$1.25 ■ NOV. 1979

Radio-Electronics®

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Computer project
TRS-80 BREADBOARD

Roundup
TELEPHONE DIALERS

How to
TUNE UP TAPE BIAS

All about
DESOLDERING TECHNIQUES

How to
PROTECT OP-AMPS

Build it for your phone
MUSIC ON HOLD

Digital logic in
VCR CIRCUITS

- **EQUIPMENT REPORTS**
- **HOBBY CORNER**

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PLUS:

★ Service Clinic
★ Communications Corner
★ 2 R.E.A.L. Sound Lab Test Reports

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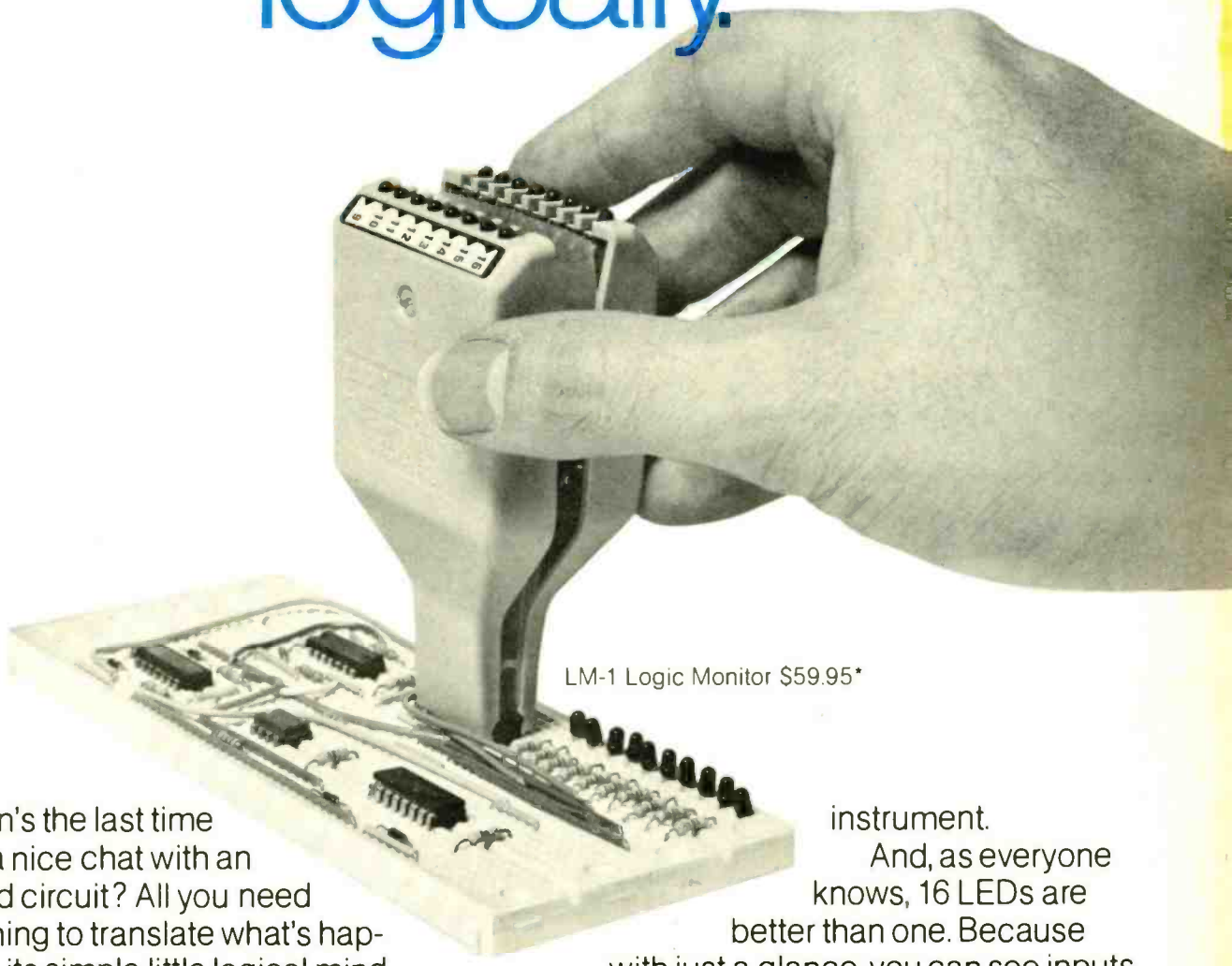

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The Personal Computer Line by OHIO SCIENTIFIC

Personal Computers

C1P: $349 A dramatic breakthrough in price and performance. Features OSI's ultra-fast BASIC-in-ROM, full graphics display capability, and large library of software on cassette and disk, including entertainment programs, personal finance, small business, and home applications. It's a complete programmable computer system ready to go. Just plug-in a video monitor or TV through an RF converter, and be up and running. 15K total memory including 8K BASIC and 4K RAM—expandable to 8K.

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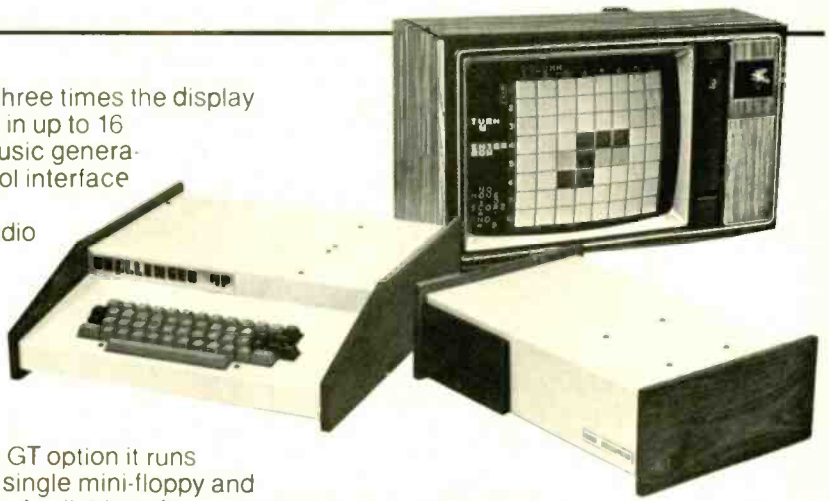
Professional Portables



C4P: $698 The professional portable that has over three times the display capability of C1Ps. Features 32 x 64 character display in up to 16 *colors*, graphics, audio output, a DAC for voice and music generation, key pad and joystick interfaces, AC remote control interface and much more. Utilizes a 4-slot BUS (2 used in base machine), 8K BASIC-in-ROM, 8K of *static* RAM and audio cassette interface. Can be directly expanded to 32K static RAM and two mini-floppy disks.

C4P MF: $1695 The ultimate portable computer has all the features of the C4P plus real time clock, home security system interface, modem interface, printer interface, 16 parallel lines and an accessory BUS. The standard machine operates at twice the speed of currently available personal computers (with GT option it runs even faster!). The C4P MF starts with 24K RAM and a single mini-floppy and can be directly expanded to 48K and two mini-floppies. Available software includes games, personal, business, educational and home control applications programs as well as a real time operating system, word processor and a data base management system.

*Monitors and cassette recorders not included. Ohio Scientific offers a combination TV/Monitor (AC-3P) for $115.

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C8P: $895 Same great features as the C4P in a tremendously expandable "mainframe package." Features over three times the expansion capability of the C4P for advanced home and demanding business applications. Can be expanded to 48K RAM, dual 8" floppies, hard (Winchester) disks and multiple I/O devices such as Voice I/O and a universal telephone interface.

C8P DF: From $2597 The ultimate Home/Very Small Business Computer at a personal computer price. Features 32K RAM (expandable to 48K) and dual 8" floppy disks (stores eight times as much information as a mini-floppy). Has all personal computer capabilities including 32 x 64 display, color graphics, sound, DAC, joystick interfaces, home features including real time clock, AC remote interface, home security and fire detection interface and can be expanded to include voice I/O and a universal telephone system for answering and initiating calls! Its large memory capability and 8" floppies allow it to run most Ohio Scientific business system software including a compete accounting system, word processor and information management system.

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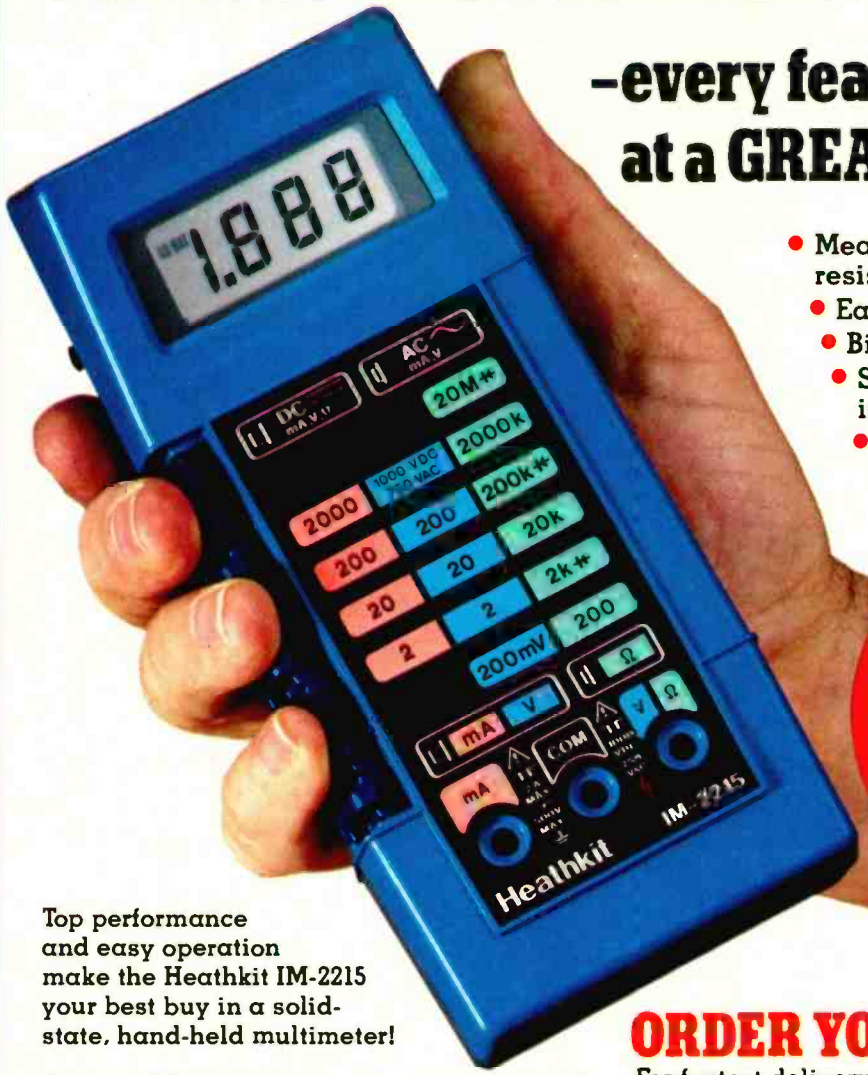

- Measures voltage, current and resistance
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EASY ONE-EVENING KIT ASSEMBLY only $94.95

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Top performance and easy operation make the Heathkit IM-2215 your best buy in a solid-state, hand-held multimeter!

The new IM-2215 brings you features you would only expect in hand-held digital multimeters costing much more! Take measurements with outstanding accuracy – DC voltage, ±.25% – AC voltage, ±.5% – DC current, ±.75% – AC current, ±1.5% and resistance, ±.25% (basic)! Alternating high-low resistance test voltage makes measuring semiconductors or in-circuit resistance easy! One-hand operation, a large 3½-digit LCD display and built-in calibration references make the IM-2215 ideal for field use. A pivoting stand adapts it to bench use. The low-drain circuitry stretches typical alkaline battery life to 200 hours! Battery condition is monitored, and a LO-BAT indicator warns you of the last 20% of battery life.

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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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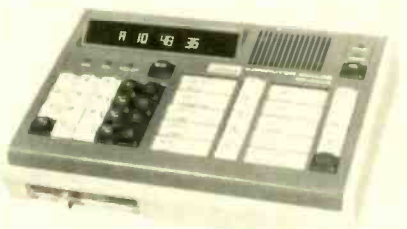
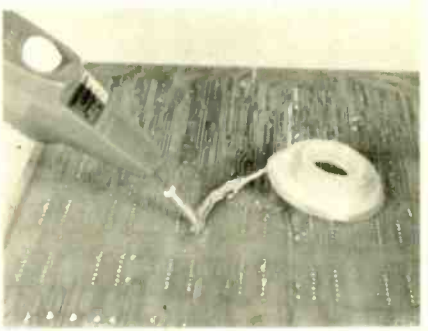
NOVEMBER 1979 Vol. 50 No. 11

ON THE COVER

This is one of the most exciting computer projects we've seen. It will enable you to interface almost any prototype circuit to a TRS-80 computer. Modified, it can probably do the same job for any other computer system. If you've got a computer, this story is must reading. If you don't own a computer, read this article first.....story starts on page 43



TELEPHONE DIALER Roundup. Some even come equipped with a calculator and clock. Story starts on page 48.



JUST ONE OF THE MANY desoldering techniques illustrated in this issue. To see the other approaches you should know about, turn to page 67

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looking ahead

FCC's satellite go-ahead: Quietly and without fanfare, a policy change was made by the FCC that could open the way to a boom in satellite reception in American homes. The Common Carrier Bureau reversed its long-standing policy of restricting the ownership of earth stations to business users and decided it will "routinely" grant applications made by private individuals. Unless countermanded as a result of pressure from broadcasters and others, this means the start of the satellite-to-home transmission era. A few hobbyists have already built their own earth stations, and the pace will now accelerate, perhaps touching off a gold rush to develop a low-cost ready-made antenna-converter combination.

Foiling TV-nappers: Hobbyists who want a free ticket to see pay-TV programs on their home satellite rigs may have to be cryptoanylists as well as electronic technicians. Anticipating the FCC's "decontrol" of earth stations and alarmed by illegal reception of its programs by some cable-TV systems, Home Box Office has embarked on a top-priority search for an ultra-secure encoding system. The system would be installed simultaneously at all cable systems authorized to carry HBO programs, and presumably the code would be changed frequently—perhaps every day. The main requirements, says HBO, are extreme security and acceptable cost. HBO's priorities on security are so high that an official said a contract would be awarded to "the first company that comes through the door" with such a system, which HBO believes doesn't exist yet. A multi-million-dollar contract awaits the person or company coming up with a secure encoding technique acceptable to HBO and other cable companies.

Please note that despite the FCC's new policy, unauthorized interception of pay-TV programs is still illegal, by satellite or any other means. Pay-TV systems point out it's a violation of the Communications Act's provisions forbidding interception of private communications as well as the federal copyright law and most states' "theft of services" laws.

From space to you: Comsat, America's congressionally mandated monopoly in international satellite communications, shook up the establishment with its disclosure that it wants to provide direct pay-TV service to "millions of American homes" by broadcasting two to six channels directly to small rooftop antennas. Comsat said it would be ready to start the service by 1983, but conceded it would take many years more before governmental roadblocks are cleared away. Comsat's proposal envisions a monthly fee—designed to be less than a family would spend for one night at the movies—to cover antenna and converter hardware as well as programming.

Direct satellite-to-TV-set experiments have been conducted in Canada, India and Japan, to supply remote rural areas with service, and this technique is being widely discussed in Europe as the wave of the future. But although cable TV systems receive their pay-TV programs via satellite in the United States, the subject of regular direct broadcasting to homes (as opposed to the *interception* of broadcast links) has never before been openly proposed here by influential sources. Comsat said it had already opened discussions with program suppliers. Most strongly affected by any such undertaking would be local TV stations, which are already beginning to protest vigorously—arguing that even though the initial proposals envision only pay-TV programming, the authorization of direct satellite broadcasting could eventually result in the addition of commercial channels, put local broadcasters out of business and stifle channels for local expression and local news coverage. Most cable-TV operators also oppose the proposal, and their argument is that broadcast programming must be limited by spectrum availability, while cable theoretically could provide hundreds of channels. But some major pay-TV proponents may not protest so loudly—seeing an opportunity to join in a nationwide satellite operation themselves.

Any such satellite broadcasting operation presumably would require a great deal of technical as well as economic and political consideration by the FCC. Quite likely the transmission would be in the 12-gigahertz band, to permit the use of small receiving dishes. Those frequencies aren't allocated to satellites in the United States, although they are in other countries.

3M into videodiscs: Videodisc fever is spreading. One of America's top industrial firms, 3M, has decided to go into the mastering and pressing business "for any viable videodisc system." It will start before the end of 1980, its first project being the manufacture of industrial-educational discs for the Thomson-CSF optical system. Although this system has been out of the limelight for a year or more, it was one of the first to be developed. It differs from the technique used in the *DiscoVision* records played on Magnavox and MCA optical players in that its discs are transmissive rather than reflective. In the Magnavox-MCA players, the laser beam is reflected by the disc to a light-sensitive detector. Thomson's discs are transparent and the laser light shines through the disc to a detector on the other side, being modulated (like the reflective system) by pits in the disc. The French company claims three advantages for its system: (1) Being uncoated, the discs are simpler to manufacture. (2) The discs can be made thin and flexible and can be sent through the mail in thin envelopes. (3) Both sides of a disc can be played in sequence without turning the record over—by simply refocusing the laser to play the far side after the near side is finished.

Thomson is still vague on its plans for the consumer market. It will build no more than 1,000 players in 1980 at about $3,000 each for business and institutional users. Each disc can play for up to 30 minutes per side.

While Magnavox was continuing to enjoy a monopoly on players for the home, this seemed destined to come to an end soon. Players built in Japan by Universal-Pioneer, a jointly owned subsidiary of MCA and Pioneer Electronics, are due to arrive here soon, probably under the Pioneer brand and possibly other trade names as well. This system is compatible with that used in Magnavox's *Magnavision* players. And before the year is over, an announcement is expected by RCA about its plans to introduce its non-compatible capacitive system. It's expected to be in large-scale production about a year from now. At least one Japanese-developed system could be headed this way within a year.

DAVE LACHENBRUCH
CONTRIBUTING EDITOR

HITACHI OSCILLOSCOPES

Single and dual trace, 15 and 30 MHz. All four high sensitivity Hitachi oscilloscopes are built to demanding Hitachi quality standards and are backed by a 2-year warranty. They're able to measure signals as low as 1mV/division (with X5 vertical magnifier). It's a specification you won't find on any other 15 or 30 MHz scopes. Plus: Z-axis modulation, trace rotation, front panel X-Y operation for the dual trace models, and X10 sweep magnification. And, both 30 MHz oscilloscopes offer internal signal delay lines. For ease of operation, functionally-related controls are grouped into three blocks on the color coded front panel. Now here's the clincher: For what you'd expect to pay more, you actually pay less. Suggested list price of our top line V-302 dual trace 30 MHz is only $945.00. The other models comparably less. Check our scopes before you decide.

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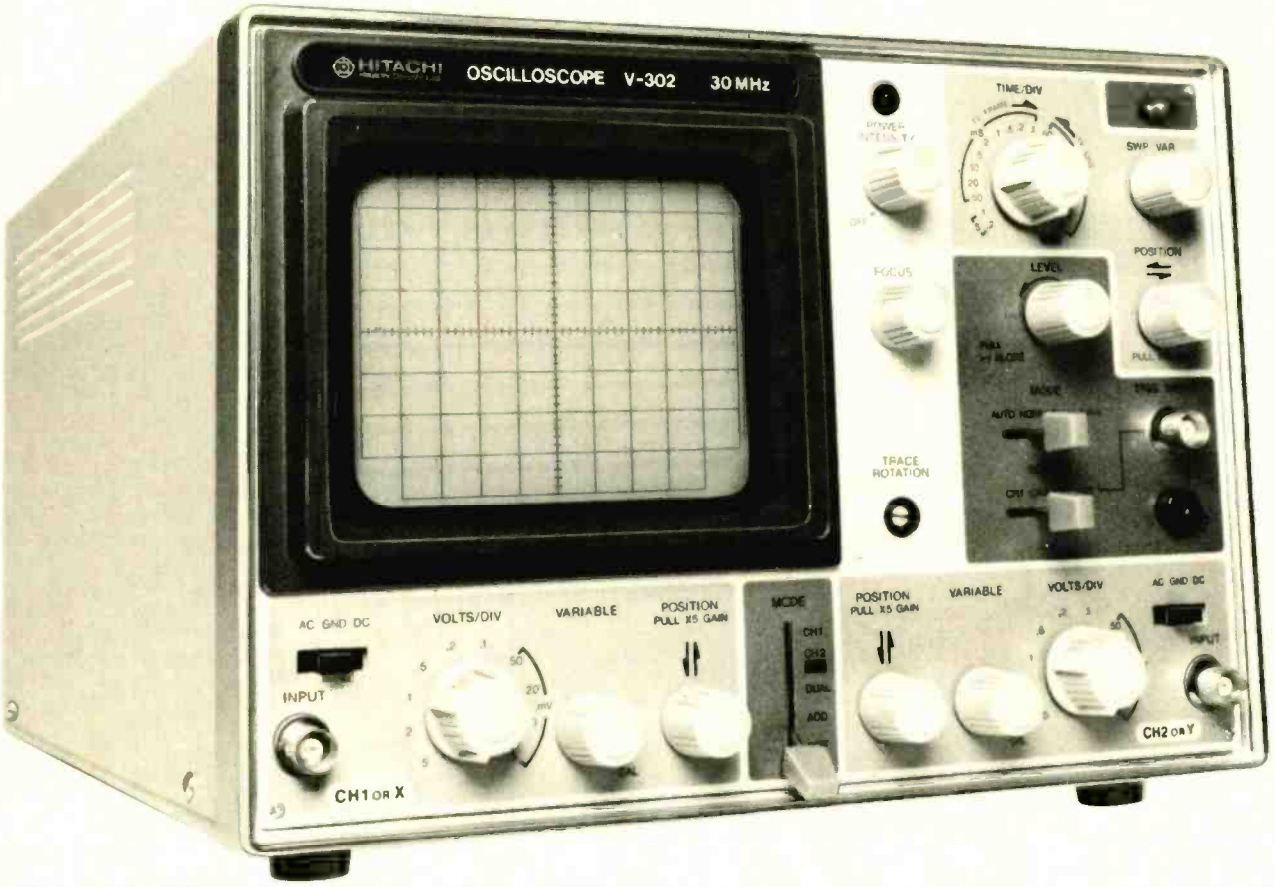


More sensitive to your input.

