highly unlikely: There are too many similarities among the different messages that have been copied. Not ony that, but when a suspected agent is caught with a one-time pad in his possession, that is prima facie evidence of his subversive activity!

More likely, the numbers messages constitute a checkerboard grid or Polybius square (see Fig. 1). In that arrangement, a checkerboard pattern of boxes is laid out, and all the necessary letters and numbers from the original text of the message are sprinkled through the grid. Each row is given a letter (or number) and so is each column. By calling out a pair of letters or numbers (called digraphs) we key out each of the hidden characters in the grid.

As to the real nature of the broadcasts and what the texts actually hold, we have no information. And if we had, we would not be allowed to reveal it. But we would enjoy hearing from anyone out there who thinks he may hold the key to those fascinating numbers stations! **R-E**

Backyard Satellite—TV Reception FACT OR FANTASY

Here are several important points to consider before you set up your own satellite-TV receiving station.

FRED HOPENGARTEN, K1VR*

THE INTEREST GENERATED BY THE IDEA of receiving programming intended for cable-TV operators has been unbelievable. For people with poor reception, or a limited selection of VHF/UHF television, satellite TV is a banquet for the entertainment-starved. But don't be too quick to think that it is for everyone.

View of the "bird"

At 4 GHz, geostationary satellites (called "birds") are limited to line-of-sight communications. Unfortunately, that means that if you are in Portugal, the lower Caribbean, Southern Mexico, or Venezuela (to cite location examples of people I've been forced to disappoint lately), you really have no hope of watching American domestic satellites. Those locations are just too far from the center of the footprint.

Even if you are right here in the good old U.S.A., you've got to "see" the spot in the sky where you will find the satellite. For example, I recently sold a system to a man living at 42°, 26′, 20″; 71°, 18′, 03″, to be specific. From his house to the RCA Satcom F1, at 135° over the equator, the azimuth is 251.56° and the elevation is 10.54°. After walking around his land with a compass (for azimuth) and a clinometer (for elevation), I found a spot where we could erect an antenna, if he was willing to cut off a large branch from a near-field tree, and willing to cut down entirely two trees almost 200 feet away. I love trees, mind you. But they kill reception at microwave frequencies.

If you have no "sight" on the "bird," you'll have no reception from "line-of-sight" signals.

Big dishes

Given a fairly weak signal, and some crowding in the sky, it is necessary to have a fairly big antenna. Standard antennas are between three and five meters in diameter. The larger ones are necessary on the two coasts, and the Southern tier. Despite the "FM Advantage," (capture effect) of satellite TV signals, a smaller than necessary antenna will only give you shadows. Just because you own a three-foot dish, that doesn't mean that a three-foot dish will work. Those neat Japanese systems you have heard about, selling for $500-1000, are for an experimental 12-GHz satellite. Don't look for that here before 1984, the proposed start date for COMSAT service.

Perhaps you've been thinking that one of these big dishes can be moved from one satellite to another, like rotating a fifteen-meter beam. Wrong again. Unless you buy a motorized version, *very expensive*, you'll have to go out in the backyard each time you want to change satellites. Count on using two people and taking at least 15-20 minutes each time. As winter rolls around here in New England, the thought loses appeal.

Don't forget something else about big parabolic reflectors: They act like big sails in a wind. For that reason you can't raise one very far off the ground without a substantial support system (concrete and cross-ties, or I-beam construction). It can even cause problems mounted on top of your apartment building, unless properly shielded from the wind.

Sharing with neighbors

I am frequently asked: "Can a bunch of us get together and buy a system?" The answer is yes, but . . . Of course you can receive satellite signals and pass them along, but then you are a cable-TV system in the eyes of the law, albeit a small one. You will need full-frequency coordination (to insure that a nearby terrestrial microwave link is not looking down your boresight), a license, and agreements with the program suppliers to pay subscription fees. Having done that, you will still only receive one channel at a time. This means that the person who has the receiver, controls what everyone else will watch. Just wait for the first 1 AM phone call asking you to switch transponders—but not offering to help.

To add more receivers, you must add a second Low Noise Amplifier, another feedline, power dividers, and another receiver for each additional transponder you wish to watch simultaneously.

How far away are your neighbors? If they are more than 200 feet away, then it is impractical—due to line losses—to send 4-GHz signals such a distance.

Bars and public rooms

Many of the entrepreneurs of this country have figured out that a satellite TV system is the perfect complement to projection television (wide-screen). Unfortunately, the movie channels won't let you buy the rights to show their stuff in public rooms. No Showtime, Star Channel, Galavision, Home Box Office, Home Theatre Network, or Take 2. But not all is lost. Obtaining a license is something that dealers and manufacturers do for their customers all the time. With FCC license in hand, there is still some wonderful programming to watch.

Here's what can be shown in a lounge: ESPN (24-hour sports), C-SPAN (the U.S. Congress), the three Christian Networks, Satellite Program Network, Modern Cable Programs, WOR (New York), WGN (Chicago), WTBS (Atlanta), and KTVU (San Francisco). That's a tremendous amount of sports . . . perfect for enjoying more beer. And you would be surprised at how interesting some of the other programming can be.

Out-of-this-world entertainment

There is no need to be scared away from satellite TV. But it is a mistake to overlook the factors which could cause you to stand by while thousands of dollars in electronics sits idle.

Satellite TV is great for country homes and places where there is no cable. The quantity of entertainment cannot presently be matched anywhere, on any existing cable system.

I just hope that I've added a touch of realism to your consideration of this wonderful new world of viewing. R-E

*President, Channel One, Inc., 68 Avalon Road, Newton, MA 02168.

new ideas

BATTERY SUBSTITUTER HAS MUSCLE

IT WOULD SEEM THAT BUILDING A LITTLE power supply to substitute for four flashlight (D cell) batteries would be a simple "handbook" job. Not so! The application in question is powering a widely-sold toy pinball machine.

The problem is that the bright bulb and electromagnetic counter draw an initial surge of about 4 amperes when the steel ball activates a scoring bumper. There are, no doubt, other toys that suffer from the same problem. The pinball machine used up alkaline batteries at a rate that began to cost a significant part of the entire house electrical bill.

The problem *has* been solved, and I set up the following criteria for the design:

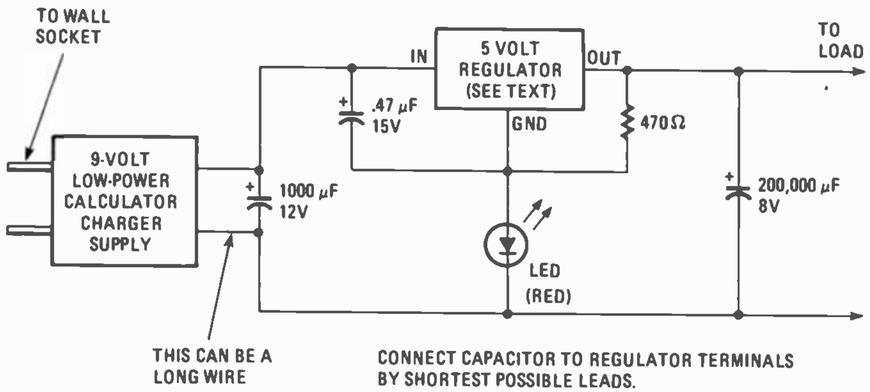
1. The supply should use a *safe* (U-L recognized) line-plug module as calculators or small tape recorders using rechargable batteries do. The idea was not to shock too many of our children, ages 4 through 14.
2. The supply should use an inexpensive and easily available regulator like the National LM340T-5.0 or the 7805-series voltage regulator available from several sources.
3. Despite using the commonly available 5-volt logic regulators, the supply should provide 6.3 to 6.5 volts.

To make the little, 100 mA-rated, calculator/charger supply provide 4-ampere surges required a minor reversal of design philosophy. Not only is the little charger-supply limited in power, but the plastic-packaged regulators that are easily available, are only rated for 1 to 1.5 amperes. Three design tricks provide the solution.

1. Only moderate filtering on the regulator input (see the schematic) is needed, and fast recovery results.
2. *Massive* filtering on the output of the regulator is used (not the usual technique) to supply the surges. The three-terminal IC regulators are stable under these conditions.
3. A LED is inserted in the ground lead of the 5-volt IC regulator. This boosts its output voltage by about 1.5 volts, and provides a nice pilot-light as well.

Parts are not critical. The line-plug supply (transformer is part of plug) that I used had an open-circuit voltage of about 10 volts and could supply a little over 100 mA at 8 volts. [A power converter designed to supply 9 volts to small radios and calculators will do nicely.—*Editor*] The capacitors are also uncritical since none of the ripple currents are very high. I happened to use two 100,000-microfarad computer-type capacitors on the output because I could get them inexpensively. A number of smaller paralleled capacitors rated at 8 volts or more would certainly work well also. Surplus or junk-box devices would be quite suitable. The IC regulators must have current-limiting to avoid damaging the line-plug type supply with surges.

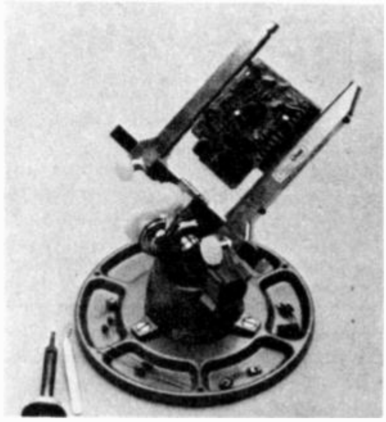
The battery-eliminator components can be placed wherever you can find the space. The location for the charger is obvious—in the wall receptacle. I distributed the other parts around the pinball machine. The small capacitor and regulator are on a bracket on the back of the machine. The LED is glued into the front panel and the two 100,000-μF capacitors are carefully insulated and then taped to the machine's back legs.—*Peter Lefferts*



NEW IDEAS

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

All published entries, upon publication, will earn $25 plus a Circuit Board Holder, Standard Base and Tray Base Mount from Panavise Products, Inc. (See photo below.) Selections will be made at the sole discretion of the editorial staff of **Radio-Electronics**.



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Level "A" Specifications

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

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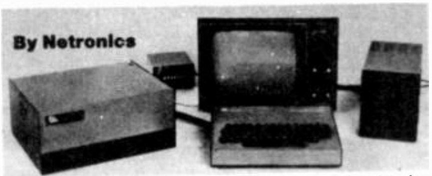
PC Board: glass epoxy, plated through holes with solder mask • **I/O:** provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader ...provision for 24-pin DIP socket for hex keyboard/display...cassette tape recorder input...cassette tape recorder output...cassette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

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

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



Hex Keypad/Display Specifications

Hex Keypad/Display.

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

Level "B" Specifications

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

Level "C" Specifications

Explorer/85 with Level "C" card cage.

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

Level "D" Specifications

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

Level "E" Specifications

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

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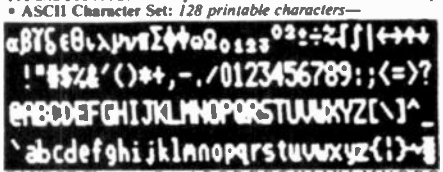

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communications corner

Boost communication receiver performance with an audio processor. **HERB FRIEDMAN**, COMMUNICATIONS EDITOR

IN A WAY I WAS VERY FORTUNATE TO start out in electronic back in the golden age of vacuum tubes (the late 40's and early 50's) for it was also the golden age of the communications receiver. A young hobbyist of that day got a chance to handle receiver circuits that few outside of the military will ever get to use.

It took two hands to count the number of amateur and SWL receiver manufacturers, each turning out several models that seemed—at the time—to be upgraded every month or two. The local "radio parts store" and Ham-equipment distributor often gave a full wall of shelving to their receiver display; there were *that many* different models.

Using tubes and circuits developed for the military during WWII, it was not unusual to find a modestly priced receiver that featured–at the very least–a crystal filter that could slice off an interfering CW signal as easily as a chef slices through roast beef. For a few dollars more we could get a receiver with selectable crystal filters. Then came the tuneable IF, where the user could position the IF bandbass to drop interference of any kind "off the cliff" (out of the passband). Another went a step farther and moved into the audio circuits with a processor that enhanced or rejected a user-tuned audio frequency.

With its cascode RF amplifier, triple-conversion, tuneable IF, audio processor, crystal filters, and heaven only remembers what else, the last of the tubed gold-plate receivers took two men to lift and generated enough heat to whip up a cup of hot chocolate on a nippy night. Fact is, all those tubes glowing away in a tabletop cabinet created a major stability problem in some "high performance" receivers. Virtually everything up to the IF had to be temperature-compensated, and as a receiver aged it often took upwards of an hour for the tuning drift to settle down. (Many hams never turned their receivers off—just left 'em on stand-by.)

We had finally reached a point of no return in consumer receivers; the heat was cancelling out the benefits of new circuit ideas.

It's debatable whether the gold-plated communications receiver was simply a dinosaur whose end was due, or whether the introduction of the Collins S-line—with its relatively simplified trouble-free circuits—spelled the end for the gold-plated specials, but in a few years most receiver brands were simply a memory.

The S-line, the forerunner of the modern solid-state single-sideband receiver and transceiver, set the standards for features we expect in today's receivers: A crystal-controlled high-frequency conversion oscillator to remove many of the temperature-compensation problems. Those included a low-frequency tuneable (local) oscillator whose low frequency, by itself, makes the circuit insensitive to temperature-caused frequency drift; and the mechanical filter that can be tailored to any desired bandwidth for optimum reception of CW, AM, or SSB. The mechanical filter replaced both the difficult-to-tune crystal filter and the tuneable IF, though many who used the tuneable IF still think it was the most effective receiving aid.

As for audio processors, they have long been a memory as original equipment, though they are still available as low-cost add-ons that (generally) plug into a receiver's headphone or speaker output.

The audio processor is basically the poor man's Q-multiplier in the sense that it can function either as a notch filter (to eliminate beats and whistles), or as a "peaker" (variable-Q bandpass amplifier). If you remember the Q-multiplier, it was a regenerative device connected into a receiver's IF. As the gain or feedback was adjusted towards self-oscillation, the effective Q rose sharply creating a sharp peak, or notch if desired, in the IF response.

The problem with the Q-multiplier is that it used vacuum tubes and was usually designed to connect into a 455-kHz or 1600-kHz vacuum-tube IF. With the advent of solid-state receivers, several attempts were made at solid-state Q-multipliers, but designing a "universal" model that could be installed without fear of catastrophic failure was almost impossible because no two solid-state receivers have circuits similar enough for modification by the average hobbyist.

Enter, now, the audio processor. Using the same solid-state technology that made the univeral Q-multiplier difficult, it was possible to design an inexpensive audio processor that performed essentially the same as an IF Q-multiplier. And the one big advantage of the audio processor over the Q-multiplier is that it is, in fact, universal: The user simply plugs it into the receiver's speaker output.

The *Mizuho AP-M1* Audio Processor shown in Fig. 1 is typical of what can be done at moderate cost. Priced at $51 from Gilfer Associates, Box 239, Park Ridge, NJ 07656, the model *AP-M1* uses almost pure textbook design to synthe-

continued on page 74

Fig. 1

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COMMUNICATIONS CORNER

continued from page 72

size a Q-multiplier for shortwave receivers. The filter is four series-connected 741 operational amplifiers in the standard notch-bandpass configuration —almost part-for-part out of a "circuit cookbook." The filter's output feeds an LM386 power-amplifer IC that drives a 2-inch speaker mounted in the top of a 5.5- × 1.5- × 4-inch plastic cabinet. The filter and power-amplifier IC are powered by a standard 9-volt battery, or by a 12-VDC external power source. A voltage regulator built into the device regulates the 12 VDC to the required 9 VDC.

A three-way switch determines the operating mode. One position is NOTCH, another is BANDPASS, and the third position is OFF, whereby power is turned off and the signal from the receiver is fed directly to the processor's speaker. The input to the processor is through a panel-mounted mini-jack. A second mini-jack is for an external speaker, which disables the processor's speaker when the connecting plug is inserted. Two LED's, which indicate the NOTCH and BANDPASS mode, also serve as the power-on indicators.

Two front-panel controls labeled FREQUENCY and BANDWIDTH determine the center frequency and the width of the notch or "peak." The FREQUENCY control can be tuned within the range of 400-4000 Hz.

As a general rule, the greatest effect is in the bandpass mode, where the processor is used to peak a desired signal, whether CW or voice. The notch filter is not as effective because it takes considerable fiddling with the controls to tune out an interference signal, beat, or whistle. That contracts with the bandpass mode that lifts the desired signal out of the general interference.

Of course, there are times when a notch filter is the only thing that will work, as when an interfering CW signal is many times stronger than the desired signal. Unlike the IF Q-multiplier that produces a very deep notch that can strip out almost all traces of a beat or whistle, the simplified audio processor has a moderately deep notch that passes a considerable amount of the interference. The notch contributes towards reception by eliminating *some* beat interference; the bandpass actually lifts the desired signal out of the interference.

While nothing is going to convert a budget- or moderate-cost shortwave receiver into a *gold-plated special* reminiscent of the tubed boat anchors of the 1950's, an audio processor is a relatively inexpensive way to add "selectivity" to lower cost receivers. Best of all it's truly *universal*; you just plug it in to any speaker or headphone output jack. R-E

radio products

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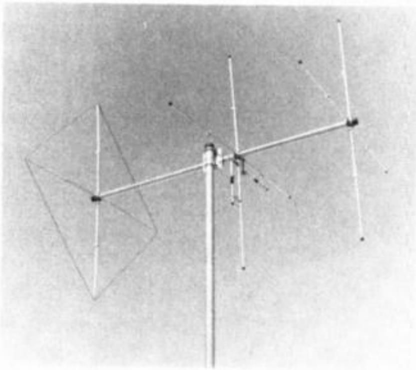
BASE STATION ANTENNA, model *Comet,* is a 6-element antenna. Specifications include ×21 power multiplication; 12.5-dB gain (34-dB front-to-back); 10-ft., 6-in. turn radius; 11-ft. × 6-in. boom length; 4-square-foot windload area; and adjustable VSWR to 1.1:1. List price: $119.95.—**Wilson Electronics Corp.,** P.O. Box 19000, Las Vegas, NV 89119.



