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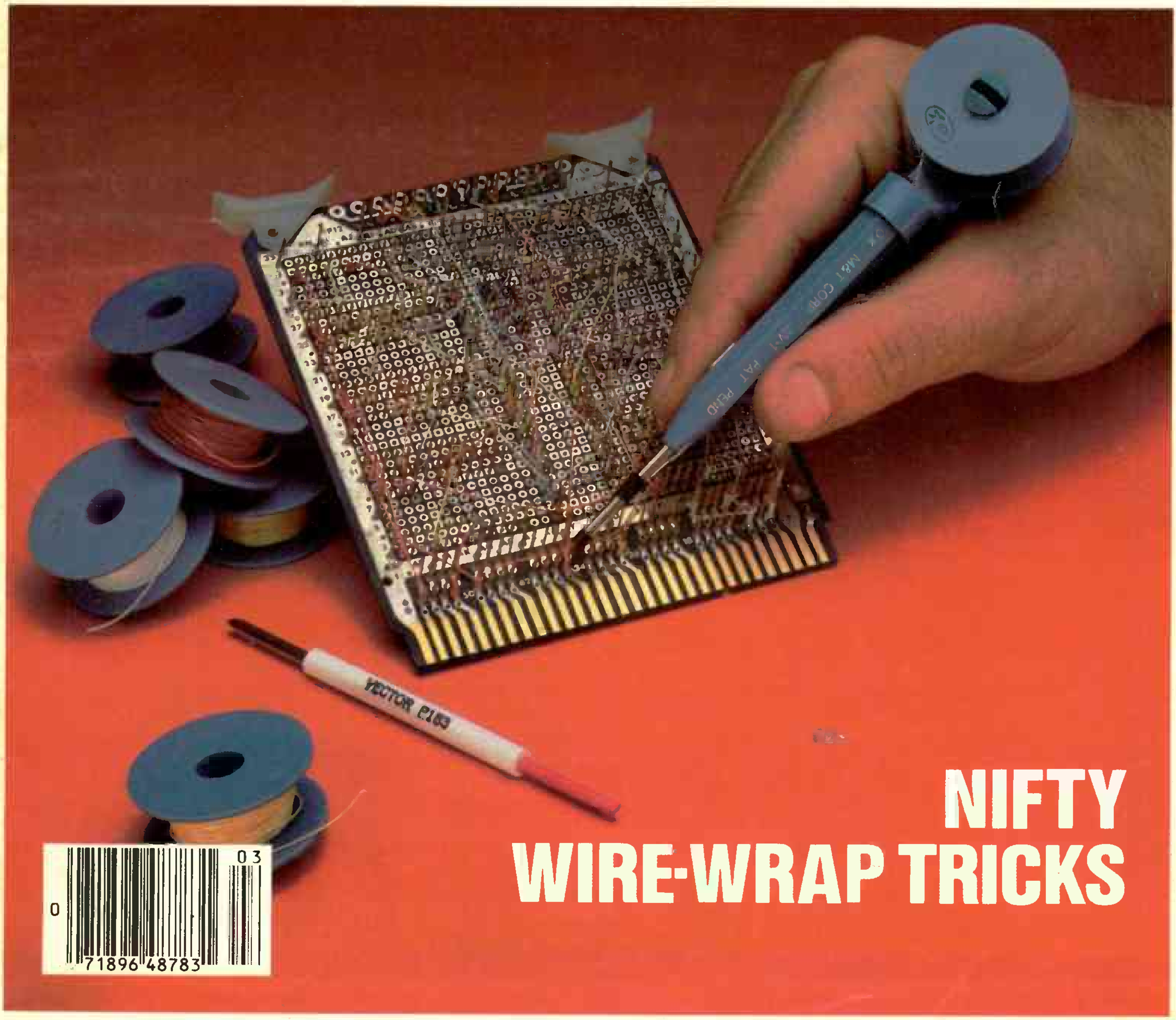

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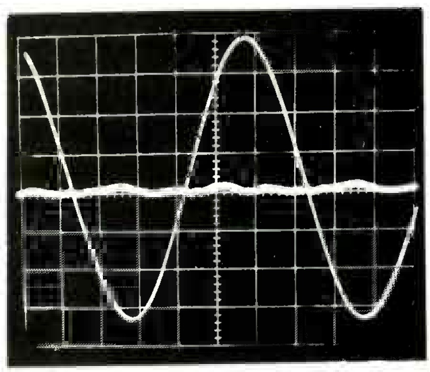
MARCH 1980 Vol. 51 No. 3

ON THE COVER

Featured on our newly designed cover is OK Machine and Tool Corporation's *Just Wrap* tool shown being used to wire wrap a prototype board. Also shown is Vector Electronics *P183* forming and cutting tool.

Wire-wrap construction has many advantages over printed circuit boards for prototype construction. However, there are also several disadvantages. To find out how to overcome many of these disadvantages and how to make your wire-wrap projects faster, easier and sturdier, turn to page 46.



SUPER CLASS-A AMPLIFIER uses new circuit techniques to radically reduce crossover distortion without any of the drawbacks associated with negative feedback. To discover how it's done, turn to page 57.

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Subscription Service: Mail all subscription orders, changes, correspondence and Postmaster Notices of undelivered copies (Form 3579) to Radio-Electronics Subscription Service, Box 2520, Boulder, CO 80322.

looking ahead

RCA's videodisc: RCA will have its capacitance videodisc system in nationwide distribution in the first quarter of 1981, after shipping demonstration players and discs to its distributors in December 1980. After nearly 15 years of development, the company revealed its plans to distributors and the public. President Edgar Griffiths said that the first players will sell for less than $500 each "in 1981 dollars" and discs of motion pictures and other entertainment will be $15 to $20 each. He said RCA hopes to have 200,000 players in distribution in 1981 and forecast that videodisc players would reach 30-to-50% penetration of color TV homes in 10 years, with disc sales of 200 to 250 million in the tenth year. Griffith revealed that the disc system "represents the largest single investment in a consumer product in RCA's history."

Some disappointment was expressed by hi-fi dealers on learning that the first player model would not be equipped for stereophonic sound and, in fact, wouldn't even have a jack for use with home stereo systems. RCA officials said that later, step-up models and some future discs would play in stereo, but that the first units were designed for use with the 140-million television sets that all have monophonic sound. Future models will feature freeze-frame, slow-motion, reverse, and other special effects.

RCA announced its videodisc plans virtually on the first anniversary of the start of marketing of the Philips/MCA optical videodisc system in the U.S. The Magnavision player is produced by Magnavox (a subsidiary of Dutch Philips) and the discs are made by DiscoVision Associates, a joint subsidiary of MCA and IBM, and marketed by MCA. The deluxe Magnavision player features all the special effects that are only in RCA SelectaVision's future, but both players and discs were plagued by low production. It's estimated that only about 5000 players were sold in the three markets (Atlanta, Seattle-Tacoma and Dallas) where they were on sale. The player sells for $775 and movie discs for $16 and $25, with shorter discs at lower prices.

Universal Pioneer, a Japan-based company owned jointly by Pioneer Electronics, MCA, and IBM, has supplied more than 10,000 microprocessor-based industrial videodisc players to General Motors. They are compatible with Magnavision players and can play standard DiscoVision discs, as well as more sophisticated programmed and indexed discs for use in automobile showrooms and for personnel training. U.S. Pioneer, the audio-equipment company, plans to have its own consumer optical disc player—also compatible with Magnavision—on the American market at about midyear at under $1,000.

Other Japanese manufacturers haven't revealed their home videodisc plans, but have experimented with different approaches. Many have taken out licensees for either the RCA or the Philips/MCA approach or both, or have developed their own non-compatible systems. Sony will produce an optical player to the Philips/MCA standards, but only for the industrial market—at least at first—and it says it hasn't decided which approach to use for the consumer market. The Matsushita organization has demonstrated two different systems, both of them incompatible with either of the two systems on the U.S. market, and says that either one could be put into production quickly. Its subsidiary, JVC, has a grooveless capacitance system which is capable of all the special effects attainable in the Philips/MCA optical system, while Matsushita Electric has demonstrated a grooved mechanical technique designed as a low-cost competitor to RCA's SelectaVision. Thomson-CSF of France sells an optical system, incompatible with all others, on the industrial-institutional market.

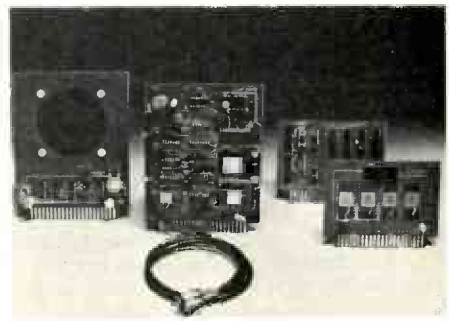
Better audio for video: The year's big "feature" in the new television set lines is sound. In the 1980 models now available, high-end sets take advantage of the full-frequency sound now being transmitted by the networks. Two manufacturers, by coincidence, adopted the same name for their new sound systems—Magnavox with "Super Sound" and Sylvania with "Supersound." Magnavox's top-of-the-line sets have 12-watt amplifiers, three-way speakers and separate bass and treble controls. Other Magnavox sets feature increased amplifier power, better speakers and improved frequency response. Some have tone controls, others "voice/music" switches. Sylvania's top-end consoles have separate eight-watt amplifiers, two-way speakers, separate bass and treble controls and a high filter switch to eliminate noise from program sources such as old movies. RCA's approach, called "Dual Dimension Sound," is quite different. It's used in some 19- and 25-inch models that have speakers on both sides of the screen, and simulates stereo. The speaker on one side carries low, and high frequencies, while the other speaker has mid-low and mid-high frequencies, giving a spatial effect.

In other new-set developments, RCA introduced a "Dynamic Detail Processor System" incorporating a new comb-filter CCD IC, increasing picture resolution. Magnavox's *Computer Color 330*, now in 75% of its line, uses a glass delay line to accomplish the same effect. RCA also introduced a 19-inch set with pushbutton "Autoprogrammer," on which seven days of programming can be set up in advance via a keyboard panel. Magnavox features a MPU keyboard tuning system that eliminates all fine-tuning and can receive mid-band cable TV channels without a converter box.

De-ghosting: Broadcast television's major bugaboo, the ghost, is under all-out attack through a variety of exorcizing programs. Some stations are now adopting circular polarization, that cuts down ghosts on rabbit-ears and can help eliminate ghosts for outside-antenna installations, too—but special outdoor antennas must still be used. TDK and others have developed ferrite-concrete coating materials that make tall buildings virtually "invisible" to TV signals by absorbtion—but that is a very expensive process. In Japan and the U.S., many firms are working on electronic de-ghosting systems. GTE Labs has demonstrated one which uses the LSI equivalent of 20,000 transistors. It indentifies the first ghost as identical to the primary signal, notes the magnitude of the signals and the distance apart. It then produces a signal equivalent to that of the ghost but of opposite polarity. That generated "ghost" cancels out the original, undesired ghost. The same function is accomplished many times in a transversal filter, to suppress multiple echoes.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

The VIP hobby computer: Start programming for only $99.



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what's news

Automotive manufacturers see day of electronics arriving

The long-predicted day of the takeover by electronics in the auto industry has finally arrived, according to analysts of *The New York Times*. After electronic ignition became pretty much standard, there was a pause, during which there was little further application of electronics in the automotive field. Now, according to Peter J. Schuyten of the *Times*, "tiny microprocessor-based systems are overseeing such vital engine functions as exhaust-gas recirculation and air-fuel ratios. Integrated circuits are being incorporated in door-lock assemblies, on the dashboard and in automotive entertainment systems."

This sudden surge, says the *Times*, could—with the imminent addition of such functions as transmission control and electronic braking—mean a market of nearly $4 billion by 1990.

This sudden "windfall" may be as much a problem as an opportunity for the semiconductor industry. Increasing markets in other fields are already taking up practically the full capacity of the semiconductor plants, and a surge of orders from Detroit is likely to prove embarrassing. The automakers may well have to turn their attention abroad. Ford is already buying circuit chips from Toshiba, and General Motors is said to have signed contracts with several European suppliers. (R-E readers have known about this for years; about time everyone else "discovered" it.—*Editor*)

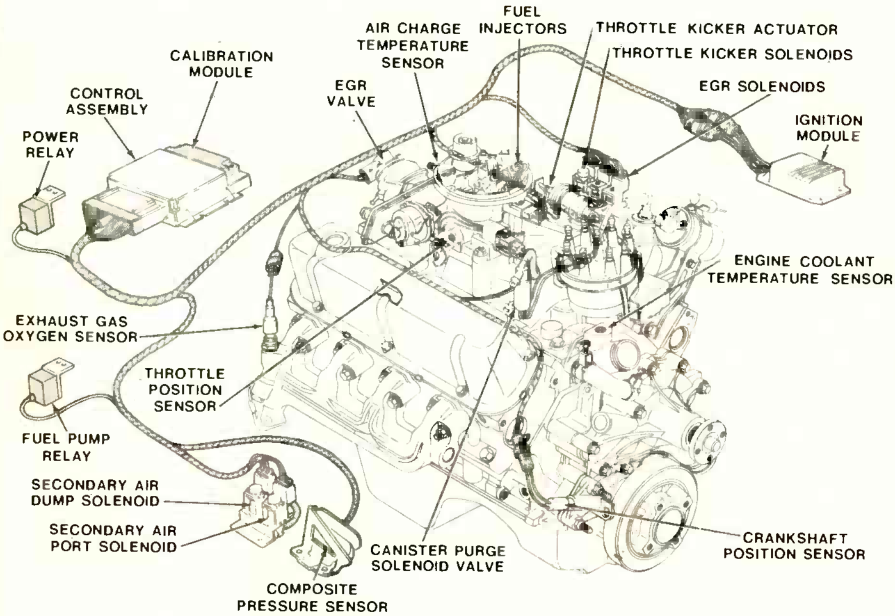
Report from Germany—IC's, new uses for TV, up

The use of transistors in German TV sets has dropped off sharply, members of the international press were told at a conference arranged by the International Radio and TV Exhibition 1979 at Berlin. Conversely, the number of integrated circuits is rising. The discrete components are being replaced by IC's. Production of TV receivers is also rising sharply—almost doubling in the past four years.

Electronic methods have almost completely superseded mechanical devices in the tuning circuits, and selection of 12 to 30 stations is standard. Remote control, a regular feature in color sets, began in 1977 to shift from ultrasonic to infra-red devices, and the microprocessor took over part of the process of station selection.

The first experiments with stereo television sound and dual-language sound are being carried out in West Germany. (In dual-language sound, the two stereo channels carry different languages instead of stereo—a re-broadcast American show may have English on one channel and a German translation on the other.)

With the prices of electronic memories dropping drastically, it is expected that such uses as Teletext and Viewdata, as well as intelligent games, will tend to become universal. Field trials of Viewdata by the German Post Office, and of Teletext by the broadcasting authorities, are due to commence in 1980; satellite television is presently expected to reach the experimental stage by 1983.



ELECTRONIC COMPONENTS of the new Ford V-8 engine used in the 1980 Lincoln Continental and Mark VI. No less than six of these are sensors of the various engine conditions, information from which is used to control the electronic fuel injection and other functions to limit emissions while promoting fuel economy. Electronic components are also used to control the entertainment apparatus, remote-control the CB equipment, and even to open the doors.

U. S. ambitions meet setback at Geneva WARC sessions

United States efforts at the World Administrative Radio Conference (WARC) to expand its allocations of the world's broadcast frequencies, to increase its share of the spectrum for governmental and scientific use, and to meet the growing demands of the exploding communications activity were largely unsuccessful. Opposition to the United States proposals came largely from the underdeveloped Third World nations. Those countries had been given scanty allocations at former conferences (which are held roughly every 20 years). Many of them were in fact colonies of the larger Powers when some of the earlier conferences were held.

The United States delegation held that the airwaves should be made available to the countries now most in need of them, rather than allocated to nations who have no present capability of using them. The small-nation approach is that if they do not do something to get a share of the frequencies immediately it will soon be too late even to try.

Armando Vargas of Costa Rica, a prominent proponent of the Third-World view that was forwarded vigorously by a 12-nation Latin American coalition, gives much credit to the instruction and counsel given the coalition by American and British public-interest organizations. They offered their support, Mr. Vargas said, because the interests of the developing nations are similar to those supported by public-interest groups in the industrialized ones.

"We both want to see the frequencies used for the types of satellites that provide inexpensive social services—education for people in remote areas or health and agricultural consultations," said Mr. Varga. "The industrial countries . . . are interested in huge satellites for widespread communications, which small countries can't afford."

Ralph Jennings, deputy director of the United Church of Christ's Office of Communications, set forth a parallel but somewhat different approach:

"With us, the issue is an ethical one. . . . It is in the long-range interest of our own country to recognize that the undeveloped nations have legitimate rights to the airwaves. They don't want to be left way behind in the next century."

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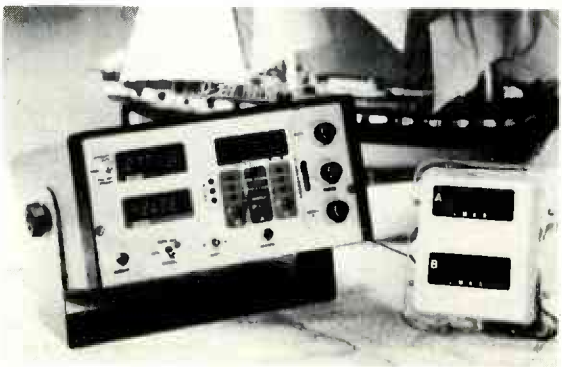

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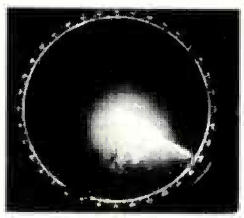

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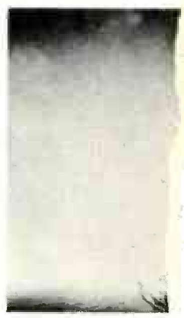

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satellite tv news

The satellite TV pioneer

Those who have been following the series of articles in **Radio-Electronics** describing the challenges offered in establishing your own private satellite TV earth station know well that the excitement attached to this project is almost uncontrollable. The combination of high-quality programming, great diversity of channels, and being involved in man's conquest of our near-space environment is an unbeatable combination

For the pioneer, these are trying times. Less than one year ago you couldn't find *any* information about satellite reception and what you did find was more often than not written for then-practitioners of "the art." The neophyte, desirous of learning the basics from the ground up, was hard pressed to locate starting data. Now there is plenty of information available. Much of it describes work done on a custom basis by talented pioneers who are more intent on making their own first terminals sit up and operate than in providing how-to-do-it data for others with less experience in microwave system design and operation.

Plainly what is needed more than anything else at the moment is a handful of dedicated sources for the specialized circuit boards and microwave-family component parts that a private satellite terminal requires. It would appear that within the next 60 to 90 days several such sources may develop and begin shipping parts kits and circuit boards on demand, in quantity. We intend to watch the development of this very carefully and we will keep you advised monthly, as circuit boards and parts kits become available. Those who have products in these areas should in turn see that we know about your products as rapidly as possible, recognizing that there is a 60-75 day delay between your telling us about such equipment and our first opportunity to discuss it here in this monthly news column.

Licensing Deregulation

As most readers are undoubtedly now aware, on October 18, 1979 the FCC determined that builders of satellite TV terminals are no longer required to obtain an FCC license to construct their terminals. Before that ruling, every cable-system constructor of a satellite terminal was supposed to go through a lengthy (and expensive) license-application process. Most private (i.e., non-commercial) terminal builders were ignoring that rule. The Commission, perhaps mindful of the difficulty presented in tracking down "unlicensed receive stations," simply decided to eliminate the requirement; now you may build your terminal without any type of federal license.

However, both the FCC and the satellite program operators maintain that while you may *build* a terminal without a license, you may not *watch* anything with it (!) unless you have the written authority of the programmers using the satellite. The FCC states that, because all satellites are licensed in a special type of service called *fixed point-to-point common carrier*, and the downlink transmission band is in turn "fixed" by international agreements for *non*-broadcasting use, none of the present-generation satellites may engage in broadcasting in the sense that people are free to simply tune in their transmissions. That issue will undoubtedly end up in the courts. For now the simplest way to "stay clean" is to obtain a letter of authorization from at least *one* satellite-programming source that approves your tuning in that source's programming transmitted via satellite. Several of the present satellite programmers have been authorizing individuals to receive their satellite transmissions *without charging a fee* for the programming. (Others grant authorizations, but only after requesting fees as high as $96 per year.) Here are four such services you can contact:

1. **PTL** (Praise The Lord), transponder 2, FI. Mr. Gary Deaner, PTL Satellite Network, Charlotte, NC 28279.
2. **CBN** (Christian Broadcasting Network), transponder 8, FI. CBN, Inc., Pembroke Four, Virginia Beach, VA 23463.
3. **KTBN** (Trinity Broadcasting Network), P.O. Box A, Santa Ana, CA 92711.
4. **Satellite Magazine** (Satellite Television Technology), P.O. Box G, Arcadia, OK 73007.

Since the FCC did away with the mandatory license requirement, a number of the satellite programmers have developed the attitude that they do not *want* private terminal viewers. Many cable-system operators feel uncomfortable with the prospect that, one day, home viewers will have access to satellite programming on their own *without* the cable system's satellite receiving terminal as an inter-connection; and considerable pressure is being placed on the satellite programmers by the cable firms. That pressure translates to "Don't authorize private viewers to watch your satellite service *if* you want the cable firms to subscribe to your service." That aspect also is in an evolutionary state.

One proposal to remedy the situation has come from Comsat, the U.S. company that represents U.S. interests in the worldwide INTELSAT network. Comsat is suggesting a special (new, not yet designed or launched) satellite that would offer up to six channels of direct-to-the-home satellite-delivered television for a monthly fee—a sort of cable service without the cable. The theory is that if people were offered six channels of high-quality satellite TV that was specifically designed for home viewing, the interest in pirating cable TV programs directly from the present satellites would fade away. Whether that proposal flies or not remains to be seen; as of now, the earliest date that such a service could become operational is five to six years ahead. For the present, then, the problems associated with the "cable-related programming" continue.

Scrambling

One proposed solution to insuring that only those receiving terminals authorized to receive transmissions may do so has been advanced by Home Box Office (HBO), which is carefully considering several technical proposals that will enable them to scramble (as in encode) their satellite transmissions. The technology for scrambling certainly exists. Unfortunately, anything that can be scrambled can also be descrambled; and to expect several thousand authorized reception terminals to stand guard over their descrambling boxes day and night may be too much to ask of anyone. Every scrambling technique advanced to date has one major drawback: It introduces some degradation to the picture even when properly descrambled. One of the big selling points for HBO and other premium (i.e., movie) services has been the high technical quality of their picture. To degrade that picture quality purposefully as a trade-off for security may make good technical sense, but would be a poor business decision. Again, we'll watch this development and keep you advised. You should be aware that few (perhaps four or five) of the present satellite programmers have indicated *any interest* in scrambling their satellite signal; most recognize that the disadvantages (for now) far outweigh any benefits.

ROBERT B. COOPER, Jr.

editorial

Times Change

Over the past 50 years, **Radio-Electronics** has come to you in a package with several different labels. In July 1929, it was *Radio-Craft* (our first issue). In 1949, the name was changed to **Radio-Electronics** and was printed in a stencil typeface. In 1957 the name was not changed, but the typeface was. And that's the way it stayed until this issue.

No! We have not changed the name, but we have given it a much more modern look—one that is inspired by the "*electricity*" in our industry. The change, the growth, the excitement.

The content has not been changed. It is still the firm in-depth editorial coverage that has made and kept **Radio-Electronics** your Number 1 Authority in this industry, and we intend to keep right on delivering that kind of information.

This month, for example, we show you how to build a low-noise amplifier for the front end of a *Backyard Satellite TV* receiver. There are some *Nifty Wirewrap Hints;* a story on how to *Build Your Own Automotive Burglar Alarm;* another on *Using An IC PRAM;* a look at *Super Class-A Audio Amplifiers;* and the first part of a feature on *Speech Synthesizers*. And that's only part of what you can discover this issue.

It is this kind of solid editorial content that keeps you reading **Radio-Electronics**, and it is the kind of editorial content you will continue to find in our pages. When something new happens—like computers or satellite TV reception, we will be sure to bring it to you.

We would like your comments on our new look, even if you disagree with our choice. But we really hope that you'll like it; obviously we do!

Larry Steckler

LARRY STECKLER
Editor

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Cover photo by Robert Lewis

Radio Electronics is indexed in *Applied Science & Technology Index* and *Readers Guide to Periodical Literature*.

Gernsback Publications, Inc.
200 Park Ave. S., New York, NY 10003
(212) 777-6400
President: M. Harvey Gernsback
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200 Park Ave. South
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letters

TECHNOLOGY

I read your editorial in the June 1979 Edition, and right on!

It's a very common opinion today that at some point technological improvement just stopped and no further innovation is necessary. We have a car that works. Stop. We have radios that work. Stop. We have computers that work. Stop.

Upon closer examination, however, we find that our cars don't work all the time and they don't last very long, either. Sure we have radios, but have we reached the full potential? The computers are marvels, but can we direct them to more human type thinking? Are there other methods of approaching or perhaps improving the computer concept?

Inventors and designers know the potential and most realize that the process of innovation can almost be carried out to infinity. But more and more today, fewer people will listen. All the immediate needs have been satisfied. They may then shut off the switch on the flow of new ideas. It is ironic that the ones who are most likely to laugh at the new breakthroughs are often the most knowledgeable in the field. Has the credential of expertise also become the license to play God?

K. RHOTEN
Schererville, IN 46375

FOR THOSE WITH LIMITED VISION

A large proportion of persons called "blind" are not totally blind; they have limited vision that may reach the extent of 5 or 10%. Many such persons can read books and magazines with the aid of special lamps and magnifiers. "Limited vision" is a condition that can remain stable over many years, and may retain its stability for life.

A friend whose vision is thus limited asked me if I could obtain a digital calculator for her—one which has digits the size of those on her digital alarm clock. She can see the 0.6-to-0.7-inch digits of the clock, but not those of the small, hand-held calculators. I checked into the features of some so-called desk calculators and discovered that the digit size was generally 0.25-inch bright fluorescent or 0.375-inch not so bright. Years ago, there were calculators with large bright readouts, but they don't seem to be around any more.

I have toyed with the idea of taking an existing desk calculator that has large, easy-to-use keys and interfacing it to a large separate display. I discussed the project with several persons more knowledgeable than I in digital techniques, and they hemmed and hawed about source and sink drivers for 8 plus 1 digits, and 7 plus 1 segments with special power supplies, and tricky ground referencing. One chap suggested looking into National's selection of high-current driver chips that can be fed from the multiplexed main chip.

Among your readers and contributors, there must be someone who has encountered and tackled this sort of project. Perhaps there is an article in a magazine that I have overlooked; perhaps there is a product that has escaped me. I would appreciate hearing from someone who has the answer, or even helpful ideas. (I know about the special "voice output" calculators that are available for the blind. So far, they are very expensive and are obtained through State subsidy in most cases. I look

continued on page 23

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CIRCLE 63 ON FREE INFORMATION CARD

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forward to a future article in **Radio-Electronics** making use of the new voice synthesizer modules.)
WESLEY H. ALDRED
Cleveland, OH

HEART RATE MONITOR

Usually, I don't read **Radio-Electronics**, but your July 1979 cover showing the Heart Rate Monitor prompted me to buy that issue. I didn't build your circuit, either, but my interest in it derives from having designed a similar circuit (digital readout) that I submitted to a design contest, and which won me the first prize! (See EDN September 5, 1977 and EDN October 20, 1977, page 79 for the circuit.) Since that circuit aroused great and unexpected interest, I am passing along the following information to your readers:

The only criticism I have of M. C. Worley's circuit is the rather slow response time (6+ seconds) because of the output filter. Also, the physical size of the circuit could be reduced by using a quad op-amp (LM324) in place of IC1 and IC4; in addition, that allows low voltage and a single supply (battery) operation. IC2 and IC3 might also be replaced by a 556 dual timer. IC5, Q3, and the speaker can also be simplified to one "Sonalert" beeper. A comparator with histeresis in front of Q1 also greatly improves noise (muscular, etc.) immunity.

My circuit updates the rate at every pulse using frequency multiplication with F/V, V/F converters, runs on one 9-volt battery, and has digital LCD display—all for less than $60. The sensor I use is a Monsanto MCA-7 ($3.95).

Since the originally published circuit turned out to have some problems, I developed an improved version obtaining f=1/t by analog division.

A copy can be obtained from Intech Function Modules (the sponsor of the contest), 282 Brokaw Road, Santa Clara, CA 95050 or directly from me. Good luck.
GERO TIMMERMANN
Multitech, P.O. Box 2277, Santiago, Chile

NOT CONFUSED ABOUT EINSTEIN

I may be careless, but I am not confused about "Einstein's Theory," as Dr. Mark suggests in his letter in the October 1979 issue. My letter in the June 1979 issue should have stressed the stability of the mobile radar transmitter, so that without measuring we know its transmitted wavelength and frequency *never* changes no matter how the police car maneuvers. Thus "simultaneity" is no longer a problem, as we know the frequency at the source is stable without measuring it again at each observer where it changes, except where there is no Doppler or radial motion.

How is the "famed" Michelson-Morley experiment even involved with photons and relativity? That experiment used monochromatic light as a source, which is light of one frequency or very stable. That monochromatic light source was solid to the same Earth as the lenses and mirrors in the interferometer, so there was *no* relative motion, which is all and precisely what the Michelson-Morley experiment measured and proved.

Today we have a much better source of monochromatic light. The laser is not only very stable, but outputs essentially only one coherent frequency, hence makes an excellent clock. We now have solid-state lasers the size of a grain of sand, which we can attach on the end of a string and swing this monochromatic light source or stable frequency back and forth. When the laser swings to a detector the detector gets a higher frequency or up Doppler as the source travels faster than the speed of light; but when the laser swings away from the detector, it gets down Doppler as the light arrives at the detector at less than the speed of light. Only at the extremes of swings does the detector get the same frequency as the laser *always* outputs. How? Because the speed of light is a constant only to the source and may not be a constant to all observers.

It has been 58 years since Einstein won the Nobel prize for the photoelectric effect. As yet, no one has ever even found one photon, let alone measure its velocity, as Dr. Mark implies is an easy thing to do. If Einstein had had precision-tuned electronic circuits, as most **Radio-Electronics** readers have, he could have explained the photoelectric effect with them. Each different atom represents a sharply tuned circuit of a different frequency, and will only emit electrons when it absorbs its own particular frequency to get sufficiently excited. Look up "postulate" in the dictionary. Einstein's math is not science. **R-E**
JOHN W. ECKLIN
Alexandria, VA

equipment reports

Radio Shack Road Patrol Radar Detector

CIRCLE 101 ON FREE INFORMATION CARD

RADAR SPEED DETECTORS STILL SEEM TO BE hot-selling items judging from the continuing production of these little devices by the electronics industry.

One of the newest designs is the *Road Patrol L.R.* recently released from Radio Shack. Made for Radio Shack by a prominent manufacturer, the Road Patrol multiband detector is designed to respond to either X-or K-band signals. As with other similar devices, the *Road Patrol* extracts power from the cigarette lighter receptacle. A retractible coil cord keeps the power line snug. A universal mounting bracket is furnished with the detector, allowing for a variety of mounting schemes. A self-adhering pad (supplied) may be used to stick the detector and bracket assembly firmly to the windshield for greatest clearance. Alternately, the bracket may be stuck or screwed down to the top of the dash or to the hardware seal around the windshield. A set of adjustable screws permit the unit to be optimally tilted on its mount so that it faces directly forward for maximum range.

The housing is plastic with a non-glare rough black texture. There are two electronic adjustments, accessible from the front. The volume of the audible alarm may be set so that any triggering may be heard above ambient vehicle noise. A sensitivity control provides an approximate range-distance selection.

Accompanying the audible alarm, a flashing red panel light displays the warning, CHECK SPEED, when the detector is triggered.

If it is likely that the owner would like to transfer the detector repeatedly between vehicles, extra mounting brackets are available at additional cost from Radio Shack.

A green LED pilot light indicates when the unit has been switched on. When first powered up, the unit will "beep" and flash the alarm light for a short stabilization period. After that, the unit may be adjusted for optimum performance.

In a major metropolitan area, there are many stray RF signals which may cause false triggering of the sensitive device. That susceptibility is common to virtually all broadband Radar detectors; it is a fact of life. Fortunately, such false indications are usually erratic and are also short-lived.

When the *Road Patrol* detects an actual speed radar transmission, the audible pulsating tone and flashing red alarm light will recur repeatedly. That signal is unmistakable when compared to the occasional signals.

How it works.

A radar detector is simply a broadband, high-sensitivity RF-level detector. It has a tuned microwave horn antenna that is designed to pass signals in the X-and K-(several thousand megahertz) bands into a diode. The radio-frequency energy is then rectified into a voltage that upsets a delicately balanced alarm circuit. Obviously, a radar speed trap cannot be detected unless the radar is actually transmitting a signal. That is one way that law enforcement agencies can outwit the detectors: They may use short bursts of radar to monitor specific vehicles momentarily—hardly enough time for a radar detector to resolve whether the incoming signal is a random bit of RF interference, or whether it actually is a transmitted radar signal.

The range of a radar detector depends on a number of factors including its own sensitivity, the power-output level of the radar transmitter, the terrain on which the transmitter is being used, the amount of surrounding traffic, and the weather.

We were able to test the *Road Patrol* over a recent holiday weekend. On a trip to a local hamfest, we entered the city limits of Knoxville, Tennessee, and the little detector began to beep persistently. We couldn't turn the sensitivity low enough to keep it from frantically trying to tell us something. Instinctively, we slowed down, and looked analytically at the bushes, trees, grass—anything and everything. After about a half mile of super-cautious driving, there it was: an airport radar dish, sweeping the horizon!

Our return trip was more productive. A series of radar traffic-control points were definitely in operation in Western North Carolina, and the *Road Patrol* let us know every time we came near one with plenty of time to spare so we could slow down.

Are they legal?

The battle in the courtrooms still looms. Some recent landmark decisions have ruled in favor of the driver. Is the mere possession of a radio-receiving device proof that the owner is guilty of trying to evade the law? That this question is difficult to answer.

Some police agencies have attempted to locate strategically old radar transmitters that will produce false signals on major highways, causing detector owners to lose faith in the judgment of their detector devices. That action has been recently struck down by the FCC because of the interference the transmitters generate on the airwaves.

So far, only one technique has been proven 100% effective for avoiding speeding tickets: Just stay under 55 miles per hour! The Radio Shack *Road Patrol* radar Detector sells for $199.95. **R-E**

Rotable TV RCA Mini-State Antenna

WE ARE LIVING IN AN AGE OF RAPIDLY INCREASING miniaturization. Watches, calculators, computers, and automobiles all reflect the trend. Now, RCA has joined the ranks of the miniaturizers with their new *Mini-State* compact UHF/VHF TV antenna.

Looking like a flying saucer, the 5MS440 *Mini-State* is mounted as high as possible, away from metallic masses. Internally, the 21-inch plastic housing encloses a motor-driven directional antenna array. A circular styrofoam form provides support for a UHF Yagi and a terminated, tuned VHF loop. The VHF loop is

continued on page 26

amplified by a single-transistor integral preamplifier, while the UHF signal is coupled directly to the downlead.

RCA supplies a 60-foot length of prefabricated coaxial/control cable. The RG-59 coaxial cable is terminated at each end with an F-type connector, compatible for hookup both to the antenna and the power-supply unit below. The three-wire control cable is connected to screw terminals for motor drive control.

Assembly is easy. A screwdriver locks down the control cable leads, and the prewired coaxial cable screws on to the F connectors. Directions are excellent and easy to follow.

The manufacturer suggests that the radome be mounted as high as possible, free and clear of metallic obstructions. That is always a good practice for any antenna.

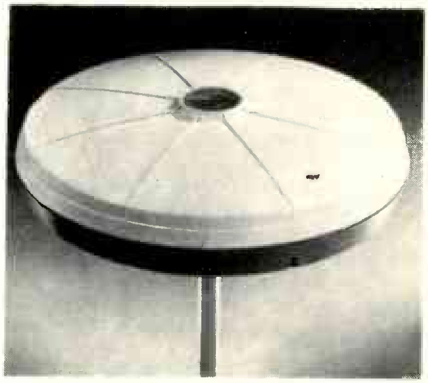
The rotable system is activated by a hand-held remote-control unit. Colorful back-lighted compass points are illuminated successively as the thumb control is depressed, signalling that the internal antenna is being rotated through its azimuth.

Mounting is provided by a stainless steel mast-mounting bracket. A set of spider legs is also included for setting the radome on a flat surface such as a closet shelf or attic floor.

Optional accessories available include a variety of mounting masts. An offset pipe facilitates the otherwise awkward case of side mounting on a wall. A rod-mounting tripod is also available.

The antenna system is powered from 120 VAC. A dual power model (includes 12 VDC) is available as the 5MS550. It is useful for portable applications, such as recreational vehicles and boats. Aside from the power supplies, the two systems are identical.

Excellent literature accompanies the *Mini-State* antenna system. The owner's manual includes a complete circuit diagram, as well as a supply of operational and installation hints.



CIRCLE 102 ON FREE INFORMATION CARD

We compared the *Mini-State* to a roof-mounted Radio Shack *V-110* log periodic dipole array. Both antennas were clear of surrounding obstructions, even though the *Mini-State* was mounted about four feet higher than the *V-110*.

Geographically, the test area was deep fringe. Since the *Mini-State* is advertised as useful in metropolitan and near suburban applications, we didn't expect it to perform as well as the large log-periodic under such conditions. Sure enough, it didn't! Stations were still visible in most cases, but they were way down in the snow. It was really an unfair comparison considering the capture area and gain of the log periodic.

Would we recommend the *Mini-State*! Yes, under certain circumstances. Unquestionably, when space is a problem, the *Mini-State* is better than rabbit ears. Also, its ability to be rotated is an advantage. On almost every channel, the sharp, unidirectional property of the unit was obvious. In urban applications where signal reflections, ghosts, and co-channel interference may be a problem, the rotating directability will be very useful.

Also, the *Mini-State* would find excellent application anywhere that signal strengths from nearby TV transmitters are sufficiently high that enormous antenna gain is not a consideration. Pleasure boats docked or being piloted in waters near major metropolitan areas would be a logical application of such a compact TV antenna system. The additional feature of rotability makes the antenna even more desirable for such mobile applications.