CIRCLE 54 ON FREE INFORMATION CARD

what's news

Solar energy from spinach?

Scientists of the University of Tokyo's Department of Synthetic Chemistry have discovered that chlorophyll—the substance in green vegetation that turns solar energy into food for the plant—may be a more efficient transformer of sunlight into electric power than most of the substances now used for the purpose. The Japanese research team reports efficiencies as high as 30 percent. In contrast, the efficiency of ordinary silicon solar conversion cells runs around 10 percent.

The scientists made their laboratory electric generator by coating a transparent crystal of tin oxide with a mixture of chlorophyll obtained from spinach and lecithin, a common substance found in egg yolks and other foods. The coated crystal was then installed as the positive terminal in a transparent cell, which was energized by an arc lamp.

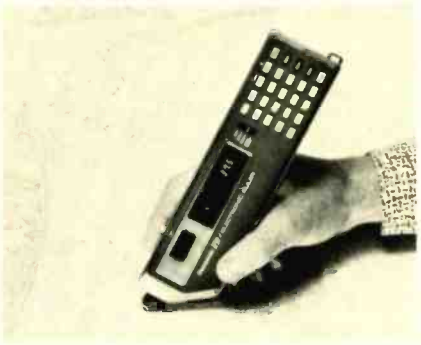
New "paper-thin" batteries are introduced by Panasonic

A new ultra-thin dry cell, specially suited for low-drain (20 to 50-μA) applications, has been put on the market by the Electronic Components Division of Panasonic Co. It is expected to find wide uses in miniature calculators, wrist watches, cameras and similar instruments.

The feature that distinguishes this battery from ordinary dry cells (other than its shape) is the use of a zinc perchlorate electrolyte. This makes it possible to use a flat anode of stainless steel, instead of the round carbon rod of the ordinary dry cell. (The ammonium chloride of a regular dry cell would attack and destroy a stainless steel plate.) The new battery can be made in almost any desired shape, giving the designer of new products wide opportunities in miniaturization.

A typical battery with a capacity of 27 milliampere-hours is 70 mm long, 20 mm wide, and only 0.8 mm thick (2.4 × 0.8 × .03 inches approximately). Not exactly paper-thin, but no thicker than about 15 pages of this magazine. Voltage is a standard 1.5.

THIS RULER THINKS



A DIGITAL MEASURING DEVICE, manufactured by Panasonic and marketed in this country by Chavitz Inc. of Rockville, MD, uses a small displacement measuring wheel to measure directly lengths, distances, areas or volumes, in any scale from any document, or from the original regular or irregular surfaces.

Documents on which measurements are made need not be in original scale—variations caused by reduction or enlargement can easily be programmed into the computer and the results will be displayed automatically in the original scale.

Chavitz, who is also the manufacturer and distributor of the BORIS line of chess computers, is selling the new ruler/computer for $99.95.

Space Shuttle will carry first off-world colony

The first colonists in space will be ants, if an experiment conducted by students at two Camden, NJ, high schools is successful. The students are working in an RCA-sponsored educational project, *Orbit '81*, under a NASA program that accepts worthy projects for Space Shuttle rides. The project was accepted by NASA, because it can add to information that may indicate the feasibility of manned colonies in space.

The students found ants specially adapted to the experiment. Ants have a hard exoskeleton that will help them survive the strains of lift-off; they are used to cramped surroundings; and their feet have hairs that can clasp rough surfaces, preventing them from floating around in the space capsule.

The colony—of several thousand ants—will be divided into three parts. One is to be absolutely weightless in space, the second to have a very low gravity, and the third to have a centrifugal motion that will give it above half the gravity of Earth.

The students will study the habits of the colony before it leaves, to be able to make intelligent comparisons with its behavior in space. The ants' full life cycle, including births and deaths, water, food and oxygen consumption, weight, incubation time and other features, will be studied by movie and still photography during the ants' stay in space.

The complete experiment, including a microcomputer, monitoring instruments, cameras and ants, will be returned to the students to complete the study after the Shuttle returns to Earth.

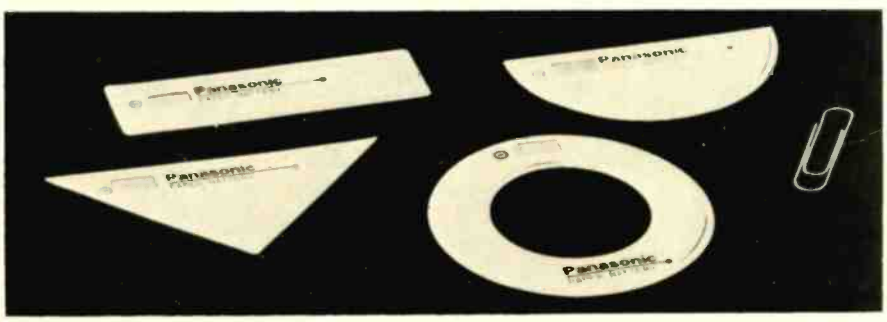
How many watts?

Everyone thinking of acquiring a hi-fi stereo unit is faced with a puzzling question: "What is the correct wattage?" says a press release of the International Radio and TV Exhibition. Held this Fall in Berlin, its audio section offered tests on "the influence of factors that may not be measurable in hi-fi." To the innocent purchaser, the author goes on, the problem is made more difficult because "things are not always what they seem," in electrical music reproduction. A 200-watt amplifier is not necessarily twice as good as a 100-watter—it is certainly not twice as loud.

Explaining that, the well known (at least to readers of this magazine) logarithmic perception of sound, that makes it possible for one to hear the soft rustle of the wind in the leaves, yet not be overwhelmed by the extreme volumes of sound produced by a symphonic orchestra (a range of possibly 130 dB) is detailed. Fortunately, a live orchestra has a range—from softest sound to loudest passages—of "only" 80 to 85 dB, and the limitations of discs and tapes make it necessary to compress that somewhat for recording.

In reproducing music, it is of course desirable to get as close to the original sound as possible. This is not feasible. In listening to recorded music, the sound we hear is composed of the basic noise level of our surroundings—usually about 20 to 30 dB over the lower limit of hearing—plus the level of the orchestra, amounting to as much as 85 dB. This is a maximum level of 115 dB. Not only is this close to the threshold of pain, and capable of damaging the listener's hearing permanently, but is socially impractical. An attached-house or apartment dweller would be ejected immediately. Even a suburbanite's neighbor—if

continued on page 12



SOME DESIGN POSSIBILITIES of the new cell. The one at rear left is the "chewing-gum" battery whose dimensions are given in the text.

can you be bribed?

FREE CATALOGUE "HOW TO RECORD" BOOKLET

You get $35.21 in bribes when you try 10 DAK ML90 high energy cassettes risk free for only $2.19 each. Your bribe is bigger than your purchase!

Hats off to Maxell. Their UDXL cassette established a new standard of sound quality for all cassettes.

The new DAK ML90 starts another new technology. A technology of protection from Hi frequency loss and of extreme reliability.

Later we are going to offer you valuable bribes, just for testing these cassettes. risk free; so read on!

YOUR TIME IS PRECIOUS

Imagine yourself just finishing recording the second side of a 90 minute cassette and horrors, the cassette jams. Tape is wound around the capstan, your recorder may be damaged and you've just wasted 90 minutes of your time and perhaps lost a great recording off FM.

Enter DAK. We manufacture over one million units of cassette tape each month in our factory. Many of our tapes are used for high speed duplication where they are recorded at speeds up to 8 times normal. This is the ultimate stress for cassettes and causes more failures than any other use.

When we first started, 12 years ago, DAK's cassettes failed, just like many others. So we installed over $20,000 worth of high speed duplication equipment at our factory and set out to design the perfect cassette.

MOLYSULFIDE

Failure after failure. For six years we substituted, remade, tested and retested until we positively linked the major cause of cassette failure to the slip sheets, or liners in the cassette. Evidently, 3M and TDK were hot on our heels, because they have now also come out with new liners.

We developed polyester slip sheets with raised spring loaded ridges to guide each layer of tape as it winds. We coat the liners with a unique formulation of graphite and a new chemical, molysulfide.

Molysulfide reduces friction several times better than graphite and allows the tape to move more freely within the cassette. The molysulfide is tougher and makes the liner much more resistant to wear.

Hi frequency protection! Tape is basically plastic, and as it moves within the cassette internal friction causes the build up of static electricity, much as rubbing a balloon against your hair, or scuffing your shoes on a carpet in dry weather.

Static electricity within the cassette was drastically reduced by the low friction of the molysulfide and easily bled off, so that its tendency to erase very high frequencies was drastically reduced. A very important consideration for often played tapes.

MAXELL IS BETTER

Yes, honestly, if you own a $1000 cassette deck like a Nakamici, the frequency responses of Maxell UDXL or TDK SA are superior to DAK and you just might be able to hear the difference.

DAK ML has a frequency response that is flat from 40cps to 14,500 ±3db. Virtually all cassette recorders priced under $600 are flat ±3db from 40cps to about 12,000cps, so we have over 2000cps to spare, and you'll probably never notice the difference.

No apology. We feel that we have equaled or exceeded the mechanical reliability of virtually all cassettes and offer one of the best frequency responses in the industry. Maxell UDXL is truly the Rolls Royce of the industry, and DAK is comparable to the 100% US made Cadillac or Corvette!

Price DAK manufactures the tape we sell. You avoid paying the wholesaler and retailer profits. While Maxell UDXL 90s may sell for $3.50 to $4.50 each at retail, DAK ML90s sell factory direct to you for only $2.19 each complete with deluxe boxes and index insert cards.

YOU WIN

You are paying less for the 10, 90 minute cassettes than you would pay for the comparable bribes we are offering if you went to a Radio Shack store.

Yours Free

CHECK THE VALUE OF THE DAK BRIBES AT RADIO SHACK

The next time your batteries are dead in a calculator, radio, flashlight or battery operated recorder, you'll be glad you have this versatile battery eliminator AC adaptor.

You'll save lots of money on batteries because now you can plug in, instead of using up expensive batteries. 4 voltages: 3, 4.5, 6 and 9 volts plus 4 plugs to fit virtually anything battery powered. Radio Shack sells a similar 4 voltage adaptor for $9.95.

Think of it, 10 of the most commonly used six foot hook up cords with RCA plugs at each end. You can connect friends recorders, extra tuners, or virtually any stereo equipment. You'll certainly appreciate these cords in the years to come. Radio Shack sells their six foot cords for $1.89 each.

You need clean tape heads to make good recordings. The easiest way to clean your heads is with DAK's 12 oz. deluxe spray head cleaner, complete with handy snorkel tube. Radio Shack doesn't sell a single large 12 oz. can, but 12 oz. from them costs $6.36.

The comparable Radio Shack prices are not list prices, but the actual prices you would pay at a store when this ad was written.

Yours Free

WE WIN TOO

Customers like you are very valuable in the form of future business. We anticipate receiving over 6000 orders and 4500 repeat customers from this advertisement to add to our list of over 57,000 "actives." We are betting you will buy our cassettes again, and we are putting our money where our mouth is!

TRY DAK ML90 FREE

We want you to try these high energy cassettes on your own recorder without obligation for 30 days. If you aren't 100% satisfied for any reason, simply return the tapes and bribes to DAK for a full refund.

To order your 10 DAK ML90 minute high energy cassettes and receive your $35.21 bribe with your credit card, simply call toll free 800, 423-2636, (in Calif. call 213-984-1559) or send your check for $21.90 plus $3 for postage and handling for each group of 10 cassettes and bribes to DAK. (Calif. residents add 6% sales tax).

DAK unconditionally guarantees all DAK cassettes for one year against any defects in material or workmanship.

Why not order an extra group of 10 DAK ML90 cassettes for yourself or a friend? We will add one free ML90 cassette to each additional 10 you buy and of course you get all 3 bribes with each group of 10 tapes.

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what's news

continued from page 6

he lived only a hundred yards or so away—might find it necessary to call the police if the hi-fi enthusiast tried to reproduce a symphonic orchestra at near original level.

Then how much power—how many watts—should one use? People do listen comfortably to some types of music at a living-room volume produced by only one watt. Orchestral or rock music requires more. But how much more? And what will that mean in watts? Four times the sound level of 1 watt represents an increase of 20 dB, which requires 100 times as much power, or 100 watts. And if we want a "pulse peak reserve" of only 3 dB, the output has to go up to 200 watts.

So, concludes the author, we see that hidden reserves of power are by no means unrealistic for a good sound system. Of course, one must always take into account the varied and various influences of living space, speaker design and other factors. But it is by no means a mistake to err on the generous side, to benefit acoustically from reserves when it becomes desirable.

Satellite-direct-to-home TV is possible in near future

The Communications Satellite Corporation (COMSAT) is eyeing the possibility of offering a direct satellite-to-home television service, with the subscriber paying a monthly fee to lease a 3-foot dish antenna on his roof (or in his attic) and an unscrambler to decode the signals. The satellite would transmit several types of information simultaneously and the subscriber could select entertainment, first-run movies, sports events or the other regular features of today's Pay TV.

"The technology for such a system already exists," reports COMSAT president J.V. Charyk. "We are investigating the business potential for satellite-to-home service."

The whole nation could be covered by a single satellite, and the present advantages of cable TV could be enjoyed by isolated subscribers, or those in areas too sparsely populated to attract a cable system.

If the project is adopted by the corporation and approved by the FCC, satellite-to-home TV could become a reality by 1983, COMSAT believes.

Microprocessors taking over in children's toy field

Microprocessors are beginning to dominate children's games, states Texas Instruments, whose "miracle chip," the TMS1000 microprocessor, is the heart of many of these new games. TI reports that virtually all the big toymakers are getting into the electronics market, and that there are already more than a hundred electronic toys.

Among the new ones named are *Stop Thief*, a cops-and-robbers game in which two to four players track down a gang of thieves with the help of a hand-held Crime Scanner. The Scanner starts the game off with an alarm, controls the crooks' moves and gives audible clues—the sound of broken glass or running footsteps, for example. If the players win, the cops arrive with sirens sounding, fire three shots, and cart the thief away.

Another new toy is Milton Bradley's *Big Trak*, a truck that can be programmed to follow almost any route, avoid obstacles, dump its load on command, and return to its starting point.

Microvision, a handheld video game, has its own screen, and a series of cartridges to play such games as Bowling, Pinball, Blockbuster and others.

a

b

BIG TRAK, Milton Bradley's programmed truck, is shown at *a*. Microvision, with six extra game cartridges is shown at *b*.

Kenner Products has expanded its "Star Wars" line with *Electronic Battle Command*, a game of strategy on three levels of complexity along with a self-teaching mode. Numerous other games range from bowling and basketball to way-out *Astrology Computer*.

Some leaders in the toy field predict that in a year or two we may see a "smart doll" with a vocabulary of several hundred words, among other features. Others declare that the field is just opening—that it would be unwise to even try to guess at the future of the electronic toy.

DC transmission links may end future widespread blackouts

An experiment now under way in the Consolidated Edison facility in Queens (NY) may, if successful, spell the end of long-range spreading of electric power blackouts. One of the worst features of these power failures is they tend to spread rapidly over large areas. With our present grid system, the large numbers of communities, small generating systems and large sources of power (such as hydroelectric plants) are all tied together, and all can be affected by a failure of any one of them. It is now quite possible (though unlikely) that a single catastrophe in an isolated area could black out the whole United States east of the Rockies.

The reason is that if a bolt of lightning, equipment failure or other cause cuts off a substantial portion of the power to a given area, the generators in that area can become overloaded and slow down enough to throw them out of sync with other generators on the same grid. Unless engineers act promptly to "shed" a portion of the load (cut off customers) when outside power fails, this can cause the various generators on the grid to buck one another, working 180 degrees out of phase at certain instants, thereby reducing power to zero and throwing emergency circuit breakers throughout the system. The condition spreads quickly and one area blacks out after another.

A solution for this problem is to use direct current transmission where power is to be transmitted any great distance. Direct current, of course, cannot get out of phase, and a DC link between an affected area and one operating normally would not carry the out-of-phase condition that spreads the blackout.

Direct-current transmission has another advantage—it is more efficient than AC. Because the AC peaks every half cycle, AC lines have to be built to withstand a voltage nearly 50 percent higher than the rated voltage. Thus a 100-kV AC line can carry 140 kV of DC without difficulty. The current peaks at every half cycle of AC as well, requiring thicker cables for the same nominal current.

The main drawback with DC has been that present high-voltage AC-to-DC conversion facilities have had to be extremely large, covering 20 to 30 acres. The Queens facility will produce the same results in an area 60 by 120 feet, making conversion in metropolitan or heavily settled areas practical. The compactness is attained by using sulfur hexafluoride gas as an insulator, instead of air. Distance between pieces of equipment sealed in containers of that gas can be much smaller than if the pieces were separated by air, thus making small, compact conversion stations practical. **R-E**

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RF-2900

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The Command Series from Panasonic. If you had short wave receivers as good. You wouldn't still be reading. You'd be listening.

*Short wave reception will vary with antenna, weather conditions, operator's geographic location and other factors. An outside antenna may be required for maximum short wave reception.

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CIRCLE 38 ON FREE INFORMATION CARD

editorial

Energy Alternatives—Research and Development

Energy crisis, energy shortage, oil shortage, foreign oil, foreign blackmail, conservation, belt tightening, inflation, alternate energy sources—words that are being bandied about by our Government in Washington. The lives of each and every citizen has been affected by the world energy situation. Testimony of this has been the sinfully long gas lines that formed this past summer on the East and West Coasts and by the runaway inflation rate that has cut sharply into our wallets.

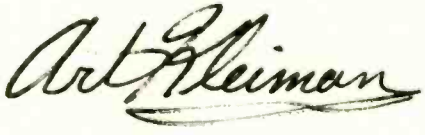
There are arguments surrounding the validity of the gasoline shortage with "authoritative" sources pointing accusing fingers at each other. What is obvious is that we must search for a cost-effective alternate energy source. One that is pollution free and safe for the citizens of our country. Of the many possible choices—geothermal, thermal electric, magnetohydrodynamic to name just a few—the most promising is solar energy produced from solar thermal panels and photovoltaic cells. Solar energy has the inherent benefits of being pollution free, safe and sustaining minimal operating costs. Photovoltaic solar cells have the additional advantage of being a direct converter of solar energy into electric power.

The major problems hindering the application of photovoltaic solar cells is the manufacturing cost and conversion efficiency. Advances have been made in both these areas. New manufacturing methods promise to substantially lower cost, albeit a one time capital outlay. Efficiency has also improved. The original solar cell, introduced in 1954 by Bell Labs, provided a conversion efficiency of 6 percent. Present silicon solar cells operate at 18 percent. Its interesting to note that both of these advances have come about by privately-funded research.

Now, from the University of Tokyo's Department of Synthetic Chemistry, comes the discovery that chlorophyll (the substance that makes plants green and combines carbon dioxide with sunlight to form oxygen and sugar) when added to a photovoltaic solar cell, raises the conversion efficiency to a reported 30 percent. All these advances combine to make solar energy more promising than ever as a viable alternate energy source.

How does our Government view solar energy? The 1979 Estimated Federal Budget for energy-related matters comes to the tune of 8,630 million dollars. Out of that sum, a total of only 105 million dollars will be spent for research and development of the solar cell. That's a little over 1 percent of the total Federal Energy Budget. A mere pittance of the required amount. Much more needs to be spent.

If you agree, write your congressmen and let them know how you feel. We must solve the energy problem. If you have some suggestions of your own, write me. I'd like to present them in our Letters column.



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letters

1990

As a subscriber to **Radio-Electronics** I was interested to read in the April "Editorial" the fact that you had no response from the dreamers amongst your readers. I have three possible thoughts for you and I believe that two of them, at least, are certainly realistic glimpses of 1990. I see no reason why "spherical television" couldn't be developed. This would reproduce TV transmissions in their dimensional entirety; one could walk around the back of a TV and see the back of a newscaster. This could possibly be achieved through further hologram techniques. I think with a little imagination one could visualize Starsky and Hutch literally chasing through your front room—full sized.

Another idea that may well be with us by then could be the use of computers to color old black and white films. The computer, under the supervision of a technician, could establish shapes and outlines and assign predetermined colors. These could be done frame by frame, automatically. Of course, adjustments would be necessary from time to time but it would certainly beat coloring the whole thing by hand, frame by frame. However, by 1990, the whole nostalgia phase may have died away and the need for this instrument could be non-existent.

My third idea is I concede, less practical and not particularly original in concept. I dream of the day matter could be trasmitted via computerized molecular reconstruction. This would mean that the commuter could travel by computer and the lyrical thought is nearly as exciting as the technical conception.

MITCH MURRAY
British Isles

SOLAR ENERGY

Although a little bit later than other readers, I would like to add a few more facts to the solar energy conversion efficiency controversy.

It was shown by Mortimer et al in the (*Journal of Chemical Physics* 35, 1013 (1961) that a similar formula to the one for the Carnot cycle could be applied to photochemical conversion: efficiency $(1 - (T_s/T_L) \times 100$ where T_L = temperature of the light and T_s = temperature of the converter.

Taking 1350 degrees Kelvin as the temperature of light at the earth surface, and 298 degrees Kelvin as the temperature for operating the converter we get maximum efficiency of about 78%.

But not even natural processes, like photosynthesis, operate with efficiencies higher than 36%, mainly due to two reasons:

1. Threshold wavelength. Any process absorbing photons needs a minimum energy for it to take place, so lower energy photons are wasted and energy photons due to quantum restrictions have to be degraded to the right energy, wasting the excess.
2. Spectral absorbence. Known systems do not have a continuous absorption of light above the threshold wavelength, but rather a spectral distribution, so that some of the high energy protons are also wasted.