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CB MICROPHONE, *model 526T Series II Super Punch,* is designed for compatibility with almost all CB transceivers. The unit can be connected to transceivers with impedances of over 500 ohms and is equipped with a six-wire coiled cord and 3PDT switch arranged for universal compatability. Features include a dynamic element and transistorized preamp that runs for hundreds of hours on a 9 volt battery, a volume control, and a transmit/receive switch. Suggested retail price $58.32—**Shure Bros., Inc.,** 222 Hartrey Ave., Evanston, IL 60204.

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The *Bearcat 5* features LED channel indicators, built-in speaker and telescoping antenna. Provision is made for an external speaker and antenna. The units operates on 117 volts AC and is UL-listed and FCC certified. Price, less crystals, is $129.95.—**Electra Company,** P.O. Box 29243, Cumberland, IN 46229. R-E

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hobby corner

A 555-timer-based signaling and control circuit that can be used in a variety of applications.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

THIS MONTH'S MAIN PROJECT IS A VERY flexible signaling and/or control device that can be used in a variety of ways. We'll look at several applications. The basic circuit is shown in Fig. 1.

Once again the old faithful 555 timer functions as a variable-frequency square-wave oscillator. On each half-cycle, one of the LED's lights—which one of them depends, of course, on whether output-pin 3 is positive or negative at that particular moment.

If you make one LED red and one green, you have a model traffic light when the 555 is set for a very low frequency. (Remember that changing the value of capacitor C1 will move the frequency range up or down.) If you like, a capacitor of about 2000 µF or so connected from ground to point A or B will remove the "snap-action" on and off either or both LED's.

Other devices can be controlled in phase with the lights by adding the circuit shown in Fig. 2. This 555 is a monostable oscillator that switches when the triggering line is connected to point A or B in Fig. 1. In turn, the relay pulls in and releases as the "traffic light" sequences.

Now the relay can be used to do such things as stop a model car or train when it approaches a red light. One method of accomplishing that is shown in Fig. 3. A section of rail is insulated and fed through the relay contacts. When the relay pulls in, power is removed from the isolated track and the car or train stops when it gets there. On the next half-cycle (green), power is restored and the model moves on.

Returning to Fig. 1 and the basic circuit, you know that the LED's are on alternately. If the frequency is made higher, persistence of vision makes it appear that *both* LED's are on continuously. You may notice that they are a bit dim but not enough to matter.

If switches and diodes are added as shown in Fig. 4, you have quite a signaling device. Close one switch and the green LED is on; close another and the red is on; close the third and both are on. If you place the LED's at a remote location, you can send at least three distinct pieces of information on the one wire.

There you have a few ideas for using the gadget. Let your imagination be your guide and see what you come up with. One more example: How about substituting relays for the LED's and using them to control stronger lights, motors, or whatever. I would be interested in hearing about applications you devise.

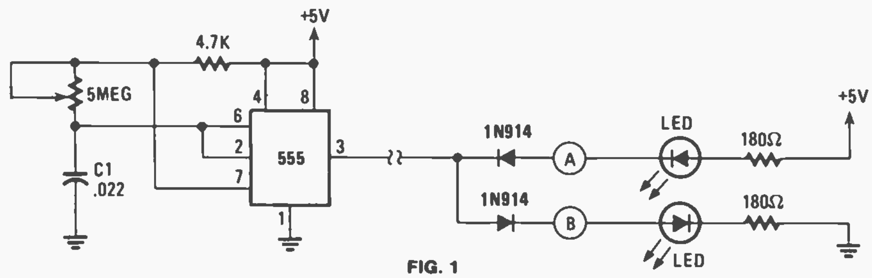

FIG. 1

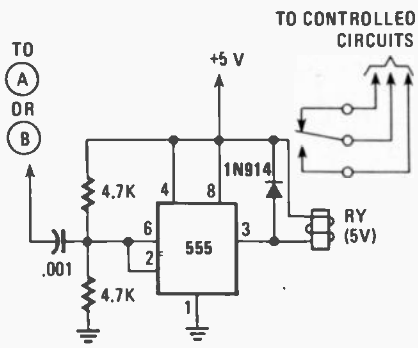

FIG. 2

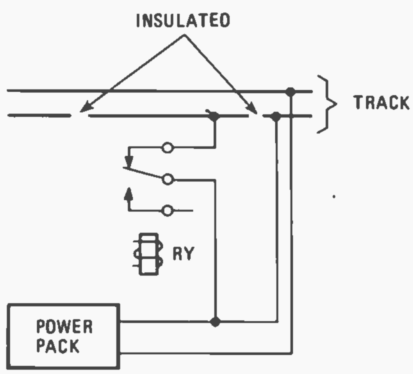

FIG. 3

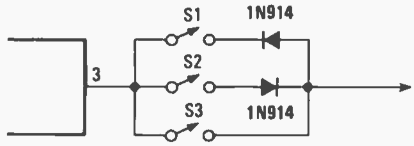

FIG. 4

Desoldering

You may recall that there was an article on desoldering techniques, several months back. After its appearance, I received a letter from a manufacturer of desoldering equipment.

The company official, whom I'll call Mr. X, wrote that all the methods discussed in the article were abandoned long ago. No one—but no one—uses such archaic desoldering methods. He then went on to inform me of the up-to-date equipment they manufacture.

Well, let me see if I can correct my error with a couple of "notices."

Notice to commercial desolderers: In the event that you are using outdated methods, stop wasting your time. Read the various equipment catalogs. Invest $300 or more with Mr. X or one of his competitors.

Notice to Mr. X: There are thousands upon thousands of electronic hobbyists out in the boondocks who build and occasionally *un*build (desolder) circuits. While your equipment is undoubtedly effective and efficient, we're in this thing for fun. For that purpose, we do not have available the kind of money your methods require. We'll stick with the cheaper, archaic methods that still work.

Desoldering hint

Arthur Coombs of Clinton, Ontario, Canada wrote to suggest another method of cleaning solder-filled PC-board holes. A large darning needle from the local variety store will do the trick. Simply heat the solder and stick the needle through. Only rarely will the solder stick to the needle, and even then a little heat will dislodge it.

Thanks, Arthur; I have used that method myself. It is easy if you push the eye-end of the needle into a wooden dowel to

continued on page 86

service clinic

Conventional power-supply circuits that look very odd.

JACK DARR, SERVICE EDITOR

IN PAST COLUMNS, WE HAVE DISCUSSED some of the newer DC power supplies. They work, but some of them seem to be a little too complex. The more parts used in a given circuit, the greater the chance of failure. (One of the designs uses 14 or 15 transistors.) Personally, the simpler the circuit, the better I like it.

Now, for a change, let's look at a couple of the more conventional DC power supplies. One is fairly new, the other pretty old. Both look just a bit unusual, but when you check them out you find they use familiar circuitry.

One is used in the Admiral K19-series of chassis. Figure 1 shows the circuit. At first glance, it looks pretty complicated—but let's follow the circuitry.

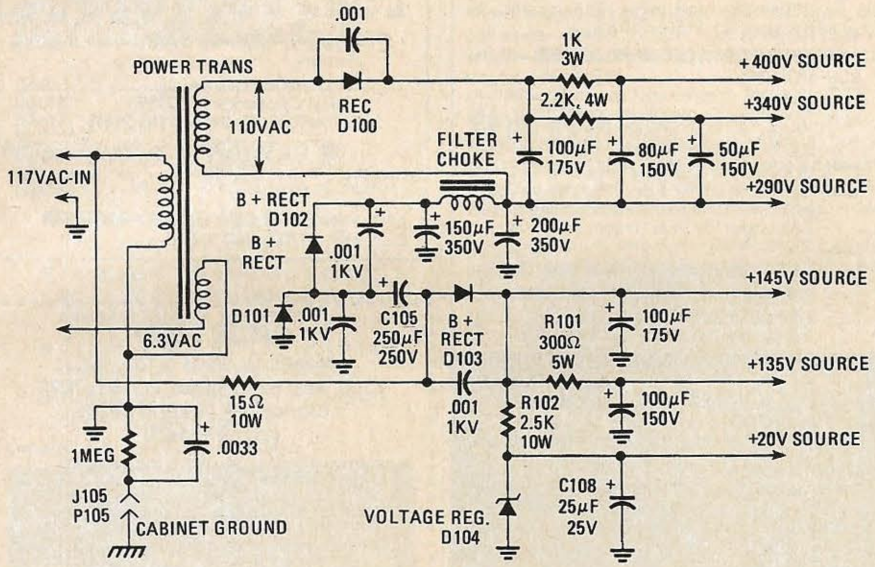

FIG. 1

The +145-volt supply comes straight off the AC line, through diode D103. Stock filtering is used to smooth out the supply. From that the +135-volt and +20-volt lines are taken, reduced by resistors.

The AC line also goes to C105, then to diodes D101 and D102. The two diodes and capacitor are connected as a stock *half-wave* voltage doubler. That produces the +290-volt line.

Now, we come to a circuit that is not often found in a TV receiver, but which was quite common some years ago in many two-way radios, especially Motorolas. The filtered output of the +290-volt DC line, also goes to the bottom end of the 110 VAC winding on the power transformer. Top end of the winding connects to diode D100 (another half-wave rectifier). The output of D100 is +400 volts. That is because the bottom end of this supply is "stacked" on top of the +290-volt line. The DC voltages add to provide the +400 volt output. The +400 volt line is dropped by a resistor to provide +340 volts. Note that the filter capacitors for the +400 volt line and the +340 volt line return to the +290 volt line, not to ground. That is where the "stacking" effect is obtained.

Every one of the circuits used here are conventional. We have worked with them a long time. Any problems in here should be easy to find.

One of the possible faults listed in the Admiral *News Letter* shows the symptoms of weak video, retrace lines and very little control of brightness. Checking DC voltages reveals that the +400-volt line is quite low, somewhere around +310 volts. The +290-volt line will be normal. Cause: the 110 VAC winding on the power transformer is open.

Another one is "No video or sound but raster present." Cause of that can be an open resistor in the +135-volt line, such as R101 or R102. A shorted Zener diode, D104, can also kill the +20-volt line. Hum-bars floating up through the picture can be caused by an open capacitor (C108) on the +20-volt line. Scope the +20-volt line and look for ripple or any signal.

In short, all of the circuits used here are conventional and so are the problems caused by defective components. The novelty is in the way they're all tied together, stacked, and so on. For testing, use the same old methods we've used for years.

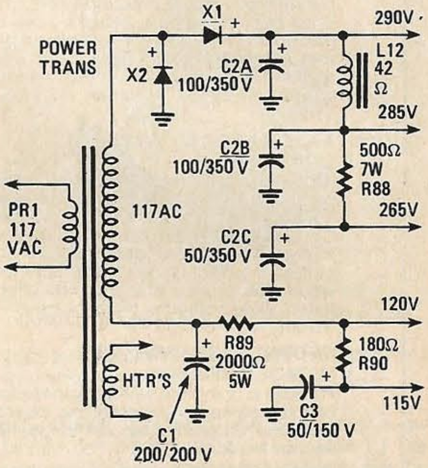

FIG. 2

The other power-supply circuit is from quite an old TV set, a *model 362* Setchell-Carlson. Figure 2 shows this one. Here again we get different DC voltages. Before reading farther, look at the circuit and see if you can tell what it is. You've seen it many times, though it may not look familiar in this configuration.

This is a plain half-wave voltage doubler. However, it looks odd, because the input capacitor isn't in its usual place on the input of the two diodes. It's at the bottom of the transformer winding and returns to ground. The function of the capacitor is exactly the same as in the more familiar circuit. By isolating that point, they are able to get a +120-volt DC supply, without having to use big dropping resistors.

This circuit was sent in by a reader in New York. The complaint was that the power transformer ran very hot. The set worked perfectly but after about 15 minutes it got hot. All DC voltages checked OK. The reader also complained about resistor R88, running very hot; however, he said the drop across it was exactly 20 volts, which was correct. The resistor has

service clinic

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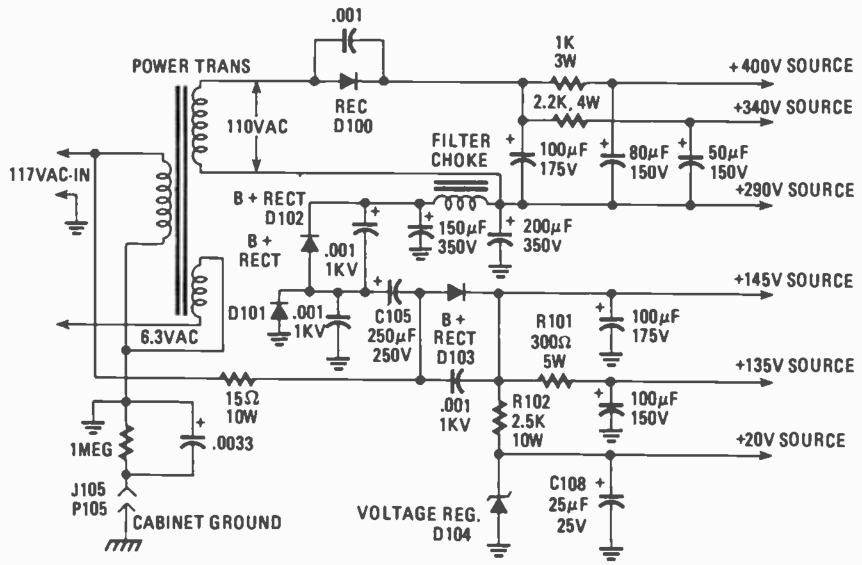

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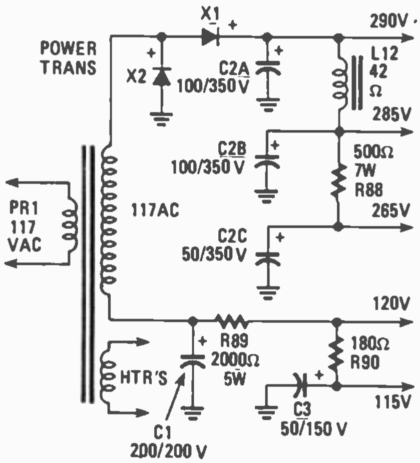

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I told him that in a lot of the older TV sets, including some of the old RCA color sets, the power transformer *did* run quite hot. I suggested cooking the set for several hours and if it didn't have any smoke or smell, send it home! After all, it had probably been working like that for many years! What might seem to be excessive heating might just be "the nature of the brute."

Problems in this circuit should be easy to pin down; low DC voltages, possible open input filter; open diodes, and so on and on.

There you have it. Perfectly ordinary circuits, once you trace them out.

The reader also wondered where he could get a replacement power transformer since the company had been out of business for so long. Looking at it, this is just a plain 1:1 isolation transformer! Secondary voltage is 117 VAC. The heaters could be supplied by a small filament transformer tacked on somewhere, in case of need. **R-E**

service questions

VERY LOW HIGH VOLTAGE

I can only get 5kv of high voltage on this Heathkit model GR-681. The focus voltage is also very low. I've checked everything I can think of. Any help you can give will be useful.—H.S., Euclid, OH.

I suggested he perform standard tests for this type of problem.

He wrote: "I tried all the things you suggested before I wrote, and I finally found it. The .01 μf spark-gap capacitor on the control grid of the 6BK4 high voltage regulator turned out to be very leaky. I hadn't suspected the regulator. Thanks just the same."

NO COLOR

I can't get any color at all on a Philco 19KT40B. I can get a white screen by setting the screen controls. What's going on?—R.P., Methuen, MA.

With these symptoms, you are probably losing the color signals somewhere in the bandpass amplifiers. Feed a color-bar signal into the input, and then scope the 1st bandpass amplifier stage. Look for the typical comb pattern. If it's there, go on and run it down through the other stages till you get to the demodulator input. Somewhere in there you are losing all of this signal. The scope will tell you where it's stopping. By the way: if you can get comb signals through the bandpass, but still no colors on screen, check color-oscillator IC91. Check for the normal +12.58 volt supply on pin 8. If this is OK, check all other DC voltages. If these are off, replace this IC. We've had some problems with it. Subs in several replacement lines—RCA, Sylvania, etc.

MORE BRADFORD PROBLEMS

The vertical linearity control in this Bradford 57141, or C-WES57141, chassis V-2487-7, is burnt up. I can't find a Photofact schematic on it. Can you help? J.O., Winthrop, ME.

More people made Bradfords than any other known name. However, in a few cases, we can get something. You're one of the lucky ones! This was built by Westinghouse; Sams Photofacts list this in 812-4. The V/Lin control is a 10-megohm unit. Key clue here is that Westinghouse part number, "V-2487-7".

CROSSOVER DISTORTION

This model TEC S-15 power amplifier has a bad distortion problem. I've replaced the output transistors with ECG-121's. The trouble seems to be crossover distortion; I can't quite get a handle on it.—H.H., Baltimore, MD.

Crossover distortion is almost always in the output stage and is due to mismatched transistors or a *bias* problem. Since you used identical transistor types here, this leaves the bias problem. Check all the bias diodes that are used. These determine the bias on the output stage; if they're bad, away you go! In this case a diode similar to an ECG-109 should work. Bias diodes should be made of the same material as the transistors. From the DC voltages given, this component seems as if it should be a germanium diode; it shows 0.2-volt drop. If the drop was 0.8 volt, the diode would be made of silicon.

(Feedback: "This worked! The ECG-109 seems to do nicely.")

OLD TUBE TYPE

I've gotten an old Philco Type 60-121, and I need a No. 75 tube for it. Do you have any idea where one could be found?—S.A., Framingham, MA.

Not definitely; check with antique radio dealers, etc. If you can find a type 6Q7, this is an exact duplicate with an octal base. You can use an adaptor or change the socket. Another solution is a 6SQ7, which is a 6Q7 in a single-ended base. Specs identical.

CALTEX IC'S FOR SMALL CALCULATORS

Roger Doering of Lakewood, CO. writes back: "I asked you about a Caltex IC for a calculator. You did not find anything on it (He's right! I hunted everywhere.) I did locate a source, if anyone else wants to mess with these things.

International Electronics Unlimited, 225 Broadway, Jackson, CA 95642, has the CT5001, CT5005 and CT7001 IC's. I hope I don't get any more of these little monsters. I was trying to fix this calculator one for a friend!"