Similarly, people with recreational vehicles parked near urban areas where there is still some reasonable level of television signals present will find the *Mini-State* a good investment. The low profile of the antenna makes it particularly suitable for mobile installations where other types of projecting antennas would be a hazard. In the majority of cases, the antenna would not have to be removed as would other types of electrically equivalent antenna installations.

If the TV set is being operated by 120 VAC power, the regular 5MS440 may be powered from the same source. In mobile applications where 12 volts is powering the TV set, the 5MS550 dual-powered *Mini-State* should be considered. The model *5MS440 Mini-State* compact TV antenna has a recommended retail price of $89.95. **R-E**

continued on page 30

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Model 2010A Bench/Portable DMM:

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#AC-115, AC adapter/charger $7.95
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Also available Model 8110A, same as 8610A except maximum frequency is 100MHz and without battery charging circuit;

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Model 8610A

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EQUIPMENT REPORTS
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Data Precision Model 938 Digital Capacitance Meter

ALTHOUGH DISPLAY SPEEDS ARE STILL SLOW when compared to other forms of character readouts, the trend toward LCD digital equipment seems well established.

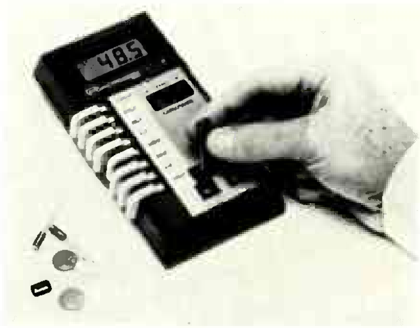
A recent introduction to the field in Data Precision's 938 3½-digit capacitance meter. The half-inch liquid crystal display shows high contrast, and is easily readable at distances of at least 20 feet.

The meter itself measures $6^{3}/_{4} \times 3^{1}/_{2} \times 1^{1}/_{2}$ inches—about the size of a good scientific calculator. It is pocketable . . . if you have a good-size pocket! Power for the unit is provided by an internal 9-volt battery (included). An ordinary battery may be expected to last about 100 hours with typical intermittent use. An alkaline battery will approximately double that lifetime. Alternately, an AC adaptor is available for test bench applications.

When battery voltage becomes too low (under 7 volts) to assure accurate measurements, a LO-BAT indication comes up clearly on the LCD display.

Automatic overrange indication is provided by the display blanking and leaving one digit and a decimal point. The 938 is current-protected by a replaceable internal input fuse. A spare fuse is provided, handily mounted inside the instrument case for easy replacement.

Also provided is a pair of 12-inch long test leads with alligator clips. An integral panel-mounted socket featuring a spring-clip connector for rapid capacitor insertion is also provided. We had considerable difficulty inserting leads of our test capacitors in several of the socket holes. We found the alligator clips more positive except at the lowest capacitance ranges where test lead capacitance was a problem. The holes in the panel-mounted socket loosened up after repeated insertions with a stiff wire.



CIRCLE 103 ON FREE INFORMATION CARD

We encountered some other minor difficulties as well. The battery leads in our unit were so short that battery installation had to be forced, pulling some of the insulation away from one lead. The on/off slide switch was quite touchy; when on, only a slight pressure against the slide would shut down the meter. The soft plastic window protecting the LCD display is quite susceptible to scuffing. Users are cautioned to remove dust carefully.

Now, the good points—of which there are many! With eight capacitance ranges, measurements from .1 pf to 2000 μF are possible. Range selection is manually chosen by pressing any one of eight interlocked switches. Sampling rate is two per second, and "settling down" time of the meter is usually within one second for a stable reading. At the worst, stable readings are available within five seconds on the highest capacitance ranges.

Accuracy is $\pm 0.1\%$ (+1 digit) on any scale (except 1% on the highest range). If a standard capacitance is available, a handy internal trimmer may be used to tweak up calibration. A convenient front-panel thumbwheel trimmer allows rapid zeroing to improve low-range accuracy. Peak excitation on any range is 2.8 volts, with the positive side always higher than the negative.

The circuit is a departure from most capacitance meters that measure indirectly. Classically, capacitance is defined as coulombic charge as compared to voltage. The 938 measures that relationship directly, via a dual-slope integrating A/D converter. The output of the analog measurement is fed into an Intersil 7106 chip, the same IC used in Data Precision's digital multimeter.

The accompanying manual is exceptional—it's both well written and profusely illustrated. Explanations are included of meter circuitry (a complete schematic diagram is included), capacitance theory, instrument calibration technique, general maintenance, and operational instructions.

When properly calibrated, an accurate capacitance meter is an invaluable aid in circuit design and troubleshooting. For determining drift rate of frequency-determining capacitors, the LCD meter will find a useful application. Similarly, leaky capacitors that degrade circuit
continued on page 32

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- AC measurements to 50 kHz and higher
- True RMS for ac accuracy
- Touch-Hold probe for tricky places (Y8008)
- Diode test and low power ohms
- Built-in batteries and charger (Option -01)

NEW

8024A
$199

Model 8024A: The Investigator

- Nine functions
  dc voltage
  ac voltage
  dc current
  ac current
  resistance
  diode test
  conductance (1/R)
  logic level and continuity detect
  temperature (K-type thermocouple)
- Peak hold on voltage and current functions
- Selectable audible indicator for continuity or level detection
- 3½-digit resolution
- 0.1% basic dc accuracy
- LCD display
- Overload protection

8022A
$139

Model 8022A: The Troubleshooter

- Six functions
  dc voltage
  ac voltage
  dc current
  ac current
  resistance
  diode test
- 3½-digit resolution
- 0.25% basic dc accuracy
- LCD display
- Overload protection

Model 8020A: The Analyst

- Seven functions
  dc voltage
  ac voltage
  dc current
  ac current
  resistance
  diode test
  conductance (1/R)
- 3½-digit resolution

8020A
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- 0.1% basic dc accuracy
- LCD display
- Overload protection
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ADVANCE ELECTRONICS

EQUIPMENT REPORTS
continued from page 30

performance can be identified with this meter. Don't forget that when equipment has gone out of spec, the blame can often be laid on faulty capacitors.

One very handy application of an instrument with such an accurate low-range scale would be to measure capacitance-per-foot of coaxial cable. Also, leaky capacitors are revealed by a continuously drifting reading.

Truly, the day of the cumbersome capacitance bridge seems to have passed, and the true Q/V measurement of digital meters like the *model 938* is upon us.

A liberal two-year warranty accompanies the versatile capacitance meter. The *model 938* has a suggested retail price of $149. **R-E**

American Beauty T-7 Micro-Soldering Station

CIRCLE 104 ON FREE INFORMATION CARD

ANYONE WHO HAS EVER DONE A FAIR AMOUNT of soldering will appreciate the flexibility of American Beauty's new *model T-7* Micro-Soldering Station. While it is certainly possible to do an array of soldering jobs with only one tip size and a single wattage iron, there is no substitute for having just the right amount of heat when you need it—and the right soldering tip to match.

The *T-7* allows heat adjustment from 175° to 910° Fahrenheit (79° to 487° Celsius) via a front-panel calibrated potentiometer control. A series of replaceable tips, both needle and chisel points, increases the flexibility of this well engineered tool.

The *T-7* is designed for serious electronic applications. For the inveterate home builder, it can be used in cramped quarters as well as on wired terminals. However, it cannot be used for heavy-duty soldering of large metallic surfaces where rapid heat sinking will quickly dissipate the small tip of the 12-watt (nominal) heating element.

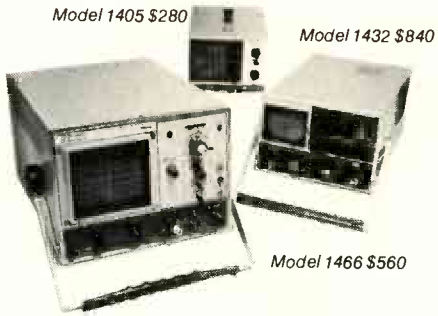
Soldering tips are very easily changed. The replaceable element and shank is removed as one piece, securely held in place in the handle. The electrical connection to the element is made by a snug push-on terminal. The tip is powered by low-voltage AC, isolated from the power lines by a transformer. A three-wire grounded cable provides an additional measure of safety.

Current to the tiny tip is controlled by an electronic circuit built into the console, and
continued on page 80

This is an offer you shouldn't resist. To introduce you to the new family of oscilloscopes from B&K-PRECISION, we'll let you "live with" one for up to 10 days, free! We're confident that after trying any one of our new scopes, you'll want to keep it for a lot longer. Of course, there's no obligation.

Leading off our 1400 series scopes is the new 1479, 30MHz dual-trace triggered scope. It's ready to challenge your testing needs with 5 mV/cm vertical sensitivity, 11.7 nS rise time, 50MHz triggering and built in high- and low-pass filters. A signal-delay line is built in to permit view of the leading edge of high frequency pulses. The 1479 also provides differential input capability and algebraic addition and subtraction of input signals.

For those requiring only a 15MHz dual-trace scope, the 1477 is an outstanding solution. Having many of the features of the 1479, the 1477 also offers a standard video sync separator for use with video systems or computer terminals. If battery portability is essential, the B&K-PRECISION 15MHz 1432 is a field-proven workhorse. It's a full-featured 3", dual-trace scope with an optional battery pack. For a 10MHz response, choose either the dual-trace 1476 or the single-trace 1466. With video sync separators and vectorscope capability, both are standouts. For basic monitoring applications, the low cost 3" 1405 is the best answer.



Common features of all 5" 1400 series scope include Z-axis inputs, plug-in PC board construction, scope camera-compatible CRT bezels, triggered sweep, excellent high- and low-voltage power supply regulation, built in calibration signals and cool, energy-efficient operation. The 1466 draws 20 watts; the 1479 draws only 25 watts.

For immediate delivery on the scope of your choice or for additional information, contact your local B&K-PRECISION distributor.

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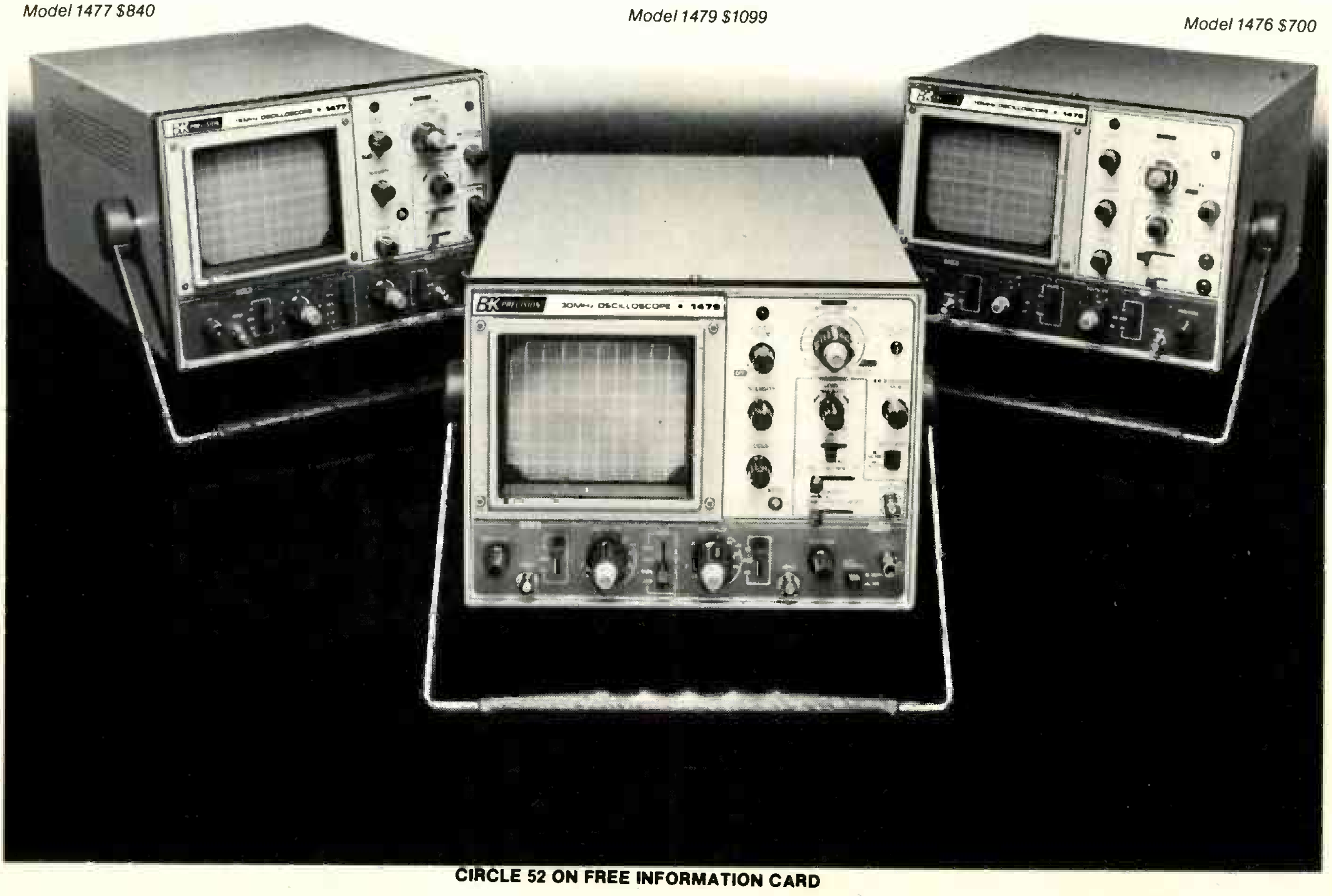


CIRCLE 52 ON FREE INFORMATION CARD

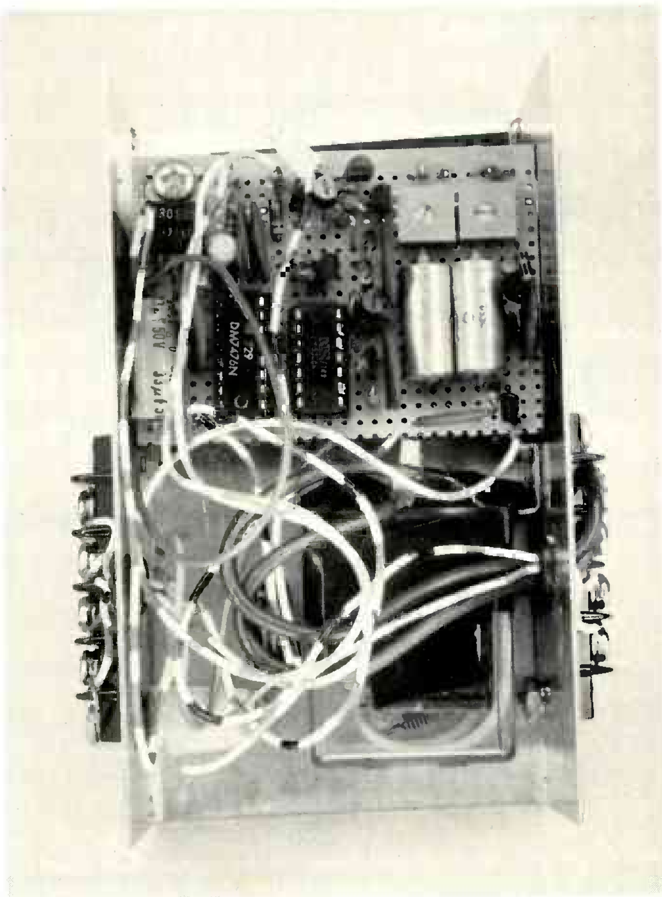
AUTOMOTIVE BURGLAR ALARM

This "hassle-free" security system protects your car and its contents without the need of a key to turn it on and off. You can build one for less than $20.00.

STEVE R. STOUT

DID YOU EVER WANT TO INSTALL A BURGLAR ALARM IN YOUR CAR, but didn't want to drill a hole in your fender or door for the keyswitch? Or maybe you just couldn't find that convenient place for a hidden switch under the dash? Or you just didn't want the hassle of having to remember to turn the alarm on and off.

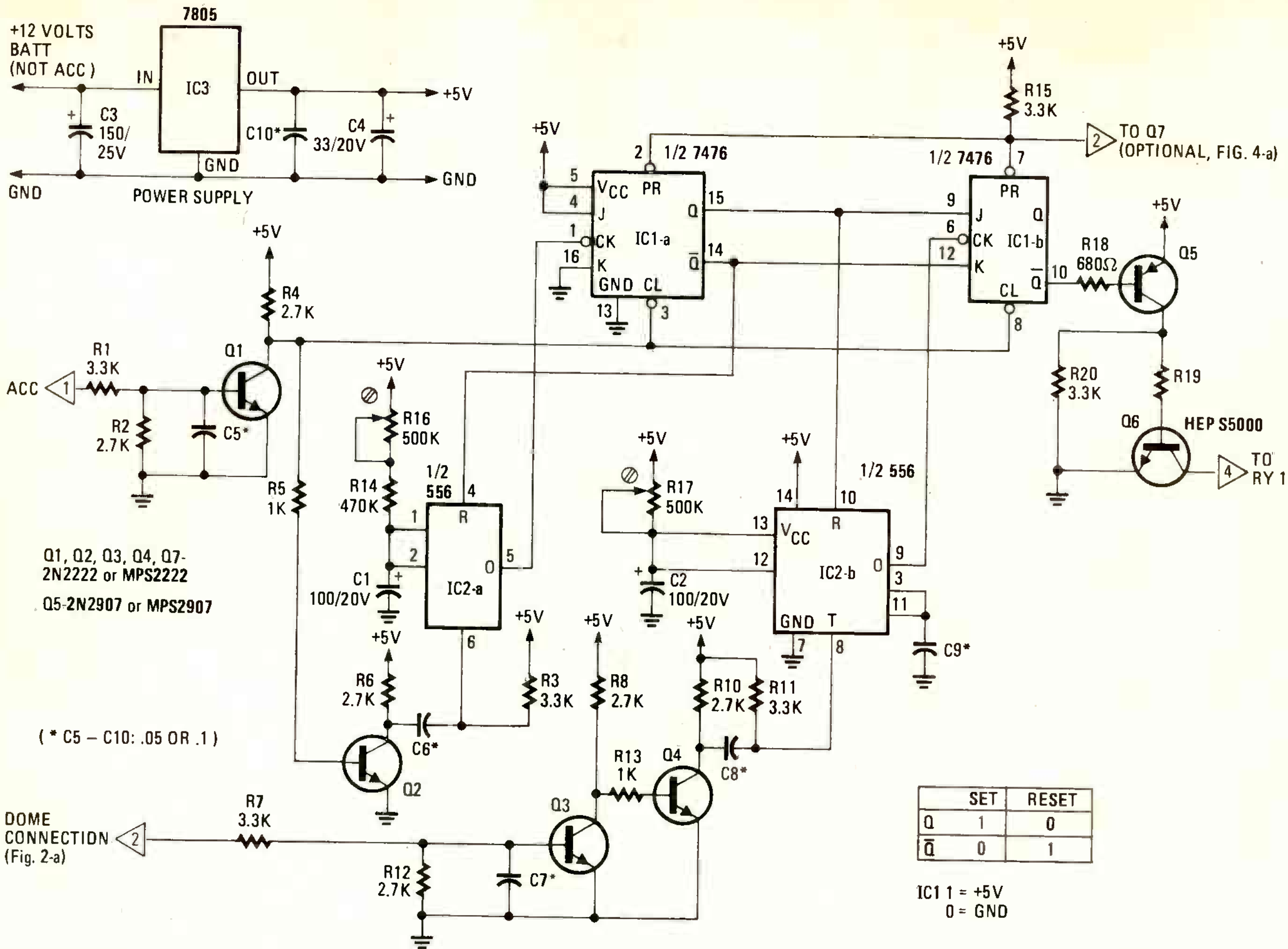
This alarm will protect the contents of your car, without the need for an outside key; you don't need to remember to turn it off or on; it will sound instantly if your radio is removed, and the basic unit can be built for less than $15.00 even if all parts are purchased new.



How it works

The base of transistor Q1 (Fig. 1) is connected via R1 to the accessory terminal on your car's fuse block. This is a point that is positive only when the car is running or the key is turned to the accessory position. With the car running, Q1's collector is low holding flip-flops IC1-a and IC1-b reset and causing Q2's collector to be high. When the car is turned off, the collector of Q1 goes high, enabling the flip-flops and pulling Q2's collector low to trigger timer IC2-a. At the end of the timing cycle, adjustable from 1-2 minutes, the output at pin 5 drops low, clocking flip-flop IC1-a to the set condition. The alarm is now armed and ready.

The base of transistor Q3 is connected via R7 to the switched side of the dome light circuit (Fig. 2-a). When a door is opened, the dome light goes on and transistor Q3's collector goes high, driving the collector of Q4 low and triggering timer IC2-b. Note that IC2-b will only start after flip-flop IC1-a has set because its reset pin (pin 10) is connected to the Q output of IC1-a. At the end of timer IC2-b's cycle, adjustable from 30-90 seconds, its output at pin 9 drops low, clocking flip-flop IC1-b to the set



	SET	RESET
Q	1	0
$\bar{Q}$	0	1

FIG. 1—SCHEMATIC of the hassle-free auto security alarm. Circuit is armed when driver leaves the car and is disarmed when he returns and switches on ignition.

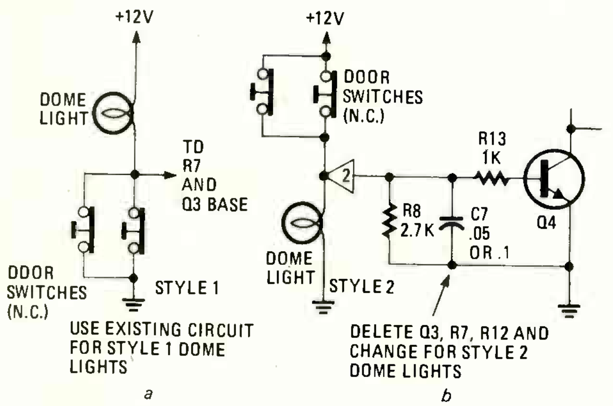


FIG. 2—DOME LIGHT circuit may have door switches on ground side as at *a* or in the "hot" side as at *b*.

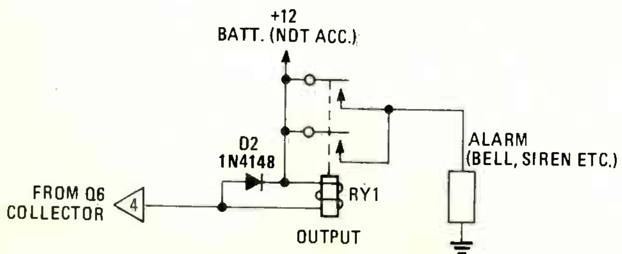


FIG. 3—RELAY is used to supply current to the horn or other alarm device. When low-current relay is used, you may need to parallel double contacts to carry load current.

PARTS LIST

Resistors 10% or better, ¼ watt

R1, R3, R7, R11, R15, R20, R21—3300 ohms
R2, R4, R6, R8, R10, R12, R22—2700 ohms
R5, R13—1000 ohms
R14—470,000 ohms
R16, R17—500,000 ohms, miniature potentiometer
R18, R19, R23—680 ohms
IC1—7476 dual J-K flip-flop
IC2—556 dual timer
IC3—7805 5-volt regulator, TO-220 case
C1, C2—100 µF, 20 volts, electrolytic
C3—150 µF, 25 volts, electrolytic
C4—33 µF, 20 volts, electrolytic
C5–C11—.05 or 0.1 µF, 16 volts, disc cer
D1, D2—1N4148 or equal
Q1–Q4, Q7—2N2222, MPS2222 or equal
Q5, Q8—2N2907, MPS2907 or equal
Q6—HEPS5000 or equal
LED1—red LED, any size suitable
RY1—relay, 12 volts DC with contacts rated to handle load

condition. This turns on Q5 and Q6, pulling in relay RY1 (Fig. 3) and sounding the alarm. If at any time before flip-flop IC1-b sets, the key is turned to accessory or the car is started, Q1 conducts resetting both and disabling the alarm.

Options

Transistor Q7, R21 and D1 may be added (Fig. 4-a) for those who wish the instant alarm feature. The free wire is connected to your radio's chassis and made to look like an extra ground

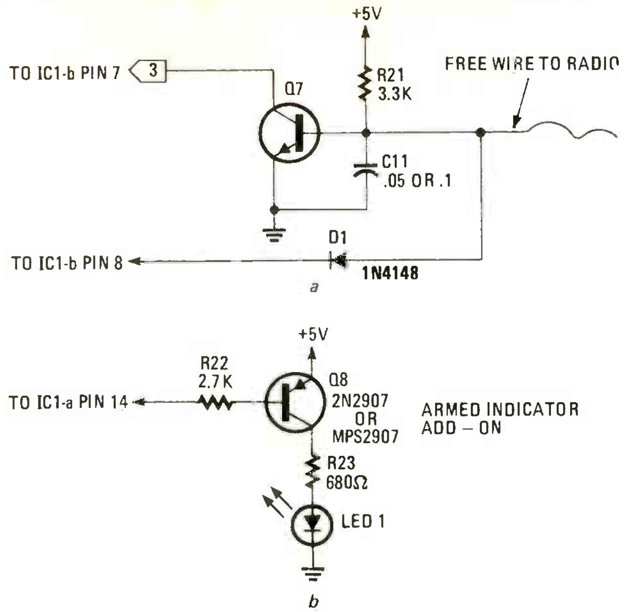


FIG. 4—TWO OPTIONAL CIRCUITS. The circuit at *a* provides added protection for radio, tape deck or CB set. Circuit at *b* shows when alarm is armed.

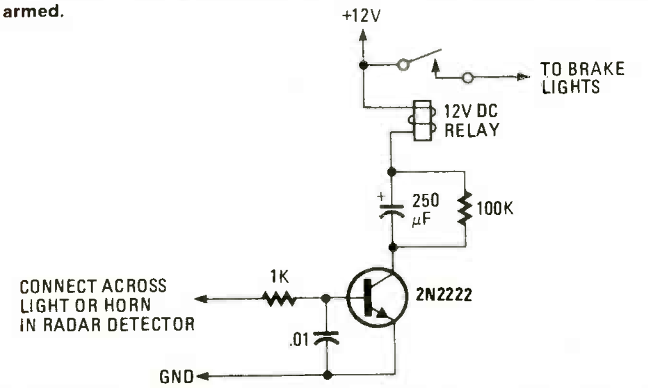


FIG. 5—CRUISE-CONTROL is disconnected automatically when radar detector picks up police clocking signal.

wire. When the wire is cut or disconnected, Q7 conducts, pulling the preset inputs of both flip-flops low, setting them and turning on the alarm.

Another option which helps during set-up and also lets you know your unit is functioning is the alarm-armed indicator (Fig. 4-b). This is an LED connected so as to light when flip-flop IC1-a is set and the alarm armed.

The circuit in Fig. 5, though not directly related to security, is something you might consider while building the alarm system. It is designed to automatically disconnect the car's cruise control, thus cutting down on reaction time, when the radar detector picks up a signal. The detected radar signal turns on the transistor and pulses the relay—causing the brake lights to flash on and off and disconnect the cruise control. You may have to replace the 250-μF capacitor with a larger one—depending on resistance of the relay coil. (Note: Not all cruise control systems are deactivated by the brake lights.—*Editor.*)

Alarm operation

The following is a typical sequence showing the operation of the alarm

1. Driver shuts off car and leaves.
2. Timer IC1-a starts and arms alarm after delay set by R16.
3. Thief or driver enters car. Timer IC2-b starts when door is opened.
4a. Thief disconnects radio and alarm sounds, or timer B finishes cycle set by R17 and alarm sounds.
4b. Driver starts car, disabling alarm. Note that the alarm is disabled anytime the car is running or the key is in the accessory position.

Notes on construction

Check the configuration of the dome light wiring in your vehicle. If the door switches are on the high side of the dome light, modify the circuit as in Fig. 2-b. Power transistor Q6 may be replaced with a 2N2222 if RY1's coil current is less than 150 mA. Mount relay RY1 near the siren, bell or horn used with the alarm. Any style of cabinet may be used but it should be mounted out of sight. Wiring is not critical and I used wire-wrap in my prototype. However, a circuit board or point-to-point using a Proto-Board is recommended for strength. **R-E**

PIONEERS OF RADIO

FRED SHUNAMAN

A.S. POPOV

THE PLACE OF PROFESSOR A.S. POPOV IN the history of radio has been obscured to some extent by rival claims of Marconi supporters and by persons who insisted that, because he was Russian, he could not have invented anything important.

The facts that most people agree on are that Popov, of the Russian Marine Academy at Kronstadt, described and demonstrated to the Russian Physical and Chemical Society, on the 7th of May, 1895, equipment he had constructed to study atmospheric electricity. It followed the "state-of-the-art" of that time, using a Branly coherer. But Popov added one improvement. The original Branly coherer had a disadvantage—once its filings had "cohered" on receiving a signal, its resistance dropped and remained low, paralyzing it until its filings were jarred loose again. Branly and Lodge "decohered" it by striking the table with a mallet. Popov used the signal itself to restore the receiver's sensitivity. Battery current through the coherer also passed through the coil of an electric bell, which was so mounted that its clapper struck the coherer on every backstroke. When a signal was received the bell rang and continuously decohered the tube of filings, producing an audible signal as long as the radio waves continued.

Popov also used an elevated aerial wire and is credited by some with the invention of the antenna. However, earlier inventors (Loomis, Dolbear) had used aerials, and Edison had described elevated "condensing plates" in his radio patent of 1885.

Although Popov designed his receiver to study atmospherics, he checked its sensitivity with a spark transmitter. Using the apparatus of Hertz, he said, "with a sphere of 30 cm," he could actuate it at a distance of 1 kilometer. With the apparatus of Bjerkness, "of a diameter of 90 cm," good results were obtained at a distance of 5 km.

There is no indication that he attempted to transmit intelligence. But later in the year he suggested that a wireless telegraph system could be established if a powerful enough "oscillator" could be made. In March, 1896, he did transmit the words "Henri Hertz" a short distance—and taped the program!

In March 1897 a radio station was established at Kronstadt under his direction, and he began outfitting ships of the Russian Navy. On the 23rd of January, 1900, a message from St. Petersburg instructed the icebarker *Yermak* to proceed to the rescue of a group of fishermen on floating ice in the Gulf of Finland. This was accomplished, and was probably the first use of a radio transmission to save life at sea. This work, incidentally, was carried out with commercial equipment, made by the French instrument maker Ducretet for the Russian Navy.

Like Hertz, Popov had a short life. He died in 1906, at the age of 45. **R-E**

BACKYARD SATELLITE TV RECEIVER

Part 6: The front end is critical if you build your own satellite TV receiver. This issue we explore several different approaches to making one that will work.

ROBERT B. COOPER, JR.

LAST MONTH, THE BASIC DO-IT-YOURSELF satellite TV receiving system was described along with a novel spherical antenna system. This month, we'll look at several approaches to building the front end of the receiver.

Suitable LNA designs

The low-noise amplifier (LNA) decision depends largely on the mixing approach taken by the builder. As discussed last month, if you decide to use a prepackaged passive double-balanced mixer, such as the VARI-L DBM 500 unit, you will need more voltage gain from the LNA than if you elect to use an active GaAs-FET mixer. We'll show both LNA approaches here: the bipolar transistor system for use where 40 to 50 dB of gain is required, and the GaAs-FET transistor system where approximately half as much gain is needed.

A few comments are in order for those building microwave circuits for the first time. Read them carefully.

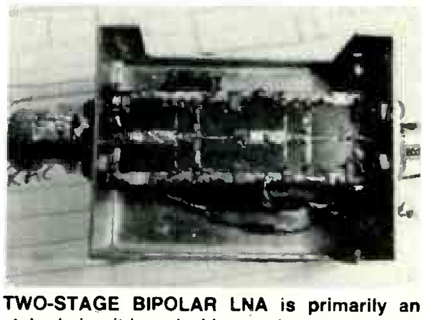
1. **Board material**—Normal circuit-board materials, such as the familiar G-10, are bad news at microwave frequencies. Any printed-circuit board *must* be designed for microwave applications. That means a microwave-rated Teflon dielectric board. Such board material is expensive but if you use very small amounts of it, the per-system costs will still be minimal.
2. **Double-sided**—Use only double-sided board for all circuits, including those at baseband frequencies. IC and packaged active devices used in this system, even when operating at baseband (video) frequencies, will oscillate when given the opportunity. (One recommended source for the microwave region board material that is used in the 4 GHz LNA stages and in the local oscillator/active mixer segments is the Rogers Corporation, Box 700, Chandler, AZ 85224. The board material is Duroid grade D-5880 226-127; dielectric thickness is 0.031 inches, 1 ounce clad on two sides.)
3. **Grounds**—All boards must be perimeter-grounded. That means all around, all four edges, both sides. Spot grounds through standup mounting lugs or pillars are not adequate.
4. **Lead length**—Exceedingly short, direct leads must be used with all parts. Remember that at microwave frequencies even a 1/8th-inch lead becomes an appreciable portion of a wavelength.
5. **Capacitors**—All capacitors specified in the microwave portion must be chip type. Normal ceramic, etc. capacitors have far too much inductance at microwave frequencies to be utilized. Where RF chokes are specified, put them in.

There are several sources for chip capacitors suitable for this project. One national source is Dielectric Labs, 69 Albany St., Cazenovia, N.Y. 13035. Smaller quantities can be obtained from Robert M. Coleman, RFD 3, Box 58-A Travelers Rest, SC 29690, and, from Satellite Innovations, Box 5673, Winston Salem, NC 27103. Where some of the circuits here specify certain brands of parts, such as capacitors, look to the *value* of the device and then locate a suitable substitute from the sources just given.

Two-stage bipolar LNA

The workhorse amplifier in this service is described in *Hewlett-Packard Applications Note 967:* a single-stage bipolar amplifier using either the HXTR-6102 or the HXTR-6101 devices. The 6102 is a better grade of the 6101 and it is capable of producing an LNA stage with approximately 10-11 dB of voltage gain in the 3.7 to 4.2 GHz range with a noise-temperature of between 270° and 290° Kelvin (K). The 6101 tends to be 15° to 25° K "hotter. (In this case, hotter is worse, not better!)

English experimenter Steve Birkill



TWO-STAGE BIPOLAR LNA is primarily an etched circuit board with very tiny parts mounted in precise position.

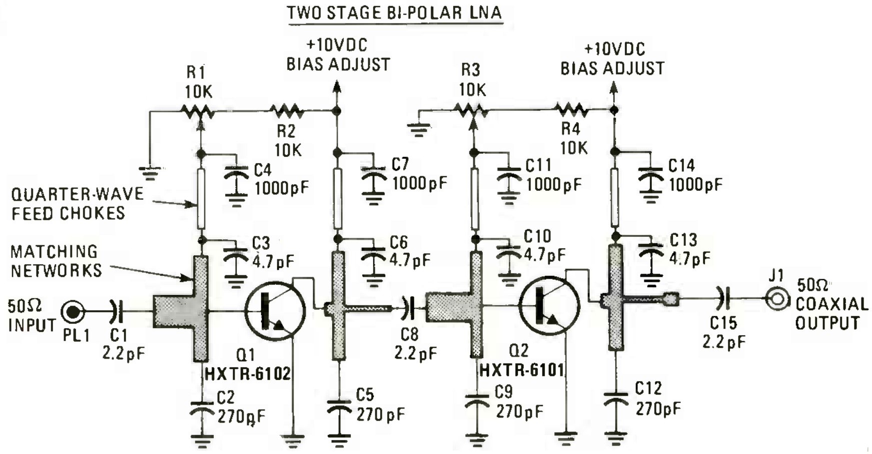


FIG. 1—SCHEMATIC DIAGRAM of the two-stage bipolar low-noise amplifier. The shaded areas represent leads and inductors that are vital parts of the circuit design.

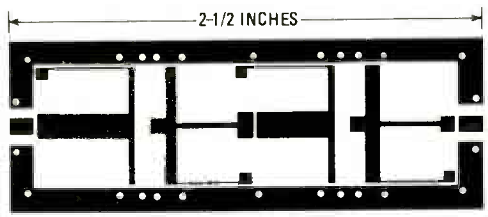


FIG. 2—PATTERN for etching the top surface of the LNA microstrip board. The lower surface is plain copper.

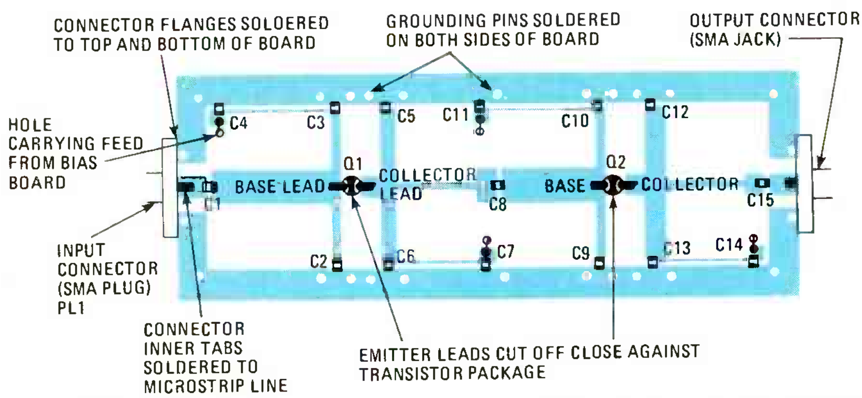


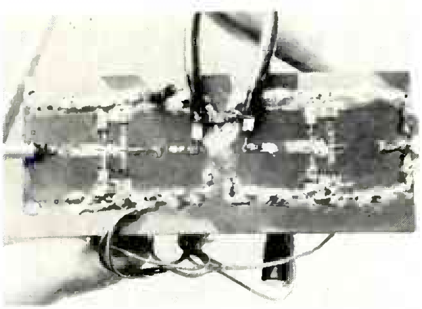
FIG. 3—COMPONENT LAYOUT shows placement of the transistors and capacitors. The capacitors are chip-type approximately 8 × 5 mm.