Besides those, the specific characteristics of any converter will introduce extra losses, thus making the process less efficient. Nevertheless, a photovoltaic converter with an efficiency of 16% is already

continued on page 24

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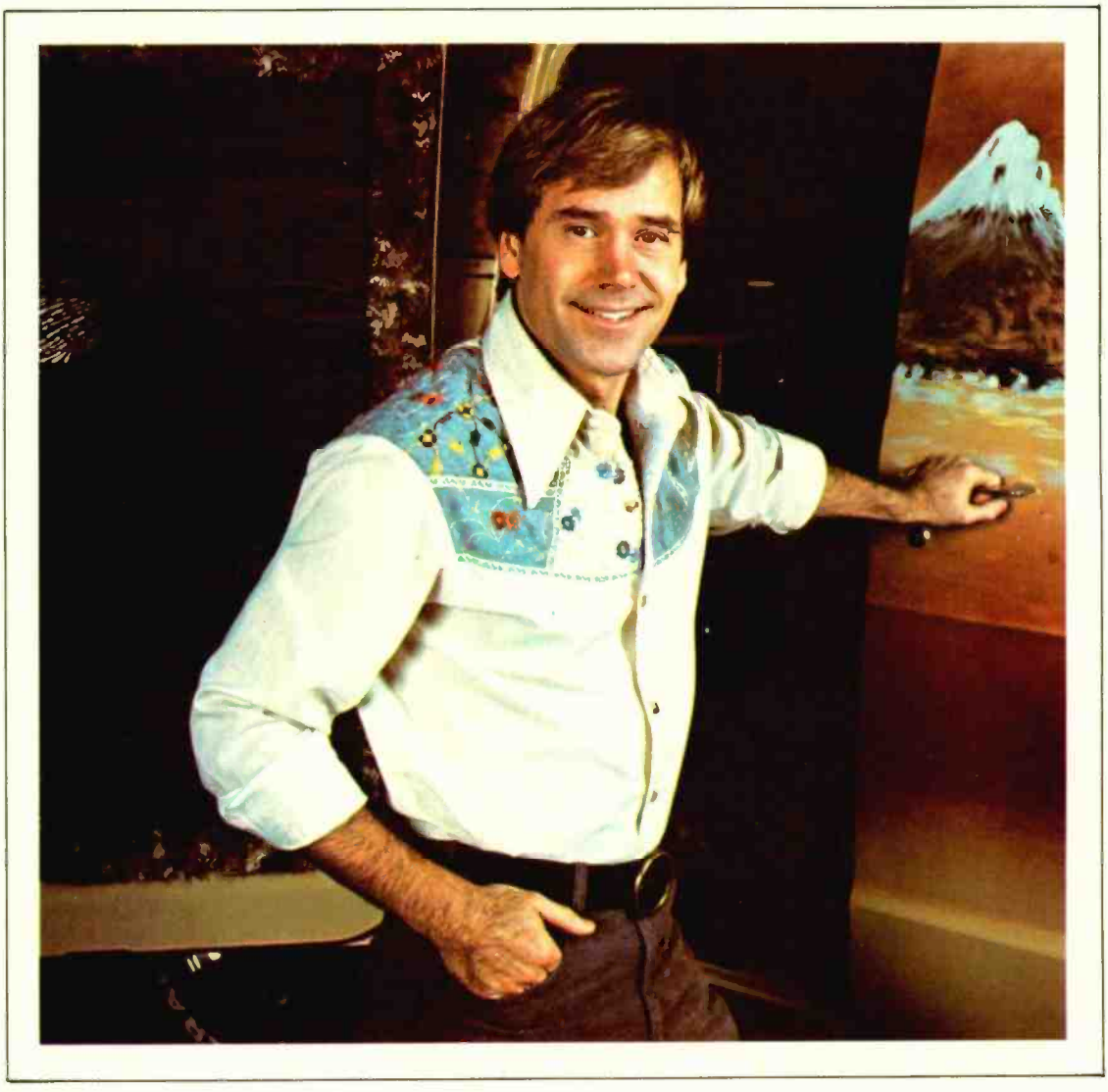

When you do, you'll probably pick CIE. You can't afford to settle for less when it comes to something like electronics training that could affect your whole life.

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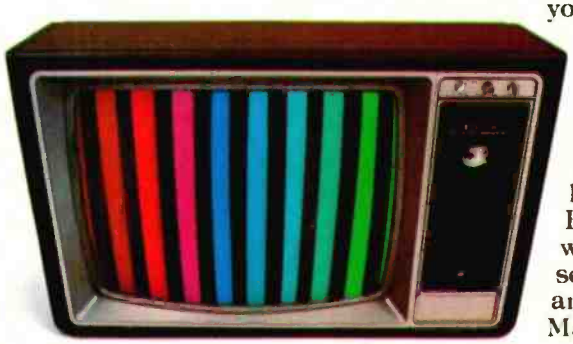

Pattern simulated.

apply your new skills to some real on-the-job-type troubleshooting! You learn to trace signal flow... locate malfunctions... restore perfect operating standards—just as with any sophisticated electronics equipment!

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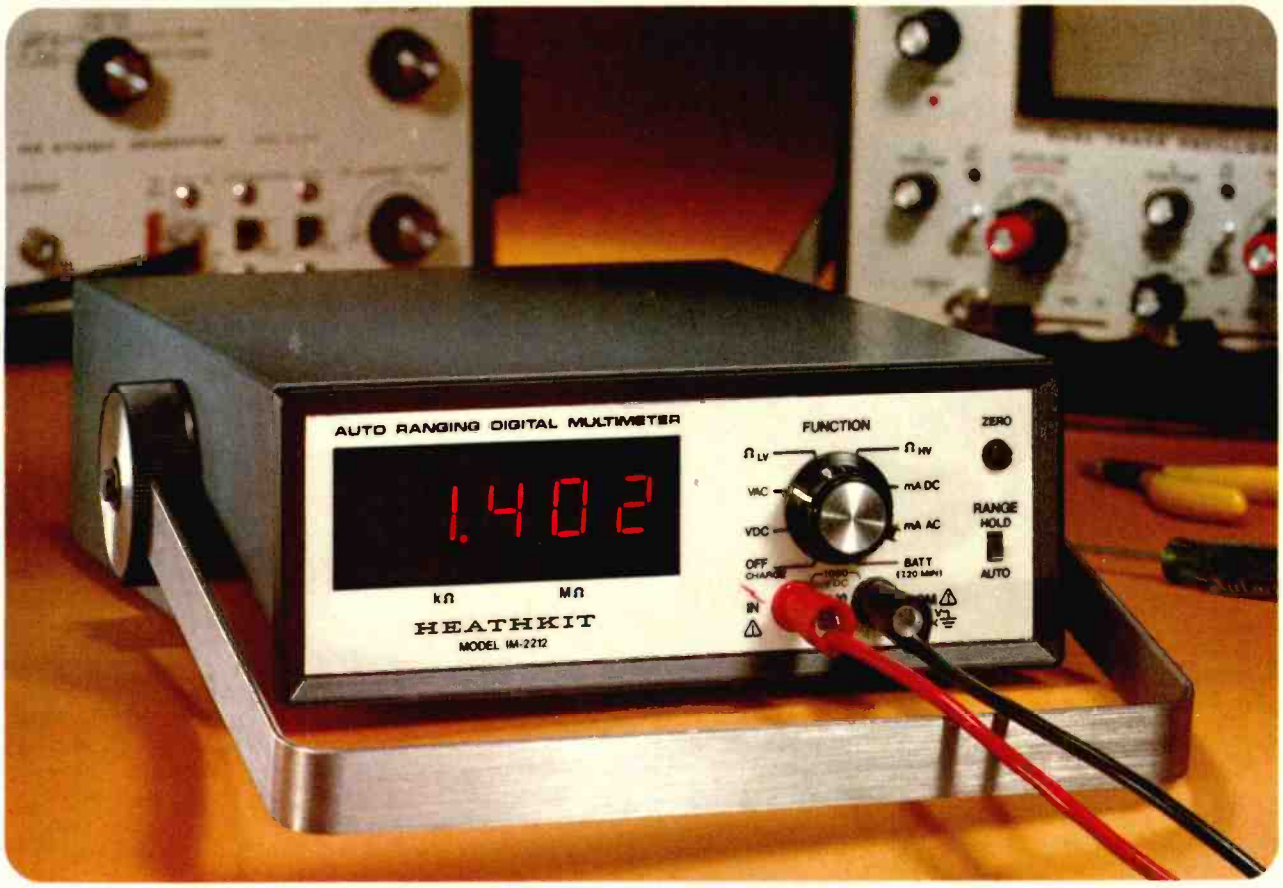

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LETTERS

continued from page 16

competitive where fuel is not easily available and will become a major source of energy if other sources are drained out or priced themselves out of the market.

In conclusion, the energy is there; the only thing that is stopping us from using it is its actual price.

J. MOZOTA
Chemistry Dept.
University of Ottawa
Ottawa Ontario, Canada

HARD TO FIND PARTS

Firstly, I am not a subscriber to your fine magazine. However, I do buy it frequently, depending on articles of interest to me and which are within the limits of my level of comprehension. The latter is almost confined to the name and address of the publisher. I have built quite a few kits and construction projects over the past 20 years or so and still enjoy this hobby. I have enough sense, I think, to know that I can substitute a capacitor of higher voltage for the one specified if I maintain the correct capacitance value. And I have a working relationship with Ohm's Law. But sometimes I feel like questioning that.

And, as Confucious or someone once said, let me make this one thing perfectly clear. I am not picking on your magazine. It seems that my problem crops up in any book for hobbyists and almost every construction feature of interest to me. Sometimes a part is very difficult to find. It would be helpful if the authors would give the name of the manufacturer or a source of supply in such cases. I have a project underway now which will remain unfinished until I can locate one part. The larger supply houses in a nearby city do not stock it and I am unable to find it listed in any of several mail-order catalogs I have on my bookshelf.

Perhaps it is only in projects I try to build, but almost invariably, there will be one part with an incomplete description, for instance, a diode bridge without the amps indicated. When I went to a local electronics distributor operated by a close friend, one who does have considerable knowledge in the field, he was unable to tell me for certain which one I should buy. I know that on occasion a particular value may not affect the operation of the project. If so, "us rank amatuers" would appreciate being told so. I have found that I am not alone in this situation, although most hobbyists are probably not as "rank" as I am. It is somewhat frustrating to buy most of the parts, get a project half finished, and spend hours trying to locate a particular item or guess at a value which was omitted from the article.

If you could publish this or pass it along to authors, it would be appreciated. As of this moment, in the middle of an unfinished project, I feel my aforementioned level of comprehension is probably limited to a Jack Daniels ad . . . and **Radio-Electronics** doesn't carry that.

NORRIS BLACKBURN
Morristown, TN

Many thanks for your comments about our construction articles. We are always concerned about the availability of parts, since this is one of the most difficult chores a reader must go through before he can build any project that appears in the magazine. We didn't realize that we had missed things like amperage values on power supply diodes, and if we did, we sincerely apologize for it. But remember, any time you cannot locate complete information on a part that you need to build a project, please write us. We'll do our best to point you in the right direction.—Editor.

COMPUTER GENEALOGY

I have a specialized interest and I need the help of others with a similar interest.

Briefly, I bought a microcomputer last year in the hope that it would bring order out of chaos in the collected documentation I have of several thousand ancestors. I would like to be able to store, file, sort, retrieve, and cross-reference genealogical data. I would like to be able to have a pedigree, individual and family group printouts as well as indexes. The Mormons have done excellent work, but they use IBM 370's. Some work out of the University of Utah has focused on minis using an excellent soundex code with printer systems for parents and progeny, but the adaptation to micros is not clear.

I would like to hear from others of a similar interest (it also has relevance to tracing genetic disorders and there are other analogs) so that possibly a network of information could be pooled and shared.

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CIRCLE 8 ON FREE INFORMATION CARD

equipment reports

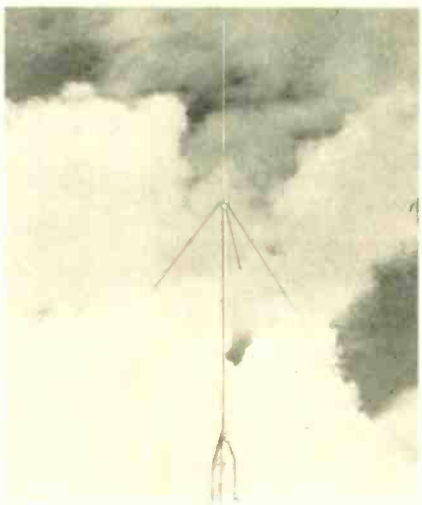
Antler Model B12 CB Base Antenna

ALTHOUGH THE NAME ANTLER ANTENNA IS A relative newcomer to the hotly competitive CB accessory field, their claim to being the "fastest-growing antenna company in the world" was hard to ignore! We decided to test one of their products—the *model B12* ground-plane vertical antenna—for quality and performance.

Although the *model B12* is advertised as a "gain antenna," it is really no more so than any other ground-plane antenna. In this case, the gain refers to an improvement in radiation and reception pattern over a reference antenna, usually a dipole. Occasionally, the reference is to an "isotropic radiator," a theoretical element that radiates its signal uniformly in all directions. Since Antler makes no mention as to what type antenna the gain is measured against, the reference is problematical.

The antenna comes packaged compactly, ready for easy assembly. The instructions are clear, orderly, well illustrated and easy to follow.

The antenna elements and mount are made



CIRCLE 101 ON FREE INFORMATION CARD

of heavy-gauge aluminum, and they should resist strong wind gusts and ice-loading.

It should take about 30 minutes to become thoroughly familiar with the instructions, match the hardware and assemble the antenna as directed. It is a good idea (and recommended in the instructions) to use silicone grease on all electrical-contact parts to avoid corrosion.

With the antenna fully assembled and the telescoping elements adjusted for proper length (as directed), the antenna was roof-mounted on a short metal mast and connected to a 100-foot length of RG-8/U 50-ohm coaxial cable. An SWR meter was connected in-line at the CB rig, and the system was checked for reflected power. Without any readjustment being made, the VSWR read less than 1.05:1; the needle hardly moved when set to show reflected power! Obviously, the system was well matched.

The instruction sheet also provides several helpful hints for antenna installation, as well as suggestions for adjusting it to different surroundings in order to optimize its performance.

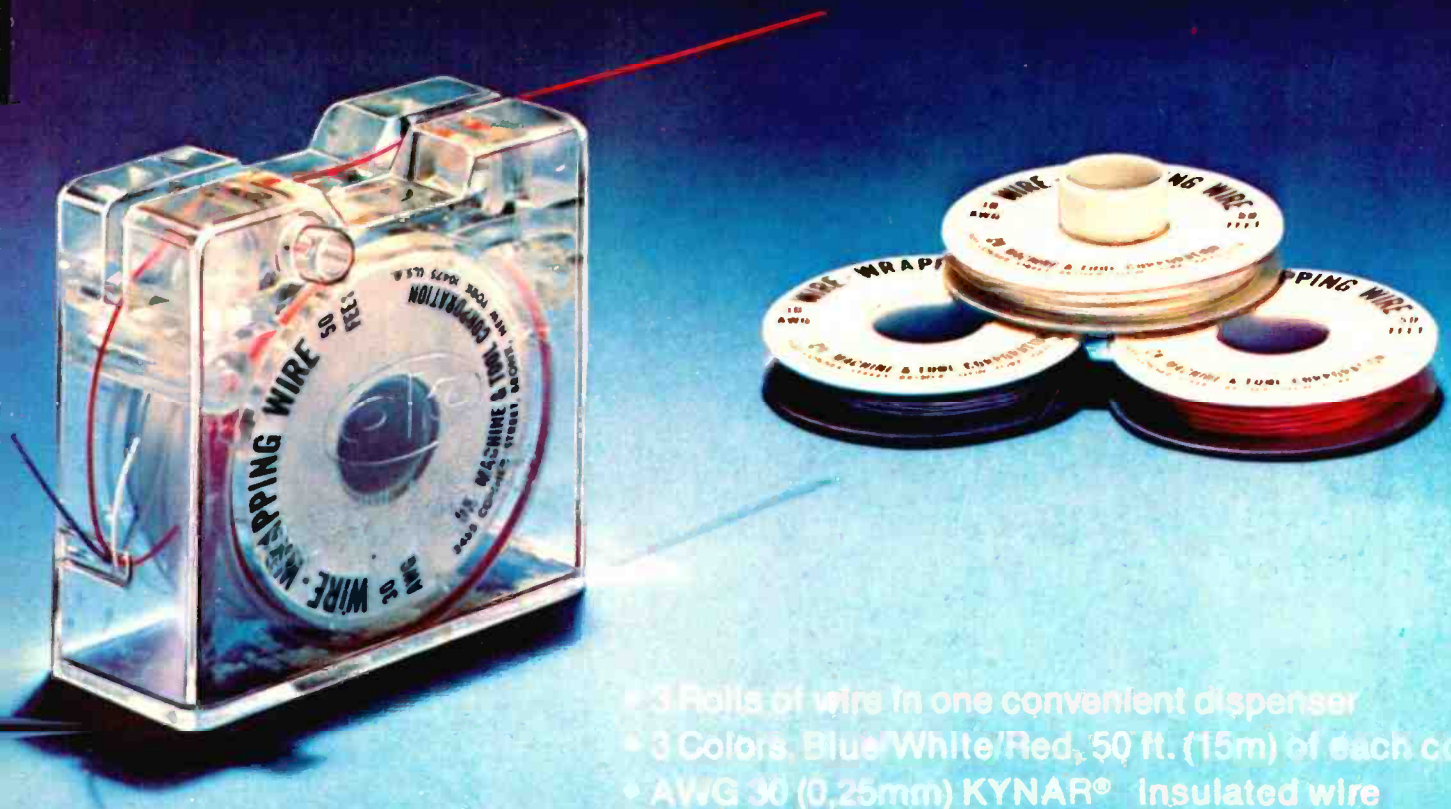
An on-air check showed the *model B12* to be radiating well; several local CB'ers gave glowing reports on the signal strength (no, we weren't using a linear amplifier!).

In sum, the *model B12* is a satisfactory choice. It is a well-designed, simple quarter-

continued on page 32

TRI-COLOR

WIRE CUTTING AND STRIPPING DISPENSER



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wave base antenna for general CB applications. It is manufactured by Antler Antennas, 6200 South Freeway, Fort Worth, TX 76134, and sells for $34.95. **R-E**

Zemco Model 44 Compucruise Automotive Travel Computer

CIRCLE 102 ON FREE INFORMATION CARD

IMAGINE DRIVING DOWN A DESERTED ROAD late at night. The next town is 25 miles away and a glance at the gas gauge reveals a rather sticky situation. Should you immediately start looking for a gas station or is there enough gas to make it to town? The immediate search may prove fruitless, leaving you stranded.

You reach towards your dashboard mounted *Compucruise* and depress two keys on the 30-key keyboard. The digital display shows 30, indicating that you have 30 miles left before your fuel runs out. You can make it to town with 5 miles to spare—end of problem.

TABLE 1

1. time of day—12 hour quartz crystal clock
2. elapsed time—hours, minutes, seconds
3. stop watch, lap timer—hours, minutes, seconds
4. trip time—hours, minutes
5. time to arrival—hours, minutes
6. time to empty—hours, minutes
7. alarm—wakeup or reminder
8. distance traveled since fillup—miles
9. distance traveled since fillup—kilometers
10. distance traveled on trip—miles
11. distance traveled on trip—kilometers
12. distance to arrival—miles
13. distance to arrival—kilometers
14. distance to empty—miles
15. distance to empty—kilometers
16. fuel used since fillup—gallons
17. fuel used since fillup—liters
18. fuel used on trip—gallons
19. fuel used on trip—liters
20. fuel to arrival—gallons
21. fuel to arrival—liters
22. fuel to empty—gallons
23. fuel to empty—liters
24. current vehicle speed—miles per hour
25. current vehicle speed—kilometers per hour
26. average vehicle speed for trip—miles per hour
27. average vehicle speed for trip—kilometers per hour
28. current fuel consumption—gallons per hour
29. current fuel consumption—liters per hour
30. average fuel consumption for trip—gallons per hour
31. average fuel consumption for trip—liters per hour
32. current fuel efficiency—miles per gallon
33. current fuel efficiency—liters per 100 kilometers
34. average fuel efficiency for trip—miles per gallon
35. average fuel efficiency for trip—liters per 100 kilometers
36. inside temperature—degrees Fahrenheit
37. inside temperature—degrees Celsius
38. outside temperature—degrees Fahrenheit (or coolant temperature)
39. outside temperature—degrees Celsius (or coolant temperature)
40. battery voltage—volts
41. cruise control—digitally input speed
42. cruise control—engage at current speed
43. cruise control—resume at last set speed
44. night time display dimming

What is *Compucruise*? It's an automotive travel computer produced by Zemco, Inc., 12907 Alcosta Blvd., San Ramon, CA 94583. It basically takes 4 parameters—time, speed, fuel flow to engine, and gas tank capacity—and derives a whole slew of information. In fact, it's almost mind boggling just how much information can be derived from those four parameters. But *Compucruise* doesn't stop here. It adds two temperature sensors, an audible alarm and an optional cruise control. With these components plus the ability to perform English to metric conversion, *Compucruise* can perform all the functions listed in Table 1.

The main system component is the command module. It measures 6″ wide × 3″ high × 1⅛″ deep housed in a black plastic case with a metallic frontpanel. The command module contains an illuminated 30-key keyboard, blue fluorescent digital display and all the electronics. The rest of the system consists of a fuel flow sensor, a speed sensor consisting of a magnetic pick-up coil that is used in conjunction with magnets mounted on the drive shaft, a brake switch, an optional vacuum servo for the cruise control feature, two temperature sensors, and an audible alarm.

Installation

The first step in installing the system is to mount the speed sensor. This consists of gluing four magnets equally spaced around the drive shaft. After the glue sets, tape is wrapped over the magnets for additional security. A magnetic pickup coil is then mounted to the chassis so that there is a ⅜ inch clearance between the coil and the magnets. As the car moves, the driveshaft rotates and the magnets induce

continued on page 36

NEW ELECTRONIC TRUTH DETECTOR MONITORS THE HUMAN VOICE!

THE TRUTH MACHINE™ T.M.

It gives you an honest answer even if someone else doesn't!

Now you can detect deception with the push of a button. . .anytime, anywhere. The Truth Machine is a new generation voice stress analyzer that is so compact, lightweight, and portable that it easily fits into your desk drawer or briefcase.

And unlike the old-fashioned polygraph it doesn't need wires connecting it to the body. So when you use the Truth Machine you will have to tell your subjects that they are being monitored, because there is absolutely no other way for anyone to know that their statements are being checked for accuracy. *

TODAY YOU NEED A TRUTH MACHINE

You succeed by knowing the answers. By making the right decisions. To make the right decision you need the facts. . .you must know the whole truth. But unfortunately, almost everyone you deal with has a motive to practice at least some deception. Unless you're a mind reader you never know whether or not you're getting a straight answer when you ask:

* Is this your lowest price. . .your best offer?
* Have you mailed that check to me yet?
* Can you deliver my order on time?
* Have you told me everything I need to know?
* Can I depend on you?
* Are these figures correct?
* Are you confident about this investment?
* Will they settle out of court?