Thanks very much, Roger. **R-E**

new products

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

VOLTAGE TESTER, *Circultracer*, is designed for testing both voltages from 0-500, and the continuity of circuits. The signal lamp is located at the working tip so you can keep eyes on work while

CIRCLE 151 ON FREE INFORMATION CARD

testing a series of points. Kit includes all test accessories and instructions and comes in a compact box. Suggested retail price is $12.96.—**Desco Industries, Inc.**, 351 F Oak Pl., Brea, CA 92621.

UNIVERSAL COUNTER-TIMER, *model 5001*, performs five functions: frequency-counting, period and multiple-period averaging, time interval and multiple-time-interval averaging, frequency ratio, and unit counting. The *5001* has an 8-digit LED display and can be operated from either

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105-130 VAC or 210-250 VAC. It is well-suited to applications in radio, data, and telecommunications; research and development; physical, chemical, and medical laboratories; quality control; industrial and process control; education and instruction; audio, recording studio, and high fidelity; and servicing. Suggested list price is $360.—**Global Specialties Corporation** (formerly Continental Specialties Corporation), 70 Fulton Terrace, New Haven, CT 06509.

TELEPHONE DIALER, the *Phone Controller*, operates with either *Touch-Tone* or rotary-dial telephone circuits and can store up to 30 different 16-digit numbers (expandable). It is quickly and easily programmed. Among its numerous features are: built-in speaker to permit on-hook dial-

CIRCLE 153 ON FREE INFORMATION CARD

ing, automatic redial (up to 14 tries), hold control, and the ability to output rotary-dial-type pulses from a *Touch-Tone* keypad. The *Phone Controller*

NEW PRODUCTS

continued from page 81

has an LED readout showing either the number being entered or dialed, the time of day, or the elapsed-time when a call is in progress. A unique security feature will make the unit "growl" and produce "horrendous noises" if an unauthorized party attempts to make use of it. A backup battery keeps the memory and clock functions alive in the event of power failure. Suggested retail price for the *Phone Controller* is $99.95.—**Dictograph Manufacturing Corporation,** 89 Glen Cameron Road, Thornhill, Ontario L3T 1N8, Canada.

AUTOMOTIVE ENGINE ANALYZER, *model CM-1550*, handles several tune-up measurements, including dwell for 4-through-8-cylinder engines, RPM to 10,000 in two ranges, DC voltage to 200

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volts in two ranges, resistance to 2 megohms in three ranges, and direct current to 20 amperes. With the optional *CMA-1550-1* Shunt Accessory, the *CM-1550* will also measure starting current and battery charging/discharging current, up to 400 amperes. All readings are shown on large LCD digits. Power is supplied by a 9-volt battery (not included), eliminating the need for external power connections. The inductive pickup for the RPM readings is attached to any spark plug wire. Thermal insulation on attachment leads resists melting or burning under high-heat conditions. The unit can be assembled in just two or three evenings. Mail-order price for the *CM-1550* kit is $94.95, while the *CMA-1550-1* Shunt Accessory sells for $13.95. All prices are FOB Benton Harbor, MI.—**Heath Company,** Benton Harbor, MI 49022.

AM RADIO, *Bloke's Radio Cap*, is a hat that cleverly conceals a portable transistor radio and lets you listen to music, news, etc., while sunning at the beach, jogging, hiking, bicycling, or even while working. The radio is powered by a single 9-volt battery (not included). Sound comes through an earpiece, which may be hidden in a secret pocket when not being used. Volume control and tuning knob are disguised as buttons. *Bloke's Radio Cap*, designed in England, is made of 100% pure cotton blue denim, and has an expandable headband so one size fits all. Price is $10.95 plus 75 cents for postage and handling.—**Edsujo Inc.,** 3716 Waverly Ave., Seaford, NY 11783.

CIRCLE 154 ON FREE INFORMATION CARD

HAND-HELD DMM, the *LX 304*, features an easy-to-read, half-inch high, 3½ digit LCD display; automatic polarity; zero and overrange indication; and half-year battery life in normal use. Other features of the meter include an automatic

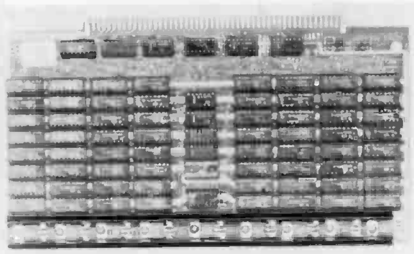
CIRCLE 155 ON FREE INFORMATION CARD

decimal point, built-in low-battery indicator, diode and transistor testing capability, and 0.5% accuracy on DC volts ranges. Suggested retail price for the *LX 304* is $89.95.—**The Hickock Electrical Instrument Company,** 10514 Dupont Ave., Cleveland, OH 44108. R-E

computer products

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

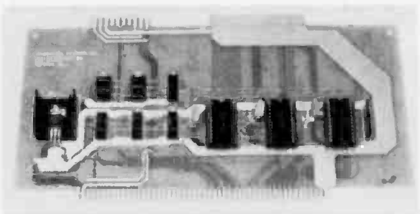
MEMORY BOARD, 32K static RAM board, is S-100 bus-compatible, has a 300-ns access time and features extended addressing (or bank switching) and 9 voltage regulators. The board includes a phantom line for memory disable, useful in bootstrapping operations. The board is also



CIRCLE 121 ON FREE INFORMATION CARD

available in 16K configuration, allowing for future expansion. The operating manual contains a parts list, schematic and test routines. The boards are assembled and factory-tested; the 32K board is priced at $625; the 16K configuration is $390.—**Tarbell Electronics**, 950 Dovlen Pl., Carson, CA 90746.

I/O INTERFACE, *IF-1*, is designed to interface *ICTM-1* IC tester module with S-100 bus-compatible computers. Available as a kit or assembled, the *IF-1* can also be used as a general-purpose I/O card for small-business applications requiring up to 16 output and 8 input lines. The *IF-1* pro-



CIRCLE 122 ON FREE INFORMATION CARD

vides two buffered 8-bit output ports and 1 buffered 8-bit input port; jumper-selectable address coding; separate 10-pin connector for +5V regulated and +8V, +16V, −16V unregulated S-100 bus power supplies. Prices: kit, $89.95; assembled, $119.95.—**Pragmatic Designs, Inc.**, 711 Stierlin Rd., Mountain View, CA 94043.

COLOR GRAPHICS GENERATOR/CONTROLLER, the *Electric Crayon*, interfaces with the *TRS-80* microcomputer. It may also be used with other computers or with a parallel ASCII keyboard. Designed to generate color displays on either a standard TV set or monitor, the *Electric Crayon* has 10 display modes including an alphanumeric-semigraphics mode, a second, higher-density, semigraphics mode, and eight additional graphics modes. Up to eight colors may be generated. Resolution is up to 256 × 192 picture elements. A full 64-character ASCII subset is also included.

The *Electric Crayon* is actually a complete, self-contained, control computer with its own operating system and with provision for 1K of add-on RAM, for EPROM to extend the existing EGOS

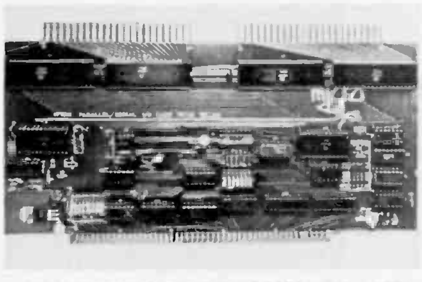
CIRCLE 123 ON FREE INFORMATION CARD

operating system and a second dual bidirectional 8-bit port.

The *Electric Crayon*, with the EGOS operating system, 1K of RAM and a comprehensive user's manual which contains instructions and a description of the system, an assembly-language listing of EGOS, and listings of demo programs in BASIC, sells for $249.95.

Options available include: color-graphics programs in BASIC on minidiskette, a 34-conductor cable to connect to the *TRS-80* printer port, add-on RAM and a sketching pad for graphics design.—**Percom Data Company**, 211 N. Kirby, Garland, TX 75042.

PARALLEL/SERIAL I/O BOARD, THE *8P2SM*, is an S-100 board that combines 8 parallel ports (including handshaking operations) with 2 serial input and 2 serial output ports. Available baud rates range from 27.5 to 307.2K. One set of serial ports can be configured for TTL or full RS-232



CIRCLE 124 ON FREE INFORMATION CARD

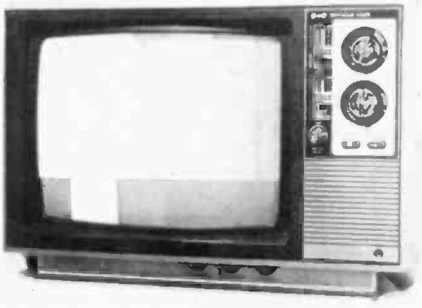
operation, and the other set can be operated as TTL or a full duplex modem in the answer or originate modes at a 300 baud data rate. The double-sided, plated-through board is solder-masked on both sides, has gold-flashed edge connectors and measures 5.50 × 10 inches. Full documentation is included. Prices: kit, $149; assembled, $199.—**MicroDaSys**, P. O. Box 36051, Los Angeles, CA 90036.

COLOR RECEIVER/MONITORS, *VM-1300* and *VM-1900*, feature the latest in integrated circuitry, a quick-start in-line picture tube with slotted mask and black matrix for sharp contrast and bright colors, AFT and automatic gain control. Receiver or monitor mode is switch selectable. In the monitor mode, the sets accept standard com-

COMPUTER PRODUCTS

continued from page 83

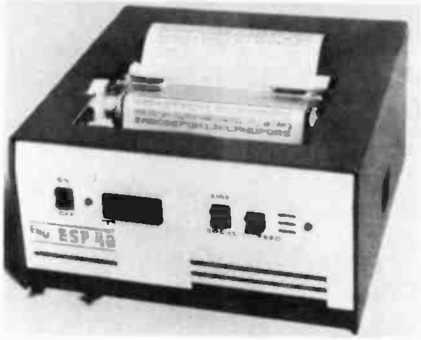
posite video. Looping inputs (with switchable 75-ohm termination) are provided to allow linking of multiple sets. A separate audio input is also provided. The units are intended for Broadcast, Industrial, Educational, Computer, and Home applications. They can be used with color VTR's,



CIRCLE 125 ON FREE INFORMATION CARD

cameras, and computers such as the Apple that output an NTSC color-video signal. Prices: *Model VM-1300* (13-inch), $449; *Model VM-1900* (19-inch), $575. Add 6% California sales tax where applicable and allow $15 for shipping within the continental United States.—**V.A.M.P. Inc.**, 1617 El Centro Ave., Suite 19, Los Angeles, CA 90028.

ELECTROSENSITIVE MATRIX PRINTER, the *ESP40*, features medium-speed, silent operation. Capable of unattended operation and integration with computers, it is a modular unit that can be built into a variety of test equipment. Because it can operate from a twelve-volt power supply, it is especially suited to mobile applications for police, fire, utility, and military users. The British-pro-



CIRCLE 126 ON FREE INFORMATION CARD

duced *ESP40* printer is currently being used in the United Kingdom for monitoring telephone exchange equipment, industrial processes, and for various digital plotting operations. The device is primarily used as a 40-character alphanumeric printer, but has options for other print fonts. The *ESP40* is typically $5-600 in single-unit quantities.—**Rank Numbering Machines, Inc.**, 411 E. Jarvis Avenue, Des Plaines, IL 60018.

A NEW S-100 MAGAZINE, *S-100 Microsystems*, is directed specifically toward users of S-100 microcomputer systems. It will serve as a forum on S-100 hardware and software. Every issue of *S-100 Microsystems* will bring the latest in the S-100 world—news, rumors, letters to the editor, newsletter columns, new products, book reviews, etc.

The publication will be edited by Sol Libes, a pioneer in the field of personal computer systems.

S-100 Microsystems will be published six times a year. A sample copy is $2. Subscriptions are $9 for one year, $17 for two years, $23.50 for three years, prepaid U.S.A. Canada is $12 per year and foreign $23 per year (add $14 for Air Mail). To subscribe, or for more information, write: ***S-100 Microsystems***, Box 1192, Mountainside, NJ 07092.

ALL-IN-ONE COMPUTER, the *H89*, includes two Z80 microprocessors, floppy-disk storage, smart video terminal, heavy-duty keyboard with numeric pad and 16K RAM (expandable to 48K).

The *H89* runs programs written in Benton Harbor BASIC, *Microsoft* BASIC and Assembly Language. The system is especially well-suited to the needs of both home and the small office.

Two Z80 microprocessors mean that terminal and computer can act independently of one-another and process data faster than most desktop units that have only one microprocessor.

CIRCLE 127 ON FREE INFORMATION CARD

The computer features a 12-inch diagonal display capable of displaying 24 lines of 80 characters. Lower-case letters have full descenders. There is also a special-purpose 25th line.

Each 5¼ inch diskette offers 100K of storage. Accessory interfaces permit communication with printers, cassettes or time-share systems. All communication is EIA RS-232. Price is $1,695 (kit) and $2,895 (assembled).—**Heath Co.**, Benton Harbor, Michigan 49022. **R-E**

CIRCLE 31 ON FREE INFORMATION CARD

VOLTAGE REGULATOR

continued from page 50

Using the templates given in Fig. 6, cut a piece of sheet aluminum to form the enclosure and heatsink—use whatever gauge stock you think appropriate. Drill the holes. Bend the four sides into place and then bend the two mounting flanges outward and parallel to the surface. Install a rubber or plastic grommet in the feed through hole. Using a piece of cardboard, make a potting form to keep the area where the heatsink is to mount clear (see Fig. 7). Fill the container about a quarter full of a silicon potting compound such as RTV. Slosh it onto the walls and let it cure. At that point you have a case with a rubber-insulated cradle. Place the PC board into the cavity; feed the wires through the grommet. Using two metal screws, fasten the case to the heatsink (one should use silicon heatsink grease at the interface, see Fig. 7). Cut a piece of plastic tubing, such as a soda straw, to form a channel for external adjustment of the trimmer. Place one end of the tube over the screw end of the pot and the other to the exit hole. Seal off those two ends with some of the potting compound—make sure that none gets inside of the tube. After the tube is secure, fill the cavity with potting compound to submerge the board, and let it cure. On the wires—which should be color-coded—solder a connector that will interface to your auto's electrical system. Either obtain one from your local automotive parts store or use the connector from your old regulator if possible.

Install the unit on your car as shown in Figs. 1 and 8. Adjust the voltage to the level recommended by your auto's service manual. During the summer you can lower the level to reduce the boiling off of your battery's water; during the winter it can be increased to aid in cold-morning starting. My first regulator has operated without any problems for about three years and a prototype for this design has been in operation now for about a year.

Changes for pulled-up field

The less-often-used pulled-up field alternator (Fig. 1-b) uses a simpler voltage regulator. Its circuit is shown in Fig. 9 and components layout in Fig. 10. Note that the phase-inverter pair (Q1 and Q2) has been eliminated and the PNP Darlington-pair driver transistor, Q3, has been replaced by Q4, an NPN type. Construction and installation follow the steps just outlined. No matter which version of the voltage regulator your car requires, you can expect it to give years of reliable service and, having built one for automotive use, you'll probably find several other battery-charging applications for this versatile regulator. R-E

HOBBY CORNER
continued from page 80

serve as a handle. A "pin vise" makes a good handle, too. (Now, can't you see a commercial outfit doing that!)

Help!

Russ Lane of Fairfield, Iowa, is looking for information about building a "negative ion generator." If you have any information, send it to "Doc" Savage at **Radio-Electronics,** 200 Park Ave South, New York, NY 10003.

Memory, Memory

John Gregory of Chicago sent along an interesting inquiry. He points out that thousands of hobbyists must have upgraded their TRS-80 computers from 4K to 16K with one of the available kits. I suspect that he is entirely right because that is one of the very first things I did to my own TRS-80.

John goes on to say that there are all those good 4K dynamic memory IC's lying around unused. He has been unable to find schematics or whatever for using those IC's. Well, John, I don't recall anything like that either. I'll pass the thought along and perhaps we can arrange for an article or two.

In the meantime, if any of you other readers have anything you have worked out, I'll pass it along to John. Those IC's could be used for additional RAM, buffer memory, message storage, and a host of other things.

PC board repair

If you have ever removed a defective part from a PC board, you know that great care is required or the board may be damaged.

Pace Inc. (9329 Fraser St., Silver Spring, MD 20910) has a repair system that makes such damaged single- or double-sided boards as good as new. Their *Cir-Kit* Selector Pack (No. 6993-0037) contains the special tools required and a selection of supplies for repairing pads, tracks, and even plated-through holes.

The Pace system is not difficult to use, if you follow instructions. All you need supply is solder, iron, and perhaps a small drill. I can find no reason to question the claim that the repaired board is as good as the original. Certainly, the repair is sturdy and functional.

The same system can be used to modify existing PC boards. Assuming that there is space to do so, you can easily make provision for one or more additional components—even an entire amplifier stage or whatever.

The single disadvantage for the hobbyist is the initial cost of the kit (about $65) but you only need to buy the tools that first time. If you have, or foresee, many repairs, it's worth it; but if you have only one repair to make, on rare occasion, it may be better to stick with jury-rigging your repairs. **R-E**

DIGITAL AUDIO

continued from page 65

of recording level. The simple statement regarding harmonic distortion of a PCM audio processor/ VCR combination doesn't quite tell the complete story either. For example, if you were to try to record a low-frequency square-wave using even the best open-reel analog tape recorder, during playback you would get something like the patterns shown in Fig. 8. Try the same experiment with a PCM/VCR combination and results would be as shown in Fig. 9. Such other aberrations as modulation noise (caused by inconsistent or wavering speed of analog tape decks) and IM distortion, seldom mentioned in discussing analog tape machines but very much a factor in determining quality of reproduced sound, are also virtually gone with PCM recording.

The EIAJ format

To make the PCM data fit within the parameters of a standard video-cassette recorder, it was necessary to take into account the TV signal requirements of the NTSC (U.S. and Japanese) TV system. In effect, the PCM data has to fit "between the lines" or, more properly, within the lines of the standard TV picture. The standardized format arrived at by the EIAJ calls for a single line of the video "picture" to contain a total of 168 bits, made up of three left-channel 14-bit words, 3 right-channel 14-bit words, 2-error correction 14-bit words and 1 16-bit error detection word. If you multiply and add all that up, it comes to 128 bits. The remaining 40 bits are used up by the usual TV horizontal-sync pulse, a white-reference pulse and a data-sync pulse, as shown in Fig. 10. Of the 262.5 horizontal lines normally contained in a single TV picture field (525 lines per frame) 245 horizontal lines are used for PCM data while the remaining time of each field is used for the usual vertical-sync pulse, equalizing pulses, a control-signal block and a vertical-blanking pulse.