PARTS LIST
Two-stage bipolar LNA

- Q1—HXTR-6102 transistor (Hewlett-Packard)
- Q2—HXTR-6101 transistor (Hewlett-Packard)
- R1, R3—10,000 ohms, linear pot
- R2, R4—10,000 ohms, ½ watt
- C1, C8, C15—2.2 pF (Vitramon VJ0805A2R2DF)
- C2, C5, C9, C12—270 pF (Vitramon VJ0805A271)
- C3, C6, C10, C13—4.7 pF (Vitramon VJ0805A4R7DF)
- C4, C7, C11, C14—1000 pF (Vitramon VJ0805X102KF)
- PL1—SMA-type plug receptacle, tab contact, flush dielectric. Selectro type 50-646-4575-31 (gold plated) or similar
- J1—SMA-type jack receptacle, tab contact, flush dielectric. Selectro 50-645-4575-31 (gold plated) or similar. Note: SMA connectors from different makers may be known variously as SMA, SRM, RIM or OSM.

Microstrip board: 62.5 × 22.5 × 0.79 mm. Duroid D-5880 226-127 dielectric constant 2.5, etched.

of Sheffield has developed a two-stage circuit board using this device series and it is shown in Fig. 1. A full-size circuit board is shown in Fig. 2. The opposite side of the board—which, as a reminder, *must* be a microwave-rated board—is solid copper.



TWO-STAGE HFET GaAs-FET LNA is similar in design and almost identical in layout to bipolar LNA two-stage device; primary difference being the substitution of HFET series transistors for bipolars.

Following the components selection guide given here and the construction tips, there is nothing to the system in the way of tuning or alignment. Ten VDC is the operating voltage; the base bias is adjusted with the 10K pots (one per stage) for a total device current of 4 mA. There is no tuning other than this; all resonant circuits are obtained with the etched inductances and the fixed capacitances shown.

Figure 3 shows a parts layout for the same two-stage amplifier. The bias parts (resistor plus pot per stage) can be located on the backside of the amplifier circuit board. When constructed, the board(s) must be mounted in a suitable microwave enclosure with suitable grounds all around as noted. The amplifier is very stable, but not when

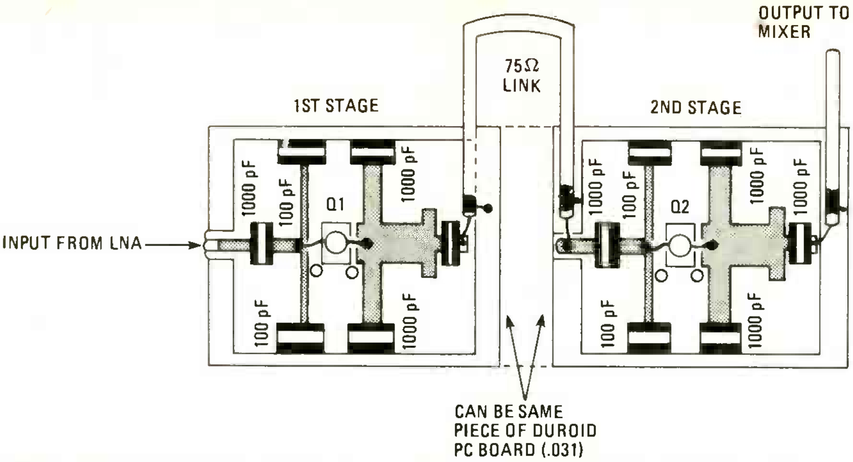


FIG. 4—SCHEMATIC AND LAYOUT of a two-stage LNA amplifier designed by Robert Coleman.

THIS INNOCENT-LOOKING DEVICE is capable of producing +10 dBm of local oscillator signal at 4 GHz! Avantek VTO 8360 is a microwave oscillator device totally self contained. It mounts on full-foil side of board with pins (leads) accessible on opposite board side with active 4-GHz circuits.

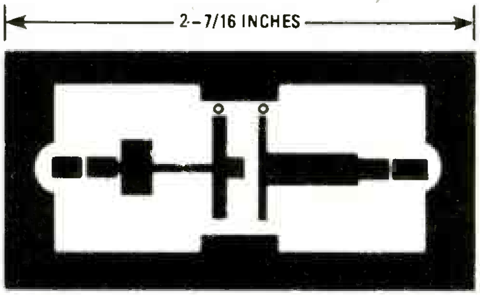


FIG. 5—PRINTED-CIRCUIT foil pattern for a single-stage low-noise amplifier. Two can be connected in cascade for more gain.

operating at the end of several clip leads as it dangles in space! One source for microwave enclosures is Adams Russell, Modpak Division, 80 Cambridge St., Burlington, MA 01803

Two-stage GaAs-FET LNA

If your approach is to follow the active mixer design of Robert Coleman, or you simply want a lower front-end noise figure than is possible with the HXTR bipolar series, then you can build the two-stage Coleman HFET-1101 amplifier. Figure 4 shows the parts layout for the HFET-1101 amplifier. The HFET series of GaAs-FET devices are also produced by Hewlett-Packard and a stocking distributor is Hallmark Electronics Corp., Attention: Paul Koeppen, 1208 Front St., Building K, Raleigh, NC 27609.

The HFET series of GaAs-FET's is capable of producing noise temperatures in the 170° K region (2-dB noise figure). Like the bipolar HXTR series, there is no tuning; the devices mount, turn on, and have voltage (positive and bias) supplies adjusted for optimum performance. Again, you cannot do that at the end of clip leads! The HFET data sheets suggest an operating voltage of +4.5 VDC. Developer Robert Coleman found that in the circuit shown (the actual-size foil pattern for a single stage is shown in Fig. 5.) the devices tended to be unstable at that voltage. By dropping the operating voltage to +3.6 and applying a −3.0 VDC (adjustable) bias to the gate lead (as shown in Fig. 6) he was able to make the stage

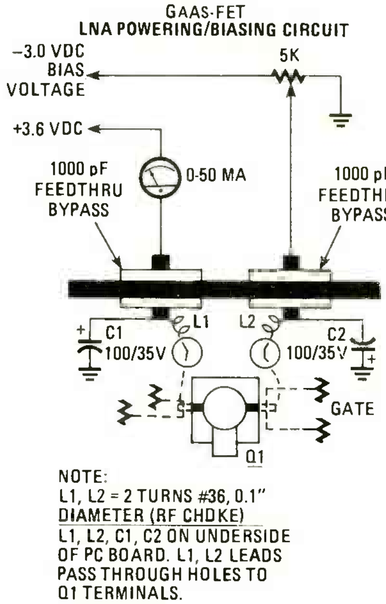


FIG. 6—HOW COLEMAN LNA IS BIASED AND POWERED. RF chokes L1 and L2 are mounted on underside of the board with leads anchored in holes in the PC board.

stable and optimize performance.

With all LNA stages (bipolar or GaAs-FET) there should be a separate bias control adjustment on *each* device. With the HFET devices, maximum gain occurs when the device current is around 40 mA *but* optimum noise figure occurs much lower; near 12 mA. Since in this situation voltage gain is secondary to noise-temperature performance, you will need a method of measuring the device current. Coleman's approach is to watch a current meter on the stage and keep an eye on the satellite-delivered picture to optimize the stages involved. Start with the first stage after setting both stages to approximately 12 mA current.

Circuit boards are available for either the Birkill bipolar (two-stage) amplifier or the single stage GaAs-FET device from Robert M. Coleman, RFD 3, Box 58-A, Travelers Rest, SC 29690. The price is $25 on the Birkill two-stage board and $15 on the single-stage GaAs-FET board. A parts list is not included for the GaAs-FET LNA since many of parts are already listed for the bipolar LNA. The 100pF capacitors are also made by Vitramon and Q1 and Q2 are Hewlett-Packard HFET-1101 transistors.

The VTO local oscillator

Creating a +10 dBm-level continuous-wave signal source for the local oscillator can be a bit of a pain, especially when the local oscillator must operate in the 4-GHz region! Fortunately, Avantek (3175 Bowers Avenue, Santa Clara, Ca. 95051) has solved that problem with a neatly packaged device that only requires board mounting (on microwave pc board). The device requires connection of a +15 VDC supply and application of a second +10-to-+20-VDC range tuning voltage. The VTO 8360 device is virtually a perfect local oscillator source for our applications since it tunes the range of interest and while not inexpensive (in the $125 region) it is far less costly to use than a lower-frequency oscillator chain with multiplying techniques. And, as Murphy notes, there is much less to go wrong because everything is inside on a substrate-designed package.

In Fig. 7 we have the complete local oscillator ready to drive any mixer put into service. The output pin four is linked through an appropriate *short* length of coaxial cable (if the length is under 6 inches, virtually any 50- or 75-ohm coax will function; but you will want to choose cable that will mate with the SMA or other series fittings you are using). Another approach is to

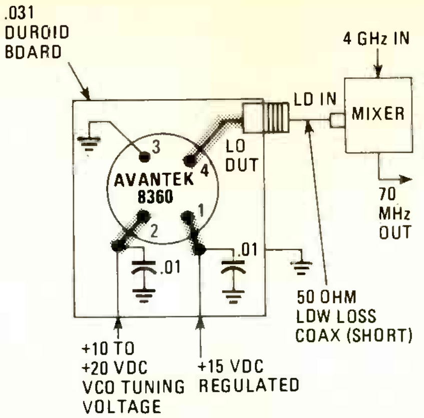


FIG. 7—THE AVANTEK VOLTAGE-CONTROLLED OSCILLATOR as it would be used as a local oscillator feeding a low-noise mixer.

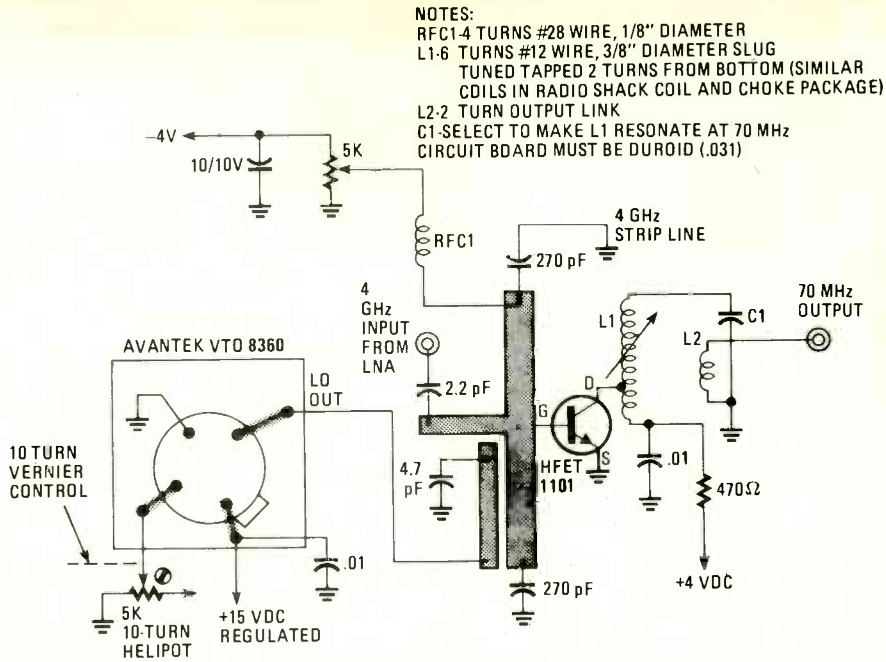


FIG. 8—A COMBINATION of the Avantek VCO and GaAs-FET used to make a tuneable 4 GHz-10 70-MHz converter using an active mixer.

use coaxial adapters to plug the output of the local oscillator directly into the appropriate input fitting on the mixer. If you are using the VARI-L DBM-500 mixer (VARI-L Company, Inc., 3883 Monaco Pkwy, Denver, CO 80297) you will need to build around the "standard" microwave SMA fittings. Note that just as you don't use any substantial lengths of low-frequency (i.e., RG-8, etc.) coaxial cable at 4 GHz, you also don't use fittings such as the UHF type. Even the BNC type are at best questionable in performance at 4 GHz, although there are some type N fittings "rated" to beyond 4 GHz. The proper fittings and coax (for short interconnecting runs) can be located at Satellite Innovations, P.O. Box 5673, Winston Salem, NC 27103). What you are looking for is type SMA series connectors and suitable coax to mate with the SMA series fittings.

There is absolutely nothing to do with the VTO 8360 local oscillator but mount it and turn it on. The +10-to-+20-VDC tuning voltage varies the operting frequency through the range of interest (3.630 to 4.130 GHz). Once again—make sure the VTO 8360 is mounted on microwave circuit board and is firmly seated into a housing before turning on.

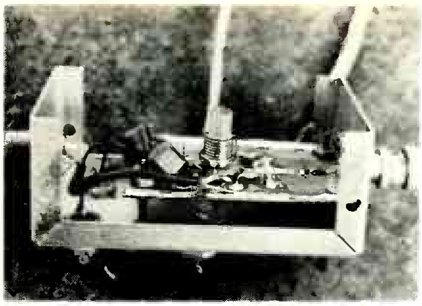
Active Mixer

The most cost-effective approach to the 4-GHz front-end at the moment appears to be a marriage of two stages of GaAs-FET LNA to the active mixer (plus local oscillator) shown in Fig. 8. This is another Robert Coleman-developed circuit, using the HFET-1101 not as an amplifier but rather as a single-ended mixer. The 4-GHz energy from the LNA stage(s) is coupled into the gate of the HFET 1101. The 4-GHz range local oscillator signal from the VTO 8360 is coupled into the same gate through a coupling strip. The 4-GHz pair of signals mix in the GaAs-FET

Additional Satellite Material

Satellite television reception enthusiasts interested in learning more about the fast developing satellite TV industry and the options available to persons building their own home terminals may find some of the following of interest:

1. **Satellite Study Package**—Designed to teach you how the satellite TV system operates, what the equipment requirements are, which services are available, and to whom and where. Includes a 72-page book written by Bob Cooper that explains in lay terms the complete satellite TV scene, plus a 22 × 35 inch four-color, two-sided wall chart depicting the location and operating characteristics of more than 30 geostationary satellites carrying television programming. Shipped via first class mail, price is $15 in U.S. and Canada (in U.S. funds), $20 elsewhere from: Satellite Television Technology, P.O. Box 2476, Napa, CA 94558.
2. **Coop's Satellite Digest**—A monthly publication providing up-to-date circuits, hardware, and satellite operational news. Mailed first class, widely read as the insider digest of the low-cost, private satellite TV industry. Price in U.S. and Canada is $50 per year ($75 outside, in U.S. funds); sample copy for $5 in U.S. funds. Order from: Coop's Satellite Digest, P.O. Box G, Arcadia, OK 73007.
3. **Paul Shuch Satellite Lecture Series Videotapes**—Approximately eight hours in Beta or VHS format; world-reknowned microwave teacher and satellite system engineer-designer H. Paul Shuch takes the student through the entire satellite equation from antenna to remodulated RF. Series originally videotaped at SPTS '79, world's first international seminar for low-cost satellite TV terminals. Excellent learning tool, teaching tool. Price is $210 in VHS (LP) and $225 in BETA-2 in U.S. and Canada; add $25 elsewhere from: Satellite Television Technology, P.O. Box G, Arcadia, OK 73007 (405-396-2574).
4. **SPTS '80/California**—A three-day lecture series and exhibit featuring noted satellite TV low-cost terminal-developers H. Taylor Howard of Stanford, Oliver Swan, who developed the Swan Spherical TVRO antenna, H. Paul Shuch of Microcomm, Robert Coleman of South Carolina, and many others. Combines classroom learning of the latest state of the art of satellite TV hardware, plus the latest in marketing of low-cost systems to private homes, with commercial exhibits of hardware. More than 25 sessions in three-day period with course learning materials. Next event will be held in San Francisco Bay Area in June of this year. For information, contact SPTS '80/California, P.O. Box G, Arcadia, OK 73007 (405-396-2574). Admission by pre-registration only, limited capacity.



ACTIVE MIXER USING HFET device along with VTO 8360 (mounted out of sight on back side) mounts in single container. Unit can mount outside, at antenna, if appropriately weatherproofed thereby running only 70-MHz IF energy down and inside (in low-cost 50- or 75-ohm coaxial cable).

and are delivered at the output in the 70-MHz region. Inductor L1 plus capacitor C1 determine the IF resonance. With the value shown for L1, C1 will typically be around 5 pF. It is important that the Q of this output section be kept fairly low so that the full 30-MHz bandwidth of the 70-MHz IF signal gets out of the mixer and into the IF amplifier stages without being restricted. The 5K pot in the −4 VDC bias supply lead is adjusted for optimized performance simply by looking at the picture on the screen. This adjustment, plus the tuning voltage on the VTO 8360 are the only two real adjustments that you need to work with to get 4-GHz energy down to 70 MHz! Inductor L1 tunes broadly and can be optimized after the satellite signal is received.

This portion of the system can be tuned by using an MATV/CATV-type field-strength meter tuned in the 70-to-80 MHz region—or, in a pinch, you can actually run the 70-MHz IF output into a standard television receiver tuned to channel 4. No, you will not recover video (or audio); remember that the satellite TV format is FM, and 30-MHz or so wide FM at that, and consequently the 4.5-MHz wide TV IF set up to detect AM video modulation simply can't recover usable video. But, the TV receiver tuned to channel 4 can act as a "tuning indicator" of sorts, and if you happen to run across a transponder transmitting a static picture, such as color bars or a slide, you may for a brief instant even see something resembling a picture.

The circuit-board layout for the active mixer is available from Robert Coleman directly (address previously given) and a complete board ready to mount the parts on (including the VTO 8360) is also available for $25.

There: Getting from 4-GHz down to the 70-MHz IF was not all that difficult! Next month we will look at the IF-to-baseband circuits, as well as the RF remodulation back to a standard NTSC format for direct viewing on a standard television receiver. **R-E**

WHAT'S 1980 TV

KARL SAVON
SEMICONDUCTOR EDITOR

HAVE YOU NOTICED THAT THE TELEVISION-receiver power transformer has virtually disappeared? Just two or three years ago one of the features of the more "solid" sets was the presence of that bulky, power-line isolating device. Today, design economy and a greater use of power-supply technology have eliminated the power transformer. Television tuners have also emerged, dramatically changed, from their mechanical infancy. Even many of the small-screen receivers use electronic tuners. The smaller sets tend to use the potentiometer-programmed varactor types first popular in the large-screen sets, while the larger deluxe sets now have "intelligent" tuning systems that smack of space-age technology and bear the fruits of microcomputer technology.

Those advances are found in both the surviving American producers' sets as well as the product releases of the Far Eastern competition.

Deflection and power-supply circuitry

Figure 1 shows the merged horizontal-deflection and power-supply circuitry of the 1980 Sharp 19D82 chassis. That receiver typifies the general circuit-design direction. The main chassis consits of four integrated circuits (two more are used in the tuning system) surrounded by a relative sparsity of discrete components. The set's schematic displays an unusual neatness and simplicity for a color television receiver. Although the innards of the IC's themselves are shown in Fig. 1 as blocks, the schematic seems to lose many of the mysteries that were inherent in the esoteric, discrete designs of the past. It is no longer necessary for manufacturers to use every circuit trick possible to keep costs under control.

This particular deflection sytem uses a single IC that contains the sync separator, horizontal oscillator, vertical oscillator, high voltage hold-down (X-ray protection), and vertical preamplifier stages. There is no fundamentally new functionality in the deflection structure, but rather a new kind of organization that supports a SCR-based regulator system. The design eliminates the power transformer by transferring its responsibility to the horizontal-output transformer. In addition to the traditional pix-tube second-anode and focus supplies, the horizontal-output transformer drives the set's main 18-VDC low-voltage power supply through D704, as well as the regulated 110-VDC power supply.

As a result of the SCR regulator circuit, all supplies energized from the deflection transformer are regulated. One interesting thing is that the 110-VDC power supply feeds the horizontal-output transistor and so is self-supplied. It's not perpetual motion though, since all the energy ultimately comes from the 170-volt DC supply that runs from the AC

NEW IN RECEIVERS

There are some interesting circuits behind the color picture tube. Here's a look at what Sharp and Zenith are doing this year

line. Besides the advantage of eliminating the power transformer, the power supplies now operating at the 15,734-Hz horizontal oscillator frequency have reduced filter-capacitance requirements because of the higher frequency.

Regulator SCR701 is fed from line rectifier diode D701 through a winding on the horizontal-output transformer. The regulator drive circuit varies the firing time of the SCR in the 63.5-microsecond horizontal period so that the average voltage developed at the cathode of the SCR is equal to the desired 110-volt regulated output. The SCR's conduction time is determined by the interval between the arrival of the SCR gate turn-on pulse and the turn-off pulse produced by the horizontal-output transformer winding. Regulator circuit Q701, Q702, Q703 is a DC comparator followed by a ramp-level detector that determines the turn-on point of the SCR. The regulator-output voltage is divided down to 7.1 volts by resistor network R708, R709, R710 and R711. Potentiometer R709 is the regulator voltage adjustment for trimming the output voltage.

Error amplifier Q703 compares the divided output voltage to the 6.2-volt Zener connected in series with the transistor's emitter. As transistor Q703's base voltage tries to decrease, the transistor conducts less. The actual determination of the trigger point occurs at the moment Q702 conducts. A winding on the horizontal-output transformer is connected to the base of transistor Q702 through R718 and C709. This R–C network is an integrator that produces a sawtooth waveform at the horizontal frequency on the base of Q702. The output current of the error amplifier transistor is returned to the 18-VDC supply through R716 and is also connected to the base of Q702 through R717.

In effect, the horizontal sawtooth waveform is biased up and down in voltage as Q703 changes conduction. The emitter of Q702 is returned to the reference Zener diode through D703 as a convenient bias point. Therefore when Q702's base reaches about 7.7 volts, the transistor begins to conduct. Exactly when this point is reached depends on the contribution of Q703.

Let's follow the regulator action in one direction with the help of Fig. 2. If the regulated supply tries to increase, for example due to a reduction in the supply load, the transistor collector current increases through R717, its collector voltage is reduced, and the bias level of the horizontal sawtooth on the base of Q702 is reduced. Now the sawtooth crosses the trigger level later in the horizontal cycle. At the point that Q702 conducts, its output current is amplified by SCR driver transistor Q701 and is coupled through R712 and C708 to the SCR gate. The action of the switched SCR regulator results in good receiver performance over a wide range of AC line voltage and supply load regulation.

Microprocessor tuning

Zenith's 1980 color TV line also uses electronic voltage regulation; the use of magnetic voltage regulation transformers has been discontinued. But the most innovative new Zenith feature is the Keyboard Touch-Command electronic tuning system. It is a microprocessor-controlled frequency synthesizer that uses a phase-locked-loop to control the tuner's local oscillator precisely. Closed-loop systems compared to open-loop schemes never require manual tuning by the viewer and, in addition, are not subject to oscillator-drift problems.

Figure 3 shows the system block diagram. The microprocessor receives command inputs from the keyboard or remote control that specify the channel to be tuned. Along with the tuning algorithms, the processor's read-only memory contains data that is used to convert channel numbers to the necessary division ratio required by the phase-locked-loop to produce the correct tuner oscillator frequency for the selected channel.

Two frequency-divider chains force the local oscillator frequency to be a programmable ratio of a reference oscillator. The loop creates whatever varactor tuning voltage is necessary to generate the exact required frequency. Because the frequencies extend into the 1000-MHz region, which cannot be economically handled by the lower frequency logic on the programmable divider IC, a separate

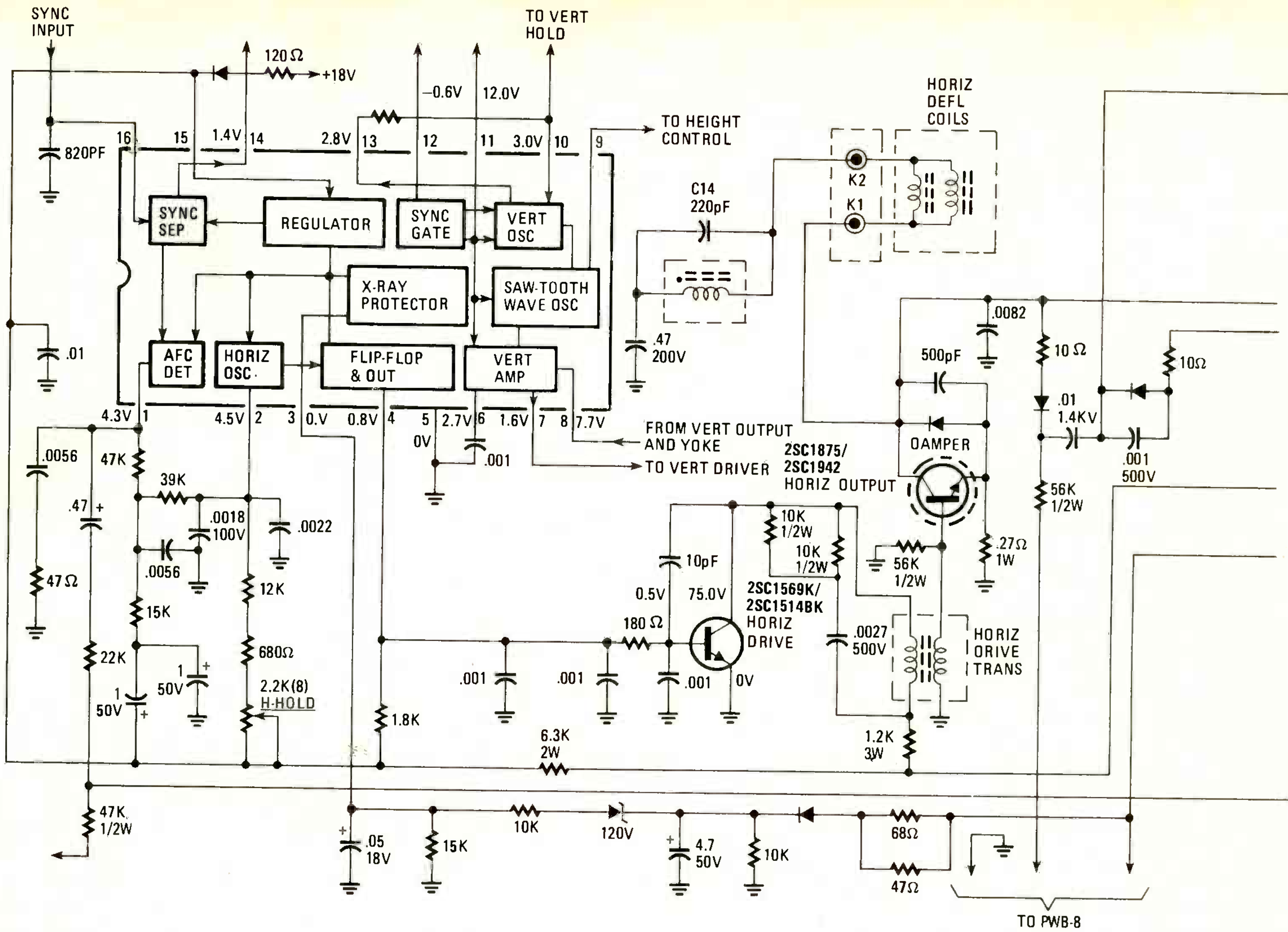


Fig. 1—HORIZONTAL DEFLECTION AND POWER SUPPLY CIRCUITRY of the 1980 Sharp 19D82 chassis. Schematic displays trend towards simplicity and increased usage of IC technology. Above circuit is remarkably simple, especially for a color-TV chassis.

dedicated divide-by-256 prescaler is necessary to do this job.

A 3.581055-MHz crystal reference oscillator is divided down by a 14-stage counter to the 976.5625-Hz reference comparator input. For example, tuning to Channel 2 requires a local oscillator frequency of 101 MHz. The total division ratio from the tuner to the comparator must be 103,424 to produce the 976.5625 Hz output. Taking into account the fixed ÷256 prescaler, the programmable divider must be set to precisely 404 by the microprocessor.

The comparator produces a signal with an average DC output that is needed to tune the oscillator frequency so that the output of the programmable divider is the same as the reference-divider output frequency. While the comparator actually produces variable-width pulses, the active filter reduces the comparator output to slowly changing DC. The active filter is an amplifier with a low-pass frequency characteristic. A clamp circuit prevents the tuning voltage from going below 2.25 volts. Reversals in the varactor tuner frequency-versus-voltage curve could otherwise cause a lockout condition.

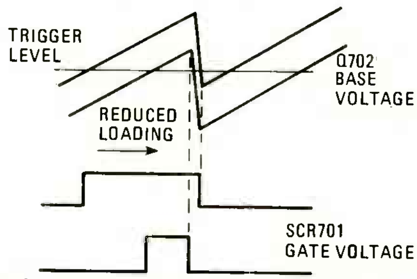
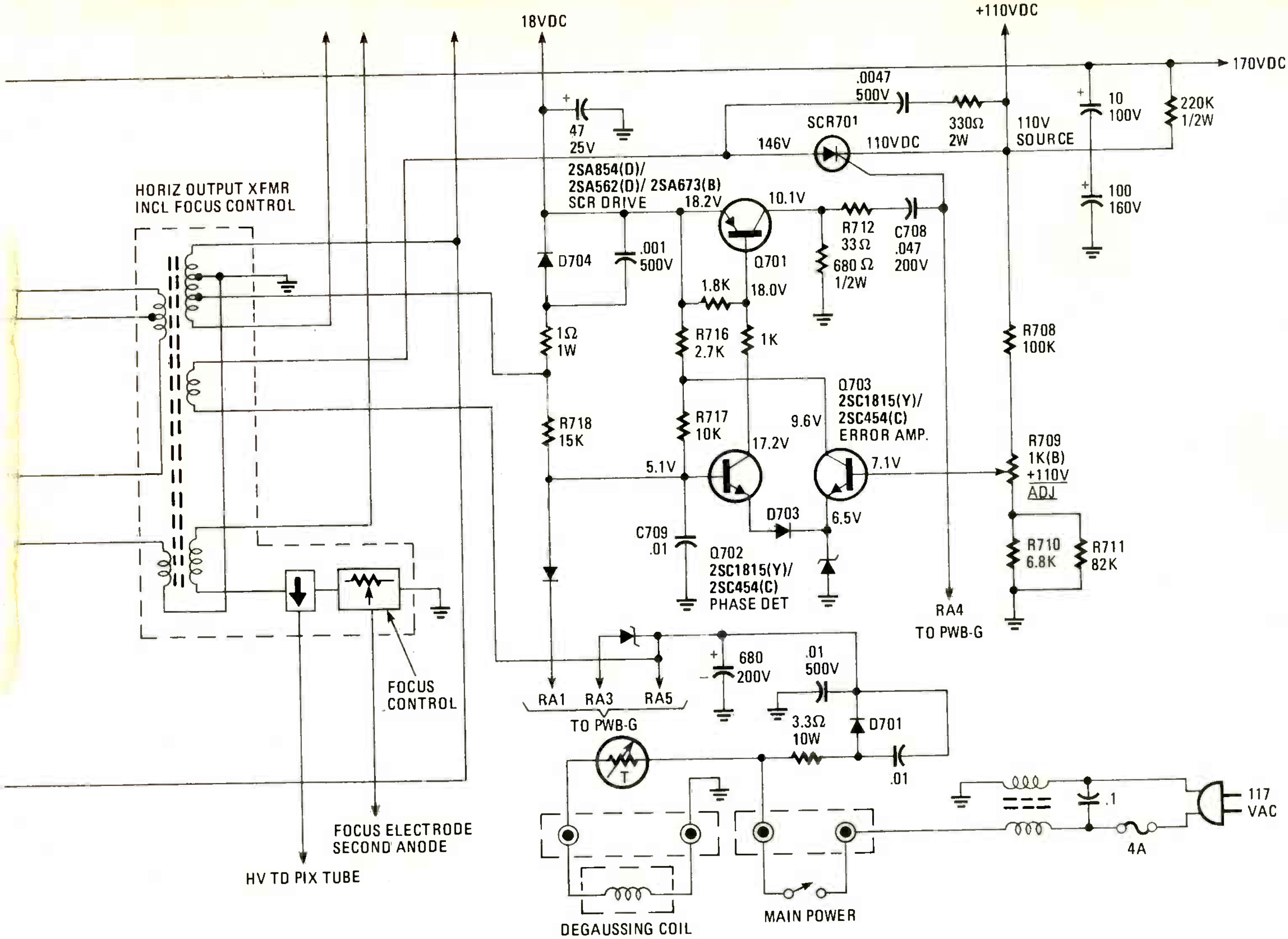


FIG. 2—SCR TRIGGER SIGNAL bias level is altered to change the conduction angle of the SCR and thus provide regulation.

Several features have been added to the basic synthesizer system to make it practical in a television receiver. First, although the system has been chosen for its precision and minimum of user intervention, there are some real-life situations where tuning off the theoretically ideal frequency is necessary. For example, some MATV systems intentionally translate the received frequencies to nonstandard frequencies to prevent adjacent-channel interference. Therefore a special AFC mode can be switched in to initiate a receiver search above and below the synthesized carrier frequency until a signal is found. To ensure that a sound carrier or other nondesired signal has been found, the system logic checks for the extremes of the allowed tuning range and verifies that a 60-Hz signal is being generated by the vertical sync separator. The special AFC mode will capture signals that may be as far as 3.25 MHz away from the standard frequencies.

Second, the tuning system has the ability to tune CATV frequencies. When the CATV-mode is selected by the viewer, the twenty-three mid-band and super-band CATV channels replace the lower UHF channels. The high-UHF channels are disabled. CATV channels A through I and J through W become channel numbers 14 through 36. For CATV tuning the system searches its programmable divider-ratio memory for the data required to tune the CATV frequencies instead of UHF. You can consider this first cable-ready TV to be a 105-channel receiver (the sum of the 82 standard channels and the 23 CATV stations).

The direct-access tuning system displays the channel number on a 2-digit



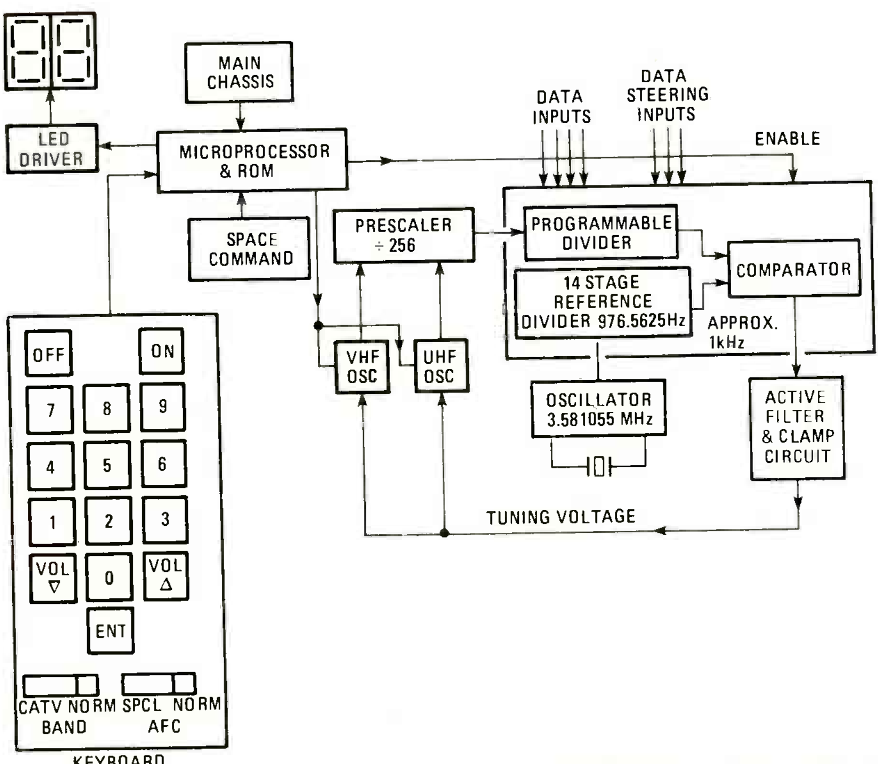


FIG. 3—ZENITH'S NEW TUNING SYSTEM is based on a phase-locked-loop controlled by a microprocessor. The system features keyboard entry of channel information and ability to tune 105 channels—82 UHF/VHF channels plus 23 CATV channels.

LED indicator which is driven by a BCD-to-seven-segment decoder. Multiplexing the digit information uses four BCD data lines and a fifth lead to indicate which of the two digits is valid at any particular time while the set is on.

Keyboard channel entry is finalized by pressing the ENTER button following the channel-number sequence. This method simplifies single-digit channel (2 through 9) selection by requiring pressing the proper digit followed by the ENTER key. Some other electronic tuning systems require a zero to be entered prior to a single-digit channel number. The system is smart enough to retain the previously selected channel upon an illegal channel entry attempt.

Three transistor circuits are fed by the microprocessor to control bandswitching. One circuit switches between VHF and UHF, a second between the low and high VHF bands. The third circuit is enabled when the super-band CATV channels are selected. The lower-frequency CATV channels are bandswitched by the standard low/high VHF circuit.

The 11-button keyboard (0 through 9 plus ENTER) is scanned by three microprocessor outputs and five inputs that sense any switch closure. R-E

OTTO SLACK

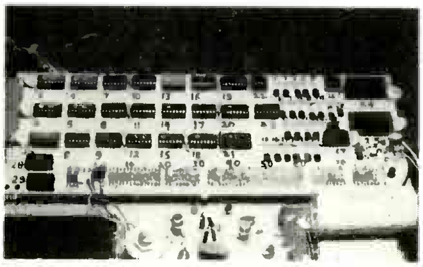
NIFTY WIRE-WRAP TRICKS

Here's a look at a few tricks to make wire-wrapped projects easier, faster and sturdier

WIRE-WRAPPING IS THE WAY TO GO IF your next electronics construction project is not being assembled on a PC board. There are several variations on the wire-wrap theme and in the instruments used. ("Doc" Savage covered wire-wrap basics in his article "Wiring Systems For Projects" in the August 1979 issue.) I use both the Vector Electronics *Slit-N-Wrap* and the OK Machine and Tool Corporation's *Just Wrap* tools and wire for most projects. The ideas expressed and demonstrated here are based on those systems. However, even if you use other standard wire-wrap tools (such as Vero Electronics Wrap tool), you'll find that you're able to apply my ideas.

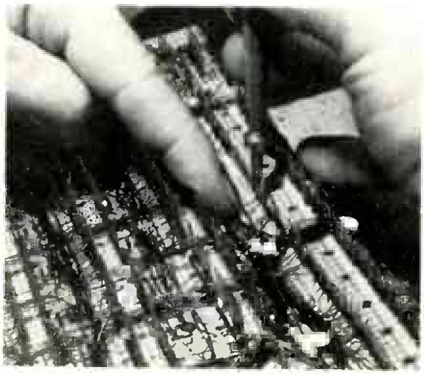
Add space for easier wiring.