When you ask a direct question you deserve a straight answer. And that's the beauty of the Truth Machine; it will give you a straight answer. . .even if someone else doesn't. It's your best possible defense against doubt, risk, and deception.

YES, IT'S ETHICAL!

It's simply a fast, efficient way to verify the truth and protect yourself against dishonesty. And after all, which is immoral - for a person to be deceitful or to have their dishonesty uncovered? There is nothing unethical about uncovering deceit and deception. In fact, you can usually prevent dishonesty simply by letting everyone know that you own the Truth Machine. It's a powerful deterrent for anyone who is tempted to mislead you or tell you less than the truth!

IT'S AMAZINGLY SIMPLE!

Like many technological discoveries, voice stress analyzers grew out of military research during the Vietnam war. Army intelligence needed something better than the standard polygraph to interrogate prisoners. A simple method that could be used without the subject's knowledge. The voice stress analyzer was the result!

The principle is remarkably simple. Scientists already knew lying produced unconscious and uncontrollable stress that could be recorded by a polygraph. Researchers soon discovered that this stress also affected the muscles controlling the vocal cords, and caused an inaudible "microtremor" in the voice. All that was needed was a device sensitive enough to pick up and record these inaudible vibrations. And that was a relatively easy accomplishment considering the state of modern electronic technology.

BUSINESSMEN BECOME MIND READERS

In addition to police and intelligence agencies, many of the "Fortune 500"corporations have quietly been using voice stress analyzers for several years. Large industrial and retail companies use it to control employee theft and screen job applicants. And dozens of large insurance companies have been using voice stress analyzers to uncover false claims. They simply tape an interview with anyone filing a suspicious claim, then play back the recording and monitor it with a voice stress analyzer.

In the past only the largest, most profitable companies felt they could justify spending $1500 to $5000 to purchase a voice stress analyzer. However, like everything else in the electronics field, these high prices reflect the heritage of a prototype, and not the quality of a reliable voice stress analyzer.

The new cost-saving, solid state, micro-chip technology and mass production have made voice stress analyzers affordable. Today, for only $149.00 you can have a compact unit that is far more sensitive than the top-secret units originally used by the military! There is no better way to get at the truth. . .and remove the risk and uncertainty from those important decisions that face you every day!

AND IT'S ENTERTAINING!

Because it can pick up and analyze any audible statement, use of the Truth Machine is limited only to your imagination. Seeing the stress reading go wild when politicians and celebrities give their 'candid' views during television press conferences and talk shows can provide you with hours of amusement, and some very important insight. You can have the satisfaction of knowing the real truth about the energy crisis. . .what people in power really expect from the economy. . .how safe experts actually think you are from a nuclear power plant. . .and you'll find the real truth behind many intriguing and controversial people in the news. You may be surprised!

EASY TO OPERATE!

Unlike the polygraph, there are no sophisticated operating techniques to learn. With our easy, step-by-step instruction manual you can easily master the Truth Machine with only a few hours of practice. You simply turn it on and adjust the sensitivity calibrator knob for average stress in the speaker's voice. Then sit back and watch the LED display. When the numbers on the digital read-out reach the stress area, you know you're hearing less than the truth. And it's versatile. You can pick up the speaker's voice with the Truth Machine's ultra-sensitive microphone. Or use the special sensor that connects it to your telephone. You can even tape a conversation with any standard tape recorder and analyze it at your convenience by attaching the special output jack and playing back the tape!

DEPENDABLE QUALITY

The Truth Machine from Telestar is the ultimate voice stress analyzer. It features solid state electronics and is manufactured to the highest technological standards. Even its tough shatterproof case was designed to withstand the roughest handling. The Truth Machine is designed and built to guarantee you years of dependable use. It should never need servicing. But if anything ever does go wrong, we will repair it through our service-by-mail center and return it to you in a matter of days.

USE IT RISK FREE!

We would like you to use the Truth Machine without obligation for 30 days. Experience its advantages. Take it to the office and enjoy surprising people with your infallible new 'insight.' Use it at home for entertainment and add a whole new dimension to your television viewing pleasure. If you don't agree that being free of doubt makes it possible for you to really relax and enjoy life more. .simply return it within 30 days for a prompt, courteous refund.

* Consent of all parties must be obtained for use in Pennsylvania.

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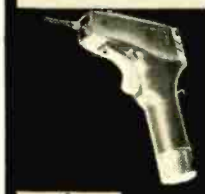
JUST WRAP KIT

JWK-6	JUST WRAP KIT	$24.95



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BW-2630	FOR AWG 26-30	$19.95

Use "C" size NICAD Batteries, not included. Bits not included.

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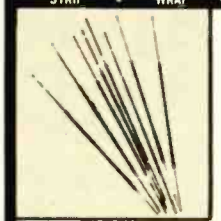

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Wire for wire wrapping, AWG-30 (0.25mm) KYNAR® wire, 50 wires per package stripped 1" both ends.

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30-B-50-020	30 AWG Blue Wire 2" Long	$1.07
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30-W-50-020	30 AWG White Wire 2" Long	$1.07
30-R-50-020	30 AWG Red Wire 2" Long	$1.07
30-B-50-030	30 AWG Blue Wire 3" Long	$1.16
30-Y-50-030	30 AWG Yellow Wire 3" Long	$1.16
30-W-50-030	30 AWG White Wire 3" Long	$1.16
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30-Y-50-050	30 AWG Yellow Wire 5" Long	$1.30
30-W-50-050	30 AWG White Wire 5" Long	$1.30
30-R-50-050	30 AWG Red Wire 5" Long	$1.30
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R-30-TRI	REPLACEMENT ROLLS	$3.95

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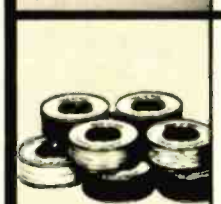

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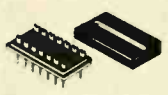

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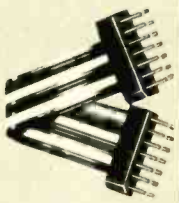

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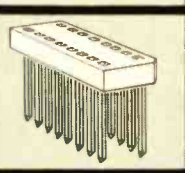

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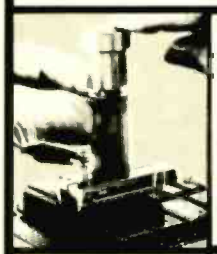

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continued from page 32

pulses in the pickup coil. The command module simply measures the time between each pulse to determine speed and counts the number of pulses to determine distance.

If you've opted for the cruise control feature, the vacuum servo is installed next. This is mounted behind the carburetor and in line with the accelerator linkage using a bracket that is supplied. The installation manual illustrates no less than nine possible mounting variations. The vacuum servo is connected to the accelerator linkage using a bead chain. A hose coming from the vacuum servo must be connected to a vacuum source. This is accomplished by connecting to an engine vacuum hose using a "T" fitting that is supplied. The command module compares the time between the pulses from the speed sensor to a preset value and sends an error signal to the vacuum servo that controls the position of the accelerator linkage and thus the car's speed.

The flow sensor is installed in the fuel line between the carburetor and the fuel pump. A length of rubber fuel line and clamps are provided. The sensor provides a signal that is proportional to the fuel flow to the engine. This is the basis for many of the calculations the command module makes. Also, the command module is initially set up with the capacity of the fuel tank. After fill up, the command module subtracts the amount of fuel that has flowed to the engine from the tank capacity to calculate the various fuel remaining functions, such as distance to fuel exhaustion. The *Compucruise* operating manual therefore recommends that each time you refuel, you fill up the tank and clear the command module's distance and fuel registers by depressing two keys.

The next step in installing the system is mounting the command module on the dashboard. The installation manual, which is easy to read and clearly written, with plenty of illustrations, points out that "it is absolutely imperative that the site selected allows you to view the road while you look at the display. Otherwise, a vehicle accident could result." The actual mounting can be accomplished several different ways. A "U" bracket is supplied for mounting the module either above or below the dashboard. This mounting enables you to tilt the module for better visibility. Two flat rectangular mounting brackets are also provided in case these are easier than the "U" bracket to install. If you're ambitious enough to cut a hole in the dash, two "L" shaped brackets are provided for a flush mount. In case mounting by the brackets is impractical, double-sided tape is provided. This will mount the command module on a flat clean section of the dashboard.

Part of the wiring harness coming from the command module is routed through the fire wall and into the engine compartment. If a suitable hole doesn't exist in the firewall, you'll have to drill one. These wires have push-on connectors and are attached to the vacuum servo, speed sensor, and flow sensor. The rest of the wiring harness remains inside the passenger compartment and is connected to the brake switch. Also connected to the wiring harness is an audible alarm that is mounted at a convenient location under the dashboard.

The next step is to mount the two temperature sensors. The mounting locations for these two sensors depends on which temperatures you care to monitor. The installation manual lists three options—inside (passenger compartment) and outside temperature, inside and coolant temperature, coolant and outside temperature. If you select one of the options that monitors inside temperature, then mount one of the temperature sensors at a convenient location under the dashboard. The other temperature sensor is routed through the firewall and is either mounted in front of the radiator and behind the grill to monitor outside temperature or is mounted against the coolant hose that carries water from the engine block to the radiator to monitor coolant temperature.

Finally, the command module is connected to the car's electrical system. Since the command module contains RAM memory, it requires a constant source of power. However, to reduce current drain when the car is not running, power is cut to the display and the rest of the circuitry when the ignition is off.

Calibration

After installation is complete, you must calibrate the Compucruise system. The first step is to input the capacity of your car's fuel tank. This is obtained by consulting your automobile Owner's Manual. Once the capacity is determined, you enter it into the command module by depressing four keys on the keyboard as outlined in the *Compucruise* Installation Manual.

To calibrate distance and speed, it is necessary to drive the car over a measured distance. This can be accomplished on any of the major highways by using the "mile markers." Other than setting *Compucruise's* clock to the correct time, calibration is complete.

Use

Using Compucruise is not as difficult as it might seem. There are many, many functions and you will have to spend some time familiarizing yourself with the keyboard. But once this is done, the keystrokes involved in displaying a desired function seems natural.

Very few features have been omitted from *Compucruise*. In fact, you would be hard pressed to say "They should have included . . ." Another look at Table 1 will verify this. When you start combining functions, the value of *Compucruise* really increases. For example, you can determine optimum speed for maximum fuel efficiency and then set the cruise control for that speed. Or you can engage the cruise control at your present speed and display at what time you will arrive at your destination.

Compucruise is not a toy. It will tell you when you're not getting maximum gas mileage and therefore need a tuneup. You can easily determine if a particular brand of gasoline gives you better mileage. Having the kind of information that *Compucruise* provides at your fingertips is not only convenient, but in certain situations, important.

Compucruise can be installed in any domestic or foreign car except those with fuel injection or diesel engines. A special adapter, Part No. 44A4W is required for front-wheel drive cars.

The model 44 sells for $199.95. The model 41 (less cruise control feature) sells for $159.95. Not expensive when you consider a major car manufacturer offers a similar device, that does not have half the features or capability of Compucruise, for more than three times the price. And Compucruise offers you the ability to add cruise control to your car. **R-E**

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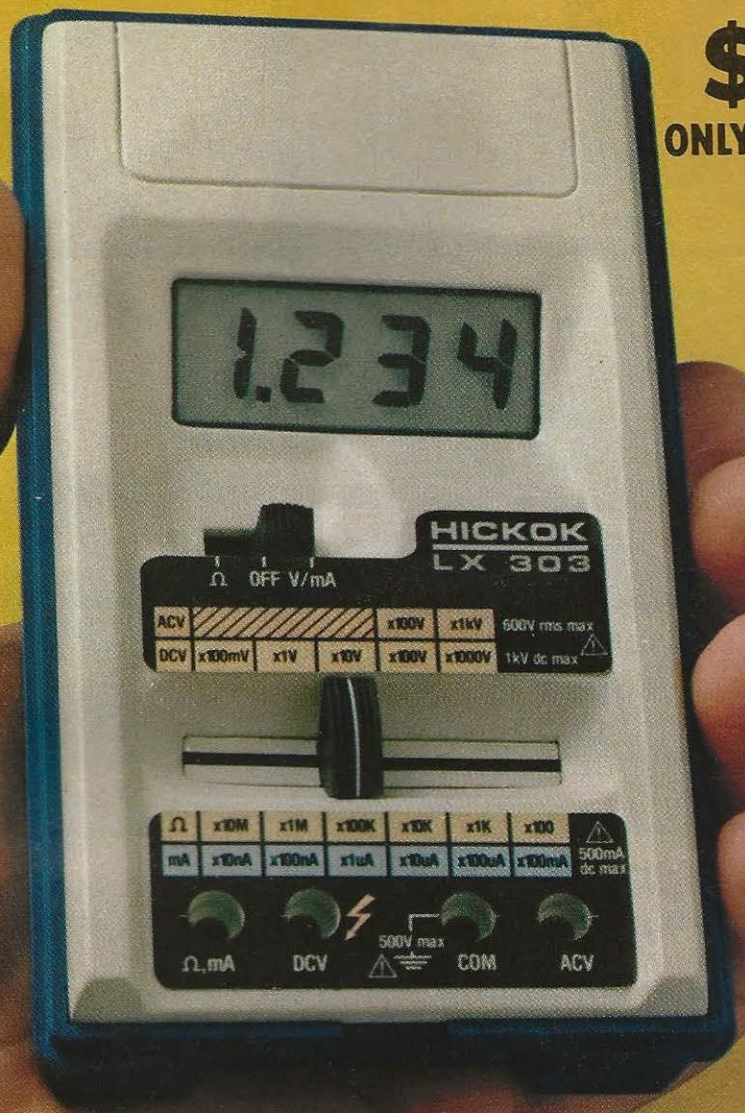

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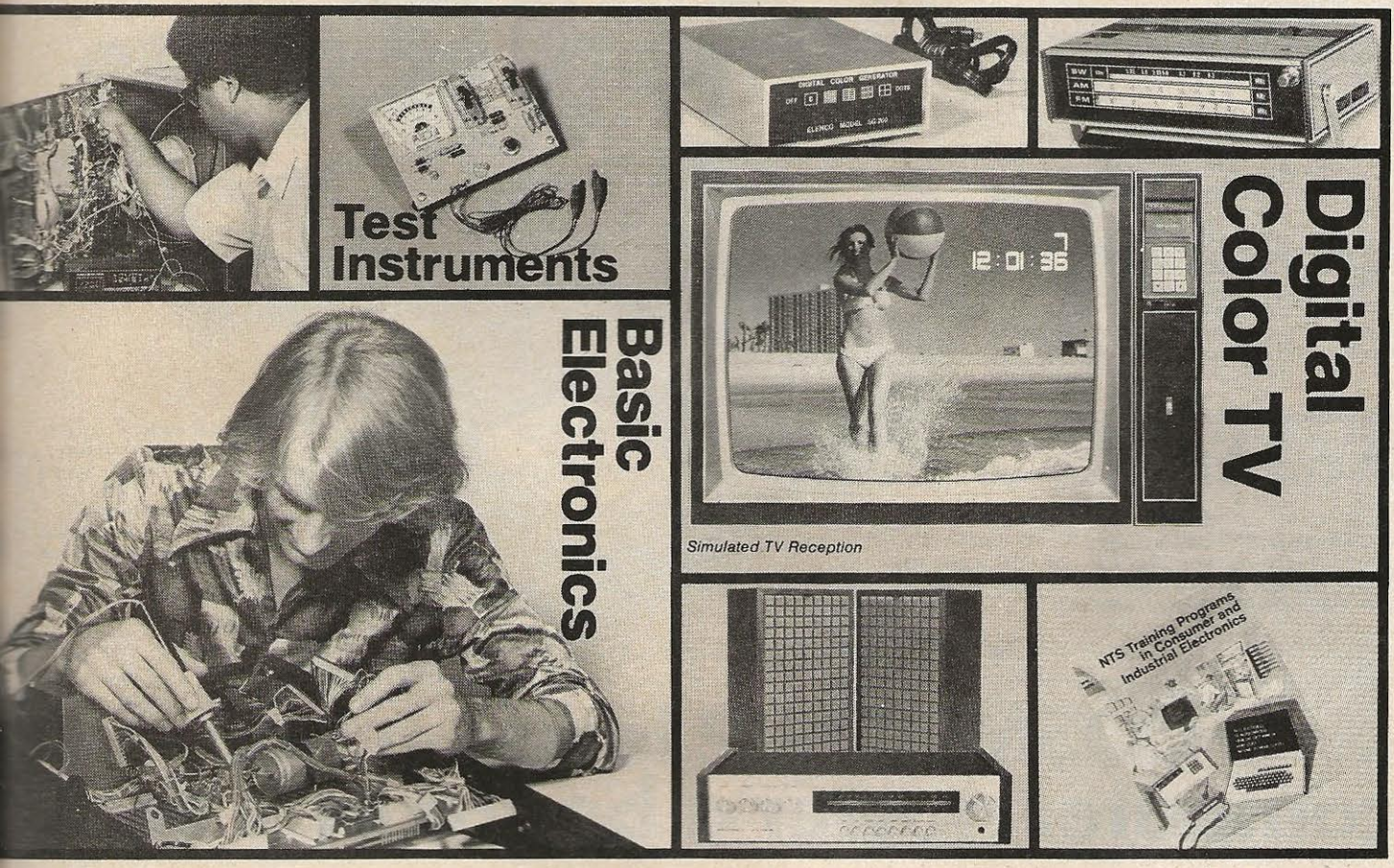

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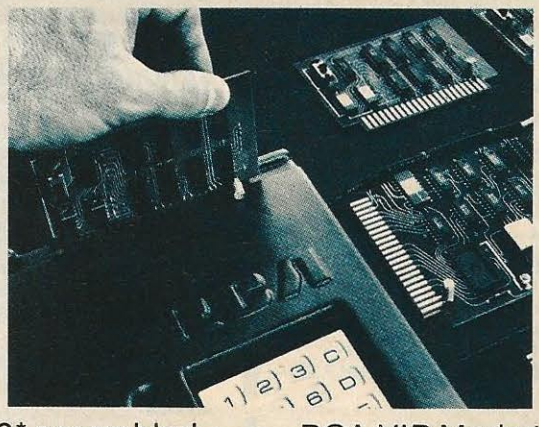

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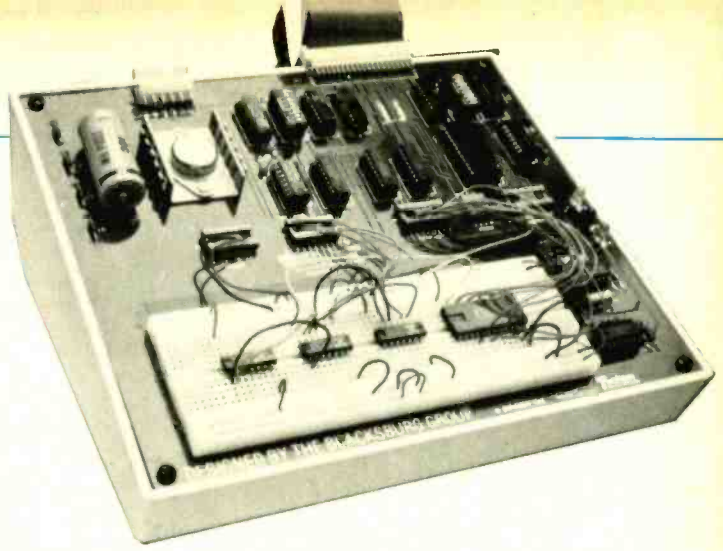

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JON TITUS, CHRIS TITUS, and DAVID LARSEN

MANY OF THE PRESENT *TRS-80* MICROCOMPUTER USERS ARE INterested in data-processing applications, whether they be for game-playing, business-forecasting, inventory-management, payroll-computation, or educational use. Many users are also interested in having their *TRS-80* microcomputer do something outside of the computer itself, in the so-called "real world." Typical real-world applications for the *TRS-80* involve monitoring or testing external devices and performing some sort of control operation based upon the result of a data processing step. Many articles have been written about programming in BASIC, and many BASIC programs have been developed for the *TRS-80*. Very little has been written, so far, that describes the *TRS-80*'s signals, and how they may be used to interface the computer to the real world so that it can perform useful tasks beyond data processing.

The TRS-80

The *TRS-80* computer is available in a number of configurations. Since the *Level-I* BASIC does not include any general-purpose input/output (I/O) commands, it is useless for the control of I/O devices. The *Level-II* BASIC interpreter does recognize four general-purpose I/O commands, so it will be the basis for our discussion. We will discuss these commands shortly, but first, we need to take a look at the *TRS-80*'s signals that are provided for the control of external devices.

If you haven't done so already, you may wish to remove the plastic hatch cover at the left-rear corner of the keyboard's housing. This cover provides access to the RESET pushbutton, and to a double-sided, 40-pin male edge connector. The edge connector provides the means for connecting external devices to the *TRS-80*'s bus. The signals that are available along with their abbreviations and functions, are listed in Table 1. You will note that some of the signal abbreviations are followed by an asterisk. This designates that the signal is normally a logic one, and that the action described takes place when the signal is in the logic zero state. We will use the more familiar "bar" notation throughout this article, since it is a standard. Thus, the *TRS-80* bus signal, IN*, will be noted as $\overline{IN}$.

At this point, the four important bus signals for interfacing are $\overline{IN}$, $\overline{OUT}$, $\overline{WR}$ and $\overline{RD}$, along with the 16-bit address bus (A15–A0), and the eight-bit data bus (D7–D0). Some readers that are familiar with the S-100 bus will wonder about the use of a single data bus, instead of the "split" buses found in some early computer systems. The *TRS-80* uses a single eight-bit bi-directional data bus to communicate between I/O devices, memories and the Z80 microprocessor IC.

The flow of data on the buses is carefully synchronized by the Z80 through the use of the $\overline{IN}$, $\overline{OUT}$, $\overline{WR}$ and $\overline{RD}$ control signals. Individual memory locations and I/O devices are specified by the 16-bit address bus signals A15–A0. The *TRS-80*'s address bus and its control signals are all uni-directional; that is, the signals are all generated by the Z80 microprocessor, and transmitted to external devices.

I/O devices and memory

At this point, we need to distinguish between the I/O devices, and the memory locations that may be addressed by the *TRS-80*. In each case, special signals are generated to control and synchronize the flow of information between the memory IC's, or I/O devices, and the *TRS-80*. An understanding of these signals, and how they affect external devices is very important. In fact, interfacing the *TRS-80* would be impossible if we did not know how to use these signals.