If PCM recording sounds like a perfect system, that's not quite the case either. In an analog tape-recording system, tape drop-outs have a relatively minor effect upon reproduced sound. If the drop-out is of short duration, our ears tend to overlook the interruption of sound. In PCM recording, however, a drop-out, even of short duration, means a loss of vital "bits" needed to reconstruct the original waveform with precision. Error-correction and error-detection is therefore an important part of any PCM audio-processor design. The new EIAJ Standards provide for various levels of error correction and detection, with each manufacturer able to decide and select the degree and sophistication of the error correction used. The Toshiba unit with which I conducted my preliminary experiments can provide correction for two full words of drop-out in a single horizontal line of data and even if a third word is lost because of further drop-outs, the Toshiba *PCM Mark II* processor would "fill in" the average amplitude value that is mid-way between the previous "word" and the one that follows, to make a smooth and indistinguishable transition.

PCM in your future

The first manufacturer to make a definite commitment with regard to delivery and price of a PCM processor was Sanyo. Their recently announced model *Plus 10* is, of course, built to the new EIAJ standards and will work with any VCR (Beta or VHS). The unit was expected to be available at Sanyo dealers by the end of the first quarter of 1980 and carries a suggested retail price of $3995.00. Admittedly, that's a lot more than most consumers would ever spend for home recording facilities, but for those who are seriously involved in recording and were considering a high-quality reel-to-reel tape deck perhaps for live recording purposes, or for use in a home semi-professional recording studio, the price does not seem all that far out of line. From what I have been able to learn, the high cost of PCM processors arises primarily from the high cost of the analog-to-digital and digital-to-analog converter circuits that are a primary element in these devices. When these circuits are reduced to LSI (large scale integrated) circuitry we might well enter an era in which PCM processors are no more costly than present-day high-quality cassette decks.

PCM recording is rapidly replacing analog equipment in professional recording studios (where 16-bit systems are becoming the norm) where master tapes are made. Many famous recording artists, having heard their recordings played back via digitally recorded tapes, are demanding that their future releases be mastered by means of PCM audio processing.

Some day, of course, digital recordings will become available in disc form. At the moment, there is no general agreement as to which of many proposed types of discs should be used. But there is no longer any confusion when it comes to PCM recording on tape. The serious audiophile, with the aid of a PCM audio processor and a video recorder is now able to produce PCM taped recordings at home that are actualy superior in many ways to the master tapes made in professional recording studios just a couple of years ago on the most expensive and elaborate open-reel analog tape decks. **R-E**

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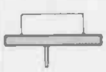

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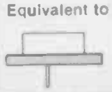

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2N2368	.35	.35
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2N2475	.60	.40
2N2476	.60	.40
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2N3054	.90	.79
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2N3416	.25	.16
2N3440	1.35	.75
2N3442	2.25	1.50
2N3553	1.80	1.25
2N3563	.15	.12
2N3564	.25	.16
2N3565	.20	.14
2N3566	.25	.16
2N3567	.20	.14
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2N3645	.25	.16
2N3687	2.10	1.40
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2N3703	.20	.13
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2N3716	1.50	1.00
2N3721	.20	.14

Part No.	1-99	100 up
2N3724	$ .63	$ .42
2N3725	.75	.50
2N3731	3.60	2.40
2N3741	1.50	.95
2N3771	2.40	1.99
2N3772	2.50	2.15
2N3773	2.88	2.30
2N3789	1.28	.85
2N3790	1.35	.90
2N3791	1.43	.95
2N3792	1.50	1.00
2N3793	.25	.16
2N3819	.40	.26
2N3823	1.05	.70
2N3824	1.20	.78
2N3825	.23	.14
2N3827	.19	.12
2N3839	3.00	2.00
2N3843	.50	.33
2N3859	.25	.16
2N3860	.20	.14

Part No.	1-99	100 up
2N4060	$ .20	$ .14
2N4061	.19	.12
2N4062	.19	.12
2N4093	1.05	.70
2N4123	.19	.12
2N4124	.19	.12
2N4125	.20	.13
2N4126	.25	.13
2N4141	.20	.14
2N4142	.20	.14
2N4143	.20	.14
2N4220	1.00	.65
2N4220A	1.15	.74
2N4224	1.15	.74
2N4228	.40	.26
2N4234	1.50	1.00
2N4235	1.65	1.10
2N4236	1.80	1.20
2N4237	1.35	.90
2N4238	1.50	1.00
2N4239	1.80	1.20
2N4248	.25	.16
2N4249	.20	.14
2N4250	.25	.16
2N4256	.20	.14
2N4258	.35	.23

Part No.	1-99	100 up
2N4905	$2.23	$1.65
2N4918	.66	.44
2N4919	.72	.48
2N4920	.81	.54
2N4921	.66	.44
2N4922	.72	.48
2N4923	.81	.54
2N4957	4.50	3.00
2N4958	3.75	2.50
2N4959	3.00	2.00
2N4983	1.10	.73
2N4984	1.50	1.00
2N4987	.75	.50
2N4988	1.20	.80
2N4989	1.60	1.05
2N4991	.75	.50
2N4993	1.80	1.20
2N4994	.30	.20
2N5038	4.50	3.00
2N5039	3.90	2.60
2N5086	.19	.12
2N5087	.19	.12
2N5088	.19	.12
2N5089	.19	.12
2N5105	2.60	2.05
2N5109	.40	.26

Part No.	1-99	100 up
2N5232	$ .35	$ .23
2N5232A	.45	.30
2N5294	.70	.46
2N5298	.70	.46
2N5306	.40	.26
2N5308	.40	.26
2N5309	.60	.40
2N5320	.87	.58
2N5321	.75	.50
2N5322	.90	.60
2N5323	.81	.54
2N5336	3.60	2.40
2N5337	3.90	2.60
2N5338	4.20	2.80
2N5339	4.90	3.20
2N5354	.40	.26
2N5355	.40	.26
2N5366	.50	.34
2N5367	.50	.34
2N5368	.25	.17
2N5369	.30	.20
2N5397	1.65	1.10
2N5398	1.60	1.04
2N5400	.32	.21
2N5401	.32	.21
2N5418	.30	.20

Part No.	1-99	100 up
2N5781	$1.65	$1.10
2N5782	1.50	1.00
2N5783	1.50	1.00
2N5784	1.50	1.00
2N5785	1.35	.90
2N5786	1.35	.90
2N5817	.40	.26
2N5822	.60	.40
2N5824	.25	.17
2N5827	.30	.20
2N5828	$ .40	.26
2N5828A	.40	.26
2N5830	$ .27	.17
2N5831	.27	.17
2N5833	.27	.17
2N5875	1.35	.90
2N5876	1.47	.98
2N5877	1.35	.90
2N5878	1.65	.98
2N5961	.19	.12
2N6004	.70	.46
2N6014	.70	.46
2N6027	.50	.27
2N6028	.60	.35
2N6032	24.00	16.00
2N6033	27.00	18.00
2N6034	.90	.60
2N6035	.90	.60
2N6036	1.05	.70
2N6037	.90	.60
2N6038	.90	.60
2N6039	1.05	.70
2N6050	1.65	1.10
2N6051	1.80	1.20
2N6052	2.10	1.40
2N6053	1.50	1.00
2N6054	1.65	1.10
2N6055	1.50	1.00
2N6056	1.65	1.10
2N6057	1.65	1.10
2N6058	1.80	1.20
2N6059	2.10	1.40
2N6076	.19	.12
2N6099	.87	.58
2N6103	1.10	.73
2N6107	.87	.58
2N6109	.84	.56
2N6111	.84	.56
2N6121	.90	.60
2N6122	.90	.60
2N6123	1.05	.70
2N6124	.90	.60
2N6125	.90	.60
2N6126	1.05	.70
2N6220	.60	.40
2N6288	.72	.48
2N6290	.72	.48
2N6292	.78	.52
2N6303	4.90	3.60
2N6306	4.35	2.90
2N6307	5.10	3.40
2N6308	6.00	4.00
2N6354	5.40	3.60
2N6386	1.05	.70
2N6387	1.17	.78
2N6388	1.26	.84
2N6486	1.11	.74
2N6487	1.20	.80
2N6488	1.29	.86
2N6489	1.11	.74
2N6490	1.20	.80
2N6491	1.29	.86
2N6530	1.26	.84
2N6531	1.35	.90
2N6532	1.50	1.00
2N6533	1.80	1.20
2N6542	4.80	3.20
2N6543	5.40	3.60
2N6544	5.40	3.60
2N6545	5.50	3.70
2N6546	7.80	5.20
2N6547	8.40	5.60
2N6671	6.00	4.00
2N6672	6.60	4.40
2N6673	7.50	5.00
2N6674	7.80	5.20
2N6675	9.00	6.00
3N83	1.80	1.20
3N84	1.80	1.20
3N85	3.00	2.00
3N128	1.35	.90
3N155	2.50	1.50
3N156	2.50	1.50
3N157	2.50	1.50
3N158	2.50	1.50

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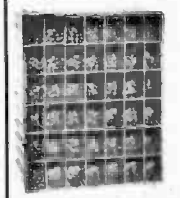

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Part No.	1-99	100 up
2N3866	1.05	.70
2N3867	1.80	1.20
2N3868	1.90	1.30
2N3877A	.25	.16
2N3903	.19	.12
2N3904	.19	.12
2N3905	.20	.13
2N3906	.20	.13
2N3933	1.50	1.00
2N3957	2.55	1.70
2N3962	.51	.34
2N3963	.57	.38
2N3964	.68	.46
2N3965	.68	.46
2N3970	.90	.59
2N3972	.90	.59
2N4030	.69	.46
2N4031	.75	.50
2N4032	.81	.54
2N4033	.90	.60
2N4036	.66	.44
2N4037	.60	.40
2N4058	.19	.12
2N4059	.19	.12

Part No.	1-99	100 up
2N4289	.20	.14
2N4341	1.50	1.00
2N4347	1.65	1.10
2N4348	2.10	1.40
2N4356	.30	.20
2N4358	3.00	2.00
2N4360	.54	.33
2N4395	1.30	.85
2N4400	.20	.13
2N4401	.20	.13
2N4402	.20	.13
2N4403	.20	.13
2N4409	.19	.12
2N4410	.19	.12
2N4416	1.00	.64
2N4425	.45	.30
2N4427	1.50	1.00
2N4858	1.30	.85
2N4859	1.30	.85
2N4878	5.85	3.90
2N4895	3.00	2.00
2N4896	3.60	2.40
2N4897	4.50	3.00
2N4898	1.10	.95

Part No.	1-99	100 up
2N5131	.25	.17
2N5132	.20	.14
2N5133	.20	.14
2N5134	.25	.17
2N5135	.20	.14
2N5172	.20	.14
2N5179	.75	.43
2N5190	.84	.56
2N5191	.90	.60
2N5192	.99	.66
2N5193	$ .84	$ .56
2N5194	.90	.60
2N5195	.99	.66
2N5198	5.98	3.88
2N5209	.19	.12
2N5210	.19	.12
2N5219	.19	.12
2N5220	.20	.13
2N5221	.20	.13
2N5223	.19	.12
2N5224	.24	.15
2N5225	.20	.13
2N5226	.20	.13
2N5227	.19	.12

Part No.	1-99	100 up
2N5419	.30	.20
2N5420	.40	.26
2N5447	.25	.17
2N5448	.25	.17
2N5449	.25	.17
2N5450	.25	.17
2N5451	.25	.17
2N5453	8.10	5.40
2N5457	.45	.30
2N5458	.45	.30
2N5459	.50	.33
2N5484	.55	.34
2N5486	.51	.35
2N5490	.70	.46
2N5550	.27	.17
2N5551	.27	.17
2N5671	10.50	7.00
2N5672	12.60	8.40
2N5681	.99	.86
2N5769	.24	.15
2N5770	.23	.14
2N5772	.24	.16
2N5557	.90	.50
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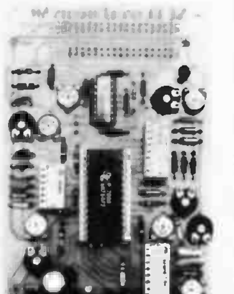

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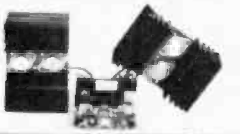
- TX. RES. ADD 5% STATE SALES TAX
- FOREIGN ORDERS ADD 10% (EXCEPT CANADA) (20% AIRMAIL) U.S. FUNDS ONLY.

catalog free on request

100W CLASS A POWER AMP KIT

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

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



TA-1000 KIT $51.95
Power transformer $15.00 each

PROFESSIONAL 10 OCTAVE STEREO GRAPHIC EQUALIZER!!

Graphic equalizer have been used for years in sound studios and concert arenas but were too expensive to be considered for home use. Now we offer you the facility at an affordable price. This unit can extend your control of your Hi-Fi system by minimizing the non-linearities of the combined speaker/room system. Fantastic features as follows:
- 10 double slide controls for two channels
- Cut out rumble, surface noise and hiss
- Minimizes speaker/room non-linearities
- Frequency response from 30Hz to 16KHz
- 10 tone controls plus defeat, monitor and tape selector.
- Control range ± 12dB in 10 octaves (30Hz, 60Hz, 120Hz, 240Hz, 500Hz, 1KHz, 2KHz, 4KHz, 8KHz, 16KHz.)
- Operating voltage 117V 50/60Hz.

FACTORY ASSEMBLED UNIT, NOT A KIT
SPECIAL PRICE $117.00 ea

SUB MINI SIZE FET CONDENSER MICROPHONE

Specification:
Sensitivity: — 65dB ± 3db
FEQ. Response: 50 Hz 8 KHz
Output Impedance: 1K ohm max.
Polar Pattern: Omni-directional
Power Supply: 1.5V 10V D.C.
Sound Pressure Level: Max. 120dB
EM4RP $2.50 ea. or 2 for $4.50

NEW MARK III
9 Steps 4 Colors
LED VU

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

IN KIT FORM $18.50

MARK II SOUND ACTIVATED SWITCH KIT

A new designed circuit employed 2 I.C., a DPDT relay with a led indicator. A condensor microphone comes with the kit. The relay can handle up to 200 watts contact to allow to control most things. Just click the finger, the relay will close, the second click will release it. Sensitivity can be adjusted by an on board trim-pot. Operating voltage 9V D.C.
TY-18
$8.50 PER KIT

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 36 4-color LED (15 per channel) to indicate the sound level output of your amplifier from —36dB ~ +3dB. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6 ~ 12V D.C. with THG on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W!

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

MARK IV KIT $31.50

30W + 30W STEREO HYBRID AMPLIFIER KIT

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

$32.50 PER KIT

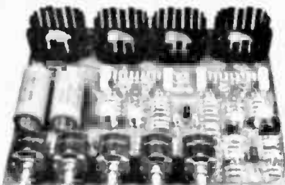
BATTERY POWERED FLUORESCENT LANTERN

MODEL 888 R

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

$10.50 EA

STEREO AMPLIFIER



60 W + 60 W

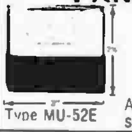
COMPLETED UNIT — NOT A KIT!

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

5W AUDIO AMP KIT

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

PROFESSIONAL PANEL METERS



Type MU-52E

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

All meters white face with black scales. Plastic cover.

SPECIAL 0.5" LED SALE ALARM CLOCK MODULE

ASSEMBLED! NOT A KIT!

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

ONLY $7.00 EACH
SPECIAL TRANSFORMER FOR CLOCK (FREE)

DIGITAL AUTO SECURITY SYSTEM

4 DIGITS PERSONAL CODE!!

SPECIAL $19.95

- proximity triggered
- voltage triggered
- mechanically triggered

This alarm protects you and itself! Entering protected area will set it off, sounding your car horn or siren you add. Any change in voltage will also trigger the alarm into action. If cables within passenger compartment are cut, the unit protects itself by sounding the alarm. 3-WAY PROTECTION!

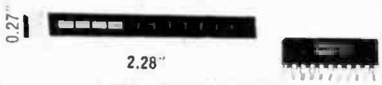
All units factory assembled and tested — Not a kit!

A NEW LED ARRAY AND DRIVER FOR LEVEL METERS

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

LEO ARRAY

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



LED DRIVERS

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

PROFESSIONAL FM WIRELESS MICROPHONE

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

$16.50

FLASHER LED

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

2 for $2 .20

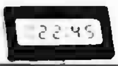
BIPOLAR LED RED/GREEN

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

LCD CLOCK MODULE!

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

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



MINI-SIZED I.C. AM RADIO

Size smaller than a box of matches!
Receives all AM stations.
Batteries and ear phones included.
Only $10.50

12 DC MINI RELAY

6V	SPDT	2 AMP	1.30
12V	SPDT	3 AMP	1.60
12V	DPDT	2 AMP	2.50
12V	4PDT	3 AMP	3.50

LINEAR SLIDE POT

500Ω SINGLE
Metal Case 3" Long
2 FOR $1.20

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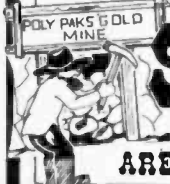
CIRCLE 17 ON FREE INFORMATION CARD

THERE'S GOLD IN THEM THAR PAKS!!