In wire-wrap layouts using normal spacing, Vector's *P183* forming and cutting tool is used to hold the loose end of the wire while the wire-wrap tool is anchoring the wire on the terminal post. The *P183*—supplied with the *P184* manual *Slit-N-Wrap* tool—has a sharp, metal

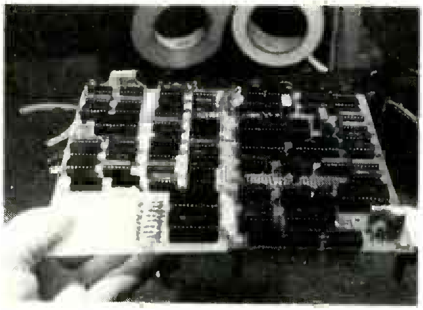


BOARD LAYOUT with "finger-distance" spacing between rows. Too much room at the ends of the IC's is wasted space. You don't need to manipulate the wire there and the 0.2-inch spacing provides enough room to cross over in-between rows. All wire in this series of photos is the older polyurethane-Nylon-coated wire. If you use the Tefzel insulated wire, you may find that you'll have to increase the end-to-end distance between the sockets because of its larger diameter.

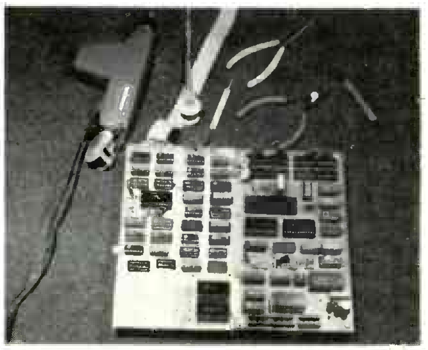
MEASURING CORRECT DISTANCE between the rows. The "finger distance" is 0.8 inches on this board. You could also turn your finger to manipulate the wire. Too narrow a distance will slow you down and give you a sore finger.



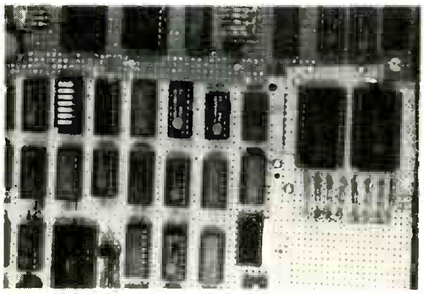
USING YOUR FINGER to hold the wire down while turning it onto the post with the tool. You never have to pick up or lay down your finger: Notice the hot-melt glue holding down the wire runs. If you have any wires that you're afraid will get snagged and broken, or skuffed on a post and shorted, hold them down in this manner.



DEMONSTRATION OF THE STRENGTH of a splice. It is nearly as strong as a single piece and it can be turned over and lifted in the same manner.



TWO PROJECTS ARE SPLICED TOGETHER, one being on the dark perf board and the other on the light. Both projects were wire-wrapped, but the "finger-distance" concept wasn't used here. The tools shown from left to right are Vector's *P160-4T1* powered and the *P108* manual *Slit-N-Wrap* tools, the *P183* chisel knife and forming tool, a needle nose and diagonal pliers, and, finally, an O.K. Machine & Tool Co. hobby wrap tool.



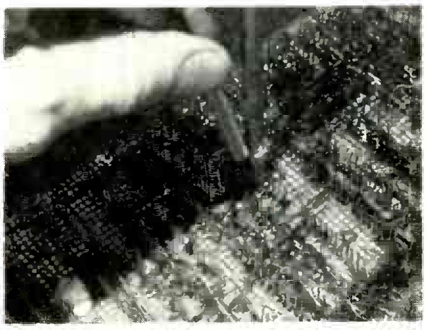
SPLICING TWO BOARDS together using strips of perf board. Use a No. 44 drill bit to drill the holes and 2-56 × ¾ screws and 2-56 nuts.

MANUFACTURERS of tools and materials

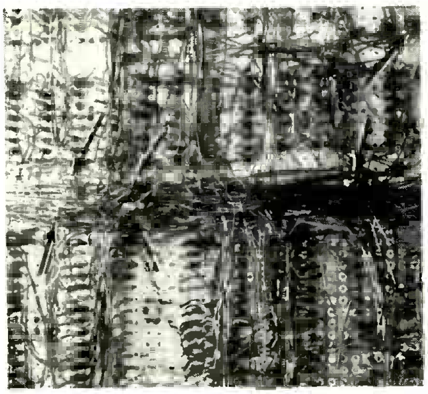
OK Machine & Tool Corp., 3455 Conner St., Bronx, NY 10475:
CIRCLE 148 ON FREE INFORMATION CARD
WSU-30—Wrap/unwrap tool, $6.95, plus materials, accessories, boards.
JWK-6—Just Wrap kit, $24.95.
R-JW—Just Wrap wire, 50-foot spool, $2.98.

Vector Electronics Co., Inc., 12460 Gladstone Ave., Sylmar, CA 91342:
CIRCLE 149 ON FREE INFORMATION CARD
P-183—Chisel knife and forming tool, $2.15.
P-180—Slit-N-Wrap tool, $25.00, plus materials, accessories, boards, kits.
P-160-4T1—Motorized handle, includes P-180 Slit-N-Wrap tool, $99.50.

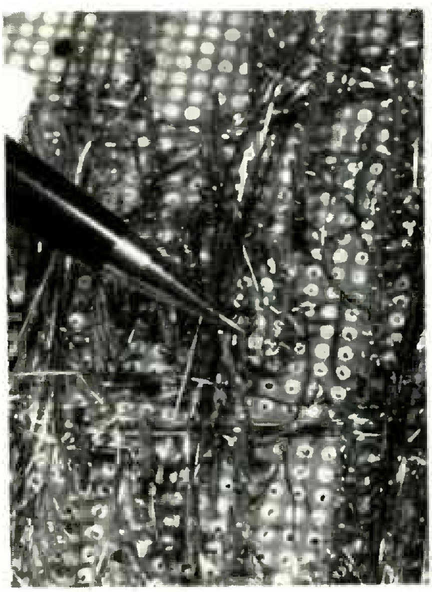
Vero Electronics, Inc., 171 Bridge Rd., Hauppauge, NY 11787:
CIRCLE 150 ON FREE INFORMATION CARD
163-28300A—Combiwrap tool, $12.36, plus materials, accessories, boards, kits.



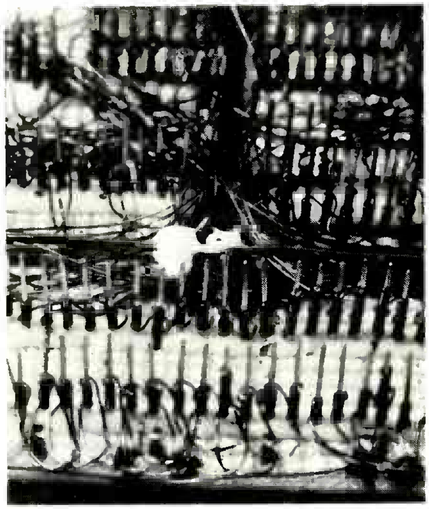
USING THE *P183* FORMING TOOL and *P180 Slit-N-Wrap* tool. This board layout is poor. Even if you must make your rows too narrow and have to use the forming tool, lay them out end-to-end. Extra room on the ends of the IC's is wasted space because the room isn't needed for your finger or the forming tool.



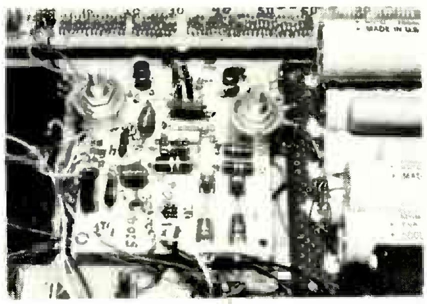
ARROWS POINT to the nuts on the bottom of board holding the splice together. Notice that there are no strips of perf board on the bottom. That makes it relatively easy to splice a board near a heavily wired area.



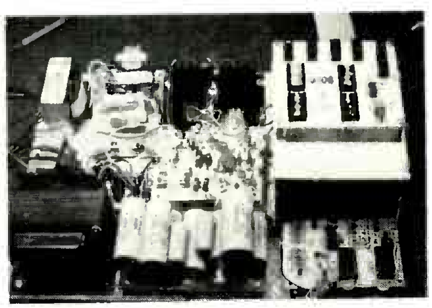
THE PENCIL POINTS to an area of wire-wrap pins that have bent over in their holes from handling. The posts themselves have not bent. Some of these posts will fall out of the holes when handled if the wire-wrapping hasn't been completed on them yet.



HOLDING WIRE-WRAP POSTS in place with hot-melt glue. A wire run is also held down with the glue. If you see a leaning post here, that's because it was either glued that way or the post is bent. These glued-down posts hold resistors and transistors.



MORE USES FOR THE HOT-MELT GLUE GUN. The two metal pots, the T0-220 regulator, the bridge rectifier and the bottom electrolytic capacitors are all held in place with hot-melt glue. The advantage of hot melt in these examples is that it is fast, strong, and the components are removable with heat.



THIS EPROM LOADER AND TESTER was built using the "finger-distance" concept and hot-melt glue to hold the wire-wrap and other posts in place. It has been running for a year. It is made almost exclusively with wire-wrap and perf board. The big exception to this is the PC board in the upper left-hand part of the photo. The device contains 32 IC's, including three hex readout chips plus the high-voltage power-supply board in the center, all wired with the wire-wrap technique. This project is ready to be mounted in an aluminum box with the perf board on the plywood frame mounted in a hole in the top.

chisel point on one end and a plastic piece similar to a blunt screwdriver or alignment tool on the other. It is the blunt end that is used to hold the wire and dress it against the board when necessary.

I find the forming tool cumbersome to use in some spots so I eliminate the need for it by spacing out the IC's, transistors, and other components on the perforated board. The IC's are placed end-to-end and spaced 0.2 inch apart in rows. The rows are spaced "finger distance" from each other. I usually space the rows 0.8 inch apart but it could be less depending on the size of your finger and the available room. Now, instead of using the forming tool you can use your finger to hold the wire in place. I find that my finger does a faster and better job. The only disadvantage in using that technique is the additional board space required for your layout.

Expanding a wire-wrap circuit

Sometimes a circuit change requires more space than is available on the perforated board. In other instances, two circuits must be tied together with a large number of connections. You can use a ribbon cable, but that is both expensive and unnecessary. A better solution is to butt-splice the two circuit boards together using strips of perforated board about one-half inch wide. I use 2-56 × ⅜ inch screws and 2-56 nuts.

You don't need splicing strips on the bottom side of the board; the assembly is strong enough without them. That makes it relatively easy to splice two boards in heavily wired areas.

Keeping terminal posts in place

A large, densely wired project requires a lot of handling before it is completed. The board flexes when handled by one edge; that flexing action can loosen the terminal posts. Some posts can loosen enough to bend over in the holes; and since most of the posts are installed before you start wiring, they can fall out if your wire-wrapping hasn't reached that point. To eliminate the problem, use a hot-melt glue gun and run a bead of glue down each side of each row of wire-wrap posts. (Adjacent rows of posts must be at least one-half inch apart so you can get the glue gun between them. Don't get glue on the tops of the posts! It is a very good insulator.) The end result is posts that are anchored in place and will take all the handling you have to give them while assembling a large wire-wrap project.

You can also use a dab of hot-melt glue to hold wires in place. Pots, and most other components, can also be anchored to the perforated board using hot-melt glue so they don't have to rely on circuit wiring for support. **R-E**

HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

APPLICATION NOTE 514

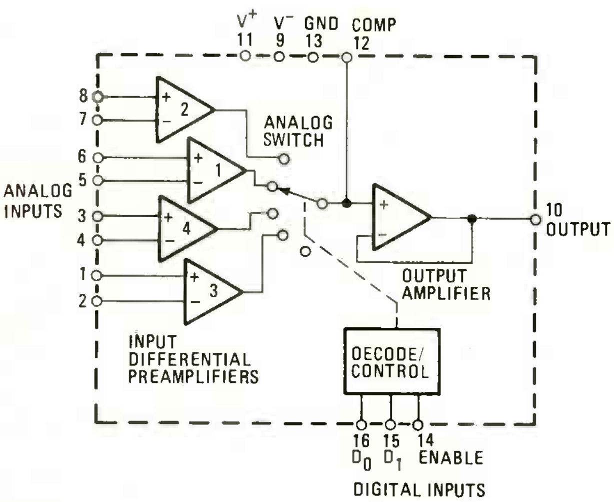
THE HA-2400 PRAM FOUR CHANNEL OPERATIONAL AMPLIFIER

DON JONES

INTRODUCTION

HARRIS SEMICONDUCTOR'S HA-2400/HA-2405 FOUR CHANNEL Operational Amplifier combines the functions of an analog switch and a high-performance operational amplifier, and makes practical a large number of linear circuit applications.

A functional diagram of the HA-2400 is shown. There are four preamplifier sections, one of which is selected through the DTL/TTL-compatible inputs and connected to the output amplifier. The selected analog input terminals and the output terminal form a high-performance operational amplifier.



In actuality, the circuit consists of four conventional op-amp input circuits connected in parallel to a conventional op-amp output circuit. The decode/control circuitry furnishes operating current only to the selected input section.

CIRCUIT CONNECTIONS

These inputs control the selection of the amplifier input channels in accordance with the following truth table:

D_0	D_1	ENABLE	CHANNEL 1	CHANNEL 2	CHANNEL 3	CHANNEL 4
L	L	H	ON	OFF	OFF	OFF
H	L	H	OFF	ON	OFF	OFF
L	H	H	OFF	OFF	ON	OFF
H	H	H	OFF	OFF	OFF	ON
L OR H	L OR H	L	OFF	OFF	OFF	OFF

$0V \leqq L \leqq +0.8V$ $+2.0V \leqq H \leqq +5.0V$

The digital inputs can be driven with any DTL or TTL circuit that uses a standard +5.0-volt supply.

COMPENSATION

Frequency compensation for closed-loop stability is recommended for closed-loop gains less than 10. This is accomplished by connection of a single external capacitor from pin 12 to AC ground (the V+ supply is recommended). The following table shows the minimum suggested compensation for various closed-loop gains, with the resultant bandwidth and slew rate. Obviously, when the four channels are connected with different feedback networks, the channel with the lowest closed-loop gain will govern the required compensation.

GAIN, VOLTS/VOLT		C_{COMP}	BANDWIDTH (TYPICAL)	SLEW RATE (TYPICAL)
NON-INVERTING	INVERTING	pF	(-3 dB), MHz	VOLTS/μs
1	–	15	8.0	15
2	1	7	8.0	20
3	2	4	8.0	22
5	4	3	6.0	25
8	7	2	5.0	30
>10	>9	0	40÷GAIN	50

Compensation capacitors of greater value can be used to obtain lower bandwidth, greater phase margin and reduced overshoot, at the expense of a proportionately reduced slew rate.

External lead-lag networks could also be used to optimize bandwidth and/or slew rate at a particular gain.

APPLICATIONS

Any circuit function that can be constructed using a conventional operational amplifier can also be constructed using any channel of the HA-2400. Similar or different networks can be wired from the output to each channel input pair. The device can therefore be used to select and condition different input signals, or to select between different op-amp functions to be performed on a single input signal.

To wire a particular op-amp function to a channel, simply connect the appropriate network between the two inputs for that channel and the common output in the same manner as in wiring a conventional op-amp. It is often possible to design with fewer external components than would be required in wiring four separate op-amps (see Applications 2 and 3). It should be remembered that the networks for unselected channels may still constitute a load at the amplifier output and the signal input, as if the unselected input terminals were disconnected from the network.

If offset adjustment is required, it can generally be accomplished by resistive summation at either of the inputs for each channel (see Application 8).

The analog input terminals of the OFF channels draw the same bias current as the ON inputs. The maximum differential input voltage of these terminals must be observed and their voltage levels must never exceed the supply voltages.

When the enable input is held low, all four input channels are disconnected from the output. When this occurs, the output voltage will generally slowly drift towards the negative supply. If a zero-volt output condition is required, one channel should be wired as a voltage follower with its positive input grounded.

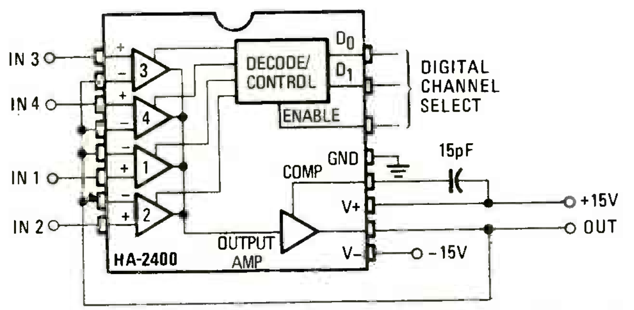
The amplifier output impedance remains low, even when the inputs are disabled; so it is not generally practical to wire the outputs of two or more devices directly together. The compensation pins of two devices, however, could be wired together to produce a switch with one output and more than four input channels.

The voltage at the compensation pin is about 0.7 volt more positive than the output signal, but has a very high source impedance. Maximum current from this pin is about 300 μA, which makes it a convenient point for limiting the output swing through clamping diodes and divider networks (see Application 13).

Even if the application only requires a single channel to be switched on and off, it is often more economical to use the HA-2400 rather than a separate analog switch and high-performance op-amp. Unused analog channel inputs must be grounded. Unused digital inputs may be wired to ground for a permanent low input, or either left open or wired to +5.0 volt for a permanent high input.

Here are a few of the thousands of possible applications for the Four Channel Operational Amplifier. These will give the reader a general impression of how the units can be connected; and probably will help generate many other ideas for applications. Also included are some challenges for the reader to modify the designs shown to perform different functions.

APPLICATION NO. 1



ANALOG MULTIPLEXER WITH BUFFERED INPUT AND OUTPUT

This circuit is used for analog signal selection or time division multiplexing. As shown, the feedback signal places the selected amplifier channel in a voltage follower (noninverting unity gain) configuration, and provides very high input impedance and low output impedance. This single package replaces four input buffer amplifiers, four analog switches with decoding and one output buffer amplifier.

For low-level input signals, gain can be added to one or more channels by connecting the (−) inputs to a voltage divider between output and ground. Bandwidth is approximately 8 MHz, and the output will slew from one level to another at about 15.0 volts-per-microsecond.

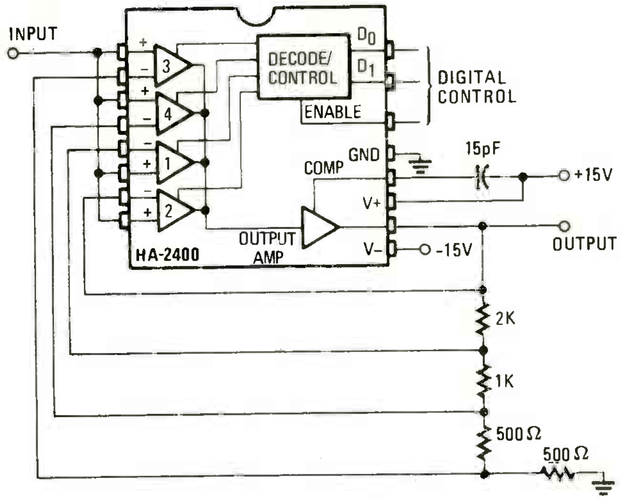
Expansion to multiplex 5 to 12 channels can be accomplished by connecting the compensation pins of two or three devices together, and using the output of only one of the devices. The enable input on the unselected devices must be low.

Expansion to 16 or more channels is accomplished in a straightforward manner by connecting outputs of 4 four-channel multiplexers to the inputs of another four-channel multiplexer.

Differential signals can be handled by two identical multiplexers addressed in parallel.

Inverting amplifier configurations can also be used, but the feedback resistors may cause crosstalk from the output to unselected inputs.

APPLICATION NO. 2



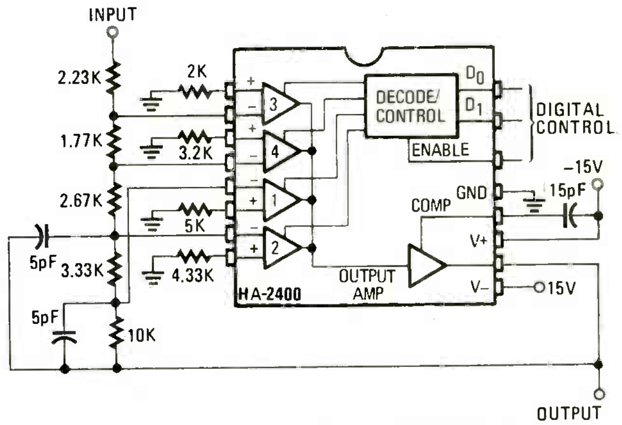
AMPLIFIER, NON-INVERTING WITH PROGRAMMABLE GAIN

This is a noninverting amplifier configuration with feedback resistors chosen to produce a gain of 0, 1, 2, 4, or 8 depending on the digital control inputs.

Comparators at the output could be used for automatic-gain selection for auto ranging meters, etc.

Challenge: Design a circuit using only two HA-2400's that can be programmed to any of 16 different gains.

APPLICATION NO. 3

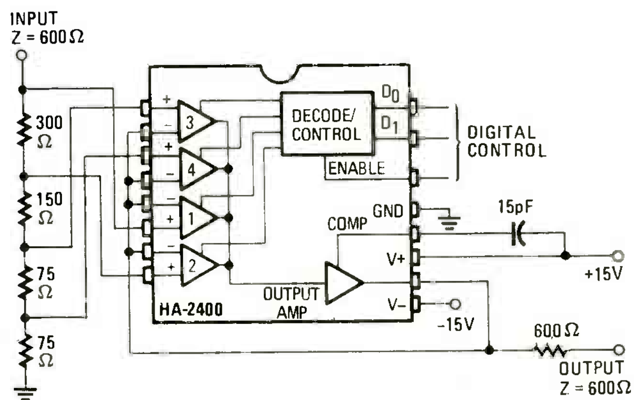


AMPLIFIER, INVERTING WITH PROGRAMMABLE GAIN

The circuit can be programmed for a gain of 0, −1, −2, −4, or −8.

This could also have been accomplished with one input resistor and one feedback resistor per channel in the conventional manner, but this would require eight resistors rather than five.

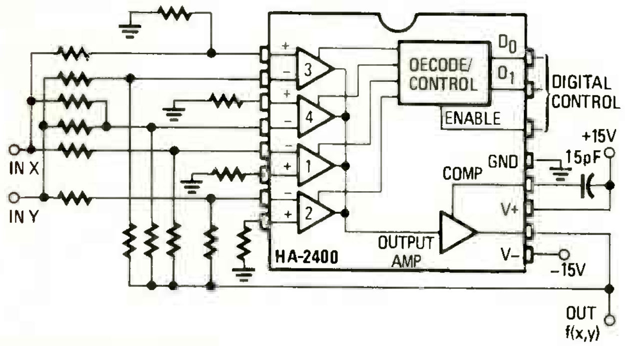
APPLICATION NO. 4



PROGRAMMABLE ATTENUATOR

This circuit performs the function of dividing the input signal by a selected constant (1, 2, 4, 8 or ∞ as shown). To multiply by a selected constant, see Application 2. White T, π or L sections could be used in the input attenuator, this is not necessary since the amplifier loading is negligible and a constant input impedance is maintained. The circuit is thus much simpler and more accurate than the usual method of constructing a constant impedance ladder and switching sections in and out with analog switches.

APPLICATION NO. 5



ADDER/SUBTRACTOR

The circuit shown can be programmed to give the output functions $-K_1 X$, $-K_2 Y$, $-(K_3 X + K_4 Y)$, or $K_5 X - K_6 Y$. Obviously, many other functions of one or more variables can be constructed, including combinations with analog multiplier or logarithmic modules.

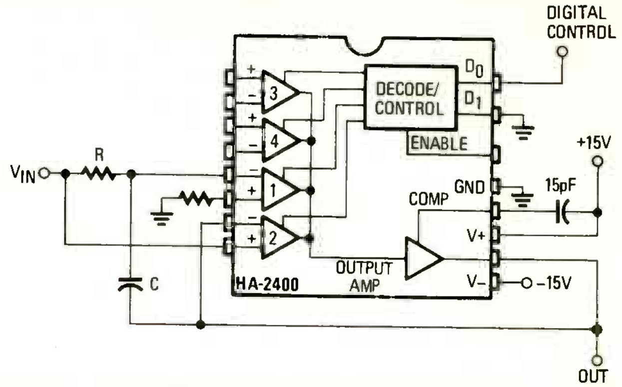
This device opens up many new design approaches in digitally controlled analog computation or signal manipulation.

APPLICATION NO. 6

Any oscillator that can be constructed using an op-amp, such as the twin-T, phase-shift, crystal-controlled types, etc., can be made programmable by using the HA-2400. Illustrated is a Wien-bridge type that is very popular for signal generators, since it is easily tunable over a wide frequency range and has a very low-distortion sinewave output. The frequency-determining networks can be designed from about 10 Hz to greater than 1 MHz. Output level is about 6.0V RMS. By substituting a programmable attenuator (Application No. 4) for the buffer amplifier, a sinewave source for testing can be constructed.

Challenge: A high-Q, narrowband filter can be made by feeding back more than one-third of the output to the negative input. Design a circuit using the HA-2400 and an R–C network that can be programmed either to generate or to detect an audio tone of the same frequency. Such a circuit would be quite useful for data communications.

APPLICATION NO. 7

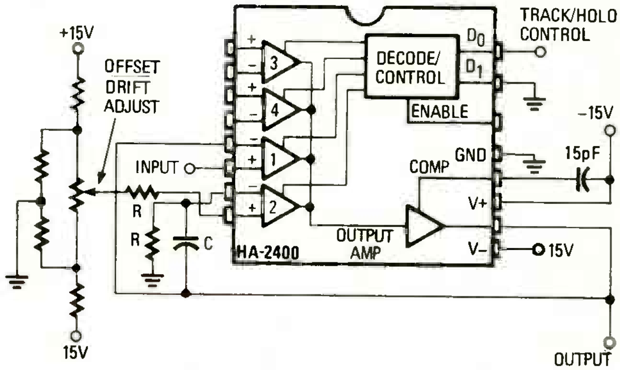


INTEGRATOR/RAMP GENERATOR WITH INITIAL CONDITION RESET

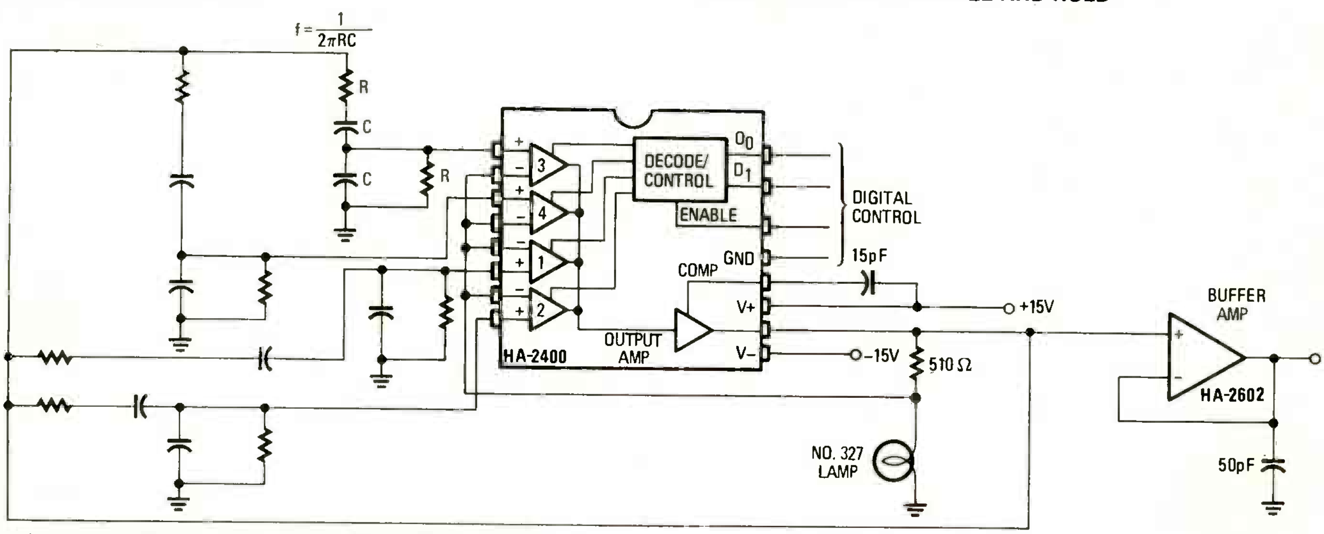
It is difficult in practice to set the initial conditions accurately in an integrator. This usually requires wiring contacts of a mechanical relay across the capacitor—leakage currents of solid-state switches produce integration inaccuracy. The scheme shown above eliminates these reliability and accuracy problems.

Channel 1 is wired as a conventional integrator, Channel 2 as a voltage follower. When Channel 2 is switched on, the output will follow V_{IN}, and C will discharge to maintain zero volts across it. When Channel 1 is then switched on, the output will initially be at the instantaneous value of V_{IN}, and then will commence integrating towards the opposite polarity. This circuit is particularly suitable for timing ramp generation using a fixed DC input. Many variations are possible, such as programmable time-constant integrators.

APPLICATION NO. 8



TRACK AND HOLD/SAMPLE AND HOLD

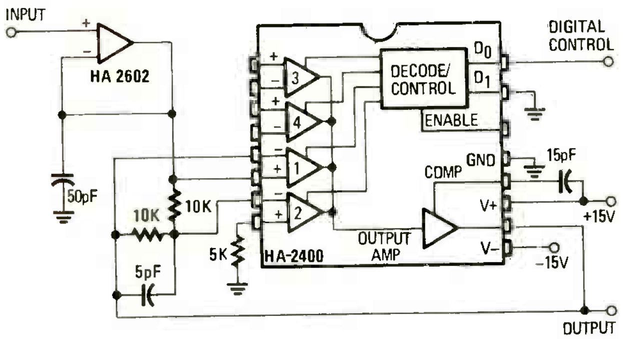


PROGRAMMABLE FREQUENCY SINEWAVE OSCILLATOR

Channel 1 is wired as a voltage follower and is turned on during the track/sample time. If the product of R × C is sufficiently short compared with the period of maximum output frequency, or sample time, C will charge to the output level. Channel 2 is an integrator with zero input signal. When Channel 2 is then turned on, the output will remain at the voltage across C.

An even simpler circuit can be made by wiring one channel as an amplifier, choosing the compensation capacitor to yield the minimum required bandwidth or slew rate. When the enable input is pulled low, the output will tend to remain at its last level because of the charge remaining on the compensating capacitor.

APPLICATION NO. 9

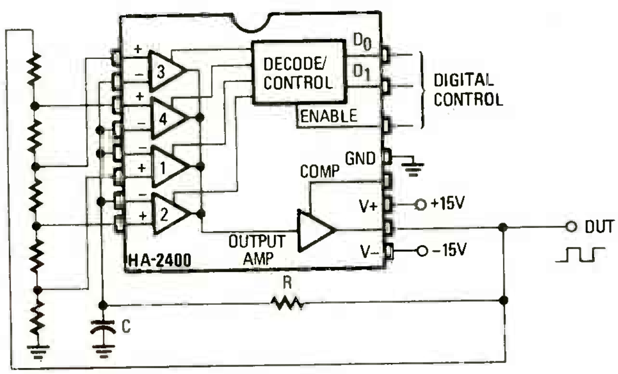


PHASE SELECTOR/PHASE DETECTOR/SYNCRONOUS RECTIFIER/BALANCED MODULATOR

This circuit passes the input signal at unity gain, either unchanged or inverted depending on the digital control input. A buffered input is shown, since low source impedance is essential. Gain can be added by modifications to the feedback networks. Signals up to 100 kHz can be handled with a 20.0-volt peak-to-peak output. The circuit becomes a phase detector by driving the digital control input with a reference phase at the same frequency as the input signal, the average DC output being proportional to the phase difference, with zero volts at ±90°. By connecting the output to a comparator, which in turn drives the digital control, a synchronous full-wave rectifier is formed.

With a low-frequency input signal and a high-frequency digital control signal, a balanced (suppressed carrier) modulator is formed.

APPLICATION NO. 10.

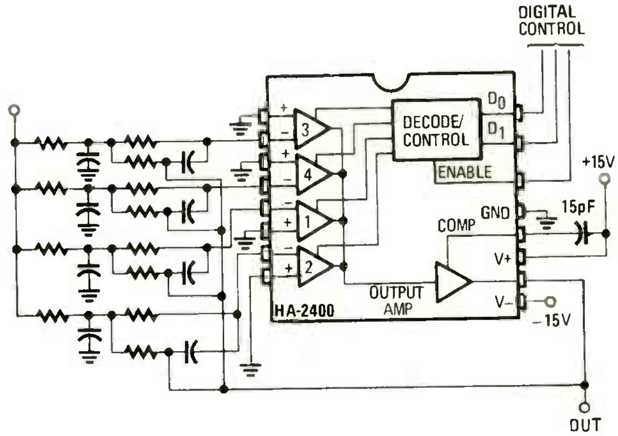


FREE-RUNNING MULTIVIBRATOR WITH PROGRAMMABLE FREQUENCY

This is the simplest of any programmable oscillator circuit, since only one stable timing capacitor is required. The output squarewave is about 25-volts peak-to-peak and has rise and fall-times of about 0.5 μs. If a programmable attenuator circuit (Application No. 4) is placed between the output and the divider network, 16 frequencies can be produced with two HA-2400's and still only one timing capacitor.

A precision, programmable square-triangle generator can also be constructed by adapting the circuit described in *Application Note 507* to the HA-2400.

APPLICATION NO. 11



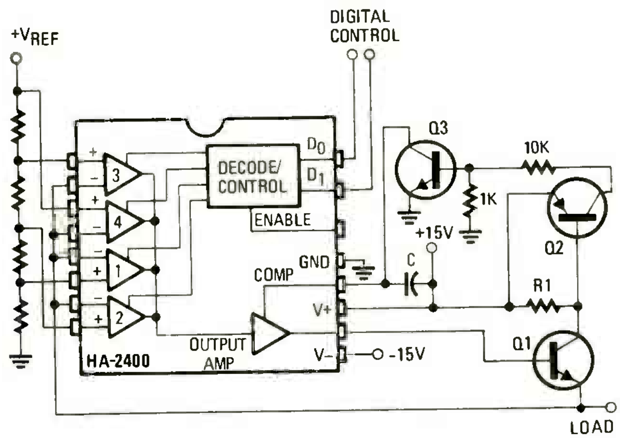
PROGRAMMABLE ACTIVE FILTER

Shown is a second-order low-pass filter with programmable cutoff frequency. This circuit should be driven from a low-source impedance, since there are paths from the output to the input through the unselected networks.

Virtually any filter function that can be constructed with a conventional op-amp can be made programmable with the HA-2400.

A useful variation would be to wire one channel as a unity-gain amplifier, so that one could select the unfiltered signal or the same signal filtered in various manners. These could be cascaded to provide a wide variety of programmable filter functions.

APPLICATION NO. 12

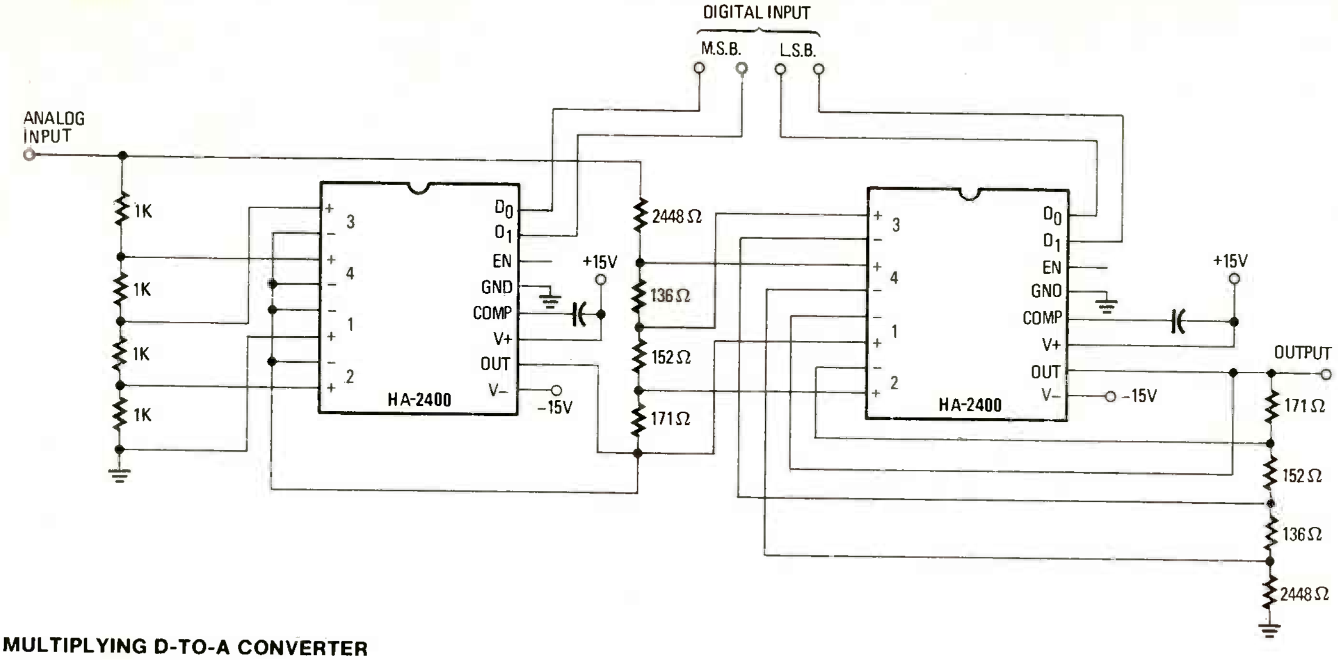


PROGRAMMABLE POWER SUPPLY

Many systems require one or more relatively low-current voltage sources that can be programmed to a few predetermined levels. It is no longer necessary to purchase a programmable power supply with far more capability than needed. The circuit shown produces positive output levels, but could be modified for negative or bipolar outputs. Transistor Q1 is the series regulator transistor, selected for the required current and power capability; Circuit R1, Q2 and Q3 form an optional short-circuit protection circuit, with R1 chosen to drop about 0.7 volt at the maximum output current. The compensation capacitor, C, should be chosen to keep the overshoot, when switching, to an acceptable level.

Challenge: Design a supply using only two HA-2400's that can be programmed to 16 binary-weighted (or 10 BCD-weighted) output levels.