The *TRS-80* addresses a specific memory location through the use of a 16-bit address on the address bus. This gives the *TRS-80* the ability to directly address up to 2^{16} or 65,536 different memory locations. Once the 16-bit address is specified either the $\overline{WR}$ (write) or the $\overline{RD}$ (read) control signal goes low (logic zero), indicating to the memory IC that it is to either "write" the eight-bit value currently present on the data bus into

the specified location, or that it is to transfer the byte contained in that location onto the data bus for a "read" operation. Note that even though your computer may only have 4K of read/write memory associated with it, all 16 of the address lines are used. A timing diagram for the read and write operations is shown in Fig. 1.

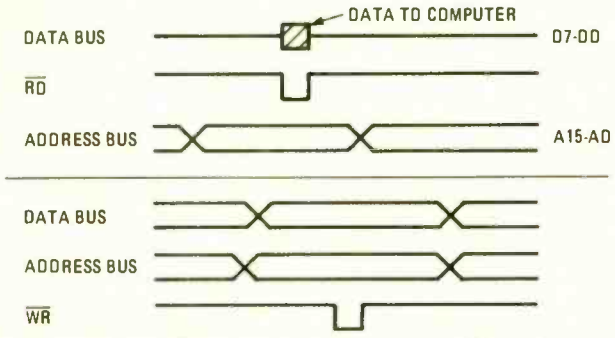


FIG. 1—TIMING RELATIONSHIPS for the memory-read (RD) and memory-write (WR) operations.

The *TRS-80* controls external I/O devices in a similar manner, using the address bus, the data bus, and two control signals. Instead of using the read and write signals, two separate signals are used just for the control and synchronization of I/O devices. These are the IN and OUT signals. The IN signal synchronizes the flow of information *to* the *TRS-80*, while the OUT signal synchronizes the flow of information *from* the *TRS-80* to external devices.

While the address bus is used to address either a memory location or an I/O device, the use of the bus differs in each case. While 65,536 memory locations may be addressed, the *TRS-80* can only address 256 I/O devices, since only address lines A7 through A0 are available for device addressing. This isn't much of a limitation, however, since few users will have more than a few devices connected to their computer system. During I/O device addressing, the remaining address lines, A15 through A8, are used by the Z80 IC to transfer other information, but it is unimportant for I/O device addressing and for normal I/O device interfacing. A typical timing diagram for I/O device addressing and synchronizing is shown in Fig. 2.

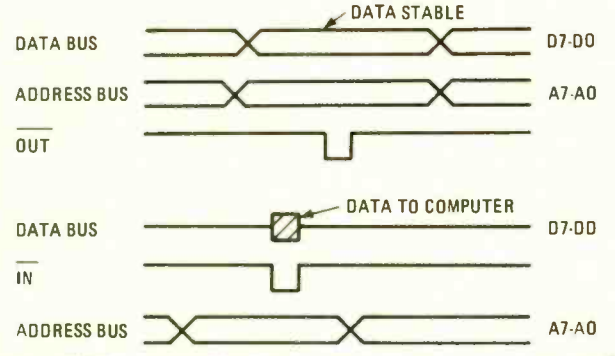


FIG. 2—TIMING RELATIONSHIPS for I/O device data transfers. The IN and OUT signals are about 1.3 μs.

At this point, there are four areas that we must cover before we can interface the *TRS-80*. These are: device address decoding, device selecting, I/O ports, and software (programming).

Address decoding and device selection

These two topics are covered together, since it is difficult to separate them. To address and select an I/O device, the information on address lines A7 through A0, must be decoded so that the addressed device is only selected when the proper address is present on these lines. Since the address bus lines serve two purposes—the addressing of memory locations, and the addressing of I/O devices—some additional information is necessary so that external devices can distinguish between memory addresses and I/O device addresses. The IN or the OUT pulse can be gated with a decoded address signal to provide this distinction.

TABLE 1—TRS-80 EXPANSION CONNECTOR SIGNALS

PIN	SIGNAL	DESCRIPTION
1	RAS*	Row address strobe for dynamic memories †
2	SYSRES*	RESET signal for resetting I/O devices
3	CAS*	Column address strobe for dynamic memories †
4	A10	Address bus bit
5	A12	Address bus bit
6	A13	Address bus bit
7	A15	Address bus bit (MSB)
8	GND	Ground
9	A11	Address bus bit
10	A14	Address bus bit
11	A8	Address bus bit
12	OUT*	OUT signal for the control of output ports
13	WR*	WR write signal for the control of memory-writing
14	INTAK*	INTAK interrupt acknowledge signal
15	RD*	RD read signal for the control of memory-reading
16	MUX	Dynamic memory multiplexer control †
17	A9	Address bus bit
18	D4	Data bus bit
19	IN*	IN signal for the control of input ports
20	D7	Data bus bit (MSB)
21	INT*	INT interrupt signal to Z-80 chip
22	D1	Data bus bit
23	TEST*	Test input †
24	D6	Data bus bit
25	A0	Address bus bit (LSB)
26	D3	Data bus bit
27	A1	Address bus bit
28	D5	Data bus bit
29	GND	Ground
30	D0	Data bus bit (LSB)
31	A4	Address bus bit
32	D2	Data bus bit
33	WAIT*	WAIT generates a processor wait state †
34	A3	Address bus bit
35	A5	Address bus bit
36	A7	Address bus bit
37	GND	Ground
38	A6	Address bus bit
39	+5V	+5 volts (DO NOT USE)
40	A2	Address bus bit

NOTES:
† These signals are not used for interfacing, and no connections should be made to these pins.

* Signals active in the logic-zero state

Viewed from the rear of the keyboard housing, pin 1 is in the upper left-hand corner, with odd-numbered pins across the top, while pin 2 is in the lower left-hand corner, with even-numbered pins across the bottom.

A typical gating scheme is shown in the schematic diagram in Fig. 3. In this simple example, an eight-input gate has been used to detect the proper combination of ones and zeros on the address bus corresponding to the decimal address of 24. While the address output from the NAND gate has been provided, this is not very useful, by itself. The useful signals are those that result from gating the device address output of the NAND gate with function pulses IN and OUT as shown in Fig. 3. Since these are the pulses that are used to select and control external devices, they are called *device select pulses*. In all cases, external devices are controlled through the combination of an address and a function pulse. These are generally gated together to generate a device select pulse.

You should not be surprised to see that the device address that was generated in Fig. 3 has been used with both an input device and an output device. Since the IN and the OUT pulse are never generated simultaneously, each device address may be

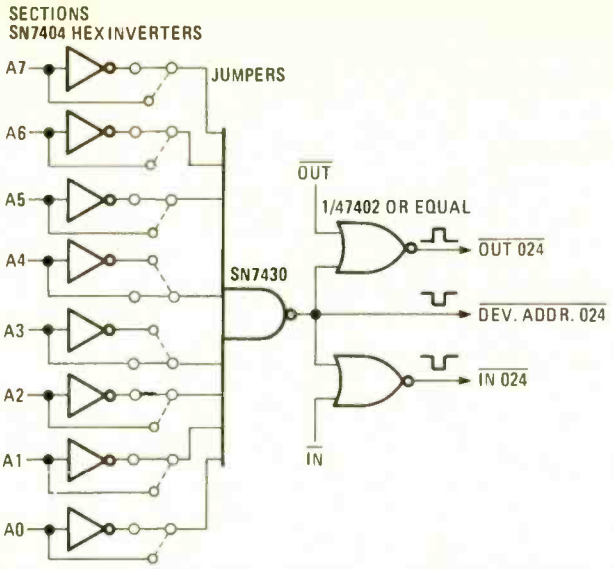


FIG. 3—A SIMPLE gate-based device address decoder and device selector circuit.

used for both an input device, and an output device. In many cases, the two devices with the same address may not be related in function. In general, though, two input devices are *never* assigned the same device address, and the same holds true for output devices. This avoids bus conflicts, much as having people talk in turn avoids the problems that would occur if they all talked at the same time.

I/O ports

Input/output ports, or I/O ports, are easily constructed. In most cases, output ports are simply latches that have their inputs connected to the data bus, and their outputs connected to the device that is to receive the transmitted data. The latches are triggered by an output device select pulse. A typical output port is shown in Fig. 4. Latches are used as output ports, since they

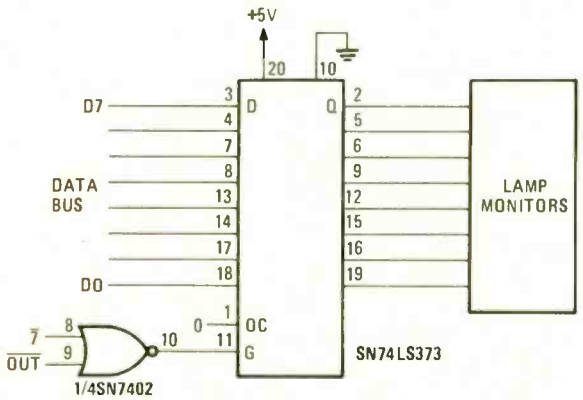


FIG. 4—LATCHED OUTPUT PORT used to drive lamp monitors or other indicators. (0 = ground or logic zero.)

can be triggered with short pulses that transfer information from their inputs to their outputs. When the pulse has been removed, the transferred information remains at the outputs until it is updated with new information or until power is removed from the system. In this way, the information is available to the output port for a long time, in fact, as long as the output device needs it, it is there. If latches were not used, the information would only be present for a short period (less than 2 microseconds in the *TRS-80*), hardly enough time for an external device to print a character, close a relay, turn on a heater, open a valve, or take any meaningful action.

Input ports are generally three-state buffers such as the DM8095, or SN74365 devices. These three-state buffers have a third state that allows them to appear electrically disconnected from the device to which their outputs have been connected. In this unselected, or high-impedance mode, these devices do not present any outputs to the lines to which they are connected, making them ideal for use on the *TRS-80*'s data bus. Since they are disconnected most of the time (when not transferring data), they do not interfere with the normal operation of the other input ports on the bus, or with output ports and memories. A typical input port is shown in Fig. 5.

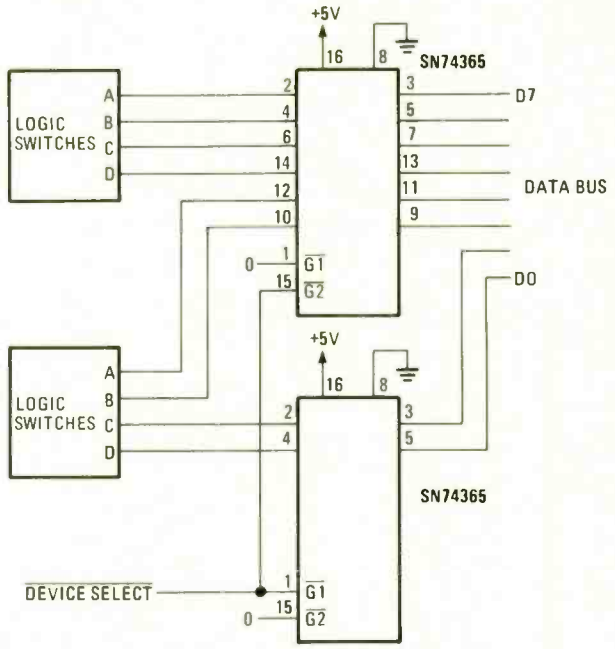


FIG. 5—THREE-STATE input port using 74365 IC's.

A device select pulse is used to turn on the three-state buffers so that they can transfer the information that is present at their inputs, through to their outputs, and onto the *TRS-80*'s data bus. The actual transfer takes place when the $\overline{IN}$ pulse is in the logic zero state. Input ports are activated by a device select pulse that is a combination of a device address, and the $\overline{IN}$ function pulse. Now you should see why input devices are not assigned the same address. They would both try and use the bus at the same time, and the computer could not distinguish between either of the devices.

Software

The transfer of data to and from I/O devices and the *TRS-80* is controlled through the use of the BASIC commands, INP and OUT. In each case, a device address must be specified as a part of the overall command. Thus, the command OUT 6,120 would transfer the decimal value 120 to the output port that has been assigned the decimal address 6. The command, A = INP(12) would set variable A, equal to the value that was input from input port 12. Since we do not know what value is to be input, a value is never incorporated within an INP command.

The device address associated with the INP and OUT commands is always expressed in decimal format, so you must convert these values to binary values to find out what bit patterns to expect on the address bus outputs. The value that is to be transferred by an output operation is also expressed as a decimal number. Since eight data bits and eight address bits are used in I/O device data transfers and in device decoding, the values for the data, and for the addresses, must always be within the range of zero to 255, inclusive. Other values will result in an error condition.

Variables may be specified within either the INP, or the OUT instructions, provided that they have been preset to a valid value prior to the use of the variable in an instruction. Thus, OUT X,Y, OUT 7,Z, OUT Q,10, M=INP(10) and L=INP(A) are all valid commands that will be correctly interpreted by the *Level II* BASIC. If fractions are specified in these instructions,

they are ignored. For example, if you attempt to output the value 6.125 to output port 7 with an OUT 7,6.125 instruction, the value 6 is transferred, with the fractional portion of the value being ignored.

This introductory information should serve to help you understand how the *TRS-80* may be easily interfaced to external devices. Since it is impossible to cover all of the basic interfacing techniques, we refer you to the new book, *TRS-80 Interfacing* (see Parts List).

The interface breadboard

To make the task of interfacing fairly easy, an interface breadboard has been designed so that the needed signals are readily available and properly buffered for use in prototype design. Without such a breadboard, it could prove difficult to interface to the *TRS-80* computer. The breadboard consists of five major sections; power supply, logic probe, device and memory address decoder, bus buffer and control circuit. Each of these sections will be described, so that you will better understand how the interface breadboard works, how it is used and how to troubleshoot it.

The power supply section of the breadboard may be operated in one of two ways. An external +5-volt power supply may be used, as long as it can supply 1 ampere, or an external transformer may be used. The external transformer should be capable of supplying 12.6 volts AC at 1 ampere. This transformer is used with an on-board diode bridge and voltage regulator, to supply the 5 volts for the IC's. Whether the onboard supply is used, or

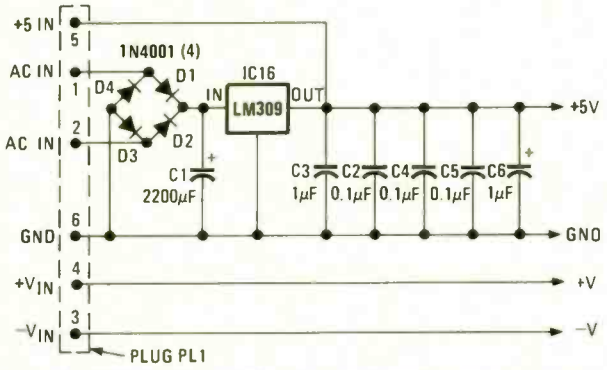


FIG. 6—SCHEMATIC DIAGRAM of the breadboard's power supply.

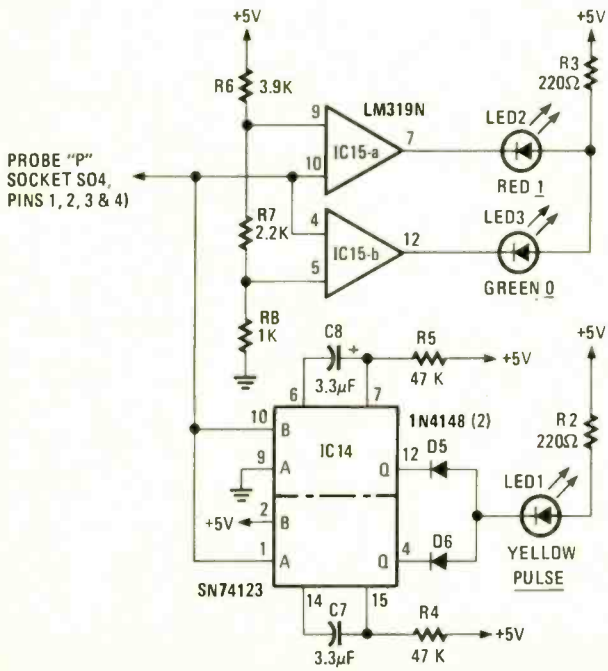


FIG. 7—THE LOGIC PROBE circuit. A 74LS123 may be substituted for the 74123.

TABLE 2—POWER SUPPLY CONNECTIONS for the Power Socket, SO1.

PIN	VOLTAGE AVAILABLE
7, 10	+5
5, 12	GND
3, 14	+V (External)
1, 16	−V (External)

All other pins are unconnected

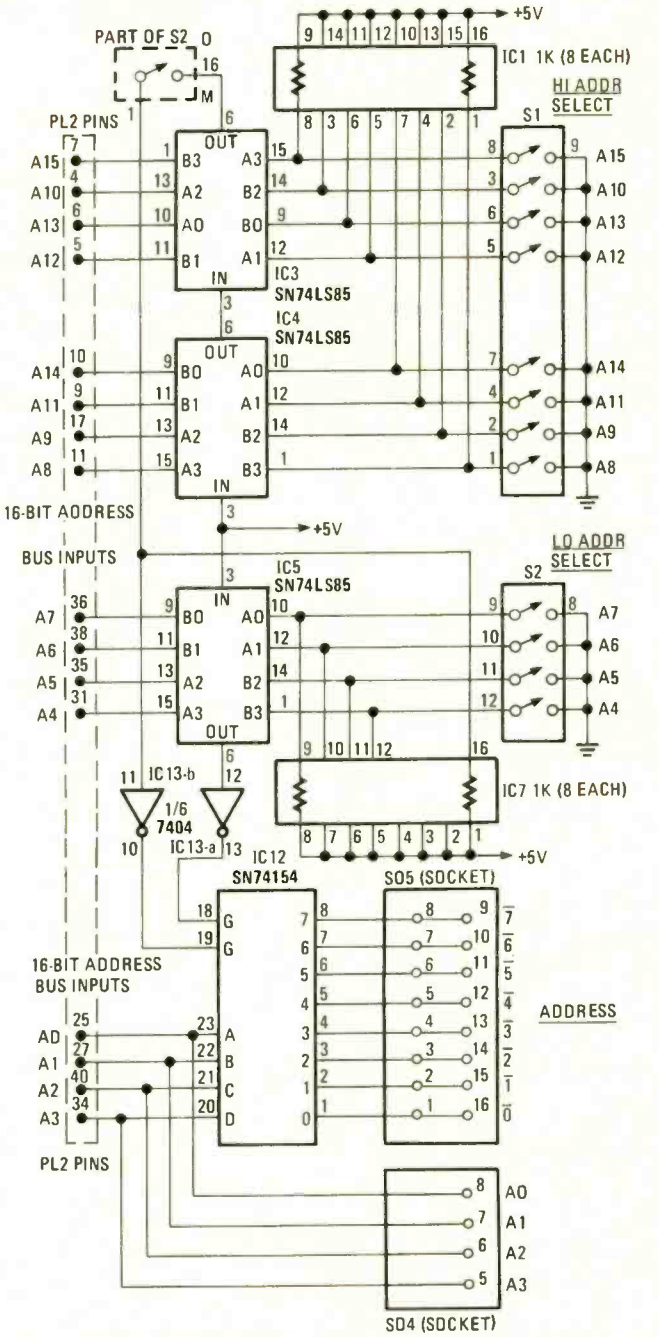


FIG. 8—SCHEMATIC DIAGRAM of the breadboard's device and memory address decoding circuits.

the external supply is used, the power supply for the breadboard is separate from the five-volt power supply that is used to power the *TRS-80*. The internal computer power supply just doesn't have the necessary power to drive the breadboard. A schematic of the power supply circuit is shown in Fig. 6.

If the on-board power supply is used, the 12.6-volt transformer is connected to pins 1 and 2 on plug PL1, and rectifier diodes D1–D4, filter capacitor C1, and the voltage regulator are all

PARTS LIST

Resistors ¼ watt, 5%
R1, R8—1000 ohms
R2, R3—220 ohms
R4, R5—47,000 ohms
R6—3900 ohms
R7—2200 ohms
C1—2200 μF, 16 volts, electrolytic, axial leads
C2, C4, C5—0.1 μF, 50 volts, disc ceramic
C3, C6—1 μF, 35 volts, tantalum electrolytic
C7, C8—3.3 μF, 50 volts, electrolytic, axial leads
Semiconductors
IC1, IC7—16-pin resistor network (eight 1K resistors)
IC2, IC6—Not used
IC3—IC5—SN74LS85 quad comparator (do not substitute SN74L85)
IC8—SN74LS20 dual 4-input NAND gate
IC9—SN74365 or DM8095 three-state buffer
IC10, IC11—8216 non-inverting bus buffer (Intel or equal)
IC12—SN74154 4-line to 16-line decoder
IC13—SN7404 hex inverter
IC14—SN74123 or SN74LS123—dual retriggerable one-shot
IC15—LM319N dual comparator (14-pin package)
IC16—LM309K, voltage regulator, 5 volts, 1 amp.
D1-D4—1N4001 or equal, 50 PIV, 1-amp, diode
D5, D6—1N4148 or 1N4154 small-signal diode
LED1—yellow LED
LED2—red LED
LED3—green LED
S01, S02, S03, S05—High-quality 16-pin DIP socket (Augat 516-AG-10D or equal)
S04—high-quality 8-pin DIP socket (Augat 508-AG-10D or equal)
PL1—Molex right-angle 6-pin connector (PN 09-75-1061) optional. Requires 1 mating female housing (PN 09-50-7061) and 6 connector pins (PN 08-50-0106 or 08-50-0108)
PL2—40-pin right-angle jumper header, AP Products 923875R or equal
T1—transformer, 12.6 volts, 1 amp
Miscellaneous
Solderless breadboard socket. E&L Instruments model SK-10, AP Products model Superstrip II, Continental Specialties model EXP-300 or equal.
Cable assembly, 40-pin header on one end and 40-pin card-edge connector on the other—facing the same direction.

The following parts are available from E & L Instruments, Inc., 61 First St., Derby, CT 06418.

Order No. 355-6125—Complete kit including PC board, case and all parts. Does not include interconnect cable. Specify 117V or 230V version. $139.00.

Order No. 355-6175—Interconnect cable assembly (connects breadboard to TRS-80 computer). $25.00.

Order No. 355-6100—Assembled 117-volt version. $185.00.