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master charge

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- ☐ 200-LONG LEAD DISCS, prime, marked caps, assorted material, (#2598) 2.99
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- ☐ 50-SLIDE SWITCHES, various shapes, sizes, and types, (#2726) 2.99
- ☐ 75-TRANSISTOR ELECTROLYTICS, epoxy encapsulated, asst. values, (#2747) 2.99
- ☐ 250-HALF WATTERS, 100%, color-coded resistors, asst. values, (#3046) 2.99
- ☐ 25-SLIDE VOLUME CONTROLS, various values & types, for Hi-Fi, etc. (#3057) 2.99
- ☐ 50-UPRIGHT ELECTROS, 100%, assorted values & voltages, marked, (#3226) 2.99
- ☐ 20-ROCKER SWITCHES, white rockers, DPDT, solder lugs, 125V 4A, (#3302A) 2.99
- ☐ 50-MINI POTS, pc style, single turn, assorted values, (#3345) 2.99
- ☐ 20-JUMBO RED LEDS, 3V 10 mA, 100% good material, red dome lense, (#3369) 2.99
- ☐ 3-SOUND TRIGGERS, sound activated amp, SCR triggered, on 3" board, (#3625) 2.99
- ☐ 50-TRANSISTOR SOCKETS, assortment may include; TO-19,5,66,3, etc, (#3845) 2.99
- ☐ 100-CABLE TIES, 4" non-slip white plastic, like Ty-wrap, (#5218) 2.99
- ☐ 150-FEEDTHRU CAPS, assorted types & sizes, for RF, UHF, etc, (#5668A) 2.99
- ☐ 250-¼ WATT RESISTORS, asstd. carbons, carbo-films, some 5%ers, (#5797A) 2.99
- ☐ 100-PLESSY CAPS, ceramic blocks in assorted sizes & vlaues, (#6221) 2.99
- ☐ 30-HOBBY LEDS, assorted types & colors, mostly dims, some good, (#6225) 2.99
- ☐ 100-TTLs, 7400 series, incl. gates, flip-flops, etc. untested, (#6226) 2.99
- ☐ 150 PC.-HEATSHRINK, slip-over type, shrinks 50%, like Thermo-fit. (#6239) 2.99
- ☐ 5-BRASS LOCKS, with key, 1½" long, for doors, windows, etc. (#6253) 2.99
- ☐ 250-MOLEX SOCKETS, "on-a-strip", make your own pc sockets, (#6255) 2.99
- ☐ 4-LM-747 OP AMPS, 100% prime, dual linear op amp, DIP package, (#6262) 2.99
- ☐ 50-RCA PHONO PLUGS, popular audio/speaker plugs, 100% material, (#3293) 2.99
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- ☐ 60-SQUARE OHM RESISTORS, prime resistors, asst. values, grab 'em! (#6261) 2.99
- ☐ 30-MICRO MINI REED SWITCHES, 1" long, for alarms, relay systems, etc. (#6263) 2.99
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- ☐ 20-PUSHBUTTON ALARM SWITCH, SPST, momentary, NC, w/hardware, (#6267) 2.99
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- ☐ 30-9V BATTERY CLIPS, snap connector, coded, insulated leads, (#6286) 2.99
- ☐ 6-WATCH GUTS, 5-function, LED style, assorted sizes, untested, (#6287) 2.99
- ☐ 10-HEAVY DUTY LINE CORDS, white, 2 cond. 6 ft. 16 gauge, (#6292) 2.99
- ☐ 20-SINGLE PIN LEDS, green, micro style, 3V 10mA, 100%, (#6293) 2.99
- ☐ 40-LED/TRANSISTOR SOCKETS, "snap-in", 3 pc leads, for TO-5,18,46,etc, (#6297) 2.99
- ☐ 200-PRE-FORMED ½ WATTERS, popular values, some 5 & 10 %ers, (#6246) 2.99
- ☐ 50-SCRs & TRIACS, assorted values, 10 Amp TO-220, untested, (#6337) 2.99
- ☐ 1-CB CONVERTER, receives CB on car radio, 12 VDC operation; (#5193) 2.99
- ☐ 40-EDGE CONNECTORS, asst. 4 & 6 pin, 2-sided, pc leads, (#6364) 2.99
- ☐ 20-6 CELL BATTERY HOLDERS, for AA size cells, 9V clip receptical, (#6386) 2.99
- ☐ 60-THERMAL FUSES, break at 257 F. 14 gauge axial leads, (#6367) 2.99
- ☐ 4-0.8" HOBBY READOUTS, 4 digit panels, Com. Cathode, untested, (#6384) 2.99
- ☐ 25-TINY SLIDE SWITCH, only 3/7" cube, SPDT, PC leads, (#6385) 2.99
- ☐ 50-TO-5 TRIACS, 50-600 prv., 3 lead TO-5 cans, 60%+ yield, (#6321) 2.99
- ☐ 30-PLASTIC POWERS, 25 watt, npn & pnp, 50-200 bvcbo, TO-220, (#6237) 2.99
- ☐ 100-2 WATT RESISTORS, assorted carbons, films, etc. some 5%ers, (#6238) 2.99
- ☐ 150 PC-HEAT SHRINK, like Thermo-Fit, asst. sizes, shrinks 50%, (#6239) 2.99
- ☐ 25-MAGNETIC DISCS, Plastalloy 13/16 dia. x 1/8" discs, (#6294) 2.99
- ☐ 150-PLUGS & SOCKETS, assorted types & styles, wide variety, (#3527) 2.99
- ☐ 15-PA-263 PC BOARDS, for GE PA-263 stereo amps, pre-etched, (#2013) 2.99
- ☐ 40-STEREO INDICATORS, tiny red 1.5V bulbs, for Hi-Fi replacement, (#6244) 2.99
- ☐ 40-800V 1A RECTIFIERS, type IN4006, epoxy, axial leads, (#6245) 2.99
- ☐ 4-2A 500V BRIDGES, silicon, full wave rectifiers, TO-5 case, (#6248) 2.99
- ☐ 10-QUAD PHONO JACKS, 4 RCA jacks on 2 x 1½" Bakelite strip, (#6249) 2.99
- ☐ 50-MODULAR SWITCHES, by Centralab, "push-on" DPDT, 6PDT, etc., (#3150A) 2.99
- ☐ 150-"4000" RECTIFIERS, IN4000 series, may include; 50 to 1000V, (#2417) 2.99
- ☐ 15-THUMBWHEEL TRIM POTS, snap-in type, assorted values, (#6299) 2.99
- ☐ 50-MAGNIFIED MAN-3's, 7 segment 0. " high, w/"bubble" magnifier, (#6257) 2.99
- ☐ 1-I.R. DIODE, 5-9 watts, hetero-junction coax, for Pulse mode, (#6445) 2.99
- ☐ 200-BULLPLATES, asst. resistor-capacitor networks, various values, (#6282) 2.99
- ☐ 150-METAL CAN TRANSISTORS, asst. 2N #'s in TO-5,1,18, some unmarked, (#2603) 2.99
- ☐ 24-LM-340T VOLTAGE REGULATORS, untested TO-220, may incl. 5-24V, (#2635) 2.99
- ☐ 150-POLYSTYRENE CAPS, assorted types, styles, & sizes, all good, (#2729) 2.99
- ☐ 100-PLASTIC LENSES, assorted styles, & colors, (#6266) 2.99
- ☐ 250-CERAMIC CAPS, asst. tubulars, NPO's, temp. coefficient, etc. (#5839) 2.99
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- ☐ 25-MINI PLUG & CABLE SETS, 3.5mm plug, 6' insulated 2 cond. leads, (#6269) 2.99
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- ☐ 100-METALLIC RESISTORS, mostly ½ watters, asst. val. 1-5% tol. (#6280) 2.99
- ☐ 100-POWERS POWERS, 3 to 7 watt power resistors, (#6281) 2.99
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- ☐ 30-HOBBY OPTO COUPLERS, untested, mini DIP, 1500V isolation, (#2629) 2.99
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- ☐ 100-DTL IC's, mostly dual JK flip flops, marked, 100% prime, (#6444) 2.99
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- ☐ 15-LINE CORDS, heavy-duty, 18 gauge, 6', molded plug, 2-cond. (#6499) 2.99

ULTRA-SMALL LCD CHRONOGRAPH MODULE

• Only 2-3/8 x 1-1/2" • Multi-Function Memory Enables Module To Function As: STOPWATCH!

ELAPSED TIME INDICATOR!
DUAL ZONE TIMER!
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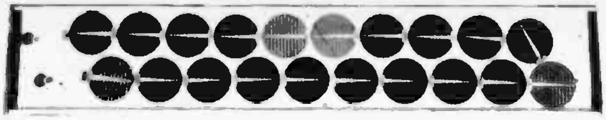

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Govt surplus walky talky, used cond. 47-55.4 mc range. Ant. $5 each extra. With data.

$25 ea 2 for $45

AN/PRC-6

SEE IN THE DARKNESS
IR viewer, portable, new with choice of one lens...close up, telephoto or gen. purpose. Requires 6 volt DC btry. $250

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Visually OK, with head.
Sold as is........................ $400.00

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INTERNATIONAL ELECTRONICS UNLIMITED

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7 segment RHD — 10/$7.95
MAN4610 - common anode — 25/$17.50
MAN4640 - common cathode — 100/$65.00

.4" ORANGE overflow ±1 — $.89ea
MAN4630 - common anode — 10/$5.95

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

JUMBO RED LED .20" diffused
SUBMIN RED LED .125" diffused
10/$1.00 25/$2.00 100/$7.50

JUMBO GREEN LED .20" diffused
SUBMIN GREEN LED .125" diffused
7/$1.00 25/$2.85 100/$9.75

Rohm METAL FILM RESISTORS

		ea	pk-10	pk-25	pk-100
R-OHM RB60FY (RN60) ±1% 50ppm/°C	1-999	.25	1.50	2.25	7.50
1/4w MIL-R-10509 250V/70°C	1000-	.25	1.25	2.10	7.25
.138" dia X .355" long (body)	5000-	.25	1.00	1.90	6.75
ALL STANDARD DECADE VALUES	10000-	.25	.95	1.75	6.00
FROM 10ohm to 475K					

.5" RED LED DISPLAY
7 segment RHD
FND500 Common Cathode
$.89ea.
10/$7.75
25/$17.00
100/$62.00

TANTALUM CAPACITORS
solid dipped ± 20%

	1-9	10-		1-9	10-		1-9	10-
.1uf/35V	.30	.25	4.7uf/16V	.38	.30	22uf/16V	.50	.40
.22uf/35V	.30	.25	4.7uf/25V	.45	.35	22uf/35V	.60	.55
.33uf/35V	.30	.25	6.8uf/6V	.35	.28	33uf/6V	.55	.45
1uf/20V	.30	.25	6.8uf/16V	.45	.39	33uf/10V	.60	.50
1.5uf/20V	.30	.25	10uf/16V	.40	.30	47uf/6V	.60	.50
2.2uf/20V	.35	.25	10uf/20V	.42	.35	47uf/15V	.65	.55
2.2uf/35V	.38	.28	15uf/6V	.42	.35	56uf/6V	.85	.75
3.3uf/35V	.40	.30	15uf/20V	.50	.40	100uf/20V	1.50	1.40

TANTALUM CAPACITOR ASST.
2ea. of above - 48 caps. $20.00

CLOCK CHIP MM5375AA
4-6 digit 60hz 12hr alarm 24 pin
$1.95
10/$17.50
100/$150.00

IC BREADBOARD
2 5/16" X 6 9/16"
UNIVERSAL BREADBOARD
3 3/16" X 5 1/16"
$1.15ea.
10/$10.00
100/$75.00

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1N4148 400mw 15/$1.00 100/$5.00
1N4001 rectifier 12/$1.00 100/$7.00
1N4007 rectifier 10/$1.00 100/$9.00

PLL TONE DECODER $.99ea.
567 8 pin DIP 10/$8.55
100/$80.00

TRANSISTOR - 2N2222A
general purpose NPN TO-18
1-9 $ .39
pk-10 2.95
pk-100 27.50

DIPSWITCH - 4 sw
8 pin DIP SPST
1-9 $1.65ea
10-24 1.55ea
25- 1.49ea

POWER SUPPLY KIT PS-29
provides simultaneous outputs of plus & minus 5V, 12V, & 15V. uses 115/29VCT transformer - 1Amp total output. kit includes PC board (2 1/8" X 3 15/16"), all parts incl transformer, schematic & layout dwg.
$14.95ea
10-24 13.50ea
25- 12.50ea

TRANSISTORS

2N3904 NPN TO-92 10/$1.50
2N3906 PNP TO-92 25/$3.00
100/$11.00

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

UART 1602B $3.95ea 10/$35.00 100/$275.00

CRYSTAL CONTROLLED TIME BASE KIT
provides accurate 1 hz, 10 hz & 60 hz double buffered outputs from 9VDC input. CMOS compatible. kit includes PC board, (1 5/8" X 3"), all parts (except battery), schematic, layout dwg, & instructions.
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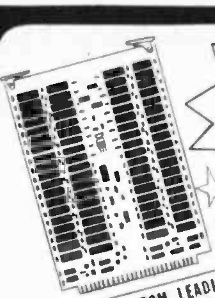
CIRCLE 51 ON FREE INFORMATION CARD



32K x 9 MEMORY BOARDS

RAM $99

NEW, SURPLUS, FROM LEADING COMPUTER MANUFACTURER ! TESTED & BURNED IN !

WITH 11 PGS DATA

ACCESS TIME:	250 NS
READ, WRITE:	430 NS
R-M-W:	550 NS

- 100 PIN BUSS
- SEVENTY-TWO 2107C 4K X 1 RAMS
- SELECTABLE 32K X 9 OR 16K X 18
- SIZE: 8.175" X 10.5"
- LOWEST PRICE ANYWHERE !

MOST FANTASTIC MEMORY OFFER OF ALL TIME!! HERE'S A CHANCE TO LOAD UP YOUR COMPUTER (EITHER 8 BIT OR 16 BIT) WITH FAST DYNAMIC RAM AT AN UNBELIEVEABLE PRICE! BOARDS ARE NEW, SURPLUS, COMMERCIAL GRADE, TESTED AND BURNED IN, JUMPER SELECTABLE FOR EITHER 32K x 9 OR 16K x 18 OPERATION (THE EXTRA BITS ARE FOR PARITY OR CAN BE IGNORED). WITH A LITTLE BIT OF INTERFACING, YOU CAN SAVE SEVERAL HUNDRED DOLLARS AND BE UP AND RUNNING IN NO TIME! UNITS COME COMPLETE WITH SCHEMATICS, BOARD LAYOUTS, AND DETAILED INFO ON THE 2107C RAM. TO MAKE IT EVEN EASIER TO GET UP & RUNNING, SEE "INFO EXCHANGE" BELOW.

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INFORMATION PACKAGE ONLY, $1

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ICM 7207A ICM 7208 $21.50

*6 MHZ COUNT RATE

*SINGLE 3-6V SUPPLY
*DIRECT DRIVE TO CC LEDS
*0.1 AND 1 SEC. GATE

WITH 10 PGS. DATA

Build a 7 Digit Portable Counter

5.24288MHz Quartz Crystal

0-3311

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49¢ 10/$4.50

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DS-7	$1.40
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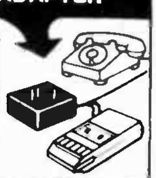

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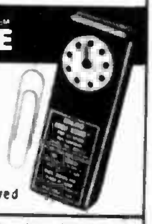

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4001	22	4023	22	4066	70	74C73	75
4002	22	4024	75	4069	45	74C74	90
4006	1.10	4025	.22	4071	20	74C83	1 30
4007	27	4027	45	4072	35	74C85	50
4009	45	4028	80	4081	22	74C93	95
4010	.45	4029	95	4083	95	74C151	1 75
4011	22	4030	35	4501	95	74C157	1 75
4012	22	4034	2.25	4514	1 95	74C160	1 20
4013	40	4035	97	4516	1 00	74C161	1 15
4014	1 20	4040	1 00	4518	1 20	74C163	1 00
4015	1 00	4042	85	4520	1 00	74C166	1 25
4016	45	4045	45	74C00	27	74C173	1 30
4017	1 05	4046	1 95	74C02	27	74C174	1 20
4018	90	4049	75	74C08	30	74C175	1 20
4019	45	4050	48	74C10	27	74C192	1 30
4020	1 10	4051	1 10	74C14	1 20	74C193	1 40
4021	1 10	4052	1 10	74C20	27	74C901	50
4022	1 00	4053	1 10	74C42	90	74C902	50
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1489 RS232 INTRFACE	1 25	TMS 4045 25 1K x 4 250NS STATIC RAM	6 70
2509 TRI STATE STAT. SR	1 35		
2518 HEX 32 BIT SR	2.20	82S23	1 95
2522 STATIC SHIFT REG	1 95	82S129	3 25
2708 8K EPROM (450 ns)	9 95	82S123	2 95
TMS 3409 NC 80 BITS DYN. S R	1 35	82S126	2 95
2716 (TI) 3 VOLTAGES	24 95	82S131	2 95
2716 (Intel) + 5V	28 95	82S130	3 45
2102-1 (450 ns)	90	AYS 1013 VART	5 25
21L02-1 (450 ns)	1 10	TPI 602B	5 25
MM5270 4K X1 DYN	3 45	MC6845	29 95
MK4008P	1 95	PT 1482 B PSAT	8 95
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8130	2 95	8T380	2 25	8837	2 25
8131	2 95	8830	2 95	8838	2 25
8833	2 50				

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5.000 MHz	18.000 MHz
6.000 MHz	20.000 MHz

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40 cond	.75/per foot
50 cond.	.90/per foot

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74S08	.40	74S86	.65	74S158	1.25
74S11	.35	74S112	.85	74S174	1.40

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PRV	1A	3A	12A	50A	125A	240A
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400	.09	.25	.65	1.50	6.50	9.80
600	.11	.30	.80	2.00	8.50	12.50
800	.15	.35	1.00	2.50	10.50	16.50
1000	.20	.45	1.25	3.00	12.50	20.00

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2N3919 NPN Si TO-3 RF	$1.50
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2N2222 NPN Si TO-18	5/$1.00
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74101	.17	7450	.17	74157	.65
7402	.17	7472	.35	74160	.85
7403	.17	7473	.35	74161	.80
7404	.24	7474	.42	74162	1.20
7405	.24	7475	.49	74163	.82
7406	.33	7476	.45	74164	.85
7407	.35	7480	.45	74165	.85
7408	.27	7483	.60	74166	1.05
7409	.24	7485	.75	74167	1.35
7410	.17	7486	.42	74170	1.60
7411	.22	7489	1.60	74173	1.30
7412	.22	7490	.50	74174	.85
7413	.42	7491	.55	74175	.75
7414	.90	7492	.50	74176	.75
7416	.33	7493	.50	74177	.75
7417	.37	7494	.60	74180	.75
7420	.17	7495	.60	74181	1.90
7425	.35	7496	.80	74190	1.20
7426	.33	74107	.35	74191	1.20
7427	.35	74121	.35	74192	.79
7430	.17	74122	.39	74193	.79
7432	.27	74123	.42	74194	.85
7437	.27	74125	.45	74195	.65
7438	.27	74126	.45	74196	.85
7440	.17	74145	.75	74197	.87
7441	.85	74148	1.10	74279	.75
7442	.50	74150	1.10	74325	2.25
7445	.70	74151	.65	74365	.80
7446	.75	74153	.55	74367	.80
7447	.75	75154	1.10	74368	.65
				75491	1.05
				75492	1.05
				8T98	1.10