APPLICATION NO. 13



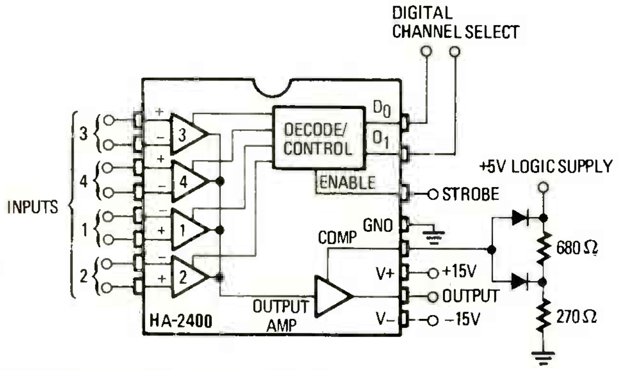
MULTIPLYING D-TO-A CONVERTER

This circuit performs the function, $V_{OUT} = V_{IN} \times N/16$, where N is the binary number from 0 to 15 formed by the digital input. If the analog input is a fixed DC reference voltage, the circuit is a conventional 4-bit D-to-A converter. The input could also be a variable or AC signal, in which case the output is the product of the analog signal and the digital signal.

The HA-2400 on the left is a programmable attenuator with weights of 0, 1/4, 1/2 or 3/4. The HA-2400 on the right is a noninverting adder that adds weights to the first output of 0, 1/16, 1/8 or 3/16.

If four-quadrant multiplication is required, place a phase selector circuit Application No. 9 in series with either the analog input or output. The D_0 input of that stage becomes the + or − bit of the digital input.

APPLICATION NO. 14



FOUR-CHANNEL COMPARATOR

When operated open-loop without compensation, the HA-2400 becomes a comparator with four selectable input channels. The clamping network at the compensation pin limits the output voltage to allow DTL or TTL digital circuits to be driven with a fanout of up to ten loads.

Output rise and falltimes will be about 100 ns for differential input signals of several hundred millivolts, but will be in the microsecond region for small differential signals.

The circuit can be used to compare several signals against each other or against fixed reference voltages; or a single signal can be compared against several reference voltages. A window comparator, which assures that a signal is within a voltage range, can be formed by monitoring the output polarity while rapidly switching between two channels with different reference inputs and the same signal input.

MORE CHALLENGES

One of our favorite college textbooks paused at each climactic point with a statement to the effect that, "Proof of the following theorem is omitted, and is suggested as an exercise for the student."

The following is a list of some additional applications in which we believe the HA-2400 will prove very valuable. The "proofs," at present, remain as exercises for our ingenious readers.

- A-to-D Converter, Dual-Slope Integrating
- Active Filter, State-Variable Type with Programmable Frequency and/or Programmable "Q"
- Amplifier with Programmable DC Level Shift
- Chopper Amplifiers
- Crossbar Switches
- Current Source, Programmable
- FM Stereo Modulator
- FSK Modem
- Function Generators, Programmable
- Gyrator, Programmable
- Monostable Multivibrator, Programmable
- Multiplier, Pulse Averaging
- Peak Detector with Reset
- Resistance Bridge Amplifier/Comparator with Programmable Range
- Sense Amp/Line Receiver with Programmable Threshold
- Spectrum Analyzer, Scanning Type
- Sweep Generator, Programmable
- Switching Regulator
- *Touch-Tone* Generator/Detector (Use Harris HD-0165 Keyboard Encoder IC)

FEEDBACK

We believe we have only scratched the surface of possible applications for a multiple-channel operational amplifier.

If you have a solution for any of the previous "challenges" or any new application, please let us know. Anything from a one-word description to a tested design will be welcome. **R-E**

MACHINES THAT CAN TALK

There are several ways we can use electronics to generate the sounds of human speech. Here's a look at some of the schemes available today.

MARTIN BRADLEY WEINSTEIN

ASK ANY YOUNGSTER HOW THE NEW talking toys like *Speak & Spell* (from Texas Instruments) can talk, and chances are you'll hear about the "little man inside." And, in fact, they won't be far wrong. Every speech-synthesis scheme ever devised is based, at some point, on a model of the human vocal tract.

Let's take a look at the various approaches to speech simulation, beginning with the simplest, while keeping an eye on the various tradeoffs. The key requirements and parameters to observe include circuit complexity, memory requirements, system cost, vocabulary size, fidelity of the resultant speech, flexibility of the synthetic voice, inflection, and software requirements. Those things will sort themselves out as we go along.

Recording and transmission media.

In the broadest sense, telephones and tape recorders might be considered speech synthesizers; after all, they are not human, yet they speak with human voices. Indeed, the telephone company has used electronic-interrupt operators for years—in fact, decades. They prove an excellent starting point.

You may have experienced, while dialing the number of a friend who had just moved, a recorded message something like: "The number you have reached, 555-1234, has been changed; the new number is 555-0987." Those interrupts (in all but the newest equipment) are recorded messages, but not in the usual sense (see Fig. 1).

Only the minimum number of words or phrases *ever* used are recorded, and only once each. When an interrupt is required, the telephone switching system alerts the interrupt subsystem to start its sequence; the particular sequence that is required for any one circumstance is programmed when the need for an interrupt is entered into the system.

Figure 1 shows how multiple-track tape recorders would be applied to the task. But for quite some time now, there have been no moving parts required; instead, the limited vocabulary is converted to data and stored in memory.

Crude digital speech

Figure 2 shows a very crude method of recording and playing back speech with digital memory.

The audio (speech) input is digitized through a zero-crossing detector and entered into RAM as the counter is clocked through the cycle of addresses. The playback operation exchanges this "write" operation for a "read" operation, and every data change is heard as a click from the speaker. The pitch of that raspy, buzzy voice can be altered by varying the clock frequency.

Experience with analog-to-digital conversion methods shows the best clock rate to be twice the highest desired frequency response, or about 10 kHz for 500–5000-Hz speech. This means that a 16K RAM is only good for about 1.6 seconds of speech.

This leads us to believe that in the mathematics of electronics, at least, the human voice may not be the best model for providing a synthesis of the human voice—a great deal of additional number crunching will be required.

Our crude digitizer, by the way, can be made quite acceptable if we expand it to 8-bit-wide data words and include an analog-to-digital converter at the input (replacing the zero-crossing detector) and a digital-to-analog converter at the output. Lowpass or bandpass filters at both input and output can further enhance fidelity.

Down the tubes

The approaches described so far can reproduce not only any voice (with varying degrees of success, depending on the approach), but any other sound within the same frequency range, including everything from music to cacophony. Mightn't we trade some of that versatility (which, by the way, the human voice does not share) for data economy?

A closer look at the human vocal tract shows that it can be modeled as a

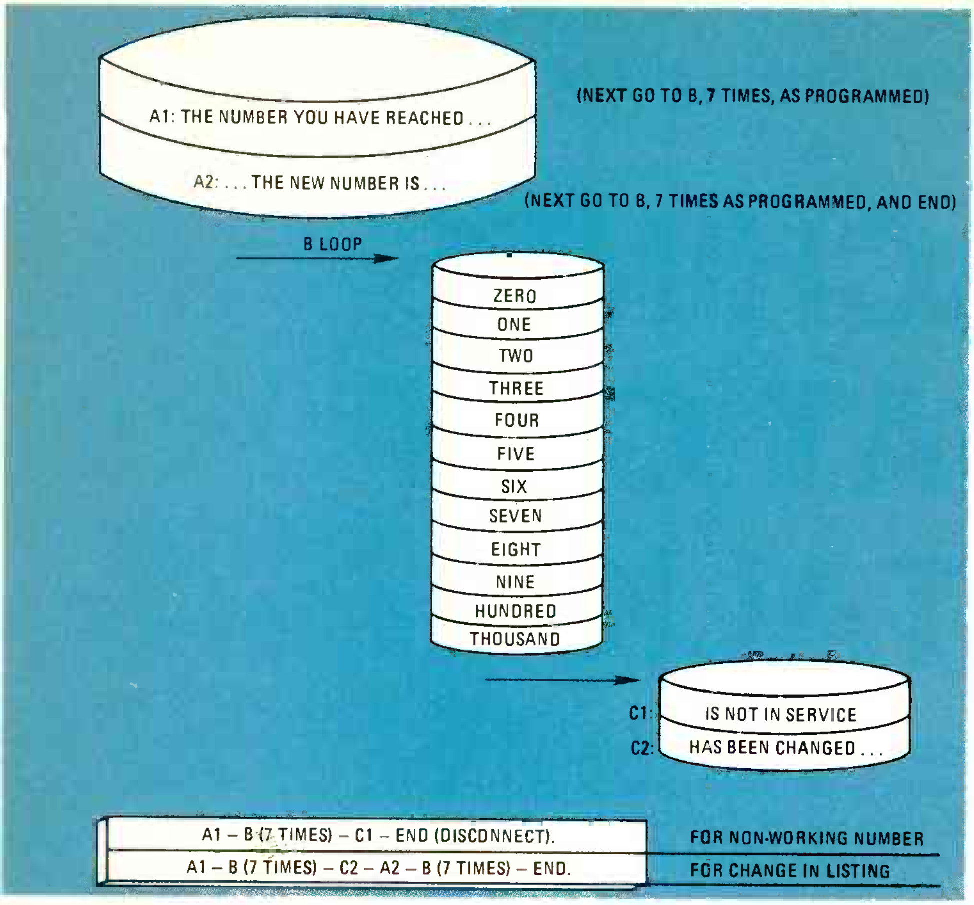


FIG. 1—GREATLY SIMPLIFIED RECORDED-LOOP TELEPHONE INTERRUPT "OPERATOR." Each loop represents a multi-track tape player. Words within each band or track represent a pre-recorded message. Although the vocabulary is quite limited, it can be used for several trillion messages of a limited nature. This system has recently been replaced by solid-state speech synthesis.

cylindrical tube, just under 7 inches long. While muscles, air flow, tongue and lip placement may vary the model in detail, we are still primarily concerned with the fundamental acoustic resonant frequency and its third and fifth harmonics, called the first, second, and third *formants*.

Think of those formants as harmonic passbands or filters or resonators. Typically, they would be near 500, 1500, and 2500 Hz, ± 50% with modulation. Which is to say, any of the three formants can slide up or down in frequency, depending on the geometry of the vocal tract.

A complete model of human speech must take in the "hiss" of *fricatives* (like s, z, f, v and so on), *aspiratives* (like h), *nasal* resonances (like n, m), and *stops* (like k,p,t).

An excellent article by D. Lloyd Rice of Computalker Consultants (821 Pacific Street #4, Santa Monica, CA 90405) appeared in the August 1976 issue of *Byte*. (A limited number of copies may still be available through either *Byte* or Computalker). Entitled "Friends, Humans and Countryrobots: Lend Me Your Ears," it follows the discussion of the human vocal tract through to a fairly comprehensive diagram of a digitally-driven speech synthesizer.

APPLICATIONS FOR SYNTHETIC SPEECH

- Handicapped aids
- Production lines
- Complex assembly operations
- Simulators
- Education aids
- Games
- Instrumentation
- Pilot's aids
- Telephone/computer services
- Robots/androids
- Appliances
- Consumer products
- Translational aids
- Pronunciational aids

Rice's circuit, based on controlled filters, is similar to one integrated onto a single, high-density chip recently by Texas Instruments—and used as the heart of their *Speak & Spell*.

Input vs storage vs output

The advantage of switched-filter-characteristic encoding versus the digital-to-analog converter technique is that, since the analog electronic hardware pre-defines limits on a number of crucial parameters, less data is needed to define any given length of speech message.

In the *Speak & Spell* synthesizer, for example, a total of 48 bits in each data "frame" defines amplitude, pitch, and filter coefficients for a ten-stage digital filter. For continuous speech, those frames are updated at 50 Hz. This means 2400 bits-per-second of speech, versus 80,000 bits for the digital-to-analog scheme, a 97% improvement.

By comparison, there's a series of synthesizers available from Telesensory Systems, Inc., that requires only seven bits to define whole *words*. And TSI synthesizers are priced between $95 and $179 standard models). The reason for all this economy is that the TSI boards have fixed and very limited vocabularies.

Their $95 *model S2A*, for example, offers only 24 words. But since the available words (in your choice of English, German, or Arabic) are tailored for calculators (TSI builds those boards for talking calculators for the blind and people with impaired vision, among other applications), the arrangement works out eminently well.

Phonemes

So why not, you may ask, break language down into its basic sounds—the various vowel sounds (long and short E, with a few in between, for example), consonants, combined sounds like th, sh, ch, and so on—and put it all into a limited "vocabulary" synthesizer?

You can. Those basic speech sounds are called phonemes. But there's something about the way we speak that

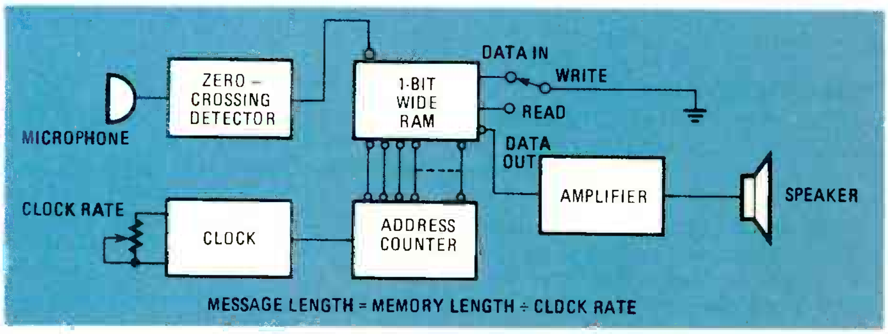


FIG. 2—CRUDE DIGITAL SPEECH RECORDER/REPRODUCER. During the write cycle—we will write into the entire length of the memory—as the counter is clocked through the entire sequence of RAM addresses. Each zero-crossing of any speech signal from the mike adds one bit of data to the memory. On read, or playback, these data bits become pulses in the speaker. Increased clock speeds enhance fidelity and intelligibility while it reduces the available message length.

Manufacturers of Speech Synthesis Hardware

Computalker Consultants
P.O. Box 1951
Santa Monica, CA 90406

Telesensory Systems, Inc.
3408 Hillview Avenue
P.O. Box 10099
Palo Alto, CA 94304

Texas Instruments
Consumer Specialty Products Division
Lubbock, TX

Votrax
Division of Federal Screw Works
500 Stephenson Highway
Troy, MI 48084

24-WORD CALCULATOR MODULE VOCABULARY, Telesensory Systems, Inc., S2A and S 16000 series

oh	percent
one	low
two	over
three	root
four	em (m)
five	times
six	point
seven	overflow
eight	minus
nine	plus
time-minus	clear
equals	swap

makes those simple phoneme-rostering synthesizers only marginally intelligible.

The specific pronunciation of a phoneme, it seems, is altered not only by inflection, as we might expect, but also by the "flavor" of the phonemes surrounding it.

Because of that, the software that drives Computalker Consultants phoneme-based *CT-1T* Speech Synthesizer, for example, first sets target values for the centers of each string of phonemes, then plots a smooth curve through them (or near them) to produce a more natural sound.

In addition to their *phonetic* (phoneme-based) software system, Computalker offers a direct parameter control mode requiring nine 8-bit bytes at a 100 Hz frame rate.

It isn't easy—yet

Electronically, all the hardware sophistication we'll ever need for completely natural synthetic speech is available today—and at reasonable prices.

But we're still not close enough to having the software and firmware we need to drive it. Work on that front is progressing rapidly, with some good news to report.

First, National Semiconductor is rumored to be preparing a single-chip speech synthesizer capable of accepting phoneme data (address) code and needing little else to output natural-sounding synthesized speech. The good news is that it should be under $30 or so; the bad news is that it will only be available in mask-programmed custom-vocabulary versions to large industrial customers for the next year or more. The news leaking out of Santa Clara is hazy at this writing, but we will advise you of coming developments.

Second, we may soon see an under-$200, single-board microprocessor-compatible phonetic synthesizer based on a custom LSI IC in about two years—very available at the hobby level.

So the era of smooth synthetic talkers should soon be upon us. **R-E**

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JOHN STONE *Radio-Pioneer*

FRED SHUNAMAN

A FEW PIONEERS REMEMBER HIM WITH respect, but the name of John Stone Stone rings no bell with the majority of today's engineers. Yet he was the person who introduced exact science into the communications art. The first to work out his problems theoretically, then verify his results by experiment, he "could well, therefore, be considered the progenitor and exemplar of the communications research engineer of today," according to the *History of Engineering & Science in the Bell System*. He was early in the field—when Marconi's tuning patent was declared invalid in 1943 (indicating that he had never had any right to the near-monopoly he enjoyed many years), it was on the basis of "earlier work by Tesla and John Stone Stone."

Stone joined Bell Labs as a graduate student in 1890, and was assigned in 1892 to attempt "to transmit speech to vessels at sea." He worked with a tiny arc as "discharger" and a Tesla coil resonating in the order of 50 kHz (receiver unknown). He was not successful—the trouble was that he was just too far ahead of him time.

The same year, he suggested that radio could be used for multiplex telephony by sending several messages over the wires at different frequencies, then sorting them out at the receiver end with tuned circuits. Again, the idea could not be carried out with the equipment of 1892, and, in fact, carrier telephony did not come into general use until about 1915.

Stone left Bell in 1899 (still retained as consultant and patent affairs expert) to develop a wireless system that would conquer interference problems with "selectivity," a term he invented. After early difficulties, the Stone Telegraph and Telephone Co. made several successful installations for the Navy. He also installed Stone equipment on a half dozen ships and looked forward to successful business when the Navy let a large contract in 1908. But the award went to a competitor, and lack of income forced Stone to sell his company, to the de Forest Company.

Some of his trouble may have been due to the very excellence of his equipment. Radio inspectors found his apparatus puzzling, and were suspicious. All other systems showed a double hump on their wavemeters—what now would be called overcoupling. Stone's had a single hump, obtained by using a four-coil circuit. The usual coils were used in the spark and antenna circuits, but they were not coupled—between them were two other coils, connected together conductively. One of these was coupled inductively to the spark coil; the other was coupled to the "aerial" coil.

After several years as a successful consultant, Stone moved to California. There, in 1920, he was engaged by AT&T as engineer-at-large, living in San Diego, with AT&T paying transportation whenever he had to come East. Between 1920 and his retirement in 1934 he developed about 30 patents for AT&T; the most notable of them was probably the 3-dimensional antenna array, with antennas stacked above one another for vertical selectivity. **R-E**

BUILD THIS

THUNDERSTORM ALARM

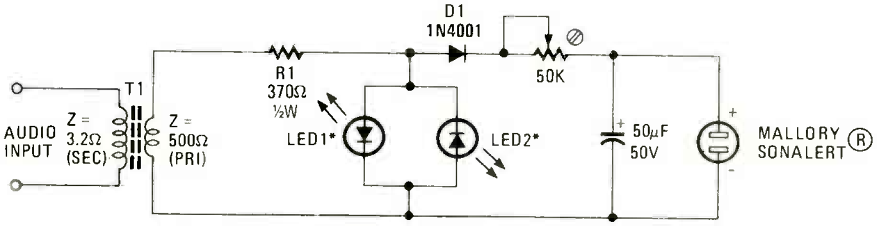
Don't be caught unawares by the sudden arrival of a thunderstorm with its accompanying wind and rain. This simple radio accessory gives an early warning.

CALVIN R. GRAF

THUNDERSTORMS, AND THEIR ACCOMPANYING strong winds, rain, and possible hail, can make their appearance rather suddenly sometimes. This is especially so in spring and summer months, but they can actually sneak up on you at almost any time in some parts of the country. When camping out, fishing, picnicking, or just relaxing at home, it is important to know of any severe weather that might be approaching the local area. This is of special interest to those who have to conduct outdoor operations such as construction workers, farmers, and ranchers. Campers, away from their vehicles, can be warned to seek higher ground in case of flash floods.

The thunderstorm activity indicator described in this article will alert you to an approaching electrical storm through the flashing of two light emitting diodes (LED's) and the sounding of an audio alarm. The activity indicator is connected to the earphone audio output jack of a pocket transistor radio or connected across the speaker terminals of any radio receiver. The radio is then tuned to a clear spot near the upper end of the broadcast band (1600 kHz) where there are no stations being received. An AC power supply with 9-volt DC output can be used to operate the radio at home. With this supply, the receiver can be left on continuously and the receiver will consume little power but will provide an alert no matter the time of day or night a storm may appear. The AC-operated supply is inexpensive and can be purchased at any local radio store. A volume control is provided so that the audio alert level may be adjusted or turned down completely. A visual alert is still provided, however, by the continuous flashing of the LED's as a storm appears.

The circuit diagram shows how the alarm is connected to the receiver. Transformer T1 is a small transistor radio output transformer connected in reverse. It is used to raise the audio voltage across the loudspeaker (3.2 ohms) to a level that will cause the LED's to operate properly (500 ohms). Resistor R1 serves as a current limiting resistor for the LED's so that the voltage drop across them never exceeds a nominal 1.6 to 1.7 volts. The LED's are connected in reverse polarity parallel so that one will conduct in the forward (positive) direction of the audio signal and other LED will conduct in the reverse (negative) direction of the audio.



*ANY GENERAL PURPOSE LED

FIG. 1—THUNDERSTORM ACTIVITY indicator and alarm. The audio input terminals are connected to the speaker terminals of any AM broadcast radio receiver.

Diode D1 is used to rectify the alternating audio voltage so that only pulsating DC is applied to the Sonalert as its polarity markings must be observed. The Sonalert emits a pleasant 2900 Hz signal when the applied voltage is a nominal 1 volt DC. The capacitor charges up on the sharp noise impulses that occur each time there is a lightning flash. When the voltage across the capacitor rises to a value close to one volt, the Sonalert will emit a long "ping". The capacitor thus serves as an integrator and stores up lightning flashes before it causes the Sonalert to sound forth. In this manner, short noise transients on the power line that are radiated from light switches, air conditioners and the like, do not cause the Sonalert to sound. Output from the alarm is also dependent on the setting of the receiver volume control and it will sound out with a normal room level setting.

When a thunderstorm is 10 to 20 miles away, the audio output from the radio due to atmospheric disturbances will cause the LED's to flash and the Sonalert to sound. As the thunderstorm approaches the local area, thunder may be heard following the "ping" of the Sonalert. Knowing that sound travels one fifth of a mile per second in air, the exact distance to the storm area can be calculated by counting seconds from the time the ping is heard until the thunder is heard. If you count to five, the storm is one mile away, and so forth. When the Sonalert sounds continuously, the electrical storm and accompanying rain are very nearby.

The approximate direction to the storm can be determined by "aiming" the receiver's antenna toward the storm area that produces maximum audio output from the Sonalert. The storm passage through the local area can be followed by plotting the relative bearing against time. Keep the volume level constant.

Remember, as the storm approaches, light intensity of the LED's and the sound duration from the Sonalert will increase. As the storm recedes, the relative levels of both light and sound will drop. The storm passage may last from 30 minutes to several hours. With a little experience, you will soon learn to recognize whether it is going to rain or not, in spite of what the weather man may say! (If you live in the cyclone or tornado belt consider using the Stormwarn alarm along with a tornado alert device based on light flashes on a blank TV raster.—*Editor*)

R-E

SUPER CLASS A Audio Amplifiers

New breed of Class A audio amplifiers for hi-fi reproduction deliver high power and eliminates nonlinearity in the driver stages

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

THE CHOICE OF WHICH "CLASS" OF AMplifier to use in high-fidelity applications has always involved a series of trade-offs. Most high-powered audio amplifiers use Class-B circuitry, or Class-AB circuitry, in which a slight amount of idling current flows in the output-stage transistors at all times. Class-AB power amplifiers provide relatively high efficiency (around 60% when they are delivering rated output, lower efficiency at other output levels). Their chief drawback, however, is that they often produce crossover distortion (also known as switching distortion) when one transistor of the output pair turns off and the other one turns on.

Figure 1 illustrates the problem. The sinusoidal trace is the output waveform of a Class-AB amplifier that uses high-speed bipolar transistors having fairly good switching characteristics. The distortion (mid-screen trace), measured on an average-reading distortion analyzer, is very low: 0.0036%, which would certainly be regarded as insignificant. Nevertheless, the clearly visible spikes in the distortion-waveform output that occur every time the audio signal crosses the zero axis are much higher in amplitude than is indicated in the average reading of the distortion meter.

What makes matters worse is the fact that at the low listening levels more typically used, the crossover or switching distortion remains as great, and therefore constitutes a higher percentage of the total signal heard. Furthermore, because of the nature of this type of distortion, it consists of higher-order harmonics that are subjectively more annoying to a listener than second- or third-order harmonic distortion components.

One way to eliminate crossover distortion completely is to operate the output stages of an amplifier in Class A. In Class-A amplifier circuits, the output transistors conduct fully during the entire cycle of the input signal. A few high-powered Class-A amplifiers have appeared in the audio market but, as might be suspected, they are extremely inefficient; they generate a great deal of heat and are generally extremely large and heavy, because of their tremendous heat-sink requirements and, often, their requirement for self-contained fans.

Nonlinear amplifier stages

Distortion in an audio amplifier can also result from nonlinear operation of

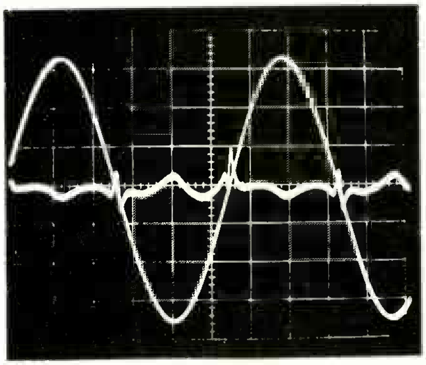


FIG. 1—CROSSOVER DISTORTION is chief drawback of Class-AB amplifier. Center trace shows crossover distortion in relation to output signal.

voltage-amplifying stages that precede the output stage, including the driver stage. Figure 2 shows a typical power-amplifier circuit. The voltage gain A_v of the voltage-amplifier stage is given by:

$$A_v = gm \times \beta \times R_L,$$

where gm is the transconductance of FET's Q1 and Q2, β is the DC current-amplification factor of transistor Q3, and load impedance R_L is the combined impedance of the power-stage input impedance and the constant-current source I_2 in parallel with it.

In the above equation, it is β that contributes the greatest nonlinearity in actual amplifiers. That can be understood by examining the transfer curves shown in Fig. 3 for a common-emitter transistor amplifier stage. As the collector-to-emitter voltage varies from 13 volts to 28 volts, collector current varies from 100 mA to around 120 mA for a constant input current of 1 mA. On the other hand, if a common-base amplifier stage could be used, the gain would be constant regardless of the collector-to-base voltage (see Fig. 4.)

As for the term β in the gain equation relating to Fig. 2, the maximum variation of collector-to-emitter voltage V_{CE} of transistor Q3 will be $2V_{CC1}$, which is nearly identical with the power-supply voltage. So the nonlinear variation of β due to variations of V_{CE} will be more than 10%.

Distortion can also be caused by nonlinear variations of the junction capacitance of semiconductor devices. In the equation cited earlier, the gain was expressed for DC amplification only. Under actual signal conditions, the collector-to-base junction capacitance of transistor Q3 functions as a feedback capacitance. As frequency increases, the gain A_V decreases at a rate of 6 dB-per-octave. Since the collector-to-base junction capacitance varies depending on the base-to-collector voltage in a nonlinear manner, it follows that the gain also has a non-linear characteristic, thereby causing distortion in the

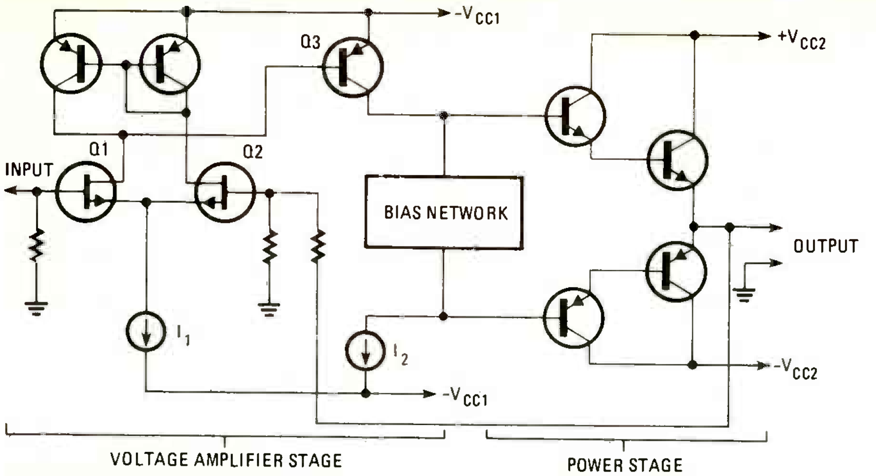


FIG. 2—AUDIO AMPLIFIER consists of a power-output stage that is preceded by voltage-amplifying driver stages.

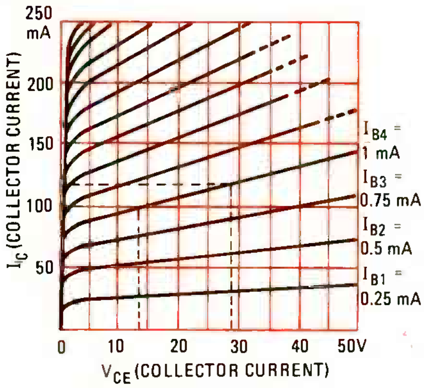


FIG. 3—GAIN of common-emitter transistor circuit varies as the collector-to-emitter voltage varies.

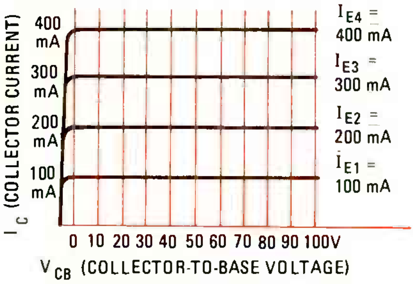


FIG. 4—CONSTANT GAIN is obtained with common-base transistor circuit.

output-voltage waveform.

These two conditions that can generate distortion are also present with the FET's used in the input stage and can cause distortion of the input signal and the negative feedback signal.

JVC's new Super-A class circuit

What JVC calls their Super-A class circuit is, in fact, a two-part solution to the problems we have been discussing. One circuit refinement takes care of the nonlinearity problems of the driver stage, while the second part is concerned with the output stages and possible notch or crossover distortion. We will examine the circuitry relating to voltage-amplifier/driver circuitry first.

To eliminate the nonlinear distortions caused by variations in V_{CE} (in a common emitter circuit) techniques must be used that maintain V_{CE} at a predetermined value regardless of the presence or absence of an input signal.

Figure 5 is JVC's new circuit that is used in both the input and second stages of some of their latest amplifiers. It uses cascode amplification; in addition, "bootstrapping" is applied to the base of their respective common-base circuits. In effect, this circuit combines the high gain of a common-emitter configuration with the high-linearity of common-base operation.

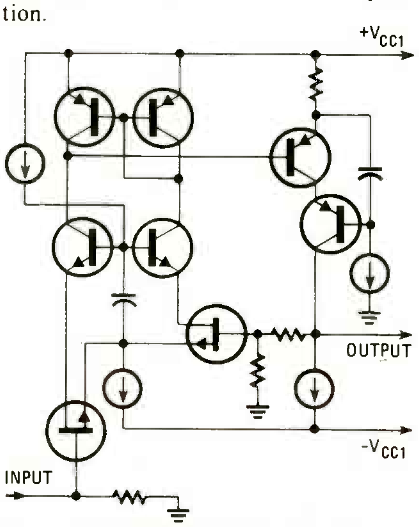


FIG. 5—JVC'S NEW AMPLIFIER CIRCUIT combines cascoded amplifier stages and bootstrapping to provide both the high gain of a common-emitter configuration and the linearity of a common-base configuration.

A simplified diagram of the cascode connection is shown in Fig. 6. When the circuit is connected in this cascode fashion, the voltage of the transistor providing the gain (lower transistor) is frozen at a constant value, resulting in constant gain. The cascode connection thus combines the characteristics of both the common-base and common-emitter configuration, as shown by the transfer curves of Fig. 7. JVC claims that this driver circuit results in reduced driver-stage harmonic distortion amounting to approximately 20 dB of improvement at high driver-output voltages. As proof, they measured distortion for a Class-A driver stage and for their new Super-A driver stage. The results are shown in Fig. 8.

Output stage operation

Ordinary class-AB output stages actually operate as Class-A stages over a limited range of low-output levels. When that range is exceeded, one of the complementary transistors is cut off, with the possible result of crossover distortion. The cut-off occurs because bias voltage in conventional Class-AB (or, for that matter, Class B) circuits is fixed. If bias voltage could be varied by means of some additional circuitry, crossover and switching distortion could be lowered or eliminated and the circuit could operate entirely in Class A but with improved

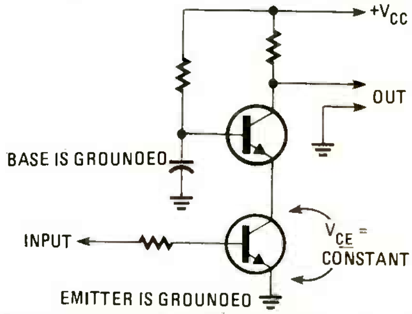


FIG. 6—CASCODE CONNECTION. Upper transistor acts as a regulator and maintains the collector-to-emitter voltage and thus the gain of the lower transistor constant.

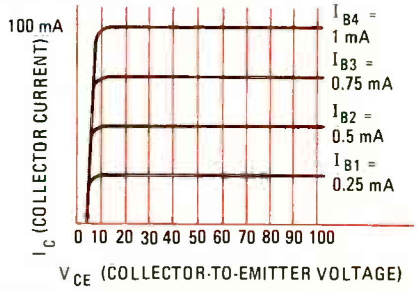


FIG. 7—LINEAR AMPLIFICATION and high gain are obtained with JVC's cascode configuration.

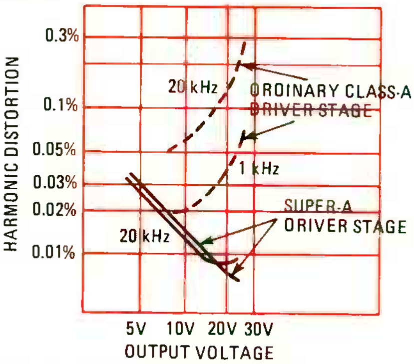


FIG. 8—HARMONIC DISTORTION of conventional Class-A amplifier and JVC's Super-A amplifier.

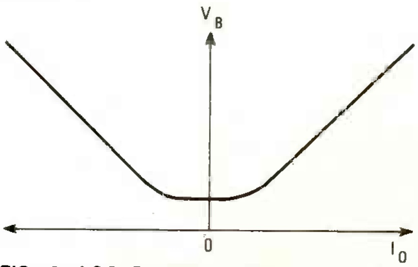


FIG. 9—LOGARITHMIC COMPRESSION-BIAS circuit varies the bias voltage of the output stage in accordance with the output current.

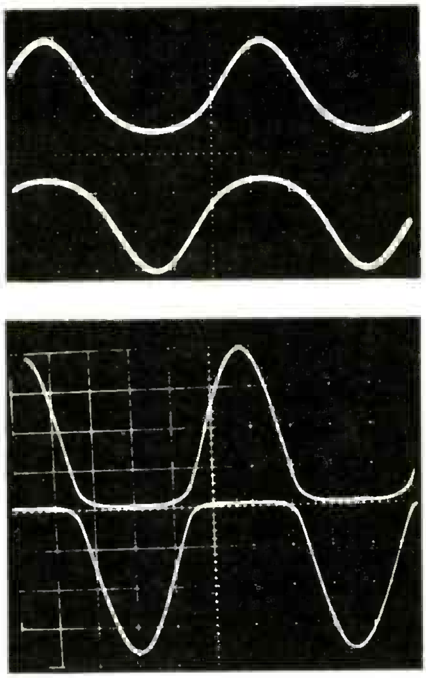


FIG. 10—OUTPUT WAVEFORMS of new Super-A 100-watt amplifer. Waveform at 1-watt output level is shown in *a;* the 100-watt output level is shown in *b.*

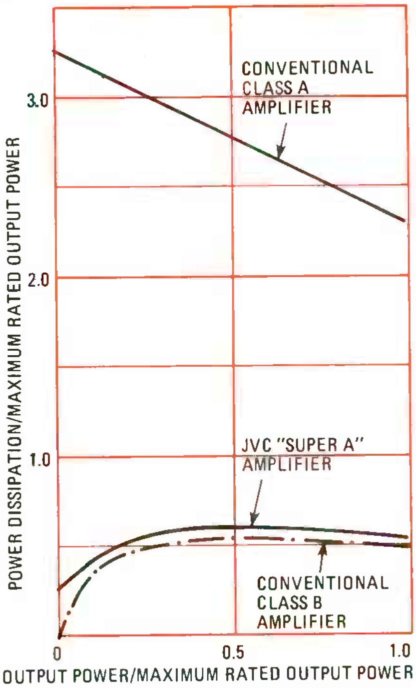


FIG. 11—POWER DISSIPATION vs. output power of conventional Class-A, Class-B and new Super-A amplifiers.

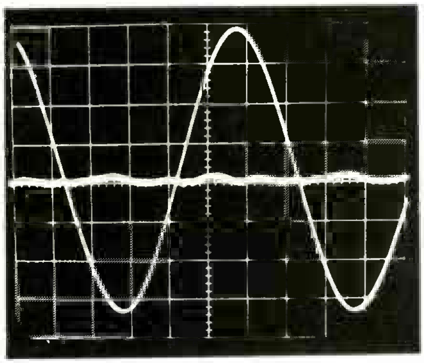


FIG. 12—REDUCED CROSSOVER DISTORTION with Super-A amplifier is shown in center trace when compared to Class-AB amplifier as shown in Fig. 1.

efficiency. JVC's solution to this problem is called a logarithmic compression-bias circuit. The actual output stage uses a pair of complementary output transistors. The bias voltage is made to vary with output current in accordance with the curve shown in Fig. 9. Using this varying characteristic of the bias voltage, the minimum bias voltage required to maintain Class-A operation is obtained even when the power transistors approach cut-off. As a result, both high efficiency and excellent linearity are claimed for the new circuit.

Figs. 10-a and 10-b show the output-current waveforms of the NPN and PNP power transistors of a power amplifier using the new bias circuit and having a rated output of 100 watts-per-channel. The waveforms were observed at two ouput levels; 1 watt and 100 watts.