Order No. 355-6150—Assembled 230-volt version. $185.00.

Connecticut residents add state and local taxes as applicable.

A pre-drilled and etched PC board is available from Techniques, Inc., 235 Jackson St., Englewood, NJ 07631, for $24.50 postpaid. New Jersey residents add 5% sales tax.

Copies of the book *TRS-80 Interfacing* (published by Howard W. Sams and Co.) is available for $7.95 plus 79¢ for shipping and handling from Group Technology, Ltd., PO Box 87, Check, VA 24072

installed. We suggest the use of a small heat sink with the voltage regulator. Be sure that it is tightly fastened to the voltage regulator and to the PC board. When the breadboard is used in this way, +5 volts are available at pin 5, and ground is available at pin 6. These connections may be used for external interfacing, if required. The actual use of a connector for PL1 is optional. You may wish to connect the power transformer or external power supplied directly to the interface breadboard without the connector.

If an external power supply will be used to provide +5 volts to the breadboard, the power supply parts (D1–D4, C1 and the voltage regulator) are not required and should not be installed. The +5 volt and ground connections are made to pins 5 and 6, on PL1, respectively, to power the system. To make the power supply voltages readily available for interfacing, an integrated circuit socket has been set aside for these connections. Two spare pins at PL1 have been used to connect to the POWER IC socket, so that external voltages may be easily connected to the system. All of the voltages are shown in Table 2, with their respective connections at the POWER socket.

The logic probe circuit shown in Fig. 7 is useful in helping you to determine the logics state of the various signals on the breadboard. It will indicate logic levels and pulse activity. Comparator IC15 is used to detect the logic one and logic zero logic levels, while dual monostable IC14 is used to detect and stretch pulses so that they may be easily observed. A green (logic ZERO), a red (logic ONE) and a yellow (PULSE) LED are used as indicators. The input to the probe is available at pins 1–4 on the socket at SOF. These inputs are all marked with a P. All of these four inputs are in parallel, and any one may be used. Since an SN74LS123 monostable is used as the pulse-stretcher, the input to the logic probe should be thought of as two low-power Schottky loads. You may wish to substitute an SN74123 monostable multivibrator, which will increase the input load to two TTL loads.

If you have an external logic probe, or an oscilloscope, you may not want to build the logic probe portion of the breadboard circuit. Since the remainder of the breadboard circuitry is independent of this section, it can be left out. We found that the logic probe portion of the breadboard is quite useful for testing and troubleshooting interface circuits as well as the various other logic circuits that can be breadboarded.

A major portion of the circuitry on the interface breadboard is devoted to device and memory address decoding, as shown in Fig. 8. The decoders can be operated as either memory address decoders, or as device address decoders, depending upon whether device or memory-mapped I/O will be used in your interface. In the device addressing mode, only address bits A7 through A0 are decoded. In the memory-mapped mode, all 16 address lines are decoded. In each case, addresses are absolutely decoded, meaning that all of the address bits in the respective group have been decoded. The decoding scheme used on the breadboard includes the necessary comparators and a decoder for both the device and memory mapped I/O modes.

In the device addressing mode, four-bit comparator IC5 is used to compare four preset address bits with four of the address bus lines, A7 through A4. The address bits are preset using a dual in-line switch package, S2. The positions are clearly marked, "4," "5," "6," and "7." You must be sure that the open or OFF position of the switch is in the logic one position (right-hand side). Pull-up resistors (in IC7) have been provided so that the open switch position provides a logic one to the comparators. Although a dual in-line resistor network has been specified, individual 1,000-ohm resistors may be used in its place. Use resistors with a 5% tolerance.

When an address match takes place between the preset address bits, and the address information on address bus, decoder IC12 is enabled and decodes the remaining four address bus bits, A3 through A0. Although the decoder IC12 can decode sixteen addresses, only eight have been implemented on the breadboard. The decoded address appears as a logic zero at its respective output, while all of the other outputs remain in the logic-one state.

Next month we will continue the discussion of the operation and applications of the TRS-80 interface breadboard and will provide illustrations showing the various types of buffering and control circuits. Following will be construction details including PC board foil patterns and a component layout. Also included will be schemes for testing the interface breadboard and various circuits that you can prototype such as a digital-to-analog converter circuit and a traffic-light simulator that is software controlled. **R-E**

Automatic Tele

HEATH ELECTRONIC DIRECTORY/DIALER model GT-1217

SUPERPHONE 7700 from Integrated Circuits Packaging, Inc.

Over the last year or so, you've probably noticed an increasing number of automatic telephone dialers and feature phones being used. Here's a look at the various models and how they compare.

WITH OVER 160,000,000 TELEPHONES IN OPeration in the United States, it's no wonder that "Consumer Electronics Monthly," an industry publication, estimates that up to 250,000 "feature phones" and 30,000 "automatic dialers" will be sold in 1979. Feature phones are telephone instruments with memory dialing capability, and usually other functions—such as calculator, clock, calendar or alarm. Automatic dialers may have these capabilities, but are used with a *separate* telephone instrument.

The basic idea is simple enough. Provide a telephone user with a device that will automatically dial a pre-programmed number with a single button that "remembers" the number. What is really surprising is that this simple requirement has been interpreted into so many totally *different* solutions!

The Comparison Chart (Table 1) shows 19 automatic dialers and feature phones available from 11 sources, plus a many-featured 500-number computer program for *Radio Shack TRS-80* owners. Since the spring of 1979, when this information was compiled, we have found a number of other manufacturers and sources of dialers and feature phones—but too late for inclusion in this detailed survey.

A manufacturer or source is listed for each unit, although many of these devices are available in specialty shops and mail order catalogs. If you find locating a specific unit difficult, write the source listed; they will tell you where you can buy a unit or see one demonstrated.

The *Memory Phone*, *Superphone*, *Freedom Dialer* and *Busy Buster* are feature phones; that is, they are basic telephone instruments with special features added. No separate telephone is needed with these devices.

Most of these devices have a digital display or light-emitting diodes (LED's). The columns in the chart show the number and size of the digits for those that have numeric displays.

Most of the units with digital displays show the number both when it is being programmed and when it is being dialed. The *DuoFONE-32*, *Electronic Dialer III* and *Electronic Dialer VI* indicate the digit being dialed at that moment by blinking the digit or moving a decimal point.

Several units also show elapsed time in minutes and seconds (for timing the phone call) and include a real-time clock as well. The *Superphone* displays the date and day-of-the week, and the *Freedom Dialer* shows the month and date. The *Superphone* and *Otron* even include calculators that can be used anytime except when dialing—even during a call!

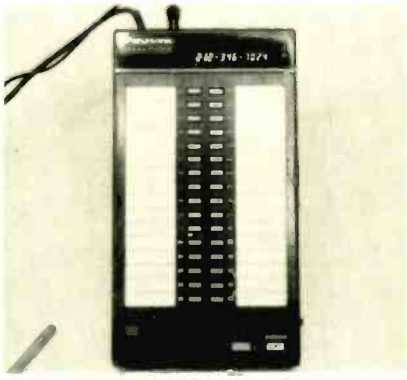
All of these units (except *TRS-80 Dialer Program*) are supplied with AC adapters that plug in the wall to provide relay and memory power. Batteries are used as a back-up to preserve the programmed numbers in memory if the AC power fails. Rechargeable batteries are most desirable, since they require little care. Some units use standard pen cells or mercury cells as backup for the memories, and the manufacturers typically suggest these be changed every year. Panasonic units have an LED to indicate low battery voltage. The Webcor unit uses 6 "C" cells for completely portable operation on tone, if desired.

It is often convenient to dial a number *without* lifting the telephone handset, leaving your hands free if the line you are calling is busy or doesn't answer. Most devices with this feature have a speaker that allows you to hear the ringing (or busy signal) and answering party. If there is no answer, you cancel the call. If there is an answer, you then pick up the handset and disable the dialer speaker. *Rapidial II* and *Busy-Buster* use LED's to indicate dialing status. Some hands-free dialing units automatically "hang-up" after a specified period of time if the phone is not answered on the other end, or if the line is busy. Most dialers hold the last number dialed by unit in memory, and pressing a RE-DIAL button dials it again.

Some special features are incorporated in a few units. The *Webcor* unit is the only completely portable unit found in this survey; it does not even have to be connected to the phone line or AC line

phone Dialers

DUOFONE-32 from Radio Shack



PANASONIC EASA-PHONE model KX-T1220

FRED BLECHMAN, K6UGT

for tone dialing! The *Webcor* unit also has a HOLD button even though your phone does not. The *Freedom Dialer* and *Webcor* have handy number-storage trays for reference of the numbers in memory. The *Panasonic* units include a wall-mounting bracket and screws. The "two-position memory switch" doubles the memory locations for a given number of calling buttons. However, if the switch is in the wrong position, you'll call the wrong number!

The *TRS-II Dialer Program* is a Level II BASIC program on cassette tape for a *TRS-80* microcomputer, with listing and documentation. The interface can be built for under $5 using standard Radio Shack parts. The program holds almost 500 names and numbers in a 16K memory *TRS-80* (40 in a 4K memory), and features automatic dialing, manual dialing, re-dialing, alphabetical display of programmed name list, and on-screen call duration timer. The name and number are displayed as the number is dialed. Other computers won't be able to load the tape, but the program can be modified for most BASICS. A program listing and documentation, without cassette tape, are available.

How they work

A high degree of technology and sophistication have gone into these dialer devices, and some use closely-guarded proprietary designs. But they all end up interfacing with the telephone line in some manner using pulses or tones for the actual dialing. Although all the units use a keyboard for number entry rather than a rotary dial, most still signal using pulses rather than Dual-Tone Multi-Frequency (DTMF) *Touch-Tone*.

Dialing using DTMF is significantly faster than using rotary-pulses. The timing associated with the types of signalling is as follows:

DTMF
Signal Rate: 10 digits per second
Interdigit Timing: 50 milliseconds
ROTARY-PULSE
Signal Rate: 10 pulses-per-second (pps), or 20 pulses-per-second
Interdigit Timing: 750 milliseconds

All telephone central offices in the United States are equipped to accept rotary-pulse signalling at 10 pulses-per-second (pps). Some of these central offices will accept 20 pps. Many offices in the major metropolitan areas are equipped to accept DTMF—*Touch-Tone*. The telephone operating companies are converting older central offices to accept DTMF on a regular schedule.

For those interested in the actual DTMF signalling frequencies, see Table 2. Seven discrete tones are used in total, with two used for each key on the phone. Each key, therefore, produces a signal with four tones (each at the basic frequencies, plus the sum and difference). These are transmitted along the phone lines to the telephone exchange, where decoders separate the high and low frequency components and then further determine the two particular frequencies that identify the digit. This takes some specialized equipment but, as just discussed, is done much more quickly than counting individual pulses.

Interfacing

The Federal Communications Commission (FCC) Rules & Regulations, Part 68, describes the requirements for the connection of terminal equipment to the telephone network. This includes telephones, dialers or other devices directly (not acoustically or inductively) connected to the phone lines. Registration procedures involve submission of an application (FCC Form 730) and compliance with the technical requirements of Subpart D. Approval results in an FCC Registration Number and Ringer Equivalence Number that must be placed on each unit. The user must notify the telephone company of these numbers when connecting the device to the phone line.

Two basic approaches to interfacing dialers are used—serial and parallel. The serial method merely opens one of the phone lines (usually red or green wires) and inserts the dialer device in series. A

TABLE 1 – COMPARISON CHART OF AUTOMATIC TELEPHONE DIALERS & FEATURE PHONES

MANUFACTURER OR SOURCE	MODEL NAME & NUMBER	SUGGESTED RETAIL PRICE ($)	TELEPHONE IS INCLUDED	MEMORY CAPACITY	DISPLAY						ALARM(S)	RECHARGEABLE BATTERIES	MAXIMUM NUMBER OF PROGRAMMED DIGITS	DIALING METHOD			HANDS-FREE DIALING	AUTOMATIC SHUT-OFF	LAST NUMBER REDIAL	AUTOMATIC REDIAL	MANUAL DIALING	SIZE (INCHES)			REMARKS & FOOTNOTES
					NUMBER OF DIGITS	SIZE (INCHES) & TYPE	ELAPSED TIMER	CLOCK	CALENDAR	CALCULATOR				10 PPS	20 PPS	TONE						HEIGHT	WIDTH	DEPTH	
BLECHMAN ENTERPRISES 7217 BERNADINE AVE., CANOGA PARK, CA 91307	TRS-80 DIALER PROGRAM	9.95		500 (1)	14	(2)	✓						14	✓	✓				✓		✓	INTERFACE 1-1/2	3	3	CASSETTE TAPE & DOCUMENTATION. LISTING & INSTRUCTIONS ONLY: $5 POSTPAID USA, NO FOREIGN. SEE TEXT
FORD INDUSTRIES, INC. 5001 JOHNSON CREEK BLVD. PORTLAND, OR 97222 (ALSO SEE JS&A)	ELECTRONIC DIALER I	129.95		16	NO DISPLAY								16	✓	✓							3	4-3/4	5-3/4	
	ELECTRONIC DIALER VI	199.95		16	8	.13 LED							15	✓	✓	✓	(3)					3	4-3/4	5-3/4	(4)
	ELECTRONIC DIALER 32	189.95		32	8	.13 LED							15	✓	✓		(3)					3	4-3/4	5-3/4	(4)(5)
	DELUXE ELECTRONIC DIALER	279.95		32	8	.13 LED		5" LED 4-DIGIT					15	✓	✓	✓	(3)					6	8-1/2	8	(4)(6)
	MEMORY PHONE®	199.95	✓	16	NO DISPLAY								15	✓			✓		(16)		✓	3-3/4	8	9	TONE RINGER INSTEAD OF BELL
HEATH CO. BENTON HARBOR, MI 49022	ELECTRONIC DIRECTORY/DIALER MODEL GT-1217	79.95 KIT (MAIL)		16	DISCRETE LED'S FOR READY, PULSE & STORE								15	✓					✓			2	8-3/4	8-3/4	ONLY IN KIT FORM. PRICE IN HEATH RETAIL STORES IS $89.95. CAN BE WALL MOUNTED
HI-TEK CONSUMER PRODUCTS DIV. 12311 INDUSTRY GARDEN GROVE, CA 92641	AUTOTOUCH M20	149.95		20	NO DISPLAY								12 (7)	✓	✓				✓		✓	3	9	8	(17)
	AUTOTOUCH M63	399.95		60	12	.13 LED	✓	6 DIGIT			1		17 (7)	✓	✓	✓	✓		✓	✓	✓	3	9	8	HOLD BUTTON. AUTO-REDIALS BUSY NUMBER 17 TIMES.
INTEGRATED CIRCUITS PKG., INC. 750 NORTH MARY AVE., SUNNYVALE, CA 94086	SUPERPHONE 7710	229.95	✓	20	14	.13 LED	✓	4 DIGIT	✓	8 DIGIT	1	✓	14	✓					✓		✓	5	8-1/2	9	EUROPEAN MODEL 7720 FOR 220V, 50Hz, 24-HR. COLORS: WHITE, BEIGE, BROWN, BLACK. DISPLAYS DAY OF WEEK.
JS&A NATIONAL SALES GROUP ONE JS&A PLAZA NORTHBROOK, IL 60062	CODE-A-PHONE® ELECTRONIC DIALER III	169.95		16	8	.13 LED							15	✓	✓		(3)					3	4-3/4	5-3/4	(4). ELECTRONIC DIALER II (149.95) IS SAME, EXCEPT NO DISPLAY.
	BUSY BUSTER	99.95	✓	2	RED LED BLINKS WHEN DIALING GREEN LED WHEN REDIALING ACTIVE						(9)		12	✓	✓		(10)	(9)	✓	✓	✓	5	8-1/2	9	REDIALS BUSY NUMBER FOR 30 MINUTES, EVERY 40 SECONDS.
LEISURECRAFT PRODUCTS, LTD. 28 S. TERMINAL DRIVE PLAINVIEW, NY 11803	WEBCOR® DIAL-A-TRON MODEL 747	149.95		32	10	.13 LED							10	✓	✓	✓	(3)					2-3/8	7-1/4	6-1/2	PORTABLE – USES 6 "C" CELLS OR AC ADAPTER. ACOUSTIC COUPLING WITH TONES. HOLD BUTTON. PULL-OUT INDEX (5)(6)
PANASONIC CONSUMER AFFAIRS ONE PANASONIC WAY SECAUCUS, NJ 07094	EASA-PHONE KX-T1210	149.95		32	NO DISPLAY								18 (7)	✓			(3)	✓	✓	✓		1-1/4	5-1/2	9-3/4	AUTO-REDIALS BUSY NUMBER 16 TIMES. KEYS BEEP (11)
	EASA-PHONE KX-T1220	179.95		32	12	.25 FLUOR.							18 (7)	✓	✓		(3)	✓	✓	✓		1-1/4	5-1/2	8-3/4	AUTO-REDIALS BUSY NUMBER 16 TIMES. KEYS BEEP. VOLUME CONTROL (11)
RADIO SHACK FORT WORTH, TX 76102	AUTOMATIC TELEPHONE MEMORY DIALER DUO PHONE-32	99.95 (12)		32	9	.15 LED	✓	4 DIGIT				✓	14	✓	✓				✓			2-1/2	6-1/4	5-3/4	DIGITS BLINK AS DIALED. (5)
ROYCE ELECTRONICS CORP. 1746 LEVEE ROAD NORTH KANSAS CITY, MO 64116	FREEDOM DIALER MODEL D-001	229.95	✓	36	8	.16 LED	✓	6 DIGIT	✓		(13)	✓	13	✓	✓				✓		✓	5	8-1/2	9	DISPLAY ALTERNATES TIME / CALENDAR EVERY 5 SECONDS. PULL-OUT INDEX WITH INSTRUCTIONS.
TECHNOLOGY APPLICATIONS CORP. 2660 MARINE WAY MOUNTAIN VIEW, CA 94040	RAPIDIAL	109.95		20	8	.13 LED						✓	10 (7)(14)	✓		✓	✓	✓	(15)		✓	1-3/4	3-1/2	6-1/2	DOES NOT DISPLAY NUMBERS WHEN PROGRAMMING.
	RAPIDIAL II	79.95		20	2 DISCRETE LED'S FOR DIALING & READY								10 (7)(14)	✓			✓	✓	(15)		✓	1-3/4	3-1/2	6-1/2	LED REPLACES SPEAKER.
WINTRON MERCHANDISE CORP. 110 WEST 40th ST., NEW YORK, NY 10018	OTRON CD 8050	199.95		20	14	.20 LED		6 DIGIT		12 DIGIT	5	✓	18	✓			✓	✓	✓		✓	3	10	7	KEYS BEEP. VOLUME CONTROL. (5)

FOOTNOTES: (1) LEVEL II 16K MEMORY. 40 NUMBERS WITH 4K MEMORY (2) DISPLAYS ON VIDEO MONITOR (3) PROGRAMMED NUMBERS ONLY (4) DECIMAL POINT ADVANCES AS NUMBER IS DIALED (5) TWO-POSITION MEMORY SWITCH (6) CONFERENCE MONITORING (7) LONGER NUMBERS CAN BE STORED IN ADJACENT STORAGE LOCATIONS (8) PIEZOCERAMIC DISC SOUNDS WHEN BUSY LINE IS CONNECTED (9) REDIALS BUSY LINE FOR 30 MINUTES (10) HAND-DIAL FIRST TIME; HANDS-FREE ON AUTOMATIC REDIAL (11) WALL MOUNTING BRACKET & SCREWS INCLUDED (12) MAIL ORDER OR LOCAL RADIO SHACK STORE (13) TONE REMINDER AT 2MIN./48 SEC. (14) SPECIAL "PAUS", "LCL" & "PABX" KEYS PROGRAM SPECIAL PREFIXES (15) IF LAST NUMBER WAS CANCELLED (16) LAST MANUALLY-DIALED NUMBER ONLY (17) OTHER MODELS AVAILABLE.

TABLE 2—DTMF DIALING FREQUENCIES

1 697 & 1209	2 697 & 1336	3 697 & 1477	← 697 HZ
4 770 & 1209	5 770 & 1336	6 770 & 1477	← 770 HZ
7 852 & 1209	8 852 & 1336	9 852 & 1477	← 852 HZ
* 941 & 1209	0 941 & 1336	# 941 & 1477	← 941 HZ
↑	↑	↑	
HIGH GROUP → 1209 HZ	1336 HZ	1477 HZ	LOW GROUP

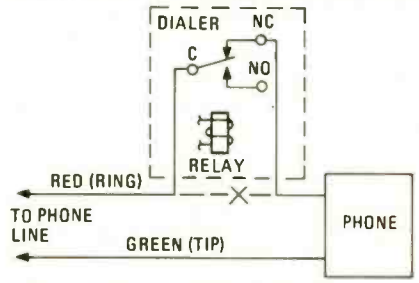


FIG. 1—ONE APPROACH to dialer interfacing. The serial (series) method has the dialer device in series with the telephone.

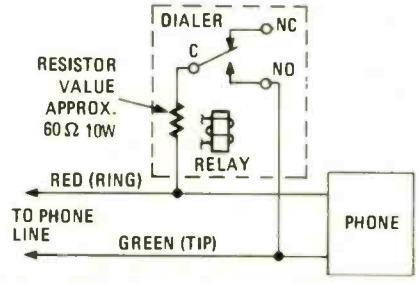


FIG. 2—THE PARALLEL CONNECTION of the dialer permits "hands-free" dialing.

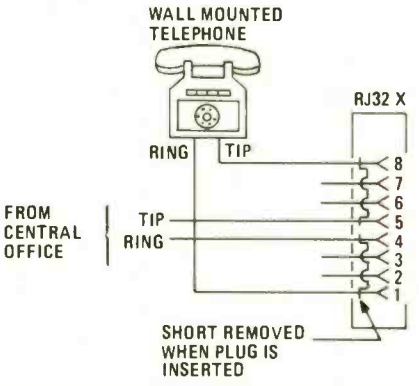


FIG. 3—WALL PHONES do not have jacks so a special jack must be installed by the phone company so a serial-type dialer can be used.

normally closed relay in the dialer opens for each pulse after the telephone handset is lifted and the dial tone is established (Fig. 1). A parallel connection has the advantage of "hands-free" dialing (Fig. 2). The handset remains on the hook while the dialer relay closes to establish dialtone. Then, opening of the relay creates the dialing pulses and the phone is lifted after the connection is made. This system requires some indication, such as an LED or monitoring speaker, to tell the user the dialing is completed. Since the parallel connection is made directly *across* the phone line, no disconnecting of the phone line is required. Some units are serial connected, but have a parallel switch to allow hands-free dialing.