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400	1.00	1.65	3.30
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3.3UF 20V	4/$1.00	100UF 15V	$ .70
		150UF 15V	$ .95

74LS SERIES

74LS00	28	74LS153	1 19
74LS01	28	74LS155	1 19
74LS02	28	74LS156	1 19
74LS03	28	74LS157	1 19
74LS04	35	74LS160	1 10
74LS05	35	74LS162	1 10
74LS08	35	74LS163	1 20
74LS09	35	74LS164	1 20
74LS10	30	74LS168	1 25
74LS11	45	74LS169	1 25
74LS12	35	74LS170	1 70
74LS13	95	74LS173	1 30
74LS14	1 95	74LS174	1 00
74LS15	35	74LS175	1 00
74LS20	30	74LS181	2 50
74LS21	95	74LS190	1 25
74LS22	35	74LS191	1 15
74LS26	35	74LS192	1 00
74LS27	45	74LS193	1 10
74LS28	.45	74LS195	1 10
74LS30	35	74LS196	1 20
74LS32	40	74LS221	1 30
74LS37	45	74LS197	1 10
74LS38	55	74LS240	2.50
74LS40	.40	74LS241	2 95
74LS42	1 00	74LS242	3 00
74LS51	35	74LS243	2 75
74LS54	35	74LS244	2 50
74LS73	.45	74LS251	1 29
74LS74	1 05	74LS257	90
74LS75	59	74LS258	1 50
74LS76	46	74LS259	1 50
74LS86	45	74LS266	70
74LS90	90	74LS279	70
74LS92	90	74LS290	80
74LS93	90	74LS293	80
74LS107	46	74LS295	1 50
74LS109	45	74LS298	1 50
74LS112	46	74LS365	80
74LS113	45	74LS366	80
74LS114	55	74LS367	80
74LS125	90	74LS368	80
74LS126	90	74LS375	95
74LS132	95	74LS377	2 75
74LS138	1 30	74LS386	50
74LS151	1 19	74LS390	1 95

LINEAR CIRCUITS

LM201	75
LM301 748	25
LM307	30
LM308	75
LM311	75
LM318	1 20
LM324	95
LM339	1 10
LM358	70
LM377	1 80
LM380	95
LM382	1 25
LM386	80
LM387	1 25
LM1808	1 75
LM1889	1 95
CA3018	1 95
CA3080	95
CA3086	95
DM1800	1 95
LM370	1 50
LM537	2 50
LM563	2 50
LM566	49
LM568	85
560	2 00
565	95
566	1 25
567	1 10
702	95
703	85
709	25
710	45
711CH	40
741C or V	30
747	50
LM1310	2 50
1458	50
3900	65
8038CC	3 90
4136	95
LF356	1 75
NE540L	2 50
1810PC	2 20

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1.5A	6A	35A
.45	.60	1.40
.70	.80	1.90
1.20	1.40	2.60
	1.80	3.60

TRIACS

	PRV	1A	10A	25A
100	100	.45	.80	1.56
200	200	.84	1.30	2.10
400	400	1.30	1.90	3.10
600	600	2.00	2.75	4.30

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Stereo Power Booster Model POW-40 ■ 40W stereo ■ 20W per channel ■ Bass boost $24.95

SPECIALS

B&K PRECISION 30 MHz Portable Frequency Counter Reg. $130.00 $65 Model 1827

HICKOK Digital CB In-Line Tester $169.95 ■ Measures all 4 transmitter output characteristics ■ Frequency ■ Power ■ SWR ■ Modulation % Model 388

Portable VOM Multitester ■ 20 KΩ VDC ■ 10 KΩ VAC $19.95 Model VM520

RCA-VIZ Super Chro-Bar Model WR-538A Reg. $129.95 $89.95

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CANON Calculator Portable Printer with Adding Machine Tape Model P10-D $69.98

Portable Oscilloscopes NLS

15 MHz Dual Trace Triggered Miniscope $369.95 Reg. $435.00 Model MS-215

15 MHz Triggered Miniscope Model MS-15 Reg. $319.00 $269.95

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Model 1400 $199.95

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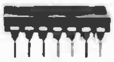


Guaranteed Specs

4000-Series CMOS ICs

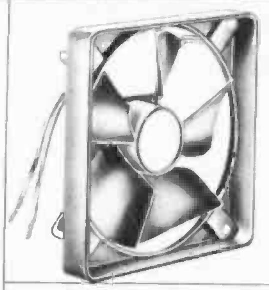
Type	Cat. No.	EACH
4001	276-2401	.69
4011	276-2411	.69
4012	276-2412	.79
4013	276-2413	.99
4017	276-2417	1.69
4020	276-2420	1.69
4021	276-2421	1.69
4023	276-2423	.69
4027	276-2427	.99
4028	276-2428	1.29
4046	276-2446	1.89
4511	276-2447	1.69
4049	276-2449	.79
4050	276-2450	.79
4051	276-2451	1.49
4066	276-2466	1.39
4070	276-2470	.79
4518	276-2490	1.49
4543	276-2491	1.99

Improved 5-volt logic devices use Schottky diode technology for minimum propogation delay and high speed at minimum power.

Type	Cat. No.	ONLY
74LS00	276-1900	.49
74LS02	276-1902	.59
74LS04	276-1904	.59
74LS08	276-1908	.49
74LS10	276-1910	.59
74LS13	276-1911	.99
74LS20	276-1912	.59
74LS27	276-1913	.69
74LS30	276-1914	.59
74LS32	276-1915	.69
74LS47	276-1916	1.29
74LS51	276-1917	.59
74LS73	276-1918	.69
74LS74	276-1919	.69
74LS75	276-1920	.99
74LS76	276-1921	.79
74LS85	276-1922	1.29
74LS90	276-1923	.99
74LS92	276-1924	.99
74LS93	276-1925	.99
74LS123	276-1926	1.19
74LS132	276-1927	.99
74LS151	276-1929	.99
74LS157	276-1930	1.19
74LS161	276-1931	1.49
74LS164	276-1932	1.49
74LS175	276-1934	1.19
74LS192	276-1935	1.49
74LS193	276-1936	1.49
74LS194	276-1937	1.49
74LS196	276-1938	1.59
74LS367	276-1835	1.19
74LS368	276-1836	1.19
74LS373	276-1943	2.39
74LS374	276-1944	2.39

All Prime from Major Semiconductor Manufacturers. Specs and Pin Out Diagram Included with Each Device.

4" AC Cooling Fan



12.95 *Value and Quality!*

Ideal for power supplies, computers, hi-fi and Ham gear. Delivers up to 70 CFM, yet very quiet. Diecast venturi. U.L. recognized motor. 4.63x4.63x2.47". 120VAC. 60 Hz.
273-241 . . . . . 12.95

12/24 Hr. LCD Clock Display

19.95

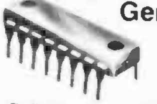
- *Time/Day/Date*
- *24-Hour Alarm*

Actual Size!

Just add switches and a buzzer for a complete alarm clock! 0.25"-tall LCD has backlight, alarm set and PM indicators. Runs a year on single 1.5V battery. Accuracy: ±13 seconds/month. 277-1005 . . . . . 19.95

Mini Piezo Buzzer. For above. 273-064 . . . . . 1.99

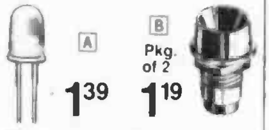
Rhythm Pattern Generator



5.99

Build your own rhythm box or drum synthesizer! Provides 6 separate patterns which can be mixed. Trigger outputs for wood block, brushes, bongo, snare and bass drum. 16-pin with data, circuits. PMOS. MM5871.
276-1785 . . . . . 5.99

Tri-Color LED



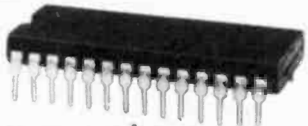
A **1.39** B Pkg. of 2 **1.19**

A **Tri-Color LED.** Red on DC, green on reverse DC, yellow on AC. Max. current: 25 mA. 276-035 . . . . . 1.39

B **Chrome Holders.** Ideal for panel mounting above.
276-080 . . . . Pkg. of 2/1.19

SN76477 Sound Effects and Music Synthesizer IC

2.99



Combines Linear and I²L Technology

Creates almost any type of sound — music, phaser gun, explosions and gunshots! 28-pin DIP has 2 VCOs, low frequency osc., noise generator, filter, 2 mixers, timing logic. Line level output. With data.
276-1765 . . . . . 2.99

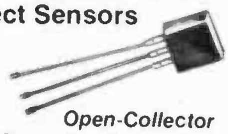
Noise Generator IC

2.69 *White or Pink Noise*

S2688. 17-bit shift register clocked by internal osc. provides consistent noise quality. Can also be used as a random event generator. Single or dual supply. 8-pin DIP with data. Use with 276-1785 (above).
276-1768 . . . . . 2.69

Hall-Effect Sensors

1.98 Pkg. of 3



Open-Collector (Switching Type) Output

Ideal for tachs, position sensing, counting. Detects magnetic fields electronically. 750 gauss "on" threshold. 5-16VDC supply. TO-92 case. With data.
276-1646 . . . . . 3/1.98

Oscillator/Divider IC

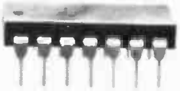
2.69

Generates Stable 60 Hz Reference

CMOS IC provides accurate 60 Hz square wave. Ideal for a battery-powered time base! Requires 3.58 MHz crystal, available through your neighborhood Radio Shack. 3-15VDC. 8-pin DIP with data.
276-1769 . . . . . 2.69

V to F, F to V Converter IC

3.49



Interfaces With Any Logic

9400CJ. Truly, a multi-function device! Use as A/D converter, data transceiver, FM modulator/demodulator, RPM indicator, systems measurements control and more. Operates to 100 kHz. 14-pin DIP with data. 276-1790 . . . . . 3.49

Precision Panel Meters

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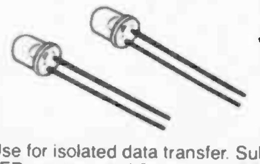
Wide-angle meters let you monitor critical circuit changes — and dress up your projects. Accuracy: ±5% full scale. All are 2¾x2¼x1¼" overall and require a 1⅞" mounting hole.

0-50 μA DC. 270-1751 . . . . . 8.95
0-1 mA DC. 270-1752 . . . . . 8.95

Infrared LED Emitter/Detector Pair



1.99 Pair

Use for isolated data transfer. Subminí LED source rated 20 mA at 1.7VDC. Matched detector uses a phototransistor for high sensitivity.
276-142 . . . . . Pair 1.99

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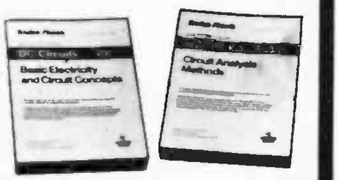

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2SA 473	.45	.55	.60
2SA 483	2.00	2.20	2.50
2SA 484	1.50	1.75	1.95
2SA 485	1.40	1.60	1.80
2SA 489	1.10	1.25	1.40
2SA 490	.70	.80	.90
2SA 493	.45	.53	.59
2SA 495	.30	.35	.40
2SA 496	.50	.64	.70
2SA 497	1.00	1.20	1.30
2SA 505	.50	.64	.70
2SA 509	.30	.35	.40
2SA 525	.50	.64	.70
2SA 530	1.50	1.70	1.90
2SA 537A	1.50	1.70	1.90
2SA 539	.40	.45	.50
2SA 545	.45	.53	.59
2SA 561	.30	.35	.40
2SA 562	.30	.35	.40
2SA 564A	.20	.27	.30
2SA 565	.70	.80	.90
2SA 566	2.50	2.70	3.00
2SA 606	1.00	1.20	1.30
2SA 607	1.10	1.25	1.40
2SA 624	.70	.80	.90
2SA 627	3.10	3.30	3.60
2SA 628	.30	.35	.40
2SA 634	.40	.45	.50
2SA 640	.30	.35	.40
2SA 642	.30	.35	.40
2SA 643	.30	.40	.45
2SA 653	1.90	2.10	2.40
2SA 659	.35	.40	.45
2SA 661	.50	.64	.70
2SA 663	3.65	3.80	4.20
2SA 666	.35	.40	.45
2SA 671	.80	.90	1.00
2SA 672	.30	.35	.40
2SA 673	.35	.40	.45
2SA 678	.35	.40	.45
2SA 679	4.20	4.40	4.90
2SA 680	4.20	4.40	4.90
2SA 682	.80	.90	1.00
2SA 683	.30	.35	.40
2SA 684	.35	.40	.45
2SA 695	.40	.53	.59
2SA 697	.40	.53	.59
2SA 699A	.50	.64	.70
2SA 705	.40	.53	.59
2SA 706	.85	1.00	1.10
2SA 715	.60	.70	.80
2SA 719	.30	.35	.40
2SA 720	.30	.35	.40
2SA 721	.30	.35	.40
2SA 725	.30	.35	.40
2SA 726	.30	.35	.40
2SA 733	.20	.27	.30
2SA 738	.40	.53	.59
2SA 740	1.50	1.70	1.90
2SA 743A	.85	1.00	1.10
2SA 744	4.20	4.40	4.90
2SA 745R	3.80	4.00	4.40
2SA 747	4.20	4.40	4.90
2SA 748	.70	.80	.90
2SA 750	.35	.40	.45
2SA 755	.80	.90	1.00
2SA 756	2.30	2.40	2.65
2SA 758	3.40	3.55	3.90
2SA 764	3.80	4.00	4.40
2SA 765	3.10	3.30	3.60
2SA 774	.40	.45	.50
2SA 777	.50	.64	.70
2SA 794A	.60	.70	.80
2SA 798	.50	.55	.60
2SA 814	.70	.80	.90
2SA 815	.60	.70	.80
2SA 816	.50	.64	.70
2SA 818	.70	.80	.90
2SA 837R	2.50	2.70	2.90
2SA 839T	1.30	1.45	1.60
2SA 908	8.60	8.80	9.80
2SA 913	.70	.80	.90
2SB 22	.30	.35	.40
2SB 54	.20	.27	.30
2SB 55	.40	.53	.59
2SB 75	.35	.40	.45
2SB 77	.35	.40	.45
2SB 173	.30	.35	.40
2SB 175	.20	.27	.30
2SB 176	.30	.35	.40
2SB 178	.35	.40	.45
2SB 186	.20	.27	.30
2SB 187	.20	.27	.30
2SB 202	1.10	1.20	1.30
2SB 220	.90	1.10	1.20
2SB 303	.30	.35	.40
2SB 324	.30	.35	.40
2SB 337	1.40	1.80	1.80

TYPE	25-UP	10-24	1-9
2SB 346	.30	.35	.40
2SB 367	1.10	1.25	1.40
2SB 368B	1.80	2.00	2.25
2SB 379	.70	.80	.90
2SB 381	.30	.35	.40
2SB 400	.30	.35	.40
2SB 405	.30	.35	.40
2SB 407	.80	.90	1.00
2SB 415	.30	.35	.40
2SB 434	.80	.90	1.00
2SB 435	.90	1.10	1.20
2SB 440	.40	.53	.59
2SB 449	1.30	1.45	1.60
2SB 461	.90	1.10	1.20
2SB 463	.90	1.10	1.20
2SB 471	1.10	1.25	1.40
2SB 472	2.10	2.50	2.80
2SB 473	.80	.90	1.00
2SB 474	.70	.80	.90
2SB 481	.90	1.10	1.20
2SB 492	.60	.70	.80
2SB 507	.80	.90	1.00
2SB 509	1.10	1.20	1.30
2SB 511	.70	.80	.90
2SB 514	.70	.80	.90
2SB 523	.70	.80	.90
2SB 526C	.70	.80	.90
2SB 527	.90	1.10	1.20
2SB 528D	.70	.80	.90
2SB 529	.70	.80	.90
2SB 530	3.20	3.40	3.70
2SB 531	1.80	2.00	2.25
2SB 536	1.00	1.20	1.30
2SB 537	1.00	1.20	1.30
2SB 539	3.20	3.40	3.70
2SB 541	3.20	3.40	3.70
2SB 554	5.00	6.00	6.60
2SB 556	3.20	3.40	3.70
2SB 557	2.10	2.50	2.80
2SB 561B	.35	.40	.45
2SB 564	.40	.53	.59
2SB 595	1.10	1.40	1.50
2SB 596	1.10	1.40	1.50
2SB 600	5.00	6.00	6.60
2SC 183	.40	.53	.59
2SC 184	.40	.53	.59
2SC 281	.30	.35	.40
2SC 283	.40	.53	.59
2SC 284	.80	.90	1.00
2SC 317	.40	.53	.59
2SC 352A	2.00	2.20	2.50
2SC 353A	1.40	1.60	1.80
2SC 367	.60	.70	.80
2SC 369	.30	.35	.40
2SC 370	.20	.27	.30
2SC 371	.30	.35	.40
2SC 372	.20	.27	.30
2SC 373	.20	.27	.30
2SC 374	.30	.35	.40
2SC 375	.30	.35	.40
2SC 377	.30	.35	.40
2SC 380	.20	.27	.30
2SC 381	.35	.40	.45
2SC 382	.35	.40	.45
2SC 383	.35	.40	.45
2SC 387A	.35	.40	.45
2SC 388A	.40	.53	.59
2SC 394	.20	.27	.30
2SC 403	.30	.35	.40
2SC 430	.50	.64	.70
2SC 454	.30	.35	.40
2SC 458	.20	.27	.30
2SC 460	.35	.40	.45
2SC 461	.35	.40	.45
2SC 478	.60	.70	.80
2SC 481	1.30	1.40	1.50
2SC 482	1.10	1.25	1.40
2SC 484	1.30	1.40	1.50
2SC 485	1.30	1.40	1.50
2SC 486	1.30	1.40	1.50
2SC 493	3.00	3.20	3.40
2SC 495	.45	.55	.60
2SC 496	.45	.55	.60
2SC 497	1.10	1.25	1.40
2SC 509	.35	.40	.45
2SC 510	1.30	1.40	1.50
2SC 515A	.80	.90	1.00
2SC 517	2.50	2.70	3.00
2SC 535	.30	.35	.40
2SC 536	.30	.35	.40
2SC 537	.30	.35	.40
2SC 627	1.30	1.45	1.60
2SC 631	.35	.40	.45
2SC 632A	.35	.40	.45
2SC 634A	.35	.40	.45
2SC 680	1.90	2.10	2.40
2SC 681A	3.00	3.25	3.50
2SC 684	.80	.90	1.00