At the 1-watt output level, the waveforms are similar to those that would be observed with an ordinary Class-A amplifier. At the 100-watt output level, the upper and lower waveforms are asymmetric and approximate the output waveforms that might be observed with a Class-AB amplifier. The major difference, however, is in the important crossover area. With the new JVC Super-A power stage, the nonlinearity in the crossover area is extremely gradual and contains much less of the higher-order distortion components.

As JVC points out, such gradually-produced nonlinearity can easily be eliminated or reduced to insignificant levels with negative feedback.

The output waveforms of Fig. 10 suggest that the efficiency of the amplifier using this new bias circuit might be comparable to that of Class-AB amplifiers, but such is not the case at all. Figure 1 shows a comparison of efficiency between amplifiers of different classes having the same rated output (100 watts at 8 ohms or 4 ohms). The ratio of output power to maximum rated output power is plotted on the horizontal axis while the ratio of power loss to rated output is plotted along the vertical axis.

As for the improved linearity of the new circuit and the reduced "switching distortion," one has only to compare Fig. 12 with Fig. 1, shown earlier. Once more: The sinusoidal trace represents the amplifier's output (it is rated similar in power to that shown in Fig. 1) while the center trace represents what little residual distortion can be detected. The actual measurement of harmonic distortion for the Super-A class amplifier was 0.0016%; not all that much better than the 0.0036% measured for the conventionally-designed amplifier represented in Fig. 1. Note, however, that there is no trace of the switching spikes that were observed in the other amplifier. JVC intends to introduce several integrated amplifiers in the near future that make use of this new circuitry. **R-E**

SOLID STATE NEWS

Speech synthesizer

The time when the computer will be "humanized" seems to be drawing closer. Texas Instruments has developed a speech-synthesis IC using low-cost metal-gate PMOS technology. The circuit is called *Speak & Spell* when it is teamed up with two 128K dynamic ROM's and a version of the TMS1000 microprocessor. Each of the two ROM's stores the equivalent of over 100 seconds of speech.

Pitch-excited linear predictive coding (LPC) is used to reduce the redundant information in the human voice so that it can be efficiently stored in semiconductor memory. The method is based on a time-varying digital filter that is modeled on the vocal tract. An 8-bit digital-to-analog (D/A) converter transforms the stored digital information, processed through the filter, into synthetic speech.

The digital filter has 12 input parameters, including 10 filter coefficients and pitch and energy variables, that are stored in the ROM's. Periodic filter input signals produce definite pitch sounds such as vowels, and random input signals produce noise-like sounds such as "s," "f," "t" and "sh."

The 10-stage lattice filter uses an array multiplier, an adder coupler and various delay circuits. The multiplier circuit accepts two inputs every 5 μs. Twenty multiply and accumulate operations generate each speech sample up to 10,000 of which are produced per second.

That such an advanced technique can be used in a relatively low-cost product such as the *Speak & Tell* learning aid clearly indicates that the speech-synthesis circuit will become a commonplace output device.

High-voltage SCR's

Raytheon has announced a breakthrough in semiconductor technology with its silicon-controlled rectifiers (SCR's). The CR303 planar technology series has forward- and reverse-breakdown voltages up to 800. The devices exhibit a room-temperature leakage of only 100 nA and have a minimum gate sensitivity of 10 μA. They are used for such applications as appliances, timers, solid-state relays, ignition systems and motor controllers. Large-quantity prices are between $.42 and $1.03, depending on voltage ratings. Complete specifications are available from Raytheon TAG Semiconductors, 43 Third Avenue, Burlington, MA 01803. **R-E**

hobby corner

A digital temperature sensor, a mosquito-repelling circuit, plus other tid-bits. EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

A WHILE BACK I RELAYED A READER INquiry for a mosquito repeller circuit. Another reader, Steven Thomas of Sawyer AFB, MI, has come up with some very interesting information.

Steve's research indicates that a frequency just above the range of human hearing will repel both male (non-biting) and female (biting) mosquitos. It seems that they simply don't like frequencies around 20 kHz.

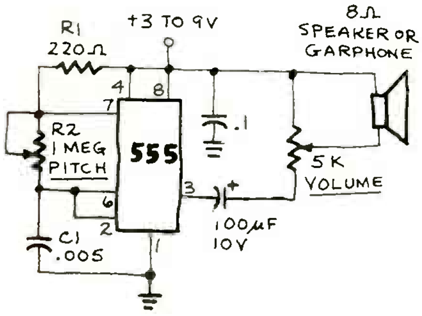


FIG. 1

The 555 oscillator circuit in Fig. 1 is Steve's answer to the mosquito problem. Adjusting R2 will provide output frequencies from below 200 Hz to above 62 kHz. Neither parts nor construction should pose any problem. The only possible difficulty is the miniature speaker or earphone. Use a good quality one so that it will produce frequencies on the order of 20 kHz.

With all the harmonics contained in the output of this squarewave generator, it should be effective if set anywhere near the right frequency. I suggest that you turn higher and higher until you can no longer hear it and then experiment with finer tuning while you are out in mosquito country!

Thanks, Steve.

Racetrack timer

Bill Wisel of Fallston, MD has sent in a neat question. It seems that his Cub Scout Troop enjoys the annual Pine Wood Derby but the close heats sometime create "heat" between the contestants. What Bill needs is a simple circuit to time each of the four lanes or, at least, to show which car comes in first, second, and so on.

Do any of you have a circuit you would share with Bill and others? If not, what can you come up with? Here are a few ideas:

Start with a timer—555 or crystal and a divider for greater accuracy. The timer can drive four separate and independent counter circuits controlled by four signals. The signals are derived from cadmium sulfide photocells, phototransistors or light activated SCR's (LASCR). The photo devices are buried beneath the finish line and activated by the shadows of cars passing between them and an overhead light.

Now what do you say?

VHF converter

Larry Tornow of Hewitt, NJ, has joined a volunteer fire company and needs an inexpensive monitor. He and the other guys don't want to lay out big money for a scanner when they are interested in only one channel.

Larry wants a "quick and dirty" way to convert a transistor FM broadcast receiver to the low VHF band. How about it you volunteer firemen, rescue squaders, and others—send along a conversion. Larry and your other fellow volunteers will appreciate your help. Oh yes, while you are at it, how about the high band?

Digital thermometer

Ken Pavlicek of LaGrange, IL has come up with a great idea for a temperature sensor and thermometer circuit. Being digital rather than the usual analog variety, it has several advantages.

Ken makes use of the fact that a diode's

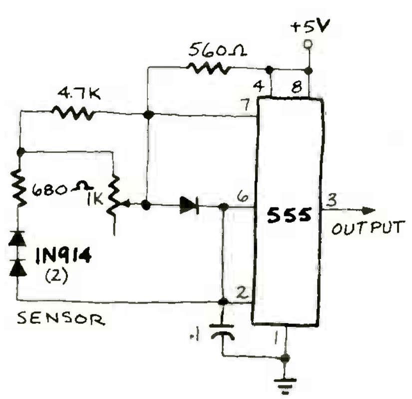


FIG. 2

resistance changes with temperature. His sensor consists of two series-connected 1N914's and these are part of the circuit of a 555 multivibrator. Wired as shown in Fig. 2, the output pulse rate is proportional to the temperature of the diodes. This output is fed to a simple frequency-counting circuit.

Adjustment of the 1K pot is fairly critical and Ken suggests using a multi-turn unit there. The use of a standard frequency counter may require a conversion formula to go from the reading to the temperature but you should be able to juggle the resistor values to make the relationship a simple one.

Ken uses a counter based on the adjustable frequency of a 555 rather than a crystal and, thus, can get a readout directly in degrees (F or C). In addition, through the use of some presettable comparators, he controls both his furnace and air conditioner with his thermometer readout. I regret that space will not permit going into the entire circuit but you have the heart of it. Thanks for sharing, Ken.

Tide timing

Have you noticed just how popular the subject of clocks is these days? A good portion of Hobby Corner mail is related in one way or another to clock circuits. Here are a couple that you may find especially useful.

Reader Art Williams of Wilmington, NC, is an amateur fisherman and keeping track of the tides is important if he wants to have the best chance for a big catch. The "slow clock" circuit that appeared here in Hobby Corner a few months ago caught Art's eye.

He went in the other direction and made a *fast* clock so that low tide occurs at 00:00 and high tide at 12:00. Now he can set the alarm in order to get down to the beach to meet the fish—he hopes!! There is no need to reset the alarm each day as would have to be done on a normal clock and referring to a tide chart is unnecessary.

I won't give Art's circuit because it is just like the one shown in the July 1979 issue. All he did was adjust the rate of the oscillator until the readout matched the tides.

If you don't need the alarm feature of the clock IC, you can keep track of the tides (or whatever) in a less expensive way, too. A standard 555 timer circuit or the fast-slow clock oscillator can drive a

counter and a couple of LED digits.
Thanks for the idea, Art.

Readout wanted

Pat Craddock of Navasota, TX is looking for a clock readout circuit that will drive lamps or LED's with minute and hour values. He would like to have four 1-minute, one 5-minute and five 10-minute lamps indicating the time with a like number to indicate hours.

Sounds like an interesting display scheme with different color LED's and so on. Can any of you help Pat with this circuit?

One final (for this time) word on clocks. Hold on to your hat as you read about this next one. Don't try to tell me that you and your fellow readers don't have imagination!

Unusual clock readout

Reader Hankinson of Downingtown, PA wrote about a really different clock he has constructed. Bob's readout consists of a single vertical row of LED's—yep, that's no misprint—one vertical row of LED's. Bob didn't send his circuit but he did send pictures of the readout including a 32-shot multiple exposure.

Let me see if I can explain how it works. Imagine one of those "moving message" signboards made of many light bulbs on which letters and numbers move from left to right. Now imagine that all the bulbs are covered from view except for one vertical line. Next, substitute fast-acting LED's for the bulbs and speed up the display. There you have Bob's readout!

There is a little trick to reading the display. If you look straight at it, all you see is a line of LED's. However, if you scan *across* it at the right speed, it's right there: 4 digits of the correct time complete with colon. It has to do with persistence of vision—the same characteristic of your eyes that keeps TV, movies, and fluorescent lights from seeming to flicker.

Now that's what I call an *unusual* display. **R-E**

"You think that's bad? That's nothing at all. You should try turning it on when it's plugged in."

HITACHI

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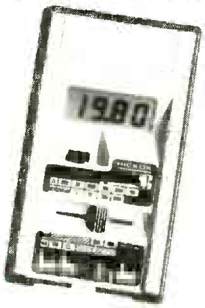

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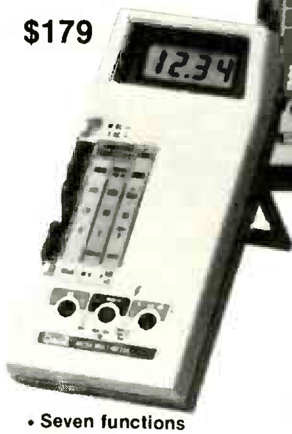

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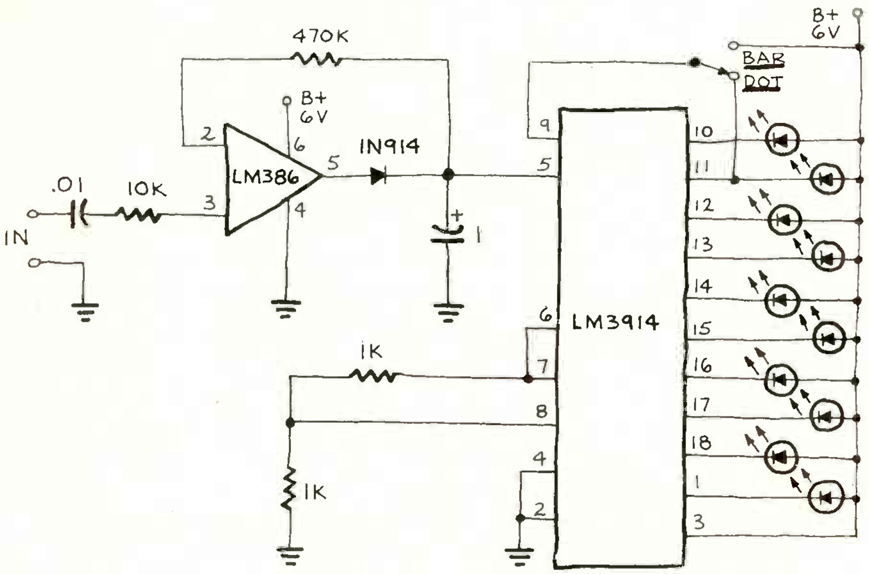
new ideas

LED PEAKMETER

I WOULD LIKE TO SUBMIT MY LATEST project to your New Ideas column. I call it the LED Peakmeter. It is a basic dot/bar readout built around the new National LM3914 display driver. The circuit also includes a peak detector that immediately drives the readout to any new higher signal level and slowly lowers it after the signal drops to zero. The readout is a moving dot or expanding bar display.

The diagram shows one channel of the stereo LED Peakmeter shown in the photograph. All parts are easily obtained and layout is not at all critical. Although not absolutely necessary, I suggest trying the circuit on a solderless breadboard before hand-wiring to check delay time and to match components in a stereo unit.



I used a spare piece of perforated board as a template to drill holes for the LED's in the project box's plastic front. A battery holder with four "C" cells is mounted on the back of the box.

The circuit has other possibilities. It can be expanded for a longer bar readout if desired. Tapping five or more LED Peakmeters into a frequency equalizer or series of audio filters should give a unique result. Physical layout of the LED's can also be changed to simulate the action of regular VU meters.

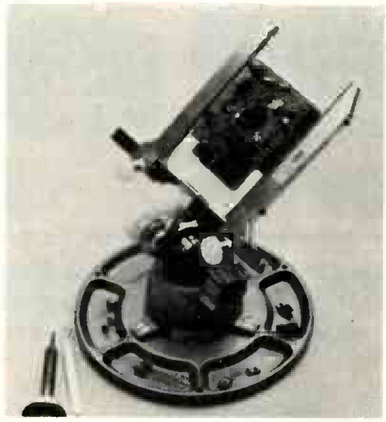
The bottom LED of each peakmeter remains on with no signal at the input, thus providing a pilot light for the unit.—*Wm. J. Cikas*

"So, we'd save 25 cents on the steak here. Now, how about the drinks?"

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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MINIATURE JOYSTICK CATALOG, *No. CAT MJ 78,* contains 16 illustrated pages of miniature joysticks designed for laboratory, industrial or military applications. Includes full descriptions and a list of environmental specifications for different models plus detailed schematics.—**Measurement Systems, Inc.,** 121 Water St., Norwalk, CT 06854.

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DMM SELECTION GUIDE is a full-color, 6-page brochure describing the maker's complete line of 3½-digit DMM's. The brochure details features, specifications and applications for all models; specifications are written in standardized format on one page. Also included is a description of a solid-state temperature probe for use with analog and digital multimeters, together with applications.—**B&K-Precision,** Dynascan Corp., 6460 W. Cortland St., Chicago, IL 60635.

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SEMICONDUCTOR REPLACEMENT GUIDE, *No. X78-2,* provides 239 pages of carefully selected and matched semiconductor replacement devices and IC's. Cross-referencing has been compiled on an equal-to or better-than basis. The first part of the catalog contains an introduction and description of device usage, as well as sections on symbols and nomenclature, device descriptions and index, specifications, case styles, etc. The second half of the catalog contains the actual listing of semiconductors with manufacturers' numbers and replacement numbers side by side. The price of the guide is $1.50.—**Workman Electronic Products, Inc.,** P.O. Box 3828, Sarasota, FL 33578.

TOOL KIT CATALOG, *Tool Kits and Test Equipment,* contains 27 pages of tool kits for the field service repair and installation industry, as well as special sections on medical electronics, instrumentation, computers, and test equipment. The kits range from complex kits for repair of sophisticated equipment to simple kits for production lines. Also included is a test equipment section that offers a large selection ranging from inexpensive analog meters, through compact DMM's, to portable oscilloscopes. Order form is included.—**Electronic Tool Co.,** Claremont Ave., Thornwood, NY 10594. **R-E**

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service clinic

More on troubleshooting automatic brightness limiters.

JACK DARR, SERVICE EDITOR

LAST MONTH'S SERVICE CLINIC WAS DEvoted to troubleshooting an ABL (*A*utomatic *B*rightness *L*imiter) circuit in a Magnavox T-995-03 chassis. The symptom was raster cutoff. Coincidences abound in our business; not more than ten days later, I came across a Sylvania E-21-3 chassis that displayed exactly the opposite symptoms.

The raster flared up to maximum brightness and the breaker tripped. The high-voltage shutdown circuit didn't work. The high voltage was not increasing but was instead being pulled down by the current overload. The symptom was intermittent. On scene changes in the program, it happened; turn the channel selector from station to station and it also happened. Apparently, the trouble was being triggered by a small transient.

Checking voltages and a bit of judicious hammering on things got us nowhere. No bad solder joints, etc. I said idly "This looks just like the last one, but the symptoms are reversed!" At that point I looked to the ABL circuit. This is similar to the Magnavox in that the control voltage is developed by sensing the voltage drop across a small resistor in the high-voltage return circuit. Figure 1 shows the circuit; the sensing resistor is R996, at the top of the schematic.

The voltage is clamped by a connection to the +24 volt line. In normal operation, the sensor voltage goes more negative with rising beam-current. That bucks and drops the voltage at the junction of R996 and R919. The lower voltage causes diode SC918 to turn on and apply the lowered voltage to the base of Q900, the Black Clamp Amplifier. (This transistor controls black level of the video, and thus determines brightness.) The change in the collector voltage of Q900 varies the base voltage of Q902, the Video Amplifier, and the direct coupling from here on through the video amplifiers and outputs reduces the beam current of the picture tube. Now that's a somewhat simplified explanation!

In this circuit as in Magnavox's circuit, we have a voltage developed across a resistor in the high-voltage return path. As the beam current increases, this voltage should go more negative; it did not! That point is screened on the board as BL. The DC voltage on BL measured almost +50 volts. (This voltage is *not* given on any of the schematics we had. However, you'll soon find out what it ought to be.) When we monitored this point and caused the fault to show up, the voltage jumped to almost +100 volts! The excessive beam current was causing a change in the voltage, but it was far too much and the wrong polarity. Now we analyze!

The first suspect was diode SC996. This checked OK. The 1.0 μF/50V capacitor C996 was the next suspect. Odd readings prompted us to replace it. Problem solved! Everything worked normally and the DC voltage at BL dropped to about +10 volts. If I were you, I'd write this in on my schematic; it is on mine. The +50-volt reading is a sure sign of serious problems. After some discussion,

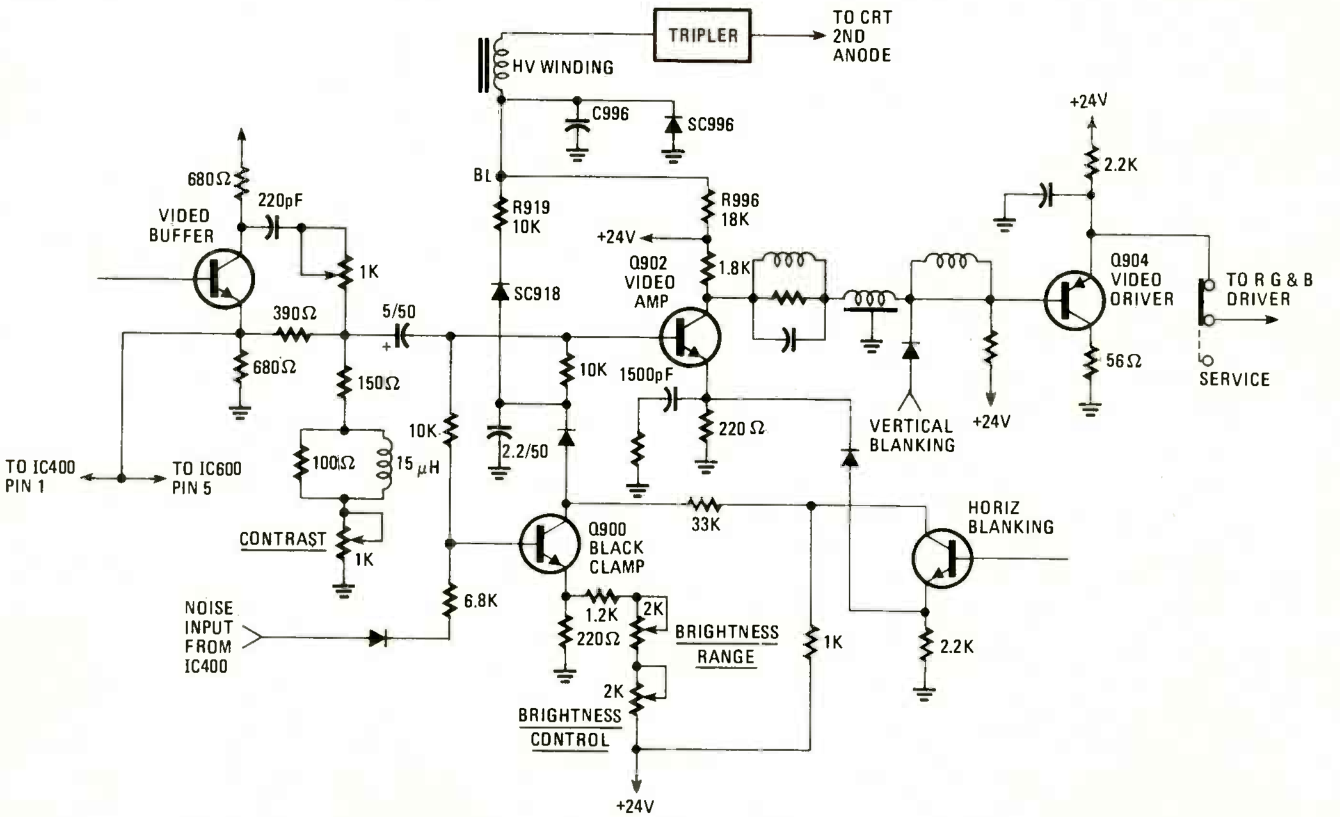

FIG. 1

we came to the conclusion that C996 had been leaking. That placed a shunt resistance across the remaining capacitance and the shunt diode. So, excessive current caused the development of more voltage. The shunt resistor across the diode developed a positive voltage. Any other interpretations will be welcomed and probably agreed with! At any rate, whatever the exact fault was, a replacement of C996 cured it.

Later, a curiosity check inspired a look at the Sylvania service literature, especially their always-welcome *Service Notebook*, from which Fig. 1 was taken. A couple of similar cases turned up. In one, the symptom was "raster cutoff." Again the culprit was C996, but this time it was open. (As with an open input filter capacitor in any DC power supply, the voltage goes down.)

Of course, there are quite a few things that can cause this type of problem. For example, leakage in the black clamp transistor, video transistor, or bad components in the low-level video circuitry. By the way, the circuit and part numbers in the E-21 chassis are the same in the E-20 chassis. So, if this type of problem shows up in a E-20 chassis, check C996 and family. As we said before, if the problem is loss of control of the brightness, scratch around in the circuitry that's supposed to be controlling it. For example, in this chassis, note that the brightness-control voltage is actually going through Q900. So, any defects in this area can cause problems. Keep your eyes open and look at what's going on. **R-E**

service questions

HIGH-VOLTAGE PROBLEM

I checked everything you suggested on high-voltage problems I had with a Zenith model 25FC45, and it didn't help. A Zenith technician told me to try changing tuning capacitor C229, even if it checked out OK. The parts supplier said that this was correct and that there was a new improved type to replace the original. I tried the new capacitor and it worked! I just thought I'd pass this along, since it might help others in the same fix.—Paul Schlie, E. Northport, NY.

Thanks, Paul. It should help a lot.

ALWAYS CHECK NEW PARTS

I wrote in February 1979 asking about a Zenith model 16Z8C50 with very low screen-grid voltage on the 6LB6 horizontal output tube. You suggested I check to make sure that the plate of the tube wasn't open, since an open plate can cause this symptom.

Since you've advised technicians for some time to recheck any parts we put in, I did. And I found that the "new" screen bypass capacitor that I'd replaced had more leakage than the old one! A good capacitor cured the problem, and now everyone's happy.—M.C.B., Newport News, VA.

SUBSTITUTE TRANSISTORS

I needed vertical output transistors for a Sears 528.43600. Set went out late Friday evening. No parts available; so, I used a pair of Radio Shack transistors. Worked, but couldn't get linearity to set up at all. Checked all parts found nothing. Got two new SK-3054 RCA's and put these in and it worked. Question: Why?—D.Y., Lexington, NC.

Crystal-ball answer: Most likely thing, the sub transistors weren't *quite* able to handle the needed power output. Drive them off the linear part of curve and that's the reaction. Radio Shack transistors are pretty good from what I've found.

PICTURE BENDING

Here's some feedback for you: You mentioned checking the AFC diode unit on an RCA CTC-72. Eventually, I did this and found that both diodes were different in their forward resistance. What threw me was that the brightness control was affecting the bending. A new and balanced diode unit did the trick.—John Conti, Texas City, TX. **R-E**


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2.


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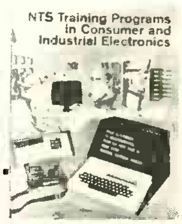

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charging it through a constant resistive load and monitoring the elapsed time and voltage. The system incorporates a high-gain voltage comparator with an accuracy of ± 10 mV, and can be used to test Motorola, GE and RCA NiCad batteries. Suggested retail price: $209.—**Reliable Measurements Systems, Inc.,** 1947 N. MacDonald, Mesa, AZ 85201.

AMMETER, *model 1800A*, is an easy-to-operate unit that checks both AC and DC currents. It reads from 1 to 800 amperes with an accuracy of 1½%. Just clamp the lightweight tong around any conductor smaller than 1¼ inches and read current on the remote digital display. Reads true

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RMS AC current from 50–1000 Hz and all DC waveforms including SCR circuits. Unit comes complete with batteries, carrying case and accessories. Price is $345.—**Pacer Industries, Inc.,** 704 E. Grand Ave., Chippewa Falls, WI 54729.

DESIGN-MATE CASES, *models DMC-1 and DMC-2*, in blue plastic, feature a slope-front, an aluminum baseplate, and mounting screws. Available in other colors for orders of 1000 or

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more. *Model DMC-1* measures 6.75 × 7.5 inches, slopes from 1.5 to 3.25 inches deep, and weighs 11 ounces. *Model DM-2* measures 5.5 × 6 inches, slopes from 1.5 to 3 inches deep, and weighs 7 ounces. Suggested retail prices: *DMC-1*, \$8.75; *DM-2*, \$8.50.—**Continental Specialties Corp.,** 70 Fulton Terr., New Haven, CT 06509.

REPLACEMENT SEMICONDUCTORS, a complete line of individually packaged replacement components, including transistors, SCR's, IC's, diodes, rectifiers, Zener diodes, etc., is available

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for TV, audio and electronic equipment applications. The semiconductors are available from nationwide distributors.—**PTS Electronics, Inc.,** 5233 S. Highway 37, Box 272, Bloomington, IN 47401.

MULTIFUNCTION FREQUENCY COUNTER, *model FC-841*, is a 7-digit counter covering the 10 Hz to 50 MHz range. It features a tilt-view stand, 0.3-inch high LED readout, a switch for selecting the kHz or MHz ranges. Supplied with 4 AA batteries, the counter can be plugged into AC

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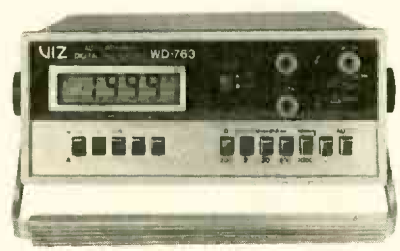
outlet or car's cigarette lighter. Unit has a gate time of 1 second and a sensitivity of 30 mv RMS up to 30 MHz. Timebase stability is 3 PPM from 68°F to 86°F. Comes complete with batteries, antenna and test lead. Price is \$90.—**Soar Electronics,** 200 13th Ave., Ronkonkoma, NY 11779.

DIGITAL MULTIMETERS, a line of four 3½ digit bench instruments, provide a choice of LED or LCD display and either manual or autorange selection. The units feature RF shielding, over-



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load protection, switching for high or low power resistance measurement, auto-zero and auto-polarity, and have an accuracy of 0.1%. The dis-

NEW PRODUCTS

continued from page 73

plays indicate the function as well as the value. The models are designed for battery or AC operation, and a 6 VAC adaptor is supplied. All measure voltage from 0.1mV up to 1000V, ohms from 0.1 ohm to 20 megohms, and current from 0.1 microamp to 10 amps. Prices range from $199 to $266.—**VIZ Mfg. Co.,** 335 E. Price St., Phila., PA 19144

CHEMICAL AEROSOLS *Kontact Clean* and *Kontact Restorer*, are designed for cleaning all types of contacts, switches and controls. Both remove grease, dirt and oxidation and are safe for use on painted and plated surfaces—even precious met-

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al. *Kontact Restorer* will also provide protection against wear through a lubricant coating left on the sprayed surface. Available in a 6 ounce can at a suggested retail price of $1.39 and in a 16 ounce can at $2.30.—**Chemtronics, Inc.,** 681 Old Willets Path, Hauppauge, NY 11787. **R-E**

stereo products

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

DIRECT-DRIVE TURNTABLE, *model PS-X60,* is an automatic turntable with a *Luminous Sensor* feature that tracks the runout record grooves electro-optically. The turntable has a brushless, slotless motor, and speed is controlled by a magnetic coating on the outer rim of the platter and by a quartz-crystal-referenced phase comparison circuit. The tonearm measures 9¼ inches and is calibrated for height, tracking force and antiskating; the base contains a holder for an extra head-shell. The *model PS-X60* measures 6⅛ H × 18$^{15}/_{16}$ W × 16$^{9}/_{16}$ inches D, and weighs 26 lb., 7 oz. It retails for $400.—**Sony Corp. of America,** 9 W. 57th St., New York, NY 10019.

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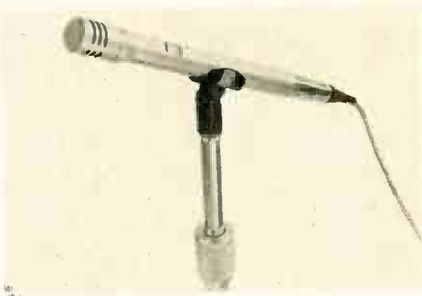
CONDENSER MICROPHONE, *model SM81,* features a 3-position low-frequency response switch to provide flat response, a low-frequency rolloff of 6 dB-per-octave below 100 Hz, or a cutoff of 18 dB-per-octave below 80 Hz. The microphone also has a built-in switchable 10-dB attenuator to protect against overload. The *model SM81* operates over a wide range of simplex power supplies including the DIN 45-596 standard 12 volts and 48 volts. The unit comes with a windscreen, swivel adapter and attenuator lock. Optional accessories available are the *model PS-1* and *model PS-2* simplex power supplies, a heavy-duty windscreen (*model A81WS*), a microphone adapter (*model A27M*) and a 14-ft. mike stand (*model S15*). The *model SM81* weighs 8 oz. and measures 8$^{11}/_{32}$ inches long. Suggested retail prices: the *model SM81,* $225; *model PS-1,* $105; *model PS-2,* $126; *model A81WS,* $17; *model A27M,* $20.10; and *model S15,* $81.—**Shure Brothers, Inc.,** 222 Hartrey Ave., Evanston, IL 60204.



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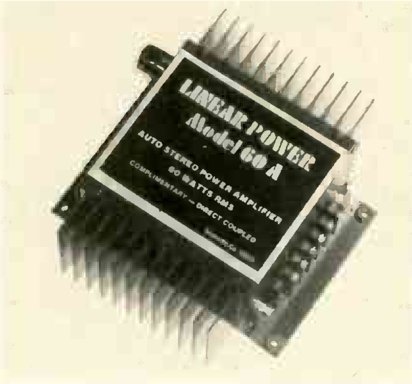
CAR STEREO AMPLIFIERS, *Linear Power model 60A* and *model 40A,* can be connected to the speaker outputs of any car stereo. The *model 60A* (shown) delivers 30 watts-per-channel minimum RMS into 4 ohms, 20 Hz–20 kHz with no more than 0.25% (0.1% typical) THD. The *model 40A* delivers 20 watts-per-channel minimum RMS

continued on page 76

STEREO PRODUCTS

continued from page 75



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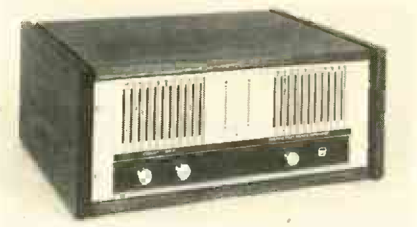
into 4 ohms, 20 Hz–20 kHz with no more than 0.25% maximum (0.12% typical) THD. Other amplifiers are also available: the *model 40* (20 watts-per-channel minimum RMS) and the *model 120* (60 watts-per-channel minimum RMS). Suggested retail prices: *model 60A*, $129.95; *model 40A*, $81.95; *model 40*, $79.95; *model 120*, $199.95.—**Shmegg Electronics, Inc.**, 8115 Berg St., Roseville, CA 95678.

POWER AMPLIFIER, *model SA2,* is rated to deliver 220 watts-per-channel minimum RMS into 8 ohms (350 watts-per-channel into 4 ohms) 20 Hz–20 kHz, at less than 0.05% THD. Other specifications include a slew rate of +30 volts per μs; damping factor, +700 DC to 400 Hz into 8 ohms; and a hum and noise factor of 115 dB below rated output, "A"-weighted. The two channels are separate with separate power supplies, and the system is air-cooled via a 2-speed built-in fan.

Front-panel controls include LED output-level indicators to display signal levels and output signal distortion, such as clipping, high-frequency overload, etc.; an amber standby light, an on/off switch, and a level control. Three rear-panel



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switches handle turn-on delay defeat and stereo-to-mono conversion. The rear panel also contains a chassis-to-circuit ground strap to eliminate ground loops. The unit weighs 57 lbs. and has optional front-panel handles. Suggested retail price: $1595.—**Crown International, Inc.**, 1718 W. Mishawaka Rd., Elkhart, IN 46514.

TV SOUND SYSTEM, *model TE-500/Simulcaster,* is designed to plug directly into an amplifier. There is no direct connection to the TV set. A

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pickup is placed in close proximity to the TV set. The unit features a built-in hi-fi IF amplifier detector and audio preamp. It provides a frequency response of 30 Hz–15 kHz, with an adjustable output level of from 0 to 3 volts, and operates from a 120-volt, 60-Hz power supply. The *model TE-500* measures 2½ H × 9 W × 6 inches D, and weighs 5 lbs. Suggested retail price: $129.95.—**Rhoades National Corp.**, 126 Volunteer Dr., Hendersonville, TN 37075.

SPEAKER SYSTEM, the *Ohm I*, is a five-speaker, four-way system housed in a tapered floor enclosure. The system uses a phase-consistent crossover network with three separate level controls.

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Frequency response is from 32 Hz to 21 kHz, ±3.5 dB. The *Ohm I* features a 12-inch subwoofer with 8-layer voice coil and separate input jack, an 8-inch woofer for the 100 Hz—2kHz range; a 1½-inch tweeter with 6-lb. magnet; and two 1-inch supertweeters. The speaker enclosure is of natural walnut veneer with a removable grille. The unit weighs 99 lbs., and has a suggested retail price of $600 each.—**Ohm Acoustics Corp.**, 241 Taaffe Place, Brooklyn, NY 11205.

CASSETTE DECKS *model SC-3300* and *model SC-3330* are designed for use with metal tapes. They feature *Direct-O-Matic* front-loading and have full logic control for their two motors—an FG DC servo motor for the capstan and a DC motor for the reels. The record/playback head uses a special alloy designed to prevent the magnetic saturation that may occur using metal tapes. The ferrite erase head has a double gap

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and an erasure factor of 70 db. 16-segment LED peak-level displays create bar-graph arrays for both channels, and a tension holdback device keeps FM modulation and wow-and-flutter to a minimum. Other features are memory rewind, auto play, and auto repeat.

The decks have a three-position bias and EQ selector switches for metal, chromium, and normal tapes. Frequency response is 20 to 17,000 Hz for metal tape and 20 to 16,000 Hz for chromium dioxide. Dolby noise reduction gives a signal-to-noise ratio of 69 dB. The *SC3330* (shown) is finished in matte black with detachable handles suitable for rack mounting, while the *SC-3300* is finished in brushed aluminum in a simulated walnut case. Suggested retail price for both models is $420.—**Sansui Electronics Corp.**, 1250 Valley Brook Ave., Lyndhurst, NJ 07071. **R-E**

books

AN INTRODUCTION TO PERSONAL AND BUSINESS COMPUTING, by Rodnay Zaks. Sybex, Inc., 2020 Milvia St., Berkeley, CA 94704. 245 pp. 5½ × 8½ in. Softcover $6.95.

This practical introduction to microcomputer technology does not require a technical or electronic background. It provides a detailed introduction to the concepts, peripherals and techniques of microcomputers. The first three chapters deal with system basics, how to use them, and how they work; Chapter 7 examines business computing; Chapter 9 deals with peripheral devices. Among the other topics covered are system costs, different types of units, plus problems occurring in business computer usage. Several appendixes and an index are included in the back of the book.

110 IC TIMER PROJECTS, by Jules H. Gilder. Hayden Book Co., Inc., Rochelle Park, NJ 07662. 115 pp. 5¼ × 9 in. Softcover. $5.25.

This sourcebook provides an in-depth look at applications for the 555 timer IC. Design ideas for interesting and useful circuits are included that can be applied to real life. Among the eight chapters are included descriptions of the basic modes and operations of the IC timer and its applications as a monostable multivibrator and in astable circuits, its use in logic devices, in automotive applications, plus many more. Schematic diagrams accompany the text.

COLOR TELEVISION: THEORY AND TROUBLESHOOTING, by Stan Prentiss. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 370pp. 7 × 9½ in. Hardcover. $16.95.

The reader is presented with a solid foundation in color TV, both the theory and detailed troubleshooting techniques which will make it possible for him or her to handle problems relating to a wide range of TV models, from the very earliest designs to the newest ones on the market.

Antenna installation and replacement is covered, as well as transmission lines, with careful notes as to what they will and won't do for reception. Specific information on remote-control-device circuitry, and the most common malfunctions relating to it, is given. The author gives detailed information on major manufacturers' designs.