Each manufacturer provides units with modular phone plugs and most include adapters that would be rquired for a "normal installation," which means you have a regular 6-pin jack installed. (These are called USOC RJ11C jacks by the telephone business office, with USOC standing for Universal Service Order Code.) To use a serial dialer with a wall phone that has no jack, you will probably need a USOC RJ32X jack installed by the phone company. For multiline phones, a USOC RJ35X jack will be needed. (See Figs. 3 and 4.) Some parallel-connected units, like the Panasonic *Easa-Phone*, used 8-pin modular plugs with the special adapter (Fig. 5).

Radio Shack carries various adapters and Technology Applications Corporation (see Chart) sells a Modular T Jack (Model TAX-10) or Quick Connect Jack (Model TAX-23) for $5.95 each. The TAX-10 allows you to insert two regular 6-pin modular plugs into a single modular jack. The TAX-23 converts a type 42A Terminal Block to a jack that accepts both a 6-pin modular plug and an old style 4-prong plug at the same time, or converts the modular plug to a 4-prong plug.

If all else fails, your local phone company—for a one-time fee—will install the necessary jacks.

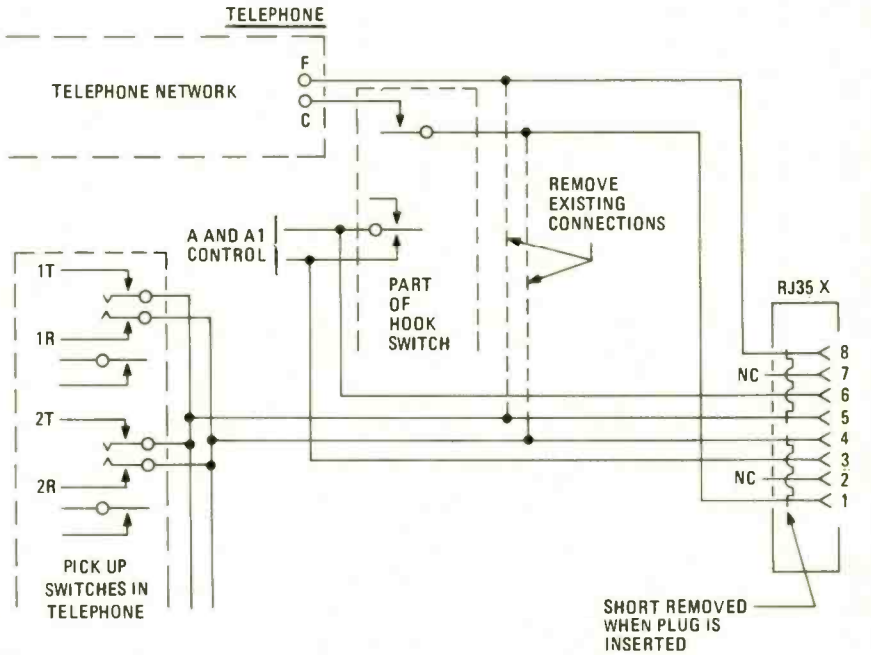


FIG. 4—MULTILINE PHONES require a special type RJ35X jack as an interface between the phone and a dialer that uses a serial type connection.

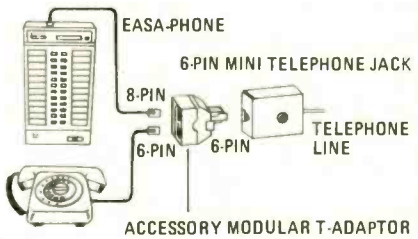


FIG. 5—SOME DIALERS such as Panasonic's *Easa-Phone* come with 8-pin modular plugs and special adapters.

Circuit operation

Very few manufacturers are willing to release the circuit details of their units. Heath, which offers their *model GT-1217 Directory/Dialer ONLY* in kit form, provides both a schematic (See Fig. 6) and complete circuit description.

All the timing and control functions of the *Directory/Dialer* are performed inside the microprocessor, IC1. The ROM (Read Only Memory) is also inside IC1

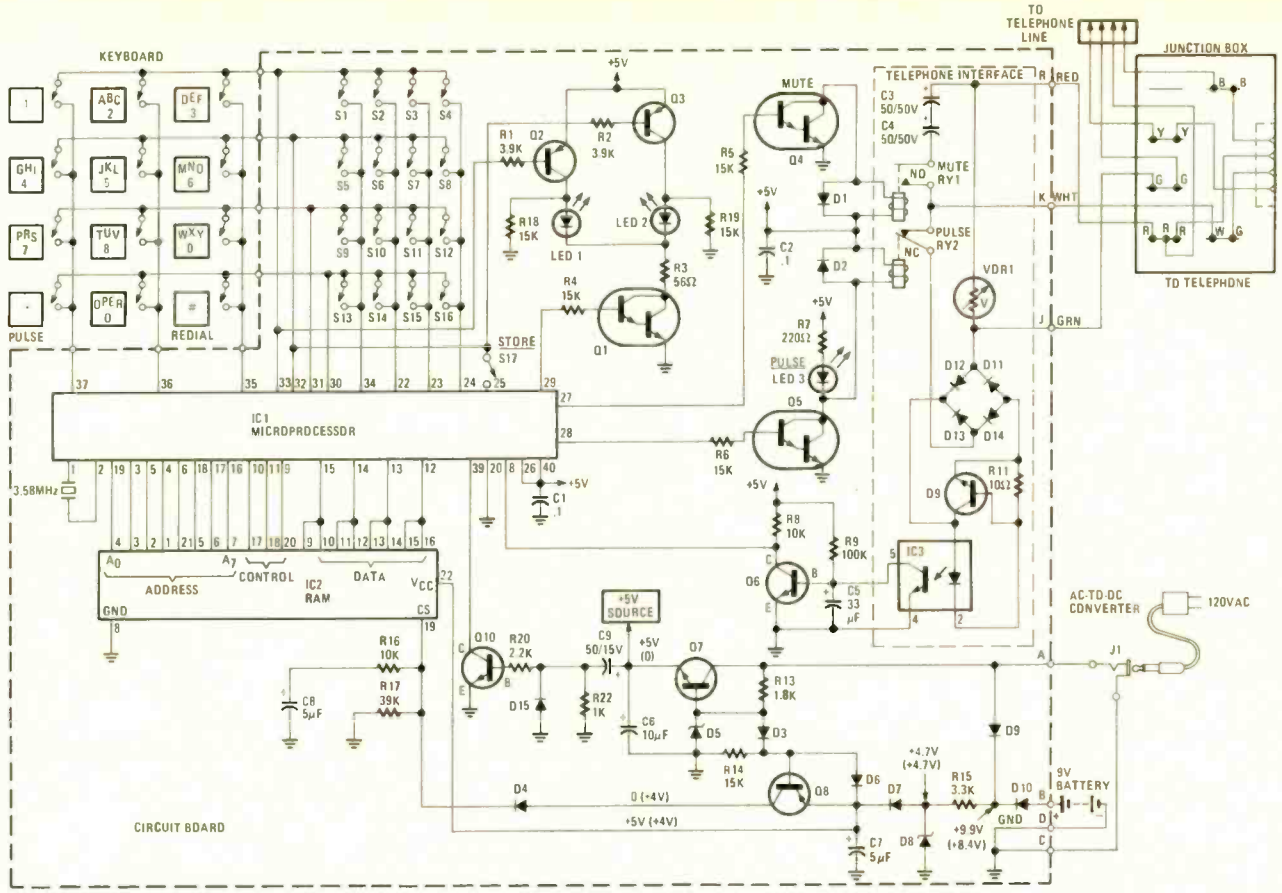


FIG. 6—SCHEMATIC DIAGRAM OF Heathkit model GT-1217 Directory/Dialer. All timing, command and control functions are in IC1. The second IC, a RAM stores the telephone numbers.

and contains all the command and timing information. The second IC is the RAM (Random Access Memory); it stores the telephone numbers. When the power line fails, the 9-volt battery supplies emergency power to only the RAM, IC2, so it will not lose the data stored in it. The rest of the *Directory/Dialer* is then inoperative until main power is restored.

Commands are entered into IC1 by the keyboard and switches S1 through S17. IC1 then turns transistors Q1 through Q5 on and off as necessary to drive the LED's, and perform the dialing and muting functions. To turn on LED1 or LED2, its associated transistor (Q2 or Q3) must be turned on at the same time transistor Q1 is on. This requires a logic low at the base of Q2 or Q3, and a logic high at the base of Q1.

Transistors Q4 and Q5 drive relays RY1 and RY2 (the mute and pulse relays), and LED3. Relay RY2 pulses the telephone line and relay RY1 mutes the line-pulsing transients in the telephone receiver by applying an AC short to the telephone line.

When the telephone receiver is "hung up," the telephone presents a high DC resistence to the line and no current flows through the diode bridge (D11 through D14). When the telephone receiver is lifted, approximately 30 mA of current flows through the diode bridge and the LED portion of IC3. Transistor Q9 limits the current through the LED to less than 70 mA. When the LED inside of IC3 lights, the phototransistor turns on, turning off Q6. This "tells" IC1 the telephone receiver has been lifted.

With Q6 turned on, there is a logic low at IC1, pin 8. However, when the receiver is lifted, the telephone line voltage drops and Q9 turns on, causing Q6 to turn off. Now IC1 pin 8 "sees" a logic high and makes IC1 ready to operate.

When power is first applied to the circuit, Q10 is turned on. This keeps a logic low at IC1, pin 39. After capacitor C9 becomes charged, Q10 turns off. Now IC1 pin 39 "sees" a logic high, that causes a reset pulse to be generated in the microprocessor. During any power line failure, C9 rapidly discharges through D15. When the power returns again the cycle is repeated, generating the reset pulse for the microprocessor. This makes the microprocessor ready for normal operation after any power line failure when the power returns.

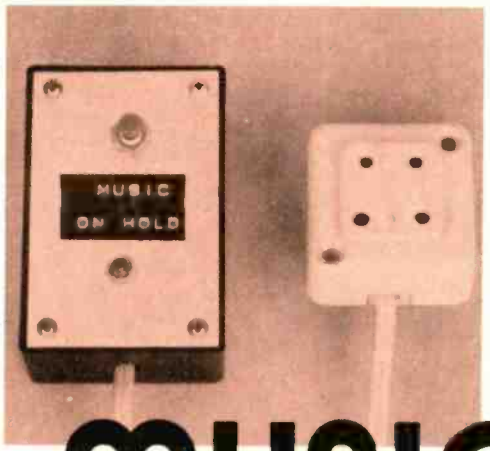
The voltage dependent resistor VDR1 protects the circuit from high voltage transients. It is electrically similar to two Zener diodes connected back-to-back. Under normal conditions, its resistance is very high. If, however, a voltage transient occurs on the telephone line, the resistance of the VDR decreases and makes sure the voltage does not rise any higher. After the transient is gone, the resistance of the voltage dependent resistor returns to a very high level.

Approximately 10.5 volts DC is applied to D9, R13, and the collector of transistor Q7. Zener diode D5, connected to the base of Q7 and voltage divider R13 and R14, maintains the base voltage at 5.6 volts. The emitter follows this constant base voltage and is therefore held constant at 5 volts (0.6-volt drop from base to emitter). The 5.6 volts from diode D5 is coupled through diode D6 to supply the +5 volts to IC2. Because the base of transistor Q8 is positive with respect to the emitter, Q8 is turned off and supplies a logic low to pin 19 of IC2 (through diode D4).

When main power fails, transistor Q7 turns off which turns off the microprocessor. The battery then supplies power to the RAM (IC2) through diodes D10 and D7. Transistor Q8 turns on, which holds pin 19 of IC2 high. This saves the data in IC2 until main power is reapplied to the microprocessor.

Depending on the nature and duration of the power failure, it is possible that a telephone number stored in the directory may be altered or destroyed in spite of the protective circuitry used. In such an event, the self-checking feature programmed into the microprocessor will sense the altered information and cause the STORE indicator (LED1) to flash on and off repeatedly when the directory button is depressed for any number that has been affected.

To be continued.



MUSIC-ON-HOLD TELEPHONE ACCESSORY

Add this feature to your telephone and entertain your callers while you are tending the roast in the oven or calling Little Johnny from play. You need only eight components plus a recorder.

JULES H. GILDER

IF YOU'VE EVER PHONED A DOCTOR'S OFfice and been told to hang on for a minute, the chances are that as you were waiting you suddenly heard some background music to entertain you and help you pass the time. Now you also will be able to place your callers on hold and even let them listen to music until you get back to them. And all this can be yours in a device you can build for less than $10.

With this music-on-hold device, you can answer the phone in one room, place the caller on hold, and then pick up the phone again at another location. When you pick up the phone the second time, you automatically deactivate the music-on-hold feature and can continue your conversation.

This construction project requires a direct connection to the telephone line. Some telephone companies object to customers making such a direct connection, fearing that this could introduce high voltages that could be harmful to telephone company employees or equipment. The music-on-hold device does not use such voltages; but, if you are in doubt as to your telephone company's position, you should check before making any direct connections to the line.

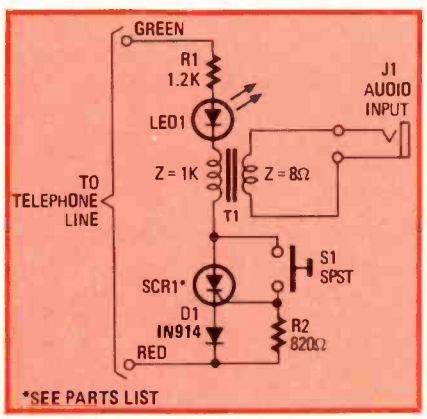


FIG. 1—MUSIC-ON-HOLD DEVICE is relatively simple and is built using standard components.

How it works

The circuit (shown in Fig. 1) is relatively simple to build. It contains a total of seven electronic components, and can be assembled in less than an hour, even by a novice.

The basic operation of any hold pushbutton requires placing a high resistance—about 1200 ohms—across the telephone line while it is in use. This resistance prevents you from disconnecting the telephone line when you hang up the receiver.

If part of this high resistance is formed by the secondary of an inversely connected transistor-output transformer, then an audio signal can be coupled into the telephone line that can be heard by the caller being kept on hold.

In operation, this eight-component circuit is connected in parallel with the telephone line. When the telephone receiver is lifted off the hook, the voltage on the telephone line is about 5 volts. Even if hold pushbutton S1 is depressed, this voltage is too low to activate the circuit. But if the pushbutton is pressed and the receiver is hung up, the voltage on the telephone line rises to about 48 volts DC. At this point, R1, T1 and LED1 momentarily form a voltage divider with R2. This allows part of the line voltage to be applied to the gate of the SCR and triggers it into its conducting (low-resistance) mode.

The triggered SCR acts as a short circuit and thus connects the resistor, LED, transformer, SCR, and diode series circuit across the phone line. The resistance of the series circuit is between 1200 and 1500 ohms, placing the line on hold. In addition, if an audio signal, such as that obtained from a radio or tape recorder, is fed into the 8-ohm primary of the transformer, the signal is coupled onto the telephone line and the person waiting on hold hears it. (Select an inobtrusive type of music for your recorder or other sound source and keep the volume low. You don't want to offend your caller nor the telephone company.—*Editor*)

When the telephone or any extension is subsequently picked up, the line voltage drops again to about 5 volts and the SCR is current-starved. This current starvation (the equivalent of opening the anode circuit) causes the SCR to stop conducting, effectively opening the circuit and disconnecting the phone line from the hold mode and the audio signal source.

Construction

As mentioned earlier, the minimal number of components required makes construction quick and easy. The whole unit can be built into a 3 × 2 × 1-inch plastic enclosure. Because of the circuit's simplicity, no PC board is needed. In fact, if you want, you can glue the transformer to the lid of the box and mount the remaining components via their connections to the switch or to the LED. Figure 2 shows the layout.

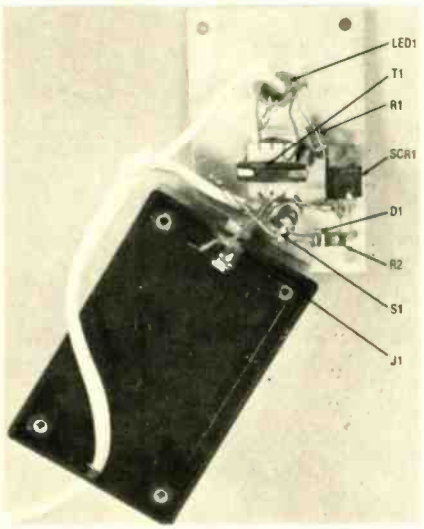


FIG. 2—LAYOUT shows how all the components fit easily into a 3 × 2 × 1-inch enclosure.

PARTS LIST

LED1—Light-emitting diode
D1—1N914
R1—1200 ohms, 1/2 watt (see text)
R2—820 ohms, 1/2 watt
T1—1000-ohm to 8-ohm audio output transformer
SCR1—276-1920 (Radio Shack)
S1—SPST momentary-contact pushbutton
J1—miniature open-circuit phone jack

There are a few simple but important details you must pay attention to. The first is the polarity of the LED. Connect the LED so its anode goes to R1 which in turn is connected to the positive (green) wire of the telephone. The other wire of the music-on-hold device goes to the red wire of the telephone. Next, you must watch out for the polarity of diode D1. The cathode of D1 must go to the red wire of the telephone, along with one side of the 820-ohm resistor.

Component values are not critical, and you can use almost any kind of silicon diode for D1. The same holds true for the SCR and the LED. Resistor R1 may need some adjustment to compensate for different values of SCR conduction current.

Installation and operation

There are two methods in which the music-on-hold device can be connected to your telephone. If you want, you can wire the unit directly to your wall jack; or a more convenient, although slightly more expensive, approach is to use a jack/plug combination. The latter method makes it possible to quickly disconnect the unit whenever you wish and move it from one location to another. Make sure that the red and green wires are properly connected.

To test out the unit, have a friend call you. Tell him you will put him on hold for a minute, but you will be right back. Next, depress the HOLD pushbutton and hang up the phone while pressing the button down. If you have previously connected an audio signal to the transformer, then the moment you press the pushbutton you should hear the audio signal in the telephone receiver. This means that the signal is successfully being coupled into the telephone line.

The person on hold will continue to hear the music until you pick up the receiver again. The LED glows brightly all the time just to remind you that someone is being kept on hold. The LED extinguishes as soon as you pick up the phone again. **R-E**

HI-FI STEREO

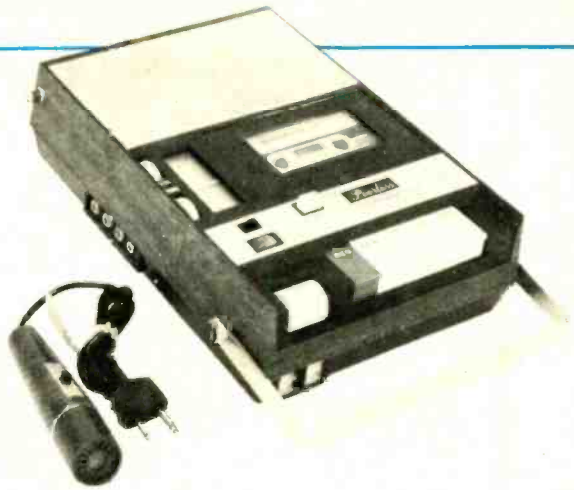
Tune TAPE

LEWIS A. HARLOW

IF YOU WERE TO ASK THREE TAPE RECORDER experts "What's the theory of recording bias?" (not, of course, to be confused with erase bias), you would probably get two answers. The third expert would probably tell you that he isn't sure—and that you are free to choose any theory that you have heard about—but that for whatever the reason, recording bias is a very good idea and very necessary to the making of high-quality, distortionless tape recordings.

If you then ask "What is recording bias?", the answer from all three experts will be alike. Recording bias is a high-frequency oscillating current that is mixed, at or near the recording head, with the audio signal to be recorded. The frequency of this bias oscillation is not critical, just so long as it is high enough so that it will not beat objectionably with the audio signal—70 kHz, more or less, is a nice bias freqency. The level of the bias signal is very important, and it is established by (1) the design characteristics of the recording head, (2) other items in the electronic circuitry, and (3) the tape selected for use. The source of the bias current can be (but need not be) the same oscillator that provides the erase cur-

Up Your RECORDER



There is an optimum value of recording bias for each tape recorder and type of magnetic tape being used. This value varies with equipment age and use. Here's how to "tune" a recorder for best performance.

rent. There is no disagreement or uncertainty here.

Out of this explanation you grasp the need for adjustment of bias level. Your recorder almost surely does not have a BIAS-ADJUST knob on its operating panel. Assuming the recorder to have been well designed and operating properly when new, its heads will have worn and its electrical components will have aged. And then there is your habit of shopping around among brands and types of tape. Can you do something about bias adjustment? Yes, you can.

A typical bias oscillator and erase/record bias circuits are shown in Fig. 1. They were developed from material supplied by Nortronics, Inc. Most professional recorders have a bias-adjust facility, and, although not shown in Fig. 1, many of them have a switching arrangement that displays the bias current on the VU meter. The bias-adjustment is usually a slotted-shaft gain control somewhere safely inside, and the service manual will recommend attention to bias as often as other maintenance projects like head cleaning and degaussing are performed. The actual adjustment of bias is a complex procedure requiring external test equipment, and this is also spelled out in the manuals and will not be covered here.