TYPE	25-UP	10-24	1-9
2SC 693F	.20	.27	.30
2SC 696	1.00	1.20	1.30
2SC 708	1.30	1.45	1.50
2SC 710	.20	.27	.30
2SC 711	.20	.27	.30
2SC 712	.20	.27	.30
2SC 715	.30	.35	.40
2SC 717	.35	.40	.45
2SC 727	1.00	1.20	1.30
2SC 730	3.00	3.20	3.40
2SC 731	2.50	2.70	2.90
2SC 732	.20	.27	.30
2SC 733	.20	.27	.30
2SC 734	.20	.27	.30
2SC 735	.20	.27	.30
2SC 738	.20	.27	.30
2SC 756	1.50	1.80	2.00
2SC 756A	1.50	1.80	2.00
2SC 763	.35	.40	.45
2SC 772	.30	.35	.40
2SC 773	.35	.40	.45
2SC 774	1.00	1.20	1.30
2SC 775	1.40	1.60	1.80
2SC 776	2.00	2.20	2.50
2SC 777	3.00	3.25	3.50
2SC 778	2.90	3.20	3.40
2SC 781	1.90	2.10	2.40
2SC 783	2.10	2.50	2.80
2SC 784	.30	.35	.40
2SC 785	.35	.40	.45
2SC 789	.80	.90	1.00
2SC 790	.80	.90	1.00
2SC 793	2.00	2.20	2.50
2SC 799	2.00	2.20	2.50
2SC 828	.20	.27	.30
2SC 829	.20	.27	.30
2SC 830H	2.50	2.70	3.00
2SC 838	.35	.40	.45
2SC 839	.30	.35	.40
2SC 853	.70	.80	.90
2SC 867	4.20	4.40	4.90
2SC 867A	4.20	4.40	4.90
2SC 870	.35	.40	.45
2SC 871	.35	.40	.45
2SC 895	4.20	4.40	4.90
2SC 897	2.00	2.20	2.50
2SC 898	2.50	2.70	3.00
2SC 900	.20	.27	.30
2SC 923	.20	.27	.30
2SC 929	.20	.27	.30
2SC 930	.20	.27	.30
2SC 941	.20	.27	.30
2SC 943	.35	.40	.45
2SC 945	.20	.27	.30
2SC 959	1.00	1.20	1.30
2SC 971	.70	.80	.90
2SC 982	.70	.80	.90
2SC 983	.50	.64	.70
2SC 1000	.35	.40	.45
2SC 1012	1.20	1.40	1.50
2SC 1013	.50	.64	.70
2SC 1014	.50	.64	.70
2SC 1017	.80	.90	1.00
2SC 1018	.60	.70	.80
2SC 1030	1.80	2.10	2.40
2SC 1047	.35	.40	.45
2SC 1051	3.40	3.55	3.90
2SC 1060	.70	.80	.90
2SC 1061	.70	.80	.90
2SC 1076	30.00	35.00	39.00
2SC 1079	3.40	3.55	3.90
2SC 1080	3.40	3.55	3.90
2SC 1096	.45	.55	.60
2SC 1098	.50	.64	.70
2SC 1111	2.10	2.50	2.80
2SC 1114	4.20	4.40	4.90
2SC 1115	2.50	2.70	3.00
2SC 1116	3.20	3.40	3.70
2SC 1116A	3.40	3.55	3.90
2SC 1124	.80	.90	1.00
2SC 1127	.80	.90	1.00
2SC 1161	1.30	1.45	1.60
2SC 1162	.70	.80	.90
2SC 1166	.20	.27	.30
2SC 1167	3.80	4.00	4.40
2SC 1170B	3.80	4.00	4.40
2SC 1172B	3.20	3.60	3.95
2SC 1173	.50	.55	.60
2SC 1175	.35	.40	.45
2SC 1177	11.00	12.60	14.00
2SC 1189	1.00	1.10	1.20
2SC 1209	.30	.35	.40
2SC 1211D	.30	.35	.40
2SC 1212A	.80	.90	1.00
2SC 1213	.30	.35	.40
2SC 1215	.35	.40	.45
2SC 1222	.20	.27	.30
2SC 1226	.50	.55	.60

TYPE	25-UP	10-24	1-9
2SC 1226A	.50	.55	.60
2SC 1237	1.80	2.00	2.25
2SC 1239	2.20	2.70	2.90
2SC 1279	.50	.55	.60
2SC 1306	1.30	1.45	1.60
2SC 1307	1.90	2.10	2.40
2SC 1310	.20	.27	.30
2SC 1312	.20	.27	.30
2SC 1313G	.20	.27	.30
2SC 1316	4.20	4.40	4.90
2SC 1317	.20	.27	.30
2SC 1318	.35	.40	.45
2SC 1325A	6.50	6.90	7.60
2SC 1327	.20	.27	.30
2SC 1330	.50	.55	.60
2SC 1335	.50	.55	.60
2SC 1342	.45	.53	.59
2SC 1344	.45	.53	.59
2SC 1358	4.20	4.40	4.90
2SC 1359	.30	.35	.40
2SC 1360	.50	.55	.60
2SC 1362	.35	.40	.45
2SC 1364	.35	.40	.45
2SC 1377	3.20	3.40	3.70
2SC 1383	.30	.35	.40
2SC 1384	.35	.40	.45
2SC 1396	.45	.53	.59
2SC 1398	.70	.80	.90
2SC 1400	.35	.40	.45
2SC 1402	3.00	3.20	3.40
2SC 1403	3.20	3.40	3.70
2SC 1407	.50	.55	.60
2SC 1419	.60	.70	.80
2SC 1444	1.60	1.80	2.00
2SC 1445	2.50	2.70	2.90
2SC 1447	.60	.70	.80
2SC 1448	.70	.80	.90
2SC 1449	.60	.70	.80
2SC 1451	1.00	1.10	1.20
2SC 1454	3.20	3.40	3.70
2SC 1475	.80	.90	1.00
2SC 1478	.50	.55	.60
2SC 1509	.50	.55	.60
2SC 1567	.60	.70	.80
2SC 1567A	.60	.70	.80
2SC 1584	6.00	6.30	7.00
2SC 1586	6.50	6.90	7.60
2SC 1624	.60	.70	.80
2SC 1626	.60	.70	.80
2SC 1628	.60	.70	.80
2SC 1647	.70	.80	.90
2SC 1667	3.00	3.20	3.40
2SC 1669	.90	1.00	1.10
2SC 1674	.30	.35	.40
2SC 1675	.20	.27	.30
2SC 1678	1.10	1.25	1.40
2SC 1679	3.00	3.20	3.40
2SC 1681	.30	.35	.40
2SC 1682	.30	.35	.40
2SC 1684	.30	.35	.40
2SC 1687	.40	.45	.50
2SC 1688	.35	.40	.45
2SC 1708	.30	.35	.40
2SC 1728	.70	.80	.90
2SC 1730	.45	.53	.59
2SC 1756	.50	.55	.60
2SC 1760	.70	.80	.90
2SC 1816	1.50	1.75	1.95
2SC 1856	.45	.53	.59
2SC 1885	.45	.53	.59
2SC 1908	.30	.35	.40
2SC 1909	1.80	2.00	2.25
2SC 1945	4.50	5.00	5.60
2SC 1957	.60	.70	.80
2SC 1969	3.60	4.00	4.40
2SC 1973	.70	.80	.90
2SC 1975	1.30	1.70	1.90
2SC 1978	5.40	6.00	6.60
2SC 2028	.50	.64	.70
2SC 2029	1.50	1.80	2.00
2SC 2074	.80	.90	1.00
2SC 2076	.50	.64	.70
2SC 2091	.90	1.10	1.20
2SC 2092	1.80	2.00	2.25
2SC 2098	3.20	3.40	3.70
2SC 2166	1.40	1.60	1.80
2SD 72	.50	.64	.70
2SD 77	.35	.40	.45
2SD 90	1.30	1.45	1.60
2SD 91	1.30	1.45	1.60
2SD 92	1.30	1.45	1.60
2SD 93	1.60	1.80	2.00
2SD 118	2.90	3.20	3.40
2SD 130	1.10	1.25	1.40
2SD 187	.35	.40	.45
2SD 201	2.30	2.40	2.65
2SD 202	3.40	3.55	3.90
2SD 218	2.50	2.70	3.00

TYPE	25-UP	10-24	1-9
2SD 234	.60	.70	.80
2SD 235	.60	.70	.80
2SD 261	.35	.40	.45
2SD 287	2.50	2.70	2.90
2SD 300	4.50	5.00	5.60
2SD 313	.60	.70	.80
2SD 315	.60	.70	.80
2SD 325	.60	.70	.80
2SD 330	.60	.70	.80
2SD 350	3.80	4.00	4.40
2SD 380	5.20	5.40	5.95
2SD 381	.85	1.00	1.10
2SD 424	3.80	4.00	4.40
2SD 425	2.90	3.20	3.40
2SD 426	3.10	3.30	3.60
2SD 427	1.80	2.00	2.25
2SD 525	.90	1.10	1.20
2SD 526	.60	.70	.80
2SK 19BL	.50	.55	.60
3SK 22Y	1.40	1.60	1.80
3SK 39	.90	1.10	1.20
3SK 40	.90	1.10	1.20
3SK 41	1.30	1.45	1.60
3SK 45	1.30	1.45	1.60
AN 203	1.40	1.60	1.80
AN 214Q	1.50	1.70	1.90
AN 239	4.20	4.40	4.90
AN 247	2.50	2.70	3.00
AN 274	1.50	1.75	1.95
AN 313	3.00	3.20	3.40
AN 315	1.80	2.00	2.25
BA 511A	1.80	2.00	2.25
BA 521	1.90	2.10	2.40
HA 1151	1.50	1.75	1.95
HA 1156W	1.60	1.80	2.00
HA 1306W	2.00	2.20	2.50
HA 1339	2.50	2.70	3.00
HA 1339A	2.50	2.70	3.00
HA 1342A	2.50	2.70	3.00
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UHIC 003	4.20	4.40	4.90
UHIC 004	4.20	4.40	4.90
UHIC 005	4.20	4.40	4.90
uPC 20C	2.10	2.50	2.80
uPC 563	1.90	2.10	2.40
uPC 575C2	1.30	1.45	1.60
uPC 576	1.90	2.10	2.40
uPC 592H	.70	.80	.90
uPC 1001H	1.90	2.10	2.40
uPC 1008C	4.20	4.40	4.90
uPC 1020H	1.90	2.10	2.40
uPC 1025	1.90	2.10	2.40
uPC 1154	2.00	2.20	2.50
uPC 1155	2.00	2.20	2.50
uPC 1156	1.90	2.10	2.40
uPD 861	8.00	8.40	9.50
uPD 857	8.00	8.40	9.50
uPD 858	6.00	6.30	7.00
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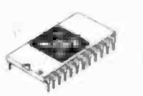

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SN7401N	.20	SN7472N	.29	SN74161N	.89
SN7402N	.20	SN7473N	.35	SN74162N	1.95
SN7403N	.20	SN7474N	.35	SN74163N	.89
SN7404N	.25	SN7475N	.49	SN74164N	.89
SN7405N	.20	SN7476N	.35	SN74165N	.89
SN7406N	.29	SN7479N	5.00	SN74166N	1.25
SN7407N	.29	SN7480N	.50	SN74167N	1.95
SN7408N	.20	SN7482N	.99	SN74170N	1.59
SN7409N	.20	SN7483N	.69	SN74172N	6.00
SN7410N	.18	SN7485N	.89	SN74173N	1.25
SN7411N	.25	SN7486N	.35	SN74174N	1.00
SN7412N	.25	SN7489N	1.75	SN74175N	1.00
SN7413N	.40	SN7490N	.45	SN74176N	.79
SN7414N	.70	SN7491N	.59	SN74177N	.79
SN7416N	.25	SN7492N	.43	SN74179N	1.95
SN7417N	.25	SN7493N	.43	SN74180N	.79
SN7420N	.20	SN7494N	.65	SN74181N	1.95
SN7421N	.29	SN7495N	.65	SN74182N	.79
SN7422N	.39	SN7496N	.65	SN74184N	1.95
SN7423N	.29	SN7497N	3.00	SN74185N	1.95
SN7425N	.29	SN74100N	1.25	SN74186N	9.95
SN7426N	.29	SN74107N	.35	SN74188N	3.95
SN7427N	.25	SN74109N	.59	SN74190N	1.25
SN7429N	.39	SN74116N	1.95	SN74191N	1.25
SN7430N	.20	SN74121N	.35	SN74192N	.79
SN7432N	.25	SN74122N	.39	SN74193N	.79
SN7437N	.25	SN74123N	.59	SN74194N	.89
SN7438N	.40	SN74125N	.49	SN74195N	.69
SN7439N	.25	SN74126N	.49	SN74196N	.89
SN7440N	.20	SN74132N	.75	SN74197N	.89
SN7441N	.89	SN74136N	.75	SN74198N	1.49
SN7442N	.59	SN74141N	.79	SN74199N	1.49
SN7443N	.75	SN74142N	2.95	SN74S200	4.95
SN7444N	.75	SN74143N	2.95	SN74251N	.99
SN7445N	.75	SN74144N	2.95	SN74279N	.79
SN7446N	.69	SN74145N	.79	SN74283N	2.25
SN7447N	.59	SN74147N	1.95	SN74284N	3.95
SN7448N	.79	SN74148N	1.29	SN74285N	3.95
SN7450N	.20	SN74150N	1.25	SN74365N	.69
SN7451N	.20	SN74151N	.59	SN74366N	.69
SN7453N	.20	SN74152N	.59	SN74367N	.69
SN7454N	.20	SN74153N	.59	SN74368N	.69
SN7459A	.25	SN74154N	1.50	SN74390N	1.95
SN7460N	.20	SN74155N	.79	SN74393N	1.95
		SN74156N	.79		
		SN74157N	.65		

CMOS

CD4000	.39	CD4028	.89	CD4070	.55
CD4001	.39	CD4029	1.49	CD4071	.49
CD4002	.39	CD4030	.49	CD4072	.49
CD4006	1.19	CD4035	.99	CD4076	1.39
CD4007	.25	CD4040	1.49	CD4081	.39
CD4009	.49	CD4041	1.49	CD4082	.39
CD4010	.49	CD4042	.99	CD4093	.99
CD4011	.39	CD4043	.89	CD4098	1.19
CD4012	.25	CD4044	.89	MC14409	14.95
CD4013	.49	CD4046	1.79	MC14410	14.95
CD4014	1.39	CD4047	2.50	MC14411	14.95
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CD4016	.59	CD4049	.49	MC14433	13.95
CD4017	1.19	CD4050	.69	MC14506	.75
CD4018	.99	CD4051	1.19	MC14507	.99
CD4019	.49	CD4053	1.19	MC14562	11.95
CD4020	1.19	CD4056	2.95	MC14583	2.49
CD4021	1.39	CD4059	9.95	CD4508	3.95
CD4022	1.19	CD4060	1.49	CD4510	1.39
CD4023	.29	CD4066	.79	CD4511	1.29
CD4024	.79	CD4068	.39	CD4515	2.95
CD4025	.23	CD4069	.45	CD4518	1.29
CD4026	2.95			CD4520	1.29
CD4027	.69			CD4566	2.25

74C00

74C00	.39	74C85	2.49	74C163	2.49
74C02	.39	74C90	1.95	74C164	2.49
74C04	.45	74C93	1.95	74C173	2.60
74C08	.49	74C95	1.95	74C192	2.49
74C10	.39	74C107	1.25	74C193	2.49
74C14	1.95	74C151	2.90	74C195	2.49
74C20	.39	74C154	3.00	74C922	7.95
74C30	.39	74C157	2.15	74C923	6.25
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LM320K-18	1.35	NE536T	6.00	LM3905N	1.49
LM320K-24	1.35	NE540	6.00	LM3909N	1.25
LM320T-5	1.25	NE544N	4.95	MC5558V	.59
LM320T-5.2	1.25	NE550N	1.30	8038B	4.95
LM320T-8	1.25	NE555V	.39	LM75450N	.49
LM320T-12	1.25	NE556N	.99	75451CN	.39
LM320T-15	1.25	NE560B	5.00	75452CN	.39
LM320T-18	1.25	NE562B	5.00	75453CN	.39
LM320T-24	1.25	NE565N/H	1.25	75454CN	.39
LM323K-5	5.95	NE566CN	1.75	75491CN	.79
LM324N	1.49	NE567V/H	.99	75492CN	.89
LM339N	.99	NE570N	4.95	75493N	.89
LM340K-5	1.35	LM703CN/H	.69	75494CN	.89
LM340K-6	1.35	LM709N/H	.29	RC4136	1.25
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LM340K-12	1.35			RC4194	4.95
LM340K-15	1.35			RC4195	4.49

74LS00TTL

74LS00	.35	74LS51	.29	74LS139	1.05
74LS01	.35	74LS54	.29	74LS151	1.05
74LS02	.35	74LS55	.29	74LS155	1.05
74LS03	.35	74LS73	.54	74LS157	1.05
74LS04	.42	74LS74	.54	74LS160	1.15
74LS05	.42	74LS75	.71	74LS161	1.39
74LS08	.35	74LS76	.54	74LS162	1.39
74LS09	.42	74LS78	.49	74LS163	1.39
74LS10	.35	74LS83	1.05	74LS164	1.50
74LS11	.75	74LS85	1.50	74LS168	1.75
74LS13	.59	74LS86	.54	74LS174	1.39
74LS14	1.25	74LS90	.71	74LS175	1.25
74LS15	.35	74LS92	.90	74LS181	2.49
74LS20	.35	74LS93	.90	74LS190	1.39
74LS21	.35	74LS95	.99	74LS191	1.39
74LS22	.35	74LS96	1.15	74LS192	1.39
74LS26	.35	74LS107	.54	74LS193	1.39
74LS27	.35	74LS109	.54	74LS194	1.39
74LS28	.35	74LS112	.54	74LS195	1.39
74LS30	.35	74LS123	1.50	74LS253	1.25
74LS32	.42	74LS125	1.05	74LS257	1.05
74LS37	.45	74LS132	.99	74LS258	1.75
74LS40	.35	74LS136	.59	74LS260	.83
74LS42	1.05	74LS138	1.05	74LS279	.90
74LS47	1.05			74LS367	.75
				74LS368	.75
				74LS670	2.49

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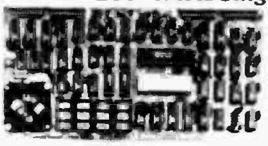
incorporated

Z80-4MHz Single Card Computer



Cromemco's Single Card Computer is a complete computer which brings the power of the Z-80 and the flexibility of the S-100 bus to the dedicated computer environment.