Special attention is given to power supplies, as well as a discussion of power transformers. After the final chapter, dealing with microprocessors and their probable future as well as present role, there are 25 pages of questions and answers, relating to each chapter.

MOST OFTEN ASKED QUESTIONS AND ANSWERS ABOUT AMATEUR RADIO, by Leo G. Sands and Joseph L. Lynch. Hayden Book Company, Inc., 50 Essex St., Rochelle Park, NJ. 07662. 111pp. 5¼ × 8¼ in. Softcover; $5.95.

This book has 10 sections, and is directed toward the person who would like to become an amateur radio operator. Each of those sections covers the most-needed information for the beginner in its subject area. The sections are as follows:

1: Amateur Licenses; 2: Communications Operations; 3: Frequency Bands; 4: The Build-or-Buy Decisions; 5: Diagrams; 6: Transmitters; 7: Receivers; 8: Antenna Systems and Propagation; 9: Microphones, and 10: Projects for Experimenters. There are also four appendices: A: Glossary; B: International Q-Signals; C: Study Guide for Element 2 Examinations for Novice Class Amateur Radio Operator License, and D: Location of Federal Communications Commission Field Installations.

The text is presented in the form of clear, brief questions and concise replies. There are many diagrams and some photos in addition to the special section explaining how to read various kinds of diagrams—block, schematic, and pictorial.

PHASELOCK TECHNIQUES (2nd Edition), by Floyd M. Gardner. Wiley-Interscience, a division of John Wiley & Sons, 605 Third Avenue, New York, NY 10016. 285 pp. 6¼ × 9¼ in. Hardcover. $18.50.

Rewritten and updated, the first portion of this second edition reviews the fundamentals of phase-locked-loops and discusses the basic problems confronting designers. That is followed by a discussion of the practical aspects of circuits and an outline of procedures for determining phase-locked-loop parameters.

The balance of the book deals with engineering descriptions and analyses of phase-locked-loop applications. Subjects covered include phase-locked modulators and demodulators, synthesizers, receivers, transponders, oscillator stabilizers, and data synchronizers. For practicing engineers, system engineers, design engineers, and equipment users who need to understand the operation of their equipment. R-E

EQUIPMENT REPORTS

continued from page 32

centered on a printed-circuit board mounted to the temperature-controlling potentiometer. The entire circuit is fused, with the fuse cartridge readily accessible from the back panel of the console.

The console is both handsome and rugged. A wrap-around black wrinkle cabinet is accented by a white panel with a baked-enamel finish. Four rubber feet under the control console provides no-slip mounting as well as scratch and mar prevention. The console is heavy enough (approximately two pounds) to provide a reliable anchor for the soldering iron.

An assortment of tip styles is available, depending upon the application of the iron. All tips are made from pure iron and are pretinned. The heating element is at zero potential to avoid any possibility of current loops between the iron and control console (or circuitry, assuming proper grounding precautions have been taken).

The pure iron tip wets easily with solder, and can tolerate a wide variety of fluxes. Excessively high temperature and extremely caustic fluxes are not recommended, however. This combination will inevitably take its toll in soldering tips!

For those of us who have taken for granted that a soldering iron must be clumsy, requires a long time to heat up, and must be set down on an improvised holder, the *T-7* offers a refreshing surprise. The *T-7* is designed to be held like a pencil and fits snugly and comfortably. Because of the low mass of the element and tip (less than one ounce!), the balance is not tiring. The power cord to the iron is extra flexible, lightweight, and thin. It is hardly noticeable while maneuvering the soldering iron. The handle of the *T-7* iron is made of nylon, and seems impervious to the heat from the tip. Much of this cool comfort is afforded by the heat-sink baffle mounted just between the fingertips and the soldering iron tip. A side-mounted cradle securely anchors the soldering iron between soldering applications. A removable tip-cleaner houses a replaceable sponge to wipe the soldering tip when necessary. The cradle is well ventilated, accounting for the cool operation of the control console.

We found the *T-7* to offer advantages of both battery-operated lightweights and cord-powered heavyweights. Like the battery-powered irons, the *T-7* is extremely maneuverable even though it has an attached cord. Like the cord-operated units, it doesn't have a limited operational life before recharge is necessary. Thus, the *T-7* is capable of long-term, tireless operation at optimum performance.

Heat-up time is about one minute. In our turn-on test, we switched the control console on, advancing the temperature control to about midrange. Within one minute the tip easily melted thin-gauge rosin-core solder. Advancing the temperature control, we found the temperature to respond almost immediately.

The Micro-Soldering Station cools down quickly. It packs away very compactly, and the high-quality power cords should endure considerable folding.

The *T-7* Micro-Soldering Station from American Beauty reflects the professionalism of thoughtful design. We liked the unit, and would recommend it for continuous production-line applications as well as serious bench applications. The *model T-7* Micro-Soldering station lists for $86. **R-E**

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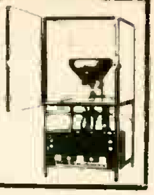

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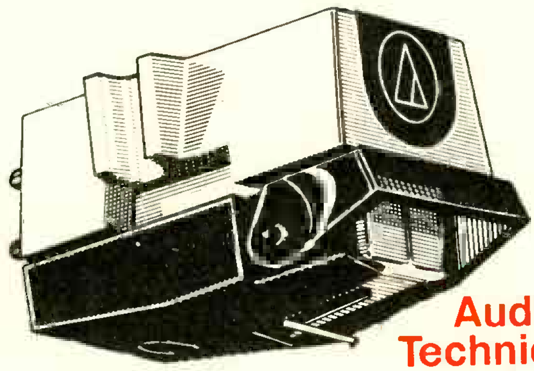

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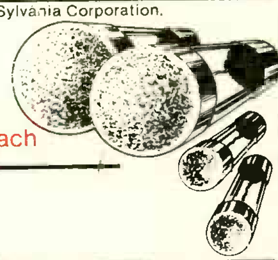

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AN211	2.10	BA511A	1.75	HA1306W	1.80	LA4032P	1.70	LM3089	1.00	STK0059	8.60	STK441	11.80	TA7140	1.80	TC5080P	4.60	UPC1156H	1.90
AN214	1.45	BA521	1.90	HA1308	3.20	LA4051P	1.70	LM3900	1.40	STK0060	9.90	STK443	15.40	TA7142	3.00	TC5081P	2.70	UPC1181H	3.20
AN217	1.00	BA532	4.30	HA1309	4.20	LA4100	1.35	M5106P	5.20	STK0065	10.40	STK457	9.80	TA7145	3.20	TC5082P	3.10	UPC1182H	3.20
AN234	4.60	CX075	3.60	HA1313	3.60	LA4101	1.35	M5112P	6.80	STK0070	11.60	STK459	10.50	TA7146	3.10	TDA2020	7.20	UPC1185	3.95
AN236	4.90	CX095	5.80	HA1314	3.60	LA4102	1.35	M5115P	6.20	STK0075	11.50	STK461	12.80	TA7148	3.00	UA703A	.95	UPC1380	6.95
AN239	4.80	CX100	9.00	HA1316	2.40	LA4220	2.10	M5134P	2.60	STK0080	12.80	STK463	13.50	TA7149	3.00	UPC16C	2.00	UPD858C	6.00
AN240	2.40	CX101G	7.60	HA1318P	3.40	LA4400	1.80	M5142P	5.30	STK0105	13.90	TA-60W	17.60	TA7150	3.40	UPC20C	2.10		
AN241	2.10	CX103	7.90	HA1319	2.90	LA4430	2.10	M5152L	.90	STK0177	10.90	TA-100WA	34.40	TA7151	5.00	UPC23C	2.40		
AN245	4.20	CX104A	7.45	HA1322	2.30	LD1110	1.20	M5155P	3.40	STK011	3.60	TA-200W	49.70	TA7152	1.70	UPC27C	2.20		
AN246	4.40	CX131A	9.90	HA1325	2.20	LD3001	1.80	M5192P	3.60	STK013	8.00	TA7027	2.40	TA7154	4.80	UPC29C	5.30		
AN247	2.40	CX133A	9.90	HA1338	3.20	LD3120	.90	M5340P	.90	STK014	7.20	TA7045	2.00	TA7156	2.80	UPC30C	3.00		
AN252	2.90	CX134A	9.80	HA1339P	2.30	LD3141	1.40	M51171L	1.60	STK015	3.90	TA7054	2.00	TA7157	2.80	UPC48C	3.00		
AN253	2.20	CX135	9.80	HA1342A	2.30	LD3150	1.40	M51182L	2.00	STK016	4.90	TA7055	2.25	TA7158	3.20	UPC48C	3.00		
AN260	2.10	CX136A	9.80	HA1339A	2.30	LM320H5	.90	M51512	2.90	STK020	4.90	TA7060	.80	TA7159	1.80	UPC81C	6.00		
AN264	2.00	CX137A	9.90	HA1366W	2.30	LM324	.90	M51513L	1.90	STK024	7.80	TA7061AP	1.20	TA7176	1.80	UPC157A	2.90		
AN271	2.80	CX138	9.90	HA1366WR	2.30	LM340	.80	M51515L	4.90	STK025	7.90	TA7062P	1.20	TA7178	4.00	UPC554	1.00		
AN272	4.20	CX139	9.90	HA1368W	3.90	LM377	3.60	M51521	1.30	STK027	9.80	TA7063P	.80	TA7200	1.90	UPC55H	1.30		
AN274	1.40	CX141	9.90	HA1368WR	3.90	LM378N	2.20	MB3705	2.40	STK032	8.20	TA7064P	.80	TA7201	1.90	UPC558	4.90		
AN275	3.80	CX145	9.90	HA1377	4.80	LM380	2.00	MB3710	3.20	STK036	12.20	TA7066P	.70	TA7202	2.40	UPC566H	.80		
AN277	1.20	CX150	9.90	HA1389	2.40	LM381N	2.10	NE556	2.40	STK040	9.80	TA7070P	1.60	TA7203	2.40	UPC570	5.20		
AN288	7.80	CX157	5.80	HA1406	2.00	LM387	1.90	NE545B	6.50	STK043	9.90	TA7072P	2.60	TA7204	1.80	UPC571C	6.20		
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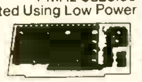

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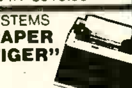

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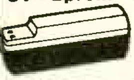

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75492CN	.89
75493N	.89
75494CN	.89
RC4136	1.25
RC4151	3.95
RC4194	4.95
RC4195	4.49

74LS00TTL

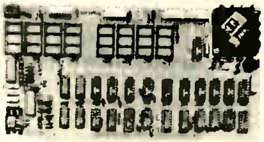
74LS00	.29
74LS01	.29
74LS02	.29
74LS03	.29
74LS04	.35
74LS05	.35
74LS08	.29
74LS09	.35
74LS10	.29
74LS11	.75
74LS13	.59
74LS14	1.25
74LS15	.35
74LS20	.29
74LS21	.35
74LS22	.35
74LS26	.35
74LS27	.35
74LS28	.35
74LS30	.29
74LS32	.35
74LS37	.45
74LS40	.35
74LS42	.89

74LS47	.89
74LS51	.29
74LS54	.29
74LS55	.29
74LS73	.45
74LS74	.45
74LS75	.59
74LS76	.45
74LS78	.49
74LS83	.89
74LS85	1.25
74LS86	.45
74LS90	.59
74LS92	.75
74LS93	.75
74LS95	.99
74LS96	1.15
74LS107	.45
74LS109	.45
74LS112	.45
74LS123	1.25
74LS125	.89
74LS132	.99
74LS136	.49

74LS138	.89
74LS139	.89
74LS151	.89
74LS155	.89
74LS157	.89
74LS160	1.15
74LS161	1.15
74LS162	1.25
74LS163	1.15
74LS164	1.25
74LS175	.99
74LS181	2.49
74LS190	1.15
74LS191	1.15
74LS192	1.15
74LS193	1.15
74LS194	1.15
74LS195	1.15
74LS253	.99
74LS257	.89
74LS258	1.75
74LS260	.69
74LS279	.75
74LS367	.75
74LS368	.75
74LS670	2.49

Cromemco

incorporated



8K Bytesaver II

Cromemco's 8K BYTESAVER® card provides a built-in programmer for the popular 2708 PROM and has the capacity for a full 8K bytes of PROM memory storage. The BYTESAVER® II also offers a number of new features including convenient switch selection of board address and Cromemco's powerful memory bank selection. The BYTESAVER® II is assembled and tested (Model 8KBS-W) for $245.

Memory Capacity: 8K bytes
Memory Type: 2708 PROM or equivalent
Memory Access Time: 450 nanoseconds
Wait States at 2MHz: none required
Wait States at 4MHz: one per machine cycle
Bus: S-100
Power Requirements: +8V @ 0.8A
+18V @ 0.4A
−18V @ 0.2A
Operating Environment: 0-55°C.

Assembled

8KBS-W $245.00

DISCRETE LEDS

.200" dia.		
XC556R	red	5/$1
XC556G	green	4/$1
XC556Y	yellow	4/$1
XC556C	clear	4/$1
.200" dia.		
XC22R	red	5/$1
XC22G	green	4/$1
XC22Y	yellow	4/$1
.170" dia.		
MV10B	red	4/$1
.085" dia.		
MV50	red	6/$1

.125" dia.		
XC209R	red	5/$1
XC209G	green	4/$1
XC209Y	yellow	4/$1
.185" dia.		
XC526R	red	5/$1
XC526G	green	4/$1
XC526Y	yellow	4/$1
XC526C	clear	4/$1
.190" dia.		
XC111R	red	5/$1
XC111G	green	4/$1
XC111Y	yellow	4/$1
XC111C	clear	4/$1

INFRA-RED LED
1/4"x1/4"x1/16" flat
5/$1

TIMEX T1001
LIQUID CRYSTAL DISPLAY
CLASS II
FIELD EFFECT

4 DIGIT — .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive	$7.95
T1001A-Reflective	8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95
MAN 2	5 x 7 Dot Matrix-red	.300	4.95
MAN 3	Common Cathode-red	.125	.25
MAN 4	Common Cathode-red	.187	1.95
MAN 7G	Common Anode-green	.300	1.25
MAN 7Y	Common Anode-yellow	.300	.99
MAN 72	Common Anode-red	.300	.75
MAN 74	Common Cathode-red	.300	1.25
MAN 82	Common Anode-yellow	.300	.49
MAN 84	Common Cathode-yellow	.300	.99
MAN 3620	Common Anode-orange	.300	.99
MAN 3630	Common Anode-orange ± 1	.300	.99
MAN 3640	Common Cathode-orange	.300	.99
MAN 4610	Common Anode-orange	.300	.99
MAN 4640	Common Cathode-orange	.400	.99
MAN 4710	Common Anode-red	.400	.99
MAN 4730	Common Anode-red ± 1	.400	.99
MAN 4740	Common Cathode-red	.400	.99
MAN 4810	Common Anode-yellow	.400	.99
MAN 4840	Common Cathode-yellow	.400	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99
MAN 6630	Common Anode-orange ± 1	.560	.99
MAN 6640	Common Cathode-orange-D.D.	.560	.99
MAN 6650	Common Cathode-orange ± 1	.560	.99
MAN 6660	Common Anode-orange	.560	.99
MAN 6680	Common Cathode-orange	.560	.99
MAN 6710	Common Anode-red-D.D.	.560	.99

TYPE	POLARITY	HT	PRICE
MAN 6730	Common Anode-red ± 1	.560	.99
MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 6760	Common Anode-red	.560	.99
MAN 6780	Common Cathode-red	.560	.99
DL701	Common Anode-red ± 1	.300	.99
DL704	Common Cathode-red	.300	.99
DL707	Common Anode-red	.300	.99
DL728	Common Cathode-red	.500	1.49
DL741	Common Anode-red	.600	1.25
DL746	Common Anode-red ± 1	.630	1.49
DL747	Common Anode-red	.600	1.49
DL749	Common Cathode-red ± 1	.630	1.49
DL750	Common Cathode-red	.600	1.49
DL338	Common Cathode-red	.110	.35
FND70	Common Cathode	.250	.69
FND358	Common Cathode ± 1	.357	.79
FND359	Common Cathode	.357	.75
FND503	Common Cathode(FND500)	.500	.99
FND507	Common Anode (FND510)	.500	.99
5082-7730	Common Anode-red	.300	.99
HDSP-3400	Common Anode-red	.800	1.50
HDSP-3403	Common Cathode red	.800	1.50
5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
5082-7304	Overrange character (±1)	.600	15.00
5082-7340	4 x 7 Sgl. Digit-Hexadecima	.600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA2023T	2.56	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	.85	CA3401N	.59
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7 seg. C A LED driver	1.50

CLOCK CHIPS

MM5309	$4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998A	4.95
CT7001	6.95

MOTOROLA

MC1408L7	$4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

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

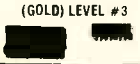
SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100
8 pin SG	$.30	.27	.24
14 pin SG	.35	.32	.29
16 pin SG	.38	.35	.32
18 pin SG	.52	.47	.43
24 pin SG	$ .70	.63	.57
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	$.39	.38	.31
10 pin WW	.45	.41	.37
14 pin WW	.39	.38	.37
16 pin WW	.43	.42	.41
18 pin WW	.75	.68	.62
20 pin WW	.85	.79	.72
22 pin WW	$ .95	.85	.75
24 pin WW	1.05	.95	.85
28 pin WW	1.40	1.25	1.10
36 pin WW	1.59	1.45	1.30
40 pin WW	1.75	1.55	1.40

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 OHM / 27 OHM	12 OHM / 33 OHM	15 OHM / 39 OHM	18 OHM / 47 OHM	22 OHM / 56 OHM	50 PCS	$1.75
ASST. 2	5 ea.	68 OHM / 180 OHM	82 OHM / 220 OHM	100 OHM / 270 OHM	120 OHM / 330 OHM	150 OHM / 390 OHM	50 PCS	1.75
ASST. 3	5 ea.	470 OHM / 1.2K	560 OHM / 1.5K	680 OHM / 1.8K	820 OHM / 2.2K	1K / 2.7K	50 PCS	1.75
ASST. 4	5 ea.	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	50 PCS	1.75
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

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

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AY-5-9200	Repertory Dialler	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	14.95
HD0165	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	7.95
74C923	Keyboard Encoder (20 keys)	6.25

ICM CHIPS

ICM7045	CMOS Precision Timer	24.95
ICM7205	CMOS LED Stopwatch/Timer	19.95
ICM7207	Oscillator Controller	7.50
ICM7208	Seven Decade Counter	19.95
ICM7209	Clock Generator	6.95

NMOS READ ONLY MEMORIES

MCM6571	128 X 9 X 7 ASCII Shifted with Greek	13.50
MCM6574	128 X 9 X 7 Math Symbol & Pictures	13.50
MCM6575	128 X 9 X 7 Alpha Control Char. Gen	13.50

MISCELLANEOUS

TL074CN	Quad Low Noise bi-fet Op Amp	2.49
TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-Isolator	3.95
MK50240	Top Octave Freq. Generator	17.50
OS0026CH	5Mhz 2-phase MOS clock driver	3.75
TIL308	.27" red num. display w/integ. logic chip	10.95
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit DPM Logic Block (Special)	3.95
LD110/111	3½ Digit A/D Converter Set	25.00/set
MC14433P	3½ Digit A/D Converter	13.95

LITRONIX ISO-LIT 1
Photo Transistor Opto-Isolator
(Same as MCT 2 or 4N25)
49¢ each

SN 76477
SOUND GENERATOR
Generates Complex Sounds
Low Power - Programmable
$3.95 each

TV GAME CHIP AND CRYSTAL
AY-3-8500-1 and 2.01 MHZ Crystal (Chip & Crystal includes score display, 6 games and select angles, etc. **7.95/set**

EXAR

XR205	$8.40
XR210	4.40
XR215	4.40
XR320	1.55
XR-L555	1.50
XR555	.39
XR556	.99
XR567CP	.99
XR567CT	1.25
XR1310P	1.95
XR1468CN	3.85
XR1488	1.95
XR1489	1.95

JE2206KB	19.95
XR1800	3.20
XR2206	4.40
XR2207	3.85
XR2208	5.20
XR2209	1.75
XR2211	5.25
XR2212	4.35
XR2240	3.45

XR2242CP	1.50
XR2264	4.25
XR2556	3.20
XR2567	2.99
XR3403	1.25
XR4136	1.25
XR4151	3.95
XR4194	4.95
XR4202	3.60
XR4212	2.05
XR4558	.75
XR4739	1.15
XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00
1N751	5.1	400m	4/1.00
1N752	5.6	400m	4/1.00
1N753	6.2	400m	4/1.00
1N754	6.8	400m	4/1.00
1N757	9.0	400m	4/1.00
1N759	12.0	400m	4/1.00
1N959	8.2	400m	4/1.00
1N965	15	400m	4/1.00
1N5232	5.6	500m	28
1N5234	6.2	500m	28
1N5235	6.8	500m	28
1N5236	7.5	500m	28
1N5242	12	500m	28
1N5245	15	500m	28
1N456	25	40m	6/1.00
1N458	150	7m	6/1.00
1N485A	180	10m	5/1.00
1N4001	50 PIV	1 AMP	12/1.00

TYPE	VOLTS	W	PRICE
1N4002	100 PIV	1 AMP	12/1.00
1N4003	200 PIV	1 AMP	12/1.00
1N4004	400 PIV	1 AMP	12/1.00
1N4005	600 PIV	1 AMP	10/1.00
1N4006	800 PIV	1 AMP	10/1.00
1N4007	1000 PIV	1 AMP	10/1.00
1N3600	50	200m	6/1.00
1N4148	75	10m	15/1.00
1N4154	35	10m	12/1.00
1N4733	5.1	1w	28
1N4734	5.6	1w	28
1N4735	6.2	1w	28
1N4736	6.8	1w	28
1N4738	8.2	1w	28
1N4742	12	1w	28
1N4744	15	1w	28
1N1183	50 PIV	35 AMP	1.60
1N1184	100 PIV	35 AMP	1.70
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
MPSA05	.30
MPSA06	5/1.00
TIS97	6/1.00
TIS98	6/1.00
40409	1.75
40410	1.75
40673	1.75
2N918	4/1.00
2N2219A	2/1.00
2N2221A	4/1.00
2N2222A	5/1.00
PN2222 Plastic	7/1.00
2N2369A	4/1.00
MPS2369	5/1.00
2N2484	4/1.00
2N2906	4/1.00
2N2907	5/1.00
PN2907 Plastic	7/1.00
2N2925	5/1.00
MJE2955	1.25
2N3053	2/1.00

2N3055	.89
MJE3055	1.00
2N3392	5/1.00
2N3398	5/1.00
PN3567	3/1.00
PN3568	4/1.00
PN3569	4/1.00
MPS3638A	5/1.00
MPS3702	5/1.00
2N3704	5/1.00
MPS3704	5/1.00
2N3705	5/1.00
MPS3705	5/1.00
2N3706	5/1.00
MPS3706	5/1.00
2N3707	5/1.00
2N3711	5/1.00
2N3724A	.65
2N3725A	1.00
2N3772	2.25
2N3823	1.00
2N3903	5/1.00

2N3904	4/1.00
2N3905	4/1.00
2N3906	4/1.00
2N4013	3/1.00
2N4123	6/1.00
PN4249	4/1.00
PN4250	4/1.00
2N4400	4/1.00
2N4401	4/1.00
2N4402	4/1.00
2N4403	4/1.00
2N4409	5/1.00
2N5086	4/1.00
2N5087	4/1.00
2N5088	4/1.00
2N5089	4/1.00
2N5129	5/1.00
PN5134	5/1.00
PN5138	5/1.00
2N5139	5/1.00
2N5210	5/1.00
2N5449	3/1.00
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	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.35	.31	.27
.22/35V	.28	.23	.17	3.3/25V	.35	.31	.27
.33/35V	.28	.23	.17	4.7/25V	.33	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.49	.45	.35
.68/35V	.28	.23	.17	15/25V	.75	.68	.59
1.0/35V	.28	.23	.17	22/6V	.75	.60	.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 26 ON FREE INFORMATION CARD

Continuity Tester and Flashlight

Convenient versatile tool for quickly checking continuity of dead circuits, switches, appliances, cords, fuses, motors, control equipment, coils and panel boards. Also tests circuits for low-resistance shorts and helps identify wires in multi-wire cables. Dozens of other uses. Plus the added convenience of a handy, durable flashlight. Uses two AA size penlight batteries (not furnished). Insulated clip prevents accidental shorting to case. Alligator clip has 48" lead with plug.

RT300 .... **$7.95**

CSC CONTINENTAL SPECIALTIES

Logic Monitor

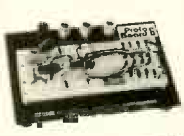
The Logic Monitor allows you to check logic levels on all 16 pins of any DTL, HTL, TTL, or CMOS device. It has a typical input impedance of 100K ohms and weighs a mere 3 oz. (85 grams). It has an input volt. range of 4V to 15V and draws a max. of 100mA@10V

LM-1 .... **$70.00**

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

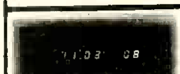


PB-6	$17.95
PB-100	19.95
PB-101	22.95
PB-102	26.95
PB-103	44.95
PB-104	55.95
PB-203	99.95
PB-203A	155.00
PB-203A-Kit	131.00

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
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾ x 3⅛ x 1¾

JE747 .... **$29.95**



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

JE701

6-Digit Clock Kit $19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200 .... **$14.95**

ADAPTER BOARD —Adapts to JE200— ±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 .... **$12.95**

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES		
8080A	CPU	$ 7.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3 95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	4.95
8238	System Controller	5.95
8251	Prog. Comm. I/0 (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. I/0 (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	$14.95
Z80A(780-1)	CPU	16.95
CDP1802	CPU	19.95
2650	MPU	19.95
6502	CPU	11 95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19.95
P8085	CPU	19 95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95

SHIFT REGISTERS		
MM500H	Dual 25 Bit Dynamic	$.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

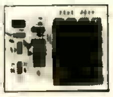
MICROPROCESSOR MANUALS		
M-Z80	User Manual	$7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

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	49.95
	*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 bistable 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

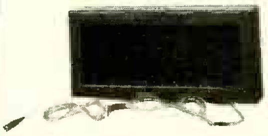
FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

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 indoor/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- 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

- Big ½ inch high, 3½ Digit Liquid Crystal Display
- Over 200 Hours of operation with a 9V battery
- Automatic zero, polarity and overrange indication
- 100mV DC F.S. sensitivity
- 1% basic accuracy
- 19 ranges and functions
- Rugged Cycolac® case and removable cover, stores test lead set.
- Full one year warranty.

SPECIFICATIONS: DC volts (5 ranges): 0.1mV to 1000V, Accuracy ±0.5% rdg ±0.5% f.s. Input imped. 10MΩ. Max. input 1kV except 500V on 200mV range
AC Volts (40Hz to 5kHz): 0.1V to 600V. Accuracy ±1.0% rdg ±0.5% f.s. (−2dB max. at 5kHz); Max. input 600V
Resistance (6 Low Power Ranges): 0.1 to 20MΩ, Accuracy: ±0.5% rdg ±0.5% f.s. (±1.5% rdg on 20MΩ range) input protected to 120VAC all ranges
DC Current (6 ranges): 01mA to 100mA. Accuracy ±1.0% rdg ±0.5% f.s.
Dimensions and Weight: 5-7/8" x 3-3/8" x 1-3/4", 8 oz. POWER: 9V battery (not included) or Hickok AC adapter
READ RATE: 3/sec

LX303 Digital Multimeter $74.95

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
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Spec Sheets — 25¢
1980 Catalog Available — Send 41¢ stamp

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1355 SHOREWAY ROAD, BELMONT, CA 94002
ADVERTISED PRICES GOOD THRU MARCH

The Incredible

"Pennywhistle 103"

$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space; 2225 Hz for mark.
Transmit Channel Frequencies	Switch selectable Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark
Receive Sensitivity	−46 dbm accoustically coupled.
Transmit Level	−15 dbm nominal. Adjustable from −6 dbm to −20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

TRS-80 16K Conversion Kit

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

- 8 each UPD416-1 (16K Dynamic Rams) 250NS
- Documentation for conversion

TRS-16K **$75.00**

ok JUST WRAP™

- 30 AWG wire
- .025" square posts
- Daisy chain or point-to-point
- Built-in cut off
- Includes 50 ft. wire
- No stripping or slitting required—just wrap

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

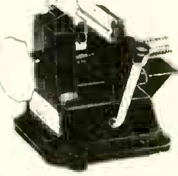
JUST WRAP™ Replacement Wire

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

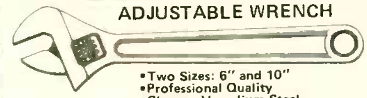
Vacuum Vise



Vacuum-based light-duty vise for small components and assemblies. ABS construction. 1½" jaws, 1¼" travel. Can be permanently installed.

VV-1 ...... **$3.49**

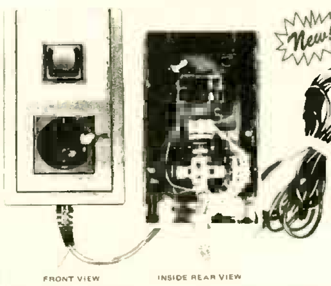
ADJUSTABLE WRENCH



- Two Sizes: 6" and 10"
- Professional Quality
- Chrome Vanadium Steel

6"– AW-6 . . $4.95 10"– AW-10 . . $6.95

JOYSTICK VIDEO CONTROLLER



- IDEAL FOR ALL VIDEO GAMES OR REMOTE CONTROL PROJECTS
- SMALL CASE SIZE: 1-1/2"H x 2-3/8"W x 4-5/16"L
- 2 MINIATURE POTENTIOMETERS–40K OHM EACH
- SPST PUSH BUTTON CONTROL
- 5-WIRE CONNECTION CABLE – 5 FEET LONG
- RUGGED PLASTIC CASE

JVC-40 ...... **$4.95 each**

P.O. Box 4430E Santa Clara, CA 95054
For will call only: (408) 988-1640
2322 Walsh Ave.

Quest ELECTRONICS

NEW PRODUCTS!

Super Color S-100 Video Kit $99.95
Expandable to 256 x 192 high resolution color graphics. 6847 with all display modes computer controlled. Memory mapped. 1K RAM expandable to 6K. S-100 bus 1802, 8080, 8085, Z80 etc.

Gremlin Color Video Kit $59.95
32 x 16 alpha/numerics and graphics; up to 8 colors with 6847 chip; 1K RAM at E000. Plugs into Super Elf 44 pin bus. Not expandable to high resolution Graphics.

Elf II Adapter Kit $24.50
Plugs into Elf II providing Super Elf 44 and 50 pin bus plus S-100 bus expansion (With Super Expansion). High and low address displays, state and mode LED's optional $18.00.

1802 16K Dynamic RAM Kit $149.00
1802/S-100 expandable to 32K, Hidden refresh w/clocks up to 4 MHz w/no wait states Addl. 16K RAM **$79.00**.

Quest Super Basic

Quest, the leader in inexpensive 1802 systems announces another first. Quest is the first company worldwide to ship a **full size Basic** for 1802 systems. A complete function **Super Basic** by **Ron Cenker** including floating point capability with scientific notation (number range ±.17E[38]), 32 bit integer ±2 billion; Multi dim arrays; String arrays; String manipulation; Cassette I/O, Save and load, Basic, Data and machine language programs; and over 75 Statements, Functions and Operators.

Easily adaptable on most 1802 systems. Requires 12K RAM minimum for Basic and user programs. Cassette version in stock now. ROM versions coming soon with exchange privilege allowing some credit for cassette version.

Super Basic on Cassette **$40.00**

Tom Pittman's 1802 Tiny Basic Source listing now available. Find out how Tom Pittman wrote Tiny Basic and how to get the most out of it. Never offered before. **$19.00**

S-100 4-Slot Expansion **$ 9.95**

Super Monitor VI.I Source Listing **$15.00**

Coming Soon: Assembler, Editor, Disassembler, DA/AO, Super Sound/Music, EPROM programmer.

RCA Cosmac Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded with additional memory, Full Basic, ASCII Keyboards, video character generation, etc.**

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique** Quest address and data bus displays **before, during and after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high** and **low** address. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95**. Expansion Cabinet with room for 4 S-100 boards **$41.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic Cassette **$10.00**, on ROM **$38.00**, original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50**. Games and Music **$3.00**, Chip 8 Interpreter **$5.50.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow you to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed**. EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232** and **20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector** set with ribbon cable is available at $15.50 for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system (see Multi-volt Power Supply).

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

INTEGRATED CIRCUITS

7400TTL	
7400N	.17
7402N	.18
7404N	.19
7409N	.23
7410N	.18
7414N	.70
7420N	.18
7422N	.39
7430N	.20
7442N	.50
7445N	.69
7447N	.60
7448N	.69
7450N	.18
7474N	.35
7475N	.49
7485N	.88
7489N	1.85
7490N	.43
7492N	.43
7493N	.43
7495N	.69
74100N	.90
74107N	.35
74121N	.34
74123N	.59
74125N	.45
74145N	.69
74150N	.95
74151N	.69
74154N	1.00
74157N	.69
74161N	.87
74162N	.87
74163N	.87
74174N	.96
74175N	.90
74190N	1.15
74192N	.87
74193N	.85
74221N	2.00
74298N	1.65
74365N	.66
74366N	.66
74367N	.66

74LS00 TTL	
74LS00N	.35
74LS02N	.35
74LS04N	.35
74LS05N	.35
74LS08N	.35
74LS10N	.35
74LS13N	.55
74LS14N	1.10
74LS20N	.35
74LS22N	.35
74LS28N	.41
74LS30N	.35
74LS33N	.75
74LS38N	.55
74LS74N	1.25
74LS75N	1.00
74LS90N	.85
74LS93N	.70
74LS95N	1.10
74LS107N	.45
74LS112N	.45
74LS113N	.35
74LS132N	.89
74LS136N	.45
74LS151N	.85
74LS155N	.85
74LS157N	.85
74LS162N	1.15
74LS163N	1.15
74LS174N	2.00
74LS190N	1.06
74LS221N	1.95
74LS258N	.67
74LS367N	1.35

LINEAR	
CA3045	.90
CA3046	1.10
CA3081	1.80
CA3082	1.90
CA3089	2.95
LM301AN/AH	.35
LM305H	.87
LM307N	.35
LM308N	.89
LM309K	1.50
LM311H/N	.90
LM317T/K	3.75
LM318	1.35
LM320K-5	1.50
LM323K-5	5.95
LM320K-12	1.50
LM320K-15	1.50
LM320T-5	1.60
LM320T-8	1.60
LM320T-12	1.50
LM320T-15	1.60
LM324N	1.15
LM339N	1.55
LM340K-5	1.35
LM340K-8	1.35
LM340K-12	1.35
LM340K-15	1.35
LM340K-24	1.35
LM340T-5	1.25
LM340T-8	1.25
LM340T-12	1.25
LM340T-15	1.25
LM340T-18	1.25
LM340T-24	1.25
LM343H	4.50
LM350	7.50
LM370	1.15
LM377	3.00
LM379	5.00
LM380N	1.00
LM381	1.60
LM382	1.60
LM703H	.40
LM709H	.28
LM723H/N	.50
LM733N	.67
LM741CH	.35
LM741N	.32
LM747H/N	.75
LM748N	.35
LM1303N	1.75
LM1304	1.10
LM1305	1.27
LM1307	2.00
LM1310	2.75
LM1458	.47
LM1800	1.75
LM1812	7.50
LM1889	3.00
LM2111	1.75
LM2902	1.50
LM3900N	.60
LM3905	1.75
LM3909N	.89
MC1458V	.50
NE540H	3.75
NE550N	1.00
NE555V	.39
NE556A	.85
NE565A	1.00
NE566V	1.50
NE567V	1.00
NE5708	5.00
78L05	.60
78L08	.60
78M05	.85
75108	1.75
75491CN	.50
75492CN	.55
75494CN	.89

A to D CONVERTER	
8038B	4.50
8700CJ	13.95
8701CN	22.00
8750CJ	13.95
LD130	9.95
9400CJV/F	7.40
ICL7103	9.50
ICL7107	14.25

CMOS	
CD34001 Fair	.50
CD4000	.16
CD4001	.28
CD4002	.28
CD4006	1.10
CD4007	.28
CD4008	.28
CD4009	.45
CD4010	.45
CD4011	.28
CD4012	.28
CD4013	.39
CD4014	1.00
CD4015	1.00
CD4016	.45
CD4017	1.05
CD4018	.94
CD4019	.45
CD4020	1.02
CD4021	1.25
CD4022	1.10
CD4023	.28
CD4024	.75
CD4025	.28
CD4026	2.00
CD4027	.66
CD4028	.85
CD4029	1.02
CD4030	.45
CD4035	1.02
CD4040	1.02
CD4042	.85
CD4043	.85
CD4044	.85
CD4046	1.67
CD4049	.45
CD4050	.49
CD4051	1.13
CD4060	1.42
CD4066	.71
CD4068	.40
CD4069	.40
CD4070	.50
CD4071	.28
CD4072	.28
CD4073	.28
CD4075	.28
CD4076	1.45
CD4078	.40
CD4081	.28
CD4082	.28
CD4116	.47
CD4490	5.50
CD4507	1.00
CD4508	4.25
CD4510	1.02
CD4511	.94
CD4515	2.52
CD4516	1.10
CD4518	1.02
CD4520	1.02
CD4527	1.51
CD4528	.79
CD4553	3.50
CD4566	2.25
CD4583	4.50
CD4585	1.10
CD40192	3.00
74C00	.28
74C04	.40
74C10	.28
74C14	2.10
74C20	.28
74C30	.28
74C48	1.95
74C74	.75
74C76	1.40
74C90	1.15
74C93	1.40
74C154	3.00
74C160	1.44
74C175	1.35
74C192	1.65
74C221	2.00
74C905	6.00
74C906	.75
74C914	1.95
74C922	5.50
74C923	5.50
74C925	6.95
74C926	6.95
74C927	6.95

INTERFACE	
8095	.65
8096	.65
8097	.65
8098	.65
8T09	1.25
8T10	4.50
8T13	3.00
8T20	5.50
8T23	3.10
8T24	3.50
8T25	3.20
8T26	1.69
8T28	2.75
8T97	1.69
8T98	1.69