Incorrect bias

If bias can be adjusted for optimum performance, it is obvious that it can also be mis-adjusted too high and too low. With an audio generator, VOM, and possibly a distortion meter and a scope, both errors can be avoided precisely. However, there are symptoms of bad bias

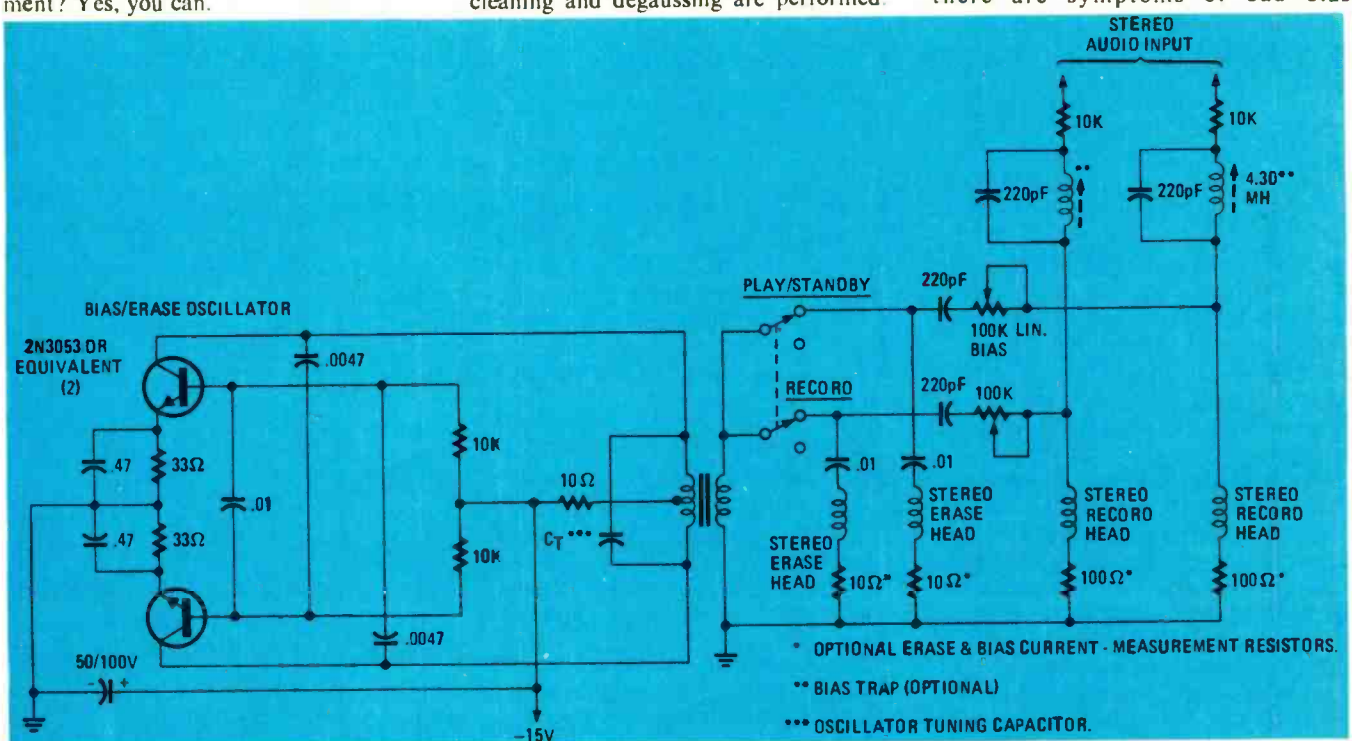


FIG. 1—TYPICAL OSCILLATOR and bias and erase circuits, for a three-head recorder. In a two-head model the record and play functions are assigned to the same head.

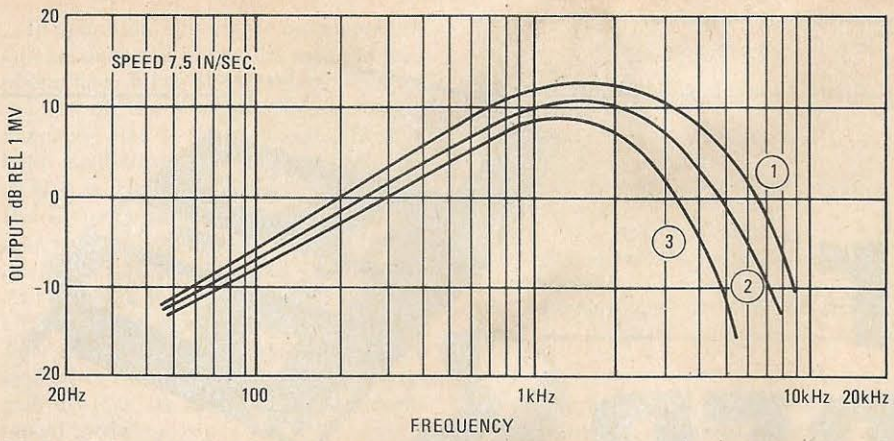


FIG. 2—HOW BIAS AFFECTS HIGH-FREQUENCY RESPONSE. Curve 1 is made with 3 ampere-turns of bias, curve 2 with 6 ampere turns. Curve 3, made with 12 ampere turns, shows the result of overbias. Erase-effect removes high frequencies which are surface recorded and do not penetrate deeply into the tape coating.

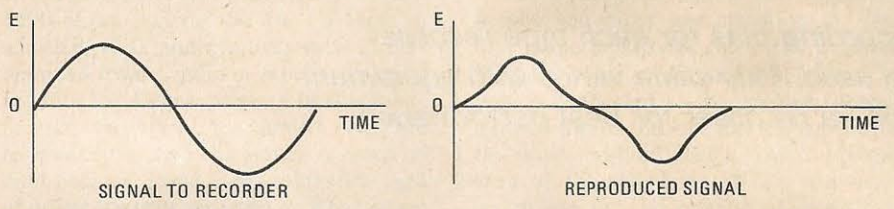


FIG. 3—TOO LITTLE BIAS causes pure signal, as at *a*, to take on a distorted form as at *b*. Distortion causes unpleasant harshness and a rise in the white-noise content of the signal.

that can be detected "by ear". They are not scientific enough to adjust by, but they are eloquent evidence of trouble that should be corrected in one way or another.

Suppose the bias is too strong. Too much of the bias will do exactly what you would expect; it will erase. This erasure concentrates on the high frequencies that have been recorded very lightly and which will erase with the slightest provocation, See Fig. 2. A too-strong recording bias is not frequently encountered, and there are other more common causes for high-frequency loss or absence.

Now suppose the bias is too weak or lacking entirely. There are two symptoms, the first is distortion (Fig. 3). This distortion may be very conspicuous, like the sound from an over-biased Class-B amplifier (if you happen to have been through this distressing experience). Or it may be quite bland if the distortion doesn't get above the second harmonic. (You hear a lot of this kind of pleasing distortion by composer intent in any live performance of a symphony orchestra). In other words, you can't be sure about all distortion as an aural symptom.

The other symptom is much more reliable. The signal-to-noise ratio goes bad. Maybe the noise comes up to meet the signal, or maybe the signal falls off to within range of the noise. This very audible result is a hissy-sounding tape, and it is a result you don't want—ever.

Now you face your own tape recorder that doesn't have a pot in it for bias-adjust. When the recorder was being designed, though, the bias problem was carefully considered, and just the right bias was designed in for all appropriate components (while new) and for the recording tapes most likely to be used. The "right" bias is a precisely measured fraction of the total estimated erase current. (The recommended ratio for use with a very popular 1.5-mil acetate tape is 104 mA of erase and 5.2 mA of bias). The bias balancing may have been done under the chassis with R-C components or inside the heads with tapped or series-connected inductances. In the first case, readjustment is messy at best, and in the second, it is impossible.

Now the recorder is tired, or at least it has been used enough that it could be tired. What do you do about a bias that isn't to be adjusted? (It is assumed here that you don't own a scope or a distortion meter).

First you rule out the mysterious possibility that the recorder has suddenly or gradually acquired too much bias. Electronic circuitry very rarely ages in this upward direction. If the symptom is loss of highs, there are other and more likely causes of the trouble.

Listening test

So, if you suspect bias trouble at all, assume that your bias is low or missing, and at this point you arrange a listening test. Place the recorder in PLAY function. Gain is full on. Reels are at rest. Listen—to establish a comparison standard. Now play a tape, any tape such as recorded speech that offers intervals of silence through which to listen for white noise (hissing). Don't confuse the white noise with hum or ripple which have pitches of their own. Is the white noise appreciably worse with the reels turning? If so, the trouble may be low bias. If the recorder is a portable and if you are listening to its self-contained speaker, results may be somewhat inconclusive. If possible, pipe the test run through the audio section of a good hi-fi system. Now the bad, if present, will be convincingly bad.

Next, demagnetize the heads. If you don't have the facility to do this, you will be unlikely to have read this far on the subject of bias. Repeat the whole of the above listening test. Better? If so, the trouble wasn't bias.

Assuming that demagnetizing doesn't correct the defect, suspect next the most likely source of bias trouble, the oscillator. Run an erase test. With the recorder in the RECORD mode, run through a five-minute sampling of normally recorded tape with nothing plugged in to the input jack, and with the GAIN control *full off*. Then play back the sampling with the GAIN control full on. Is there the slightest evidence of erase failure? If so, the weakness of erasure will suggest the parellel weakness of bias, and you have almost surely found your bias trouble. Ordinary testing of the oscillator tube or transistor will not be adequate. The corrective action is oscillator replacement. If the recorder has a tube system, this is easy. If the system is solid-state, the replacement is a more serious problem.

On the very remote possibility that a weak oscillator is not the cause of the excessive white noise, you will just have to go inside with VTVM and schematic and check around. Check voltages at the oscillator. Check continuity to and through the heads. Are the heads in need of replacement because of worn pole pieces? If you can replace everything that has worn out or changed value, the designed amplitude of your recording bias will have been restored. This is your only bias-adjust, but it is all you need.

So far we haven't mentioned trying other brands or types of tape. Their bias requirements for optimum performance may vary slightly, and some tape manufacturers mention this in their specifications. Try other brands, but don't look for the difference to be shockingly better or worse as to bias compatibility. Acetate-versus-polyester tape doesn't call for a change of bias, and neither does thickness of base. Thickness of *coating* does make a difference. A popular brand of 1-mil acetate (with a .35-mil coating) will boost high-frequency response with 20% less bias than standard. The same brand name of "high-output" tape (1.5-mil base with .65-mil coating) will improve low-frequency response with standard bias. At recording speeds of 7½ ips or slower, the "standard" bias designed into the recorder is the happy compromise for all popular brands and types of recording tape, and your best effort at bias-adjust should aim at maintaining or restoring this "standard". **R-E**

Digital Logic in VCR Servicing

Part 2—Gates, truth tables, transistors and diode logic—they're all easier to understand when you see how they can simplify VCR control.

LAST MONTH YOU WERE INTRODUCED to the basic logic circuits. Now let's take a look at some interesting adaptations.

Positive and negative logic

The gates and logic principles discussed so far assume the use of positive logic. This means that a positive DC voltage represents logic high. Gate turn-on results from some combination of positive-voltage highs. An output high also goes in a positive direction.

Some logic systems operate with negative logic. Gate turn-on occurs because of negative-going input or high negative voltage. An output high from a negative-logic gate would be in the negative direction from zero or near-zero voltage.

In theoretical discussions of digital logic, and for design purposes, you need to understand negative logic and negative-logic gates. But for practical purposes as when you troubleshoot most VCR digital stages and sections, you can deal with negative gates on a basis of what you already know. Just remember that:

1. A shift of positive logic from high to low is a negative shift, as a negative-logic high would be and:

2. A shift of positive logic from low to high can be construed as a negative-logic low.

To make life easy among the VCR's digital circuits, don't worry about negative logic. In virtually every instance, you can treat all gates *in terms of* positive logic regardless of the gate configuration. And best of all, this approach simplifies understanding.

FOREST BELT

CHART 6–NEGATIVE AND + NEGATIVE OR GATES

NEGATIVE OR GATE

INPUT A	INPUT B	OUTPUT
0	0	0
0	1	1
1	0	1
1	1	1

NEGATIVE AND GATE

INPUT A	INPUT B	OUTPUT
0	0	0
0	1	0
1	0	0
1	1	1

You've already seen gates with a Not-circle. The NOR and NAND gates are examples. Keep in mind that each Not-circle represents logic inversion. The circle makes a low become high and a high become low.

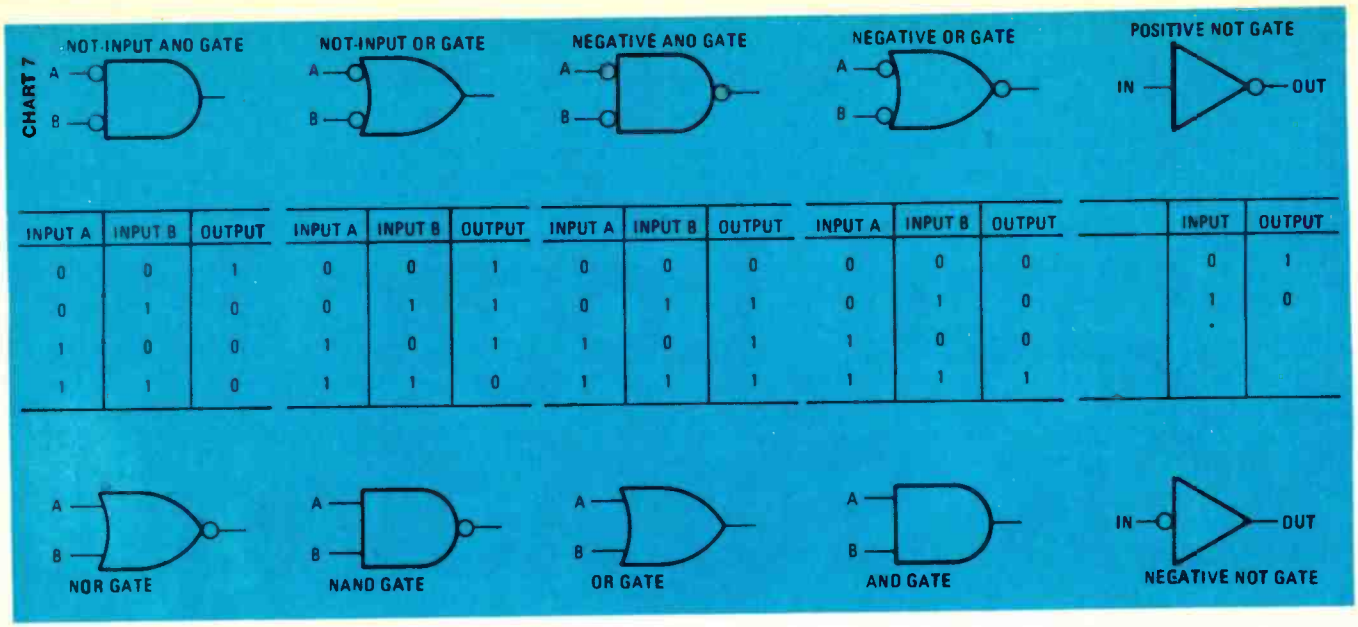
Negative-AND Gate—The symbol for a Negative-AND gate is the usual AND sign with NOT-circles at inputs and output. Let's consider operation in regular logic terms.

Low-logic input at A, through a Not-circle, inverts to logic high as it enters the gate. Low-logic input at B also inverts to logic high as it enters. The AND gate inside, effectively seeing two high inputs, turns on and produces high output. But then the output Not-circle inverts it. Hence a Negative-AND gate, with two logic-low inputs, delivers a logic-low output (see truth table line 1).

One logic high to either input gets inverted to a logic low. The AND gate can only put out low logic. But again the Not-circle inverts the input logic. So, Negative-AND output goes high when either input sees a logic high (see lines 2 and 3).

Suppose both inputs go logic high (see line 4). Both input Not-circles invert the logic. The gate, seeing lows internally, starts logic low out. The output Not-circle then inverts the logic. So logic high at both inputs of a Negative-AND gate produce output high.

Hence, the truth table lays out overall operation of a Negative-AND gate for you. Remember, you can "convert" positive logic to negative logic by considering the *direction* of the logic change.



However, you seldom need to do this in VCR logic circuits.

Negative-OR Gate—Add Not inputs and a Not output to an OR-gate symbol, and you have a Negative-OR gate. You can cover up the Negative-OR truth table and write one yourself to prove you can reason through the operation.

Line 1: Two logic-low inputs invert and become two logic highs. This turns on the OR gate (it is inclusive). A gated high becomes inverted at the output to give a Negative-OR output low.

Line 2: Input A low (becomes high); input B is high (becomes low). One high is enough to turn on the OR gate, for a high inside. But inverted output delivers a logic low.

Line 3: Input A high (inverts to low); input B is low (inverts to high). As always one high input sends an OR gate high, and the output inverts again to logic low.

Line 4: Two high inputs. Both invert to logic low. The gate stays off, developing an internal logic low. Inversion then makes the output high.

You may begin to suspect there is no end to logic-gate configurations, and you may be right. But when you reach a certain point, the logic begins repeating itself.

Let's look at the Primary Gates Master Chart. The first gate shown in the upper left is an AND gate with both inputs Not. At this point you know the truth table has been written as follows:

Line 1: Two low inputs invert and turn on the gate, for an output high.

Lines 2 and 3: One input low and the other high (both inverted) still leave one input low and one high, which keeps the output low for either condition.

Line 4: Two highs invert to lows and leave the gate off (output low).

One aspect about this Not-Input AND gate is well worth noting. Its truth table exactly matches that of a simple NOR gate. The two gates are thus interchangeable. This accounts for the OR-gate symbol placed beneath this first truth table.

Look at the second truth table: It sets forth the operation of a Not-Input OR gate:

Line 1: Two inputs invert to high, and turn on a high output.

Lines 2 and 3: If either input is low, it inverts to a high, triggering a high output.

Line 4: Two high inputs invert to both low, and the gate sends out a logic low.

This coincides with the operation of a plain NAND gate. In typical use, the two really are interchangeable.

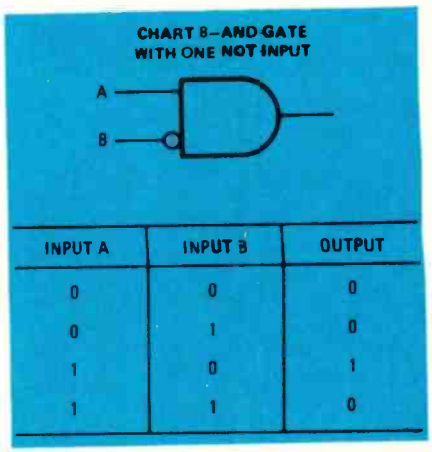
Why do both configurations exist for each operation? It's largely a matter of construction. Some digital IC's feature MOS (*M*etal-*O*xide *S*ilicon) materials; others offer bipolar-type TTL (*T*ransistor-*T*ransistor *L*ogic) and other non-MOS construction. IC designs often boil down to cost and availability. The MOS-type gates are usually OR-related; the TTL gates and the like are generally AND-based. A logic diagram shows the symbol for whichever kind of gate a function uses.

You have already spotted the other interchangeables in the Master Chart. A Negative-AND gate manipulates logic exactly the same way as an OR gate. A Negative-OR gate works just like an AND gate. Both their respective truth tables prove this.

Moreover, it's not uncommon to find logic-circuit descriptions that substitute one name for another. A Not-Input OR gate, for example, can be described as performing a NAND operation—which it does. Hence, the Primary Gates Master Chart helps you avoid confusion. I suggest you copy this chart and post it near your service bench. It can save you many wasted hours until you are a 100% familiar with logic gates.

A Not-Input Gate—Finally, here's one more hybrid gate that is commonly found VCR logic systems. Look at the symbol showing only one Not Input to an AND gate. The Not circle is at input B.

The *Not* symbol indicates logic inversion. So, logic low reaching input B of this AND gate finds itself inverted, and acts on the AND gate as a high input would. Conversely, a high to input B has the same effect on the gate as a low input would on an ordinary AND gate.



Now, figure out the truth table for this Not-Input gate, using the following reasoning:

Line 1: Input A shows logic low. Any AND gate requires both inputs to be high to turn on, so the output here must remain low. (It doesn't matter what happens at the other gate.)

Line 2: Input A is still low. The AND gate cannot turn on no matter what happens at input B. So the output stays logic low.

Line 3: Input A is high, one condition for an AND gate to turn on. Input B sees logic low. However, that low is inverted by the Not-Input configuration, so the gate (internally) sees high from input B. Therefore, the gate turns on and output goes high.

Line 4: Input A is high, meeting one condition for AND-gate turn-on. Input B sees high. But the *Not*-input configuration inverts that condition, so the gate internally finds logic low from this input.

Since the gate sees only one high input, the output stays low.

Why bother, you wonder. Some VCR controls must be activated when only one particular input reads high. Neither an AND gate nor an OR gate could manage that directly. A NOT gate could be inserted in the B-lead of an ordinary AND gate. But this means using an extra device, which is sometimes easy and sometimes not. An AND gate with one inverted input does the job more easily.

Analyzing gates

Gates such as those just described are connected every-which-way to form digital-logic circuits and systems. Your primary tool in digital troubleshooting is your knowledge of how each type of gate works. Once you identify each gate in a system, you check its inputs and then verify that the gate turns on or off in accordance with its truth table. You can thus trace highs and lows through a whole system.

Figure 3 contains the logic circuits that are involved in the automatic shutdown of the tape transport mechanism in a VHS type of video cassette recorder. The diagram shows the Stop Solenoid and four of its sensor systems. The Stop Solenoid, when it is activated, releases any control pushbuttons that are depressed. This delivers the same effect as manually depressing the Stop pushbutton on the machine.

The best way to analyze this sytem is to begin at the solenoid and work your way back. Here's how the logic goes:

During normal operation, the solenoid remains inactive. Transistor Q617 is not conducting. No current flows in it or the coil. The transistor, for all practical purposes, is open. Logic (voltage) at the collector is therefore high.

As you work your way back from any point in a diagram, label the logic at each gate, as has been done in Fig. 3. This requires only that you know how each type of gate works.

If logic is high at the collector (the output) of Q617, it must be low at the base (the input). Remember the inversion in a common-emitter amplifier (Fig. 1-a)? Label the base LO.

Transistors Q614 and Q613 are shown in Fig. 3 as NOT gates. Actually, they too are transistors that invert the logic as you saw in Fig. 1-a. So, logic must be normally high between the two and must be low at the output of the four-input Diode-OR gate.

You know that an OR gate turns on when any one of its inputs goes high. Since the output is now at logic low, all four inputs must also be at logic low. So you would label all four input lines as shown in Fig. 3. (In an actual shop situation, you would do the labeling on the manufacturer's schematic.)

Now, move down the D-input leg from the Diode-OR gate. The capacitor prevents DC from passing through, but insures that a sudden upward surge on the line passes up to the OR gate. In the quiescent state, however, logic across the capacitor is low, meaning that Not-gate output is low. Its input, therefore, must be high during normal operation, which is indicated by the HI label.

Now for the C-input leg: Logic low at the OR-gate input indicates logic low at the resistor junctions. But imagine a burnout in the end-of-tape (EOT) light. The voltage at those junctions goes high. Logic high reaches the OR gate and turns it on.

Logic high at the OR-gate output inverts to logic low after Q613, and to logic