The card offers 4 MHz operation, 8K bytes of on-board 2716 PROM, and 1K byte of static RAM memory. This stand alone card also provides an RS-232 (or 20mA current loop) serial interface with programmable baud rates to 76,800, vectored interrupts, 24 bits of bidirectional parallel I/O, and 5 programmable timers. Only a power supply and PROM software are required for operation. The Single Card Computer is assembled and tested (Model SCC-W) for $450. The Monitor and Control BASIC are available in two ROM's (Model MCB-216) for $98.

SCC-W (Assembled) $450.00

Processor: 4MHz Z-80
Instruction Set: 158 instructions incl. the 78 instructions of the 8080
ROM Capacity: 8K Bytes located from address 0000 to 1FFF
ROM Type: Intel 2716 PROM or equivalent
RAM Capacity: 1K Bytes located from address 2000 to 23FF
RAM Type: 4046, Static
Serial I/O Ports:
I/O Levels: RS-232 or 20mA current loop
Baud Rates: 110 to 76,800 (software selectable)
Parallel Ports:
Input Port: 24 bits bidirectional
Output Port: 24 bits bidirectional
Input Load: One TTL equivalent
Output Drive: 20 TTL loads
Interval Timers:
Number of timers: 5
Timer range: 0.18-32 milliseconds (software sel.)
Timer resolution: 64 microseconds
Vectored Interrupts:
No. of vector locations: 12 80 mode 2
General Information:
UART type: 5501 Bus: S-100
Power requirements: +8V at 1.4A, +18V at 70mA, -18V at 25mA
Operating environment: 0-50°C

DISCRETE LEDS

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

INFRA-RED LED
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DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.75	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.49	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.49	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	.99
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	1.50
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	1.50
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

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CA3013T	2.15	CA3082N	2.00
CA2023T	3.25	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	1.25	CA3401N	.59
CA3081N	2.00	CA3600N	3.50

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MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998a	4.95
CT 7001	6.95

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MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

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

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL (GOLD) STANDARD

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

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
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ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	50 PCS	1.75
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	50 PCS	1.75
ASST. 7	5 ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	50 PCS	1.75

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XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.95	XR2212	4.35	XR4739	1.15
XR1489	1.95	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4002	100 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4003	200 PIV	1 AMP	12/1.00
1N752	5.6	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N753	6.2	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N757	9.0	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N759	12.0	400m	4/1.00	1N3600	50	200m	6/1.00
1N959	8.2	400m	4/1.00	1N4148	75	10m	15/1.00
1N965	15	400m	4/1.00	1N4154	35	10m	12/1.00
1N5232	5.6	500m	28	1N4733	5.1	1w	28
1N5234	6.2	500m	28	1N4734	5.6	1w	28
1N5235	6.8	500m	28	1N4735	6.2	1w	28
1N5236	7.5	500m	28	1N4736	6.8	1w	28
1N5242	12	500m	28	1N4738	8.2	1w	28
1N5245	15	500m	28	1N4742	12	1w	28
1N456	25	40m	6/1.00	1N4744	15	1w	28
1N458	150	7m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N485A	180	10m	5/1.00	1N1184	100 PIV	35 AMP	1.70
1N4001	50 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.70
				1N1186	200 PIV	35 AMP	1.80
				1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C36M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05		2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369A	4/1.00	MPS3705	5/1.00	2N5087	4/1.00
MPS2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2484	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2906	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2907	5/1.00	2N3711	5/1.00	PN5134	5/1.00
		2N3724A	.65	PN5138	5/1.00
2N2925	5/1.00	2N3725A	1.00	2N5139	5/1.00
MJE2955	1.25	2N3772	2.25	2N5210	5/1.00
2N3053	2/1.00	2N3823	1.00	2N5449	3/1.00
		2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
10 pf	.05	.04	.03	.001μF	.05	.04	.035
22 pf	.05	.04	.03	.0047μF	.05	.04	.035
47 pf	.05	.04	.03	.01μF	.05	.04	.035
100 pf	.05	.04	.03	.022μF	.06	.05	.04
220 pf	.05	.04	.03	.047μF	.06	.05	.04
470 pf	.05	.04	.035	.1μF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

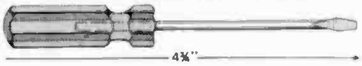
.1/35V	.39	.31	.25	1.5/35V	.41	.33	.26
.15/35V	.39	.31	.25	2.2/35V	.51	.41	.33
.22/35V	.39	.31	.25	3.3/25V	.53	.43	.34
.33/35V	.39	.31	.25	4.7/25V	.63	.51	.41
.47/35V	.39	.31	.25	6.8/25V	.79	.63	.50
.68/35V	.39	.31	.25	15/25V	1.39	1.12	.89
1.0/35V	.39	.31	.25	22/6V	.79	.63	.50

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

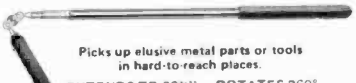
CIRCLE 2 ON FREE INFORMATION CARD

MINIATURE SCREWDRIVER



RUGGED CONSTRUCTION
1000's OF USES – 1/8" TIP . . . . 2/$1.00

MAGNETIC RETRIEVER TOOL



Picks up elusive metal parts or tools in hard-to-reach places.

EXTENDS TO 26¾" – ROTATES 360°
STRONG, LIFETIME MAGNET

MRT-2281 . . . . $3.95

CSC CONTINENTAL SPECIALTIES

LOGIC PROBE KIT

SPECIFICATIONS

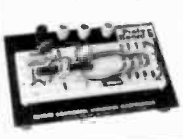
Input Impedance: 300,000 Ohms.
Thresholds: "Lo" 30%Vcc – "Hi" 70%Vcc
Maximum Speed: 300 nsec., 1.5MHz
Input Protection: ±50VDC continuous 117VAC for 15 sec.
Power: 30mA @5V – 40mA @ 15V – 25V max. reverse voltage protected; 36" cable with color coded clips included.
Operating Temp.: 0-50°C.
Dimensions: 5.8L x 1.0W x 0.7D in. (147 x 25 x 18mm)
Weight: 30 oz. (85 gm)

LPK-1 . . . . $21.95/Kit

Proto Clips

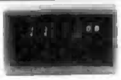
14-PIN CLIP	PC-14	$ 4.50
16-PIN CLIP	PC-16	$ 4.75
24-PIN CLIP	PC-24	$10.00
40-PIN CLIP	PC-40	$16.00

Proto Boards



PB-6	$17.95
PB-100	19.95
PB-101	22.95
PB-102	26.95
PB-103	44.95
PB-104	55.95
PB-203	99.95
PB-203A	155.00
PB-203A-Kit	131.00

Jumbo 6-Digit Clock Kit



- Four .630"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾ x 3⅛ x 1¾

JE747 . . . . $29.95

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

JE701

6-Digit Clock Kit $19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200 . . . . $14.95

ADAPTER BOARD
—Adapts to JE200—
±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 . . . . $12.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES		
8080A	CPU	$ 7.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	4.95
8238	System Controller	5.95
8251	Prog. Comm. I/O (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. I/O (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95

6800/6800 SUPPORT DEVICES		
MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS—MISCELLANEOUS		
Z80(780C)	CPU	$13.95
Z80A(780-1)	CPU	15.95
CDP1802	CPU	19.95
2650	MPU	18.95
6502	CPU	11.95
8035	8-Bit MPU w/clock, RAM, I/O lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w hardware, multiply & divide	49.95

SHIFT REGISTERS		
MM500H	Dual 25 Bit Dynamic	$.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	2.49

UART'S		
A-Y-5-1013	30K BAUD	5.95

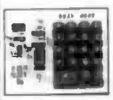
MICROPROCESSOR MANUALS		
M-Z80	User Manual	$7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

ROM'S		
2513(2140)	Character Generator(upper case)	$9.95
2513(3021)	Character Generator(lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

RAM'S			
1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	7.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin 250ns	9.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00

PROM'S			
1702A	2048	FAMOS	$5.95
2716INTEL	16K*	EPROM	59.95
TMS2516 (2716)	16K*	EPROM	39.95
	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I.	16K**	EPROM	29.95
	**Requires 3 voltages, −5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

JE600 HEXADECIMAL ENCODER KIT



FEATURES:

- Full 8 bit latched output for microprocessor use
- 3 User Define keys with one being bi-stable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin IC connector
- Only +5VDC required for operations

FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

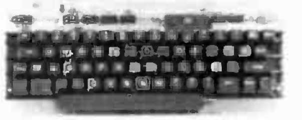
JE600 . . . . $59.95
Hexadecimal Keypad only $14.95

DIGITAL THERMOMETER KIT

- Dual sensors—switching control for in-door/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 . . . . $39.95

62-Key ASCII Encoded Keyboard Kit



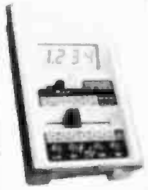
The JE610 62-Key ASCII Encoded Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10mA for operation.

FEATURES:

- 60 Keys generate the full 128 characters, upper and lower case ASCII set
- Fully buffered
- 2 user define keys provided for custom applications
- Caps lock for upper case only alpha characters
- Utilizes a 2376 (40 pin) encoder read only memory chip
- Outputs directly compatible with TTL/DTL or MOS logic arrays
- Easy interfacing with a 16-pin dip or 18-pin edge connector

JE610 . . . . . $79.95
62-Key Keyboard only . . $34.95

HICKOK LX303 Portable LCD Digital Multimeter



- Over 200 Hours of operation with a 9V battery
- 19 ranges and functions
- Full one year warranty.

LX303 1% ACCURACY $74.95
LX304 .5% ACCURACY $89.95

PART NO	DESCRIPTION	PRICE
RC-3	115V AC ADAPTER	7.50
CC-3	PADDED CARRYING CASE	7.50
VP-10	X10 DC PROBE ADAPTER (Up to 10K)	14.95
VP-40	40kV DC PROBE	35.00
CS-1	10 Amp DC Current Shunt	14.95

$10.00 Min. Order – U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage – Add 5% plus $1 Insurance (If desired)

Spec Sheets – 25¢
1980 Catalog Available – Send 41¢ stamp

FREE 1980 CATALOG

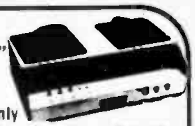
Jameco ELECTRONICS

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS – WORLDWIDE
1355 SHOREWAY ROAD, BELMONT, CA 94002
PRICES SUBJECT TO CHANGE

6-80

The Incredible "Pennywhistle 103"



$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

- **Data Transmission Method** . . . . Frequency-Shift Keying, full duplex (half-duplex selectable).
- **Maximum Data Rate** . . . . 300 Baud
- **Data Format** . . . . Asynchronous Serial (return to mark level required between each character)
- **Receive Channel Frequencies** . . . 2025 Hz for space, 2225 Hz for mark
- **Transmit Channel Frequencies** . . Switch selectable: Low (normal) – 1070 space, 1270 mark. High – 025 space, 2225 mark.
- **Receive Sensitivity** . . . . −46 dbm accoustically coupled
- **Transmit Level** . . . . −15 dbm nominal. Adjustable from −6 dbm to −20 dbm
- **Receive Frequency Tolerance** . . . Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz
- **Digital Data Interface** . . . . EIA RS-232C or 20 mA current loop (receiver is opto-isolated and non-polar).
- **Power Requirements** . . . . 120 VAC, single phase, 10 Watts
- **Physical** . . . . All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align

TRS-80 16K Conversion Kit

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

- 8 each UPD416-1 (16K Dynamic Rams) 250NS
- Documentation for conversion

TRS-16K $75.00

OK JUST WRAP™

- 30 AWG wire
- Daisy chain or point-to-point
- No stripping or slitting required—just wrap
- .025" square posts
- Built-in cut off
- Includes 50 ft. wire

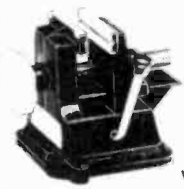
Part No.	Wire Color	Price
JW-1-B	Blue	$14.95
JW-1-W	White	14.95
JW-1-Y	Yellow	14.95
JW-1-R	Red	14.95

JUST WRAP™ Replacement Wire

Part No.	Color		Price
R-JW-B	Blue	50 ft. roll	$2.98
R-JW-W	White	50 ft. roll	2.98
R-JW-Y	Yellow	50 ft. roll	2.98
R-JW-R	Red	50 ft. roll	2.98

JUST WRAP™ Unwrap Tool $3.49

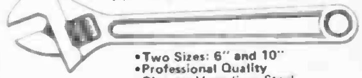
OK Vacuum Vise



Vacuum-based light-duty vise for small components and assemblies. ABS construction. 1½" jaws. 1¼" travel. Can be permanently installed.

VV-1 . . . . . . $3.49

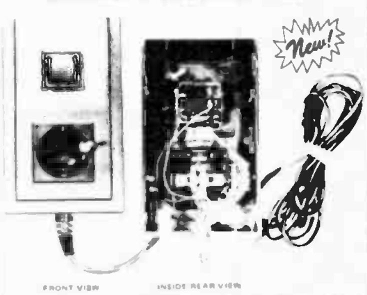
ADJUSTABLE WRENCH



- Two Sizes: 6" and 10"
- Professional Quality
- Chrome Vanadium Steel

6"– AW-6 . . $4.95   10"– AW-10 . . $6.95

JOYSTICK VIDEO CONTROLLER



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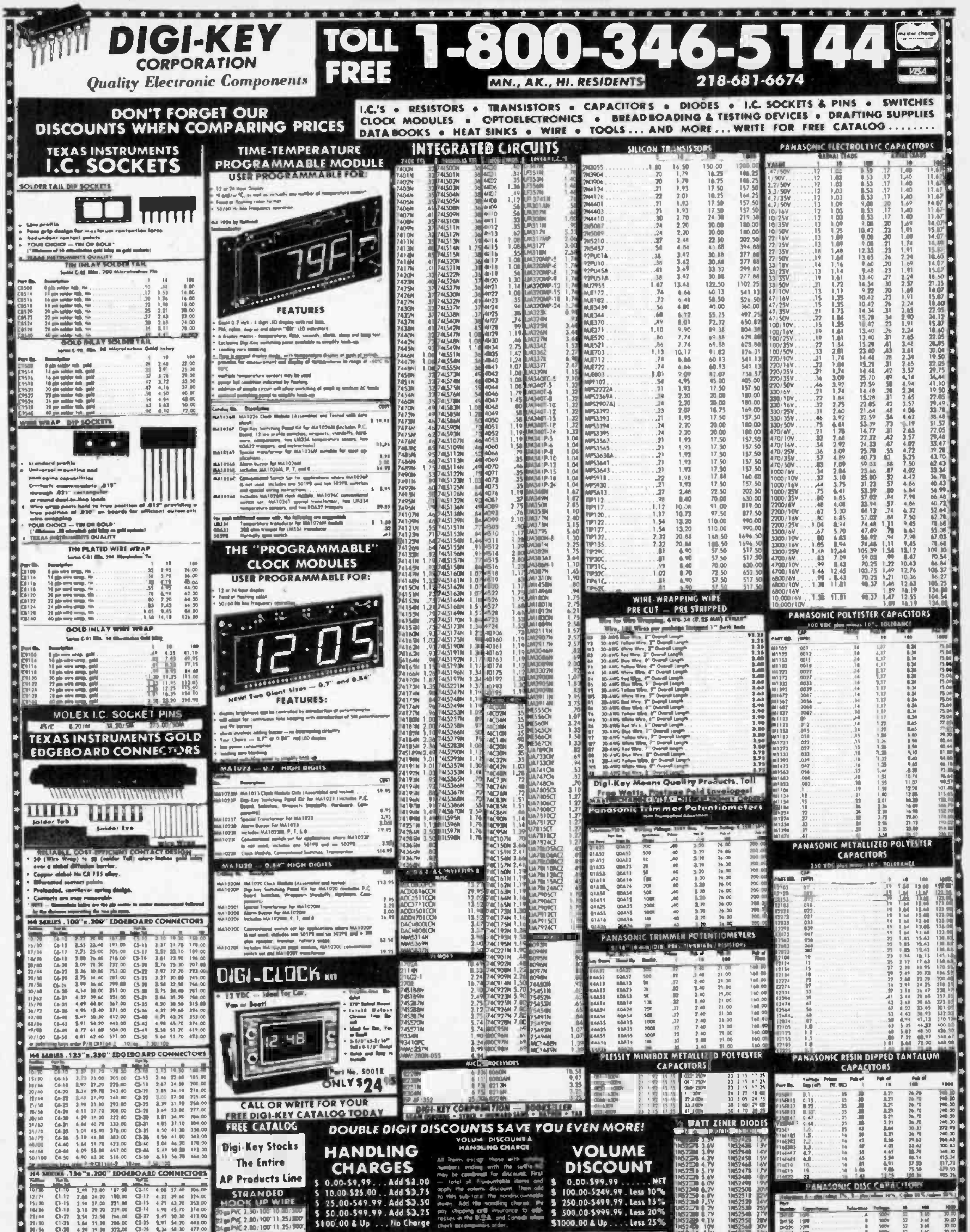
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