MOS/MEMORY RAM	
2101-1	3.95
2102-1	.95
2102AL-4	1.25
2102AN-2L	1.60
21L02-1	1.18
21F02	1.25
2104A-4	4.95
2107B-4	3.75
2111-1	3.75
2112-2	3.95
2114L-1	7.40
2114L-3	7.90
4116	10.95
2513B	6.30
MM5262	.40
MM5280	3.00
MM5320	9.95
MM5330	5.94
PD411D-3	4.00
PD411D-	5.00
P5101L	13.95
4200A	9.95
82S25	2.90
91L02A	1.50
HD0165-5	6.95
MM57100	4.50
GIAY38500-1	9.95
MCM6571A	9.95
9368	3.50
4100	10.00
416	16.00

CLOCKS	
MM5314	3.90
MM5369	2.10
MM5841	14.45
MM5865	7.95
CT7001	5.80
CT7010	8.95
MM5375AA/N	3.90
MM5375AG/N	4.90
7205	16.50
7207	7.50
7208	15.95
7209	4.95
DS0026CN	3.75
DS0056CN	3.75
MM53104	2.50

MICROPROCESSOR	
6800	17.50
6802	18.75
8080A	8.95
8085	27.00
Z80	14.75
Z80A	19.75
8212	2.90
8214	8.00
8216	2.90
8224	2.90
8228	5.35
8251	8.50
8253	15.00
8255	9.25
8257	19.50
8259	19.50
1802CP plas	13.95
1802DP plas.	17.95
1861P	11.50
CDP1802CD	19.95
CDP1802D	25.00
CDP1861	12.95
6820	9.95
6850	12.95
6502	12.50
6504	16.50
6522	13.60

UART/FIFO	
AY5-1013	5.50
AY5-1014	7.50
3341	6.95

PROM	
1702A	3.95
2708	10.50
2716T1	29.50
2716 Intel	48.00
2732	115.00
2758	22.50
8741A	85.00
8748	75.00
8748-8	60.00
8755A	65.00
N82S23	2.95
N82S123	3.50
N82S126	3.75
N82S129	3.75
N82S131	3.75
N82S136	8.75
N82S137	8.75
DM8577	2.90
8223	2.90

CONNECTORS	
30 pin edge	2.50
44 pin edge	2.75
100 pin edge	4.50
100 pin edge WW	5.25

IC SOCKETS
Solder Tin Low Profile

PIN	1 UP	PIN	1UP
8	.15	22	.30
14	.14	24	.35
16	.16	28	.42
18	.27	36	.58
20	.29	40	.57

2 level 14 pin ww .20

WIRE WRAP LEVEL 3

PIN		PIN	
14	.32	24	.86
16	.33	28	1.00
18	.57	40	1.23

CRYSTALS	
1 MHz	4.50
2 MHz	4.50
4 MHz	4.25
5 MHz	4.25
10 MHz	4.25
18 MHz	3.90
20 MHz	3.90
32 MHz	3.90
32768 MHz	4.00
1.8432 MHz	4.50
3.5795 MHz	1.20
2.0100 MHz	1.95
2.097152 MHz	4.50
2.4576 MHz	4.50
3.2768 MHz	4.50
5.0688 MHz	4.50
5.185 MHz	4.50
5.7143 MHz	4.50
6.5536 MHz	4.50
14.31818 MHz	4.25
18.432 MHz	4.50
22.1184 MHz	4.50

KEYBOARD ENCODERS	
AY5-2376	$12.50
AY5-3600	17.95
74C922	5.50
74C923	5.50
HD0165-5	6.95

D Connectors RS232	
DB25P	2.95
DB25S	3.95
Cover	1.50
RS232 Complete Set	6.50
DE9S	1.95
DA15P	2.10
DA15S	3.10

Hickok 3½ Digit LED	
multimeter	69.95
Stopwatch Kit	26.95
Auto Clock Kit	17.95

TRANSISTORS	
2N1893	.40
2N222A	.27
2N2369	.30
2N2904A	.20
2N2907A	.25
2N3053	.40
2N3638	.25
2N3643	.25
2N3904	.18
2N3906	.18
2N3055	.69
2N4400	.25
2N4401	.75
2N4402	.20
TIP31	.60
TIP33A	1.00

RESISTORS ¼ watt 5%
10 per type .03 1000 per type .012
25 per type .025 350 piece pack
100 per type .015 5 per type 6.75
½ watt 5% per type .05

KEYBOARDS	
56 key ASCII keyboard kit	$67.50
Fully assembled	77.50
53 key ASCII keyboard kit	60.00
Fully assembled 70.00 Enclosure	14.95

LEDS	
Red T018	.15
Green, Yellow T018	.20
Jumbo Red	.20
Green, Orange, Yellow Jumbo	.25
Cliplite LED Mounting Clips	8/$1.25

(specify red, amber, green, yellow, clear)

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Complete line of breadboard test equip.
MAX-100 8 digit Freq. Ctr $128.95

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Portable Multimeter $18.00

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MM5865 Stopwatch Timer	9.00
PC board	7.50
Switches Mom Pushbutton	.27
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3 Digit Universal Counter Board Kit Operates 5–18 Volt DC to 5 MHz typ. .125" LED display	10.50
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Model 150 Bus Grabber Kit	$369.00
Sinclair 3½ Digit Multimeter	$59.95
Clock Calendar Kit	$23.95
2.5 MHz Frequency Counter Kit	$37.50
30 MHz Frequency Counter Kit	$47.75

TRANSFORMERS	
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12 Volt 300 ma transformer	1.25
12.6V CT 600 ma	3.75
12V 250 ma wall plug	2.95
12V CT 250 ma wall plug	3.50
24V CT 400 ma	3.95
10V 1.2 amp wall plug	4.85
12V 6 amp	12.95
12V 500 ma wall plug	4.75
12V 1 amp wall plug	6.50
12V 3 amp wall plug	8.50

DISPLAY LEDS			
MAN1	CA	.270	2.90
MAN3	CC	.125	.39
MAN72/74	CA/CA	.300	1.00
DL704	CC	.300	1.25
DL707/DL707R	CA	.300	1.00
DL727/728	CA/CC	.500	1.90
DL747/750	CA/CC	.600	1.95
DL750	CC	.600	1.95
FND359	CC	.357	.70
FND500/507	CC/CA	.500	1.35
FND503/510	CC/CA	.500	.90
FND800/807	CC/CA	.800	2.20
3 digit Bubble			.60
4 digit Bubble			.80
DG8 Fluorescent			1.75
DG10 Fluorescent			1.75
5 digit 14 pin display			1.00
NSN69 9 digit display			.60
7520 Clairex photocells			.39
TIL311 Hex			9.50
MAN3640	CC	.30	1.10
MAN4610	CA	.40	1.20
MAN4640	CC	.40	1.20
MAN4710	CA	.40	.95
MAN4740	CC	.40	1.20
MAN6640	CC	.56	2.95
MAN6710	CA	.60	1.35
MAN6740	CC	.60	1.35
MA1002A			8.95
MA1012A			8.95
102P3 transformer			2.25

ROCKWELL AIM 65 Computer

6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display, ROM monitor, fully expandable. $375.00. 4K version $450.00. 4K Assembler $85.00, 8K Basic Interpreter $100.00.

Special small power supply for AIM 65 assem. in frame **$49.00**. Complete AIM 65 in thin briefcase with power supply **$485.00**. Molded plastic enclosure to fit AIM 65 plus power supply **$47.50**.

AIM 65/KIM/VIM/Super Elf 44 pin expansion board; 3 female and 1 male bus. Board plus 3 connectors **$22.95**.

AIM 65/KIM/VIM I/O Expansion Kit; 4 parallel and 2 serial ports plus 2 internal timers **$39.00**. PROM programmer for 2716 **$150.00**.

Multi-volt Computer Power Supply

8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12 option. ±5v, ±12v are regulated. Kit $29.95. Kit with punched frame $37.45, $4.00 shipping. Woodgrain case $10.00, $1.50 shipping.

PROM Eraser

Will erase 25 PROMs in 15 minutes. Ultraviolet, assembled **$37.50**

60 Hz Crystal Time Base Kit $4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy.

79 IC Update Master Manual $35.00

Complete IC data selector, 2500 pg. master reference guide. Over 50,000 cross references. Free update service through 1979. Domestic postage $3.50. No foreign orders.

Not a Cheap Clock Kit $14.95

Includes everything except case. 2-PC boards. 6-.50" LED Displays. 5314 clock chip, transformer, all components and full instructions. Orange displays also avail. **Same kit w/.80" displays. Red only. $21.95. Case $11.75**

NiCad Battery Fixer/Charger Kit

Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/full parts and instructions. **$7.25**

S-100 Computer Boards

8K Static RAM Kit	$135.00
16K Static RAM Kit	265.00
24K Static RAM Kit	423.00
32K Static RAM Kit	475.00
16K Dynamic RAM Kit	199.00
32K Dynamic RAM Kit	310.00
64K Dynamic RAM Kit	470.00
8K/16K Eprom Kit (less PROMS)	**$89.00**
Video Interface Kit	**$129.00**
Motherboard $39. Extender Board	**$8.99**

Video Modulator Kit $8.95

Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

Digital Temp. Meter Kit $34.00

Indoor and outdoor. Switches back and forth. Beautiful. 50" LED readouts. Nothing like it available. Needs no additional parts for complete, full operation. Will measure −100° to +200°F, tenths of a degree, air or liquid. Beautiful woodgrain case w/bezel **$11.75**

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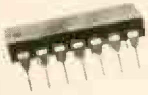


- *100% Prime*
- *Guaranteed Specs*

Improved 5-volt logic devices use Schottky diode technology for minimum propagation 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

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

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

MC14553 3-Digit BCD Counter IC

2^{99}

CMOS chip replaces over 8 separate ICs in a digital display circuit. Input pulse shaping. Master reset pin. 16-pin DIP.
276-2498 .... 2.99

RAM Memory ICs

Low As 2^{49}

2102 1024 x 1 Array. Low-cost static memory chip. 16-pin DIP. Buy 8 and save!
276-2501 .... 2.49 Ea. or 8/14.95

2114L 1024 x 4 Array. NMOS static RAM. 18-pin DIP. 276-2504 .... 10.99

Semiconductor Applications Handbook

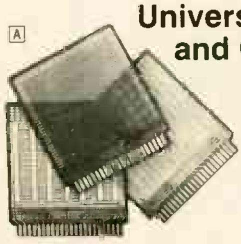
1^{99}

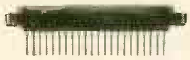
Engineer's Notebook of IC Circuits

Become your own design engineer! Handy reference gives applications and circuit examples for most popular linear and digital ICs. Basic building block circuits for digital logic includes truth tables and helpful tips. All circuits have been built and tested. 128 pages. 276-5001 .... 1.99

Universal PC Boards and Connectors

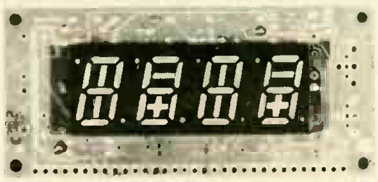
Low As 3^{49}

A 

B 

A Epoxy glass. All 4½x4" with ¹⁄₁₆" grid. Fit 22-pin dual edge connector. Reg. 4.99.
1-Voltage. 1295 holes. For most applications.
276-155 .... Sale 3.99
2-Voltage. 1368 holes. For digital circuits.
276-156 .... Sale 3.99
3-Voltage. 1368 holes. For OP amps.
276-157 .... Sale 3.99
B **22-Pin Dual Edge-Card Socket.** Wire wrapping.
276-1550 .... 3.49

NEW LED Clock Module



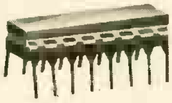
- *Selectable Time/Temp Display*
- *Large Bright 0.7" LED's*
- *Remote Temperature Sensing*

24^{95}

Complete 12/24 hour-clock features temperature display in degrees C or F. Beeping 24-hour alarm drives an 8-ohm speaker directly. 50-60 Hz operation. 277-1006 .... 24.95
Power Transformer. 273-1530 .... 4.99

Dual Analog Delay IC

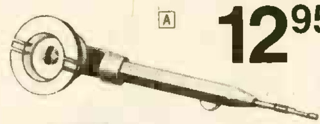
10^{95}



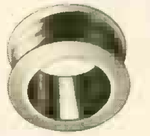
Continuously Variable—Many Audio Applications

SAD1024A. "Bucket Brigade" device has 2 separate 512-stage shift registers which can be used independently or in combination. Provides continuously variable electronic delay for complex audio signals to create reverb, echo, phase shift, chorus and vibrato effects. Reliable NMOS design operates from single supply. With applications circuits and data. 16-pin DIP.
276-1761 .... 10.95

NEW No-Strip Wire Wrapping Tool & Replacement Wire

A 

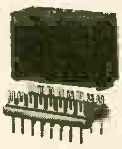
12^{95}



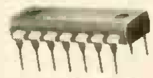
B 1^{99}

A **Quick-Wrap Tool.**™ For 0.025" square posts. No stripping required. Daisy chain or point-to-point. Cuts wire from spool. Easy wire loading. 276-1572 .... 12.95
B **Red Kynar Wire.** 50'. 278-501 .... 1.99
White Kynar Wire. 50'. 278-502 .... 1.99
Blue Kynar Wire. 50'. 278-503 .... 1.99

DIP Header & Wrapping Sockets

A 

Low As 1^{29}

B 

C 

A **DIP header.** Mounts resistors, capacitors, etc., for use with 16-pin DIP sockets. 276-1980 .... 1.29
Low-profile. 3 level pin length.
B **14-Pin Wrapping Sockets.**
276-1993 .... Pkg. 2/1.29
C **16-Pin Wrapping Sockets.**
276-1996 .... Pkg. 2/1.39

12/24-Hr. LCD Clock Module

19^{95}

Actual Size

24-Hour Alarm
Shows Time/Day/Date

Complete clock module—just add switches and battery! 0.25" LCD display has built-in backlight, alarm set, PM and snooze indicators. Piezo buzzer 273-064 is ideal for alarm. Operates up to a year on single 1.5V battery. Accuracy: ± 13 seconds per month. 277-1005 .... 19.95

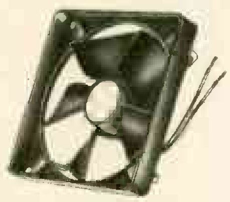
Miniature Piezo Buzzer Element

Penetrating 6.5 kHz electronic tone. Can be driven by external signal or self-oscillating circuit. 273-064 .... 1.99

4" Cooling Fan

12^{95}

Super Quiet Operation



Ideal for cooling power supplies, microcomputers, hi-fi and Ham gear. Delivers up to 70 CFM. Diecast venturi. U.L. recognized motor. For 120VAC, 60 Hz.
273-241 .... 12.95

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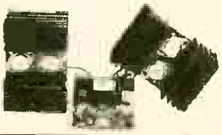
100W CLASS A POWER AMP KIT

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

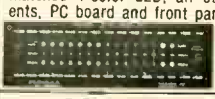
MARK II SOUND ACTIVATED SWITCH KIT

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

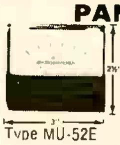
COMPLETED UNIT — NOT A KIT!

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



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.

Type MU-52E

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:

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

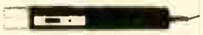
0.27"
2.28"

LED DRIVERS

IR 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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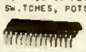
CIRCLE 39 ON FREE INFORMATION CARD

CIRCLE 35 ON FREE INFORMATION CARD

SOUND EFFECTS GENERATOR BASIC KIT

NOW CHANEY ELECTRONICS MAKES IT POSSIBLE TO BUILD YOUR OWN SOUND EFFECTS GENERATOR WITHOUT SPENDING A FORTUNE. WE SUPPLY YOU WITH THE TI76477 SOUND CHIP PLUS AN ETCHED AND DRILLED GLASS EPOXY PC BOARD WITH SCHEMATIC AND LAYOUT INSTRUCTIONS. THIS BOARD MAKES IT SIMPLE TO BUILD A GENERATOR CAPABLE OF PHASER SOUNDS, LOCOMOTIVE, SIRENS, AIRPLANES, CLOCKS, ETC. DOES NOT REQUIRE DIP SWITCHES OR OTHER EXPENSIVE/UNUSUAL COMPONENTS. YOU SUPPLY ONLY A FEW STANDARD RESISTORS, CAPACITORS, SWITCHES, POTS, SPEAKER, 2N2222 TRANSISTOR AND 9V BATTERY.



BASIC KIT CONTAINING TI76477, PC BOARD AND INSTRUCTIONS C23883 ONLY $5.95

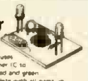
2N2222 TRANSISTOR FOR ABOVE C23884 .[illegible] EACH

IF YOU HAVE ALREADY PURCHASED THE TI76477 CHIP YOU MAY BUY THE PC BOARD AND INSTRUCTIONS ONLY. C23885 $4.00

LASCR SLAVE TRIGGER KIT

WE SUPPLY ALL THE COMPONENTS PLUS SCHEMATIC TO MAKE A SENSITIVE SLAVE TRIGGER WHICH WILL FIRE YOUR SLAVE STROBE WHEN YOU TRIGGER YOUR MASTER STROBE. C23889 $1.50

LED Flasher Kit



Simple to build kit uses the popular 555 timer IC to alternately flash a red and green LED. Comes complete with all parts, including the PC board. (9V battery is not included) C23287 $2.49

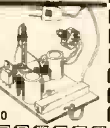
6VDC Xenon Flasher Kit

Battery operated device emits intense bursts of light at approximately 1 per second rate. Complete with all parts & PC board (Less battery) C23808 $8.00

Digital Counting Module

Made for or elec tronic diet aid. Push button until flashes for period of time then advances to next number. Operates on 9V battery (not incl.) $1.79

120 VAC Xenon Strobe Kit

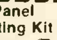


Complete variable rate strobe light kit. Contains all parts, PC board, line cord and instructions. C23071 $7.50

Wheel of Fortune

Popular game device uses LED's, transistors & IC to give the effect of a bright red ball spinning around numbers. Unit emits sound as ball spins & finally stops on a number. Incl. all parts (complete & PC board) C23008 $8.99

LED Panel Mounting Kit



C22707 12 sets for $1.00

OPTO ISOLATORS

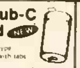
TI 111 Texas Inst.
TI 114 Texas Inst.
TI 153 Texas Inst.
OCI 717 Texas Inst.

YOUR CHOICE 49¢ EACH

RO170 Rectifier

Popular 1000V @ 2.5 amp C23784 5 for $1.00 100 for $15.00

GE Sub-C Nicad NEW



Fast charge type. Brand new with tabs C23876 $2.00

1-30 PF MINIATURE ADJUSTABLE CAPACITOR

C24083 50¢

Tube Specials

7AK7
12AU7
12AT7
Your choice
2 for $1.00

Alco Knob

Stylish brushed aluminum. With set screw for ¼" shafts. 2 for $1.00 C23871

Horse-shoe Tube

Super power rated horse shoe type strobe tube. Rated 100WS. C73885 $3.95

CHANEY electronics inc.

- Minimum order $5.00
- Please include $1.00 for postage
- Visa, MC and COD accepted
- Phone orders are welcome

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Send for our free giant catalog of unique items !!!

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CompuPro™ continues to deliver.

16K DYNAMIC RAMs — 8/$87.20!!

250 ns (4 MHz), 16K dynamic RAMs. Expand memory in TRS-80* -I and -II, Exidy, Apple, new PET, Heath H89, etc. Add $3 for 2 dip shunts plus instructions for TRS-80* expansion.

*TRS-80 is a trademark of the Tandy Corporation

MEMORY!

Choose from **unkit** (sockets, bypass caps pre-soldered in place), **assembled**, or **boards** qualified under our high-reliability **Certified System Component** (CSC) program (200 hour burn-in, extensive testing, immediate replacement in event of failure within 1 year of invoice date).

Name	Buss & Notes	Unkit	Assm	CSC
8K Econoram** IIA	S-100	$149	$179	$239
16K Econoram IV	S-100	$289	$339	$429
16K Econoram VIIA-16	S-100	$299	$349	$439
24K Econoram VIIA-24	S-100	$419	$499	$605
16K Econoram IX-16	Dig Grp	$319	$379	n/a
32K Econoram IX-32	Dig Grp	$559	$639	n/a
32K Econoram X	S-100	$549	$669	$789
32K Econoram XI	SBC/BLC	n/a	n/a	$1050
16K Econoram XIIIA-16	S-100 (1)	$349	$419	$519
24K Econoram XIIIA-24	S-100 (1)	$469	$539	$649
32K Econoram XIIIA-32	S-100 (1)	$579	$699	$849
16K Econoram XIV	S-100 (2)	$299	$359	$459
16K Econoram XV-16	H8 (3)	$329	$395	n/a
32K Econoram XV-32	H8 (3)	$599	$729	n/a

**Econoram is a trademark of Godbout Electronics

(1) Compatible with all bank select systems (Cromemco, Alpha Micro, etc.), addressable on 4K boundaries

(2) Extended addressing (24 address lines). Single block addressable on 4K boundaries

(3) Bank select option for implementing memory systems greater than 64K

TERMS: Cal res add tax. Allow 5% for shipping, excess refunded. VISA*/Mastercharge* call our 24 hour order desk at (415) 562-0636. COD OK with street address for UPS. Prices good through cover month of magazine.

GODBOUT

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Bldg. 725, Oakland Airport, CA 94614

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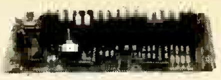
STEREO GRAPHIC EQUALIZER & PREAMP

Octave Band 50 hz to 12,800 18 CTS Slide controls



Assembled & tested $109.15
No additional components necessary for 12 VDC operation

- American made
- Glass epoxy Double sided p.t.h. circuit board
- ALLEN BRADLEY Type M conductive plastic volume control
- Adjustable input sensitivity: .3V to 3V RMS (Bourns MFT Dual trimmer)
- BIFET II Op amps: low noise, 13V/uS (TL074)
- Bourns 2% Resistor networks
- 1% Metal film resistors
- Instrument-type min. toggle switch (on-off-22 db mute)
- 2 accurate clipping lights: one on preamp stage, one on EQ stage
- All 3 LED's are Hi-brightness types (8mcd at 20mA DIFFUSED)
- Wiring & mtg. info included

80 WATT STEREO POWER AMPLIFIER
Assembled & tested circuit board.
American made $67.89 (Class B $61.90)
Ready to mount to heat sinks. Requires 27V split supply, 125W.

- 40W/ch 8 ohm Class AB • .08% THD at 20 khz, full power (.2% Class B)
- Slew Rate 33V/uS, low TIM • VI limiting

POWER SUPPLY KIT FOR ABOVE
Includes 125W xfmr, filter caps, rect, schemo $33.00
Transformer only $27.00 Schemo $1.00

NE541 80V Audio Power Driver $3.80
TIP 31A npn, TIP 32A pnp 60V compl. drivers $.51
TIP 35A npn 25A 60V output $1.65
TIP 36A pnp compl to above $1.73
VARO 331X 100V 3A FAST RECOVERY rect $.53
MR 751 6A 50V rect $.83
4700uF/35V filter $1.50
The brightest LED! Stanley SBR 5531 8mcd@20mA diff $.55
ALLEN BRADLEY type M cond. plastic dual Aud. taper 100K, 1 cm cube 3mm (1/8") shaft w/mtg. hdw $3.75
ALL PARTS PRIME, NO SURPLUS.
MANY OTHER PARTS AVAILABLE. SEND $1.00 FOR FLYER (WE INCL. WITH ORDER).
$10.00 MIN. ORDER
ONE DAY SHPMT 24 HOUR ORDER LINE (209) 577-4256 VISA/M.C. QB ELECTRONICS
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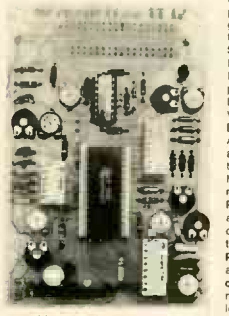
BULLET ELECTRONICS

PO Box 401244R
Garland TX 75040

SE 01 Sound Effects Kit $16.95

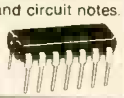


The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477 Sound Chip**, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One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

- 76477 CHIP IS INCLUDED. EXTRA CHIPS $2.95 EACH
- $16.95 LESS SPEAKER & BATTERY

From T.I.: **TL490 BAR/DOT DRIVER IC.** Drives 10 LED's with adjustable analog steps. Units are cascadable up to 10 (100 steps). Drives LED's directly. Great for **voltage, current,** or **audio displays.** Similar in features to LM3914 with specs and circuit notes.

2.95 NEW!

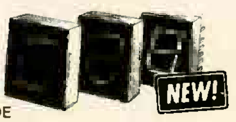


NEW ITEMS

LM3046	(CA3046) Transistor Array	.75
RCA 40430	400V 6A TRIAC TO-66	.75
CA3086	RCA Transistor Array	.80
MC1438R	Power Op Amp/Driver	.50
1N4148	Prime, Full Lead	100/2.50
LM3302	Quad Comparator	.89
2SC1849	High Freq NPN TO-92	6/1.00
MPS A20	NPN GEN PUR	8/1.00

XAN SUPER DIGITS

.6" JUMBO LED
7 SEGMENT
RED
99¢



6640 COMMON ANODE
6920 COMMON CATHODE

NOW A SUPER READOUT AT A SUPER BUY! These are factory fresh prime LED readouts, not seconds or rejects as sold by others. Compare our price and send for yours today, but hurry, the supply is limited!
SPECIFY: COMMON ANODE OR COMMON CATHODE

POTENTIOMETER ASSORTMENT

A mix of new, panel mount 3/8" bushing pots in various values. Some dual, some with switches.

10/2.00

1/2W RESISTOR ASSORTMENT

A good mix of 5% and 10% values in both full lead and PC lead devices. All new, first quality.

(Asst.) 200 pieces/2.00

SLIDE SWITCH ASSORTMENT

An outstanding bargain. Includes miniature and standard sizes and multi-position units. All new first quality, name brand switches. Try one pack and you'll reorder more: *SPECIAL — 12 for $1.20* (Assortment)

PARTS

301 OP AMP 8 LEAD CAN	3/1.00
723 VOLT REG 10 LEAD CAN	50
*13741 FET INPUT 741 MINI DIP	3/1.10
30,000 @ 15V COMPUTER GRADE	2.10
2N4400 NPN GEN. PURPOSE	8/1.00
2N4402 PNP COMPLIMENT	8/1.00
2N6028 P.U.T. W/SPECS	50
LM380 2W AUDIO IC W/SPECS	1.09
LM377 DUAL LM380 W/SPECS	2.50
*7815 VOLT REG. 1A 15V	69
IL-1 OPTO ISOLATOR MINI DIP	.60
*MEM 631 DUAL GATE MOSFET. DIODE PROTECTED SIMILAR TO 40673	50
MV1624 VARICAP DIODE 10 PFD	.49
1N4003 1A 200V DIODE	15/1.00
TIP30 TAB PNP POWER	3/1.00
*MC1351P FM IF. DISC IC	50

*INDICATES ITEM IS "HOUSE NUMBERED"

LED'S

JUMBO GREEN	4/.89
JUMBO RED	5/.89
MEDIUM RED (⅛")	.15
MEDIUM GRN OR YELLOW	.16

7 WATT AUDIO AMP KIT

SMALL, SINGLE HYBRID IC AND COMPONENTS FIT ON A 2" x 3" PC BOARD (INCLUDED). RUNS ON 12 VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 5 WATTS. COMPATIBLE WITH SE-01 SOUND KIT. $5.95

6 DIGIT AUTO/VAN CLOCK

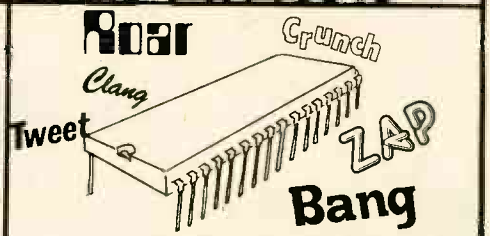
- LARGE ½" CHARACTERS (LED)
- QUARTZ XTAL TIMEBASE
- ALARM & SNOOZE OPTIONS
- NOISE FILTERING
- EASY TO ASSEMBLE
- 4¾" x 3" x 1¼"
- DRILLED & PLATED PC BOARDS

NEW!

$16.95 COMPLETE KIT 12 VDC

ULTRASONIC RELAY KIT

INVISIBLE BEAM WORKS LIKE A PHOTO ELECTRIC EYE. USE UP TO 25 FT. APART. COMPLETE KIT, ALL PARTS & PC BOARDS. $21.50



AY3-8910 PROGRAMMABLE SOUND GENERATOR

The AY3-8910 is a 40 pin LSI chip with three oscillators, three amplitude controls, programmable noise generator, three mixers, an envelope generator, and three D/A converters that are controlled by 8 BIT WORDS. No external pots or caps required. This chip hooked to an 8 bit microprocessor chip or Buss (8080, Z80, 6800 etc.) can be software controlled to produce almost any sound. It will play three note chords, make bangs, whistles, sirens, gunshots, explosions, bleets, whines, or grunts. In addition, it has provisions to control its own memory chips with two IO ports. The chip requires +5V @ 75ma and a standard TTL clock oscillator. A truly incredible circuit.

$14.95 W/Basic Spec Sheet (4 pages)
60 page manual with S-100 interface instructions and several programming examples, $3.00 extra

NPN HIGH VOLTAGE 2.00

VCEO = 450 VDC IC = 3A (5A Peak)

HOUSE #

FOR TV HORIZONTAL SECTIONS; HIGH VOLTAGE REGULATORS
REPLACES: 2N5076, 2N5077, 2N5838, 2N5665, BDY94, BU126, 2SC2121, 2N5840, 2SC1046, 2N5466, TIP556 AND MANY OTHERS.

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- PHONE ORDERS ACCEPTED ON VISA AND MASTERCHARGE ONLY
(214) 278-3553
- ADD 5% FOR SHIPPING
- TX. RES. ADD 5% STATE SALES TAX
- FOREIGN ORDERS ADD 10% (EXCEPT CANADA) (20% AIRMAIL) U.S. FUNDS ONLY.

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TEST EQUIPMENT, TOOLS, TELEPHONE DEVICES, AUTO STEREO PRODUCTS
FREE 8 pc. Tool Set (value $14.95) with $200.00 purchase of merchandise from this ad
DIGITAL MULTIMETERS
Sinclair PDM 35
Reg. $69.95
$49.95
Hickok LX 303
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Beckman TECH 310
■ 22 MΩ input resistance ■ 10 Amp AC/DC ■ 1500V Overload ■ 6KV Transient Protection ■ 2 year battery life
$130.
Simpson 461
Complete with nickel-cadmium batteries, AC charger/adapter, test leads
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Logic Probe
■ Compact circuit powered ■ Detects pulses as short as 50 μsec ■ DTL/TTL/HTL/CMOS compatibility
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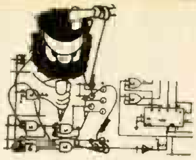

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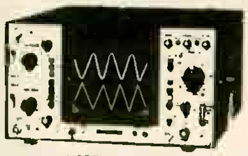

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The 30 MHz Dual Trace Oscilloscope with Delay
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- Built-in delay line.
- Single shot trigger (CH-1, CH-2).
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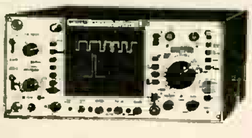

MODEL LBO-515A

25 MHz Dual Trace, Oscilloscope Delayed Sweep
- Sweep delay, continuously variable from 1 uSec to 5 Sec.
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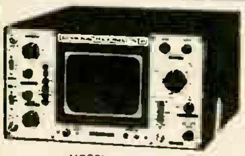

MODEL LBO 508

The 20 MHz Dual Trace Oscilloscope
- Add & subtract modes (with CH-2 invert).
- Front panel X-Y operation.
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- 10 mV sensitivity.

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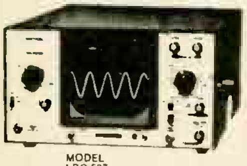

MODEL LBO-507

The 20 MHz Single Trace Triggered Oscilloscope
- Outstanding trigger sensitivity over entire operational range.
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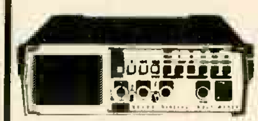

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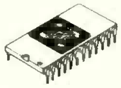
C106D	.34	400V	5.0 AMP	TO-220

EPROM'S



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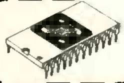

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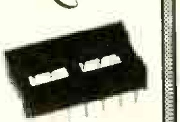

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ALARM CLOCK KITS:

4 Digit .5"

Here it is! The first of several quality kits we have been asked for: Here is what you get — unbelievable as it may sound...

- 1 National - 5375AA Clock Chip
- 1 Bowmar Clock Stick Readout (L.E.D.) 4 digit - 1/2"
- 13 Transitors
- 2 Push Buttons for time set
- 2 Toggle Switches for alarm
- 1 Filter cap
- 4 1N4000 series diodes
- 1 1N4148
- 2 Disc caps
- 29 Resistors
- 1 Transducer (Speaker) for Alarm
- 1 LED Lamp for alarm indicator

NEW! $9.99

ORDER KIT CK-100AC

P.C. Board **$2.25**
Plug In Transformer **$1.50**
Case **$3.50**

D.C. MODEL

Same as above except it includes 60 Hz timebase.
This Kit Includes:

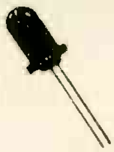
- 1 National 5375AA Clock Chip
- 1 Bowmar Clock Stick Readout - (L.E.D.) 4 digit - 1/2"
- 12 Transistors
- 2 Push Buttons for time set
- 2 Disc caps
- 27 Resistors
- 1 MOV
- 1 60 Hz time base

P.C. Board **$2.25**

NEW! $12.75

ORDER KIT CK-100DC

Case **$3.50**



We bought 350,000 LED's. And you get the savings.
Reds, greens, yellows, orange, small, medium, large. Bags of 25 - mixed $2.75. That's only 11¢ each. Compare this bargain up to twice our price.

FACTORY PRIME
BI - Polar LED 59¢ ea. or 10 for $5

LAB-BENCH VARIABLE POWER SUPPLY KIT
5 to 20 VDC at 1 AMP. Short circuit protected by current limit. Uses IC regulator and 10 AMP Power Darlington. Very good regulation and low ripple. Kit includes PC Board, all parts, large heatsink and shielded transformer. 50 MV. TYP. Regulation. **$15.99 KIT**

Sonalert® on P.C. Board

Direct from a radar detector manufacturer! 4-741 on a board - plus 12 capacitors, trim pot and many usable components plus a Mallory Sonalert® - well worth the price of the board alone - while they last - **$2.50 ea.**

MICRO MINI TOGGLE SWITCHES
6 for $5 with hardware.

99¢ EACH

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Low Cost...High Performance

DIGITAL MULTIMETER

$99.95 WIRED

Low cost, high performance, that's the DM-700. Unlike some of the hobby grade DMMs available, the DM-700 offers professional quality performance and appearance at a hobbyist price. It features 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch high LED display, with automatic decimal placement, automatic polarity, and overrange indication. You can depend upon the DM-700, state-of-the-art components such as a precision laser trimmed resistor array, semiconductor band gap reference, and reliable LSI circuitry insure lab quality performance for years to come. Basic DC volts and ohms accuracy is 0.1%, and you can measure voltage all the way from 100 μv to 1000 volts, current from 0.1 μa to 2.0 amps and resistance from 0.1 ohms to 20 megohms. Overload protection is inherent in the design of the DM-700, 1250 volts, AC or DC on all ranges, making it virtually goof proof. Power is supplied by four 'C' size cells, making the DM-700 portable, and, as options, a nicad battery pack and AC adapter are available. The DM-700 features a handsome, jet black, rugged ABS case with convenient retractable tilt bail. All factory wired units are covered by a one year limited warranty and kits have a 90 day parts warranty.

Order a DM-700, examine it for 10 days, and if you're not satisifed in every way, return it in original form for a prompt refund.

Specifications

DC and AC volts:	100 μV to 1000 Volts, 5 ranges
DC and AC current:	0.1 μA to 2.0 Amps, 5 ranges
Resistance:	0.1Ω to 20 megohms, 6 ranges
Input protection:	1250 volts AC/DC all ranges fuse protected for overcurrent
Input impedance:	10 megohms, DC/AC volts
Display:	3½ digits, 0.5 inch LED
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells, optional nicad pack, or AC adapter
Size:	6"W x 3"H x 6"D
Weight:	2 lbs with batteries

Prices

DM-700 wired + tested	$99.95
DM-700 kit form	79.95
AC adapter/charger	4.95
Nicad battery pack	16.95
Probe kit	3.95

TERMS: Satisfaction guaranteed or money refunded. COD, add $1.50. Minimum order $6.00. Orders under $10.00, add $.75. Add 5% for postage, insurance, handling. Overseas, add 15%. NY residents, add 7% tax.

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600 mHz COUNTER

$99.95 WIRED

The CT-70 breaks the price barrier on lab quality frequency counters. No longer do you have to settle for a kit, half-kit or poor performance, the CT-70 is completely wired and tested, features professional quality construction and specifications, plus is covered by a one year warranty. Power for the CT-70 is provided by four 'AA' size batteries or 12 volts, AC or DC, available as options are a nicad battery pack, and AC adapter. Three selectable frequency ranges, each with its own pre-amp, enable you to make accurate measurements from less than 10 Hz to greater than 600 mHz. All switches are conveniently located on the front panel for ease of operation, and a single input jack eliminates the need to change cables as different ranges are selected. Accurate readings are insured by the use of a large 0.4 inch seven digit LED display, a 1.0 ppm TCXO time base and a handy LED gate light indicator.

The CT-70 is the answer to all your measurement needs, in the field, in the lab, or in the ham shack. Order yours today, examine it for 10 days, if you're not completely satisfied, return the unit for a prompt and courteous refund.

Specifications

Frequency range:	10 Hz to over 600 mHz
Sensitivity:	less than 25 mv to 150 mHz less than 150 mv to 600 mHz
Stability:	1.0 ppm, 20-40°C; 0.05 ppm/°C TCXO crystal time base
Display:	7 digits, LED, 0.4 inch height
Input protection:	50 VAC to 60 mHz, 10 VAC to 600 mHz
Input impedance:	1 megohm, 6 and 60 mHz ranges 50 ohms, 600 mHz range
Power:	4 'AA' cells, 12 V AC/DC
Gate:	0.1 sec and 1.0 sec LED gate light
Decimal point:	Automatic, all ranges
Size:	5"W x 1½"H x 5½"D
Weight:	1 lb with batteries

Prices

CT-70 wired + tested	$99.95
AC adapter	4.95
Nicad pack with AC adapter/charger	14.95
Telescopic whip antenna, BNC plug	7.95
Tilt bail assembly	3.95
CT-70 Kit Form	75.95

ramsey electronics

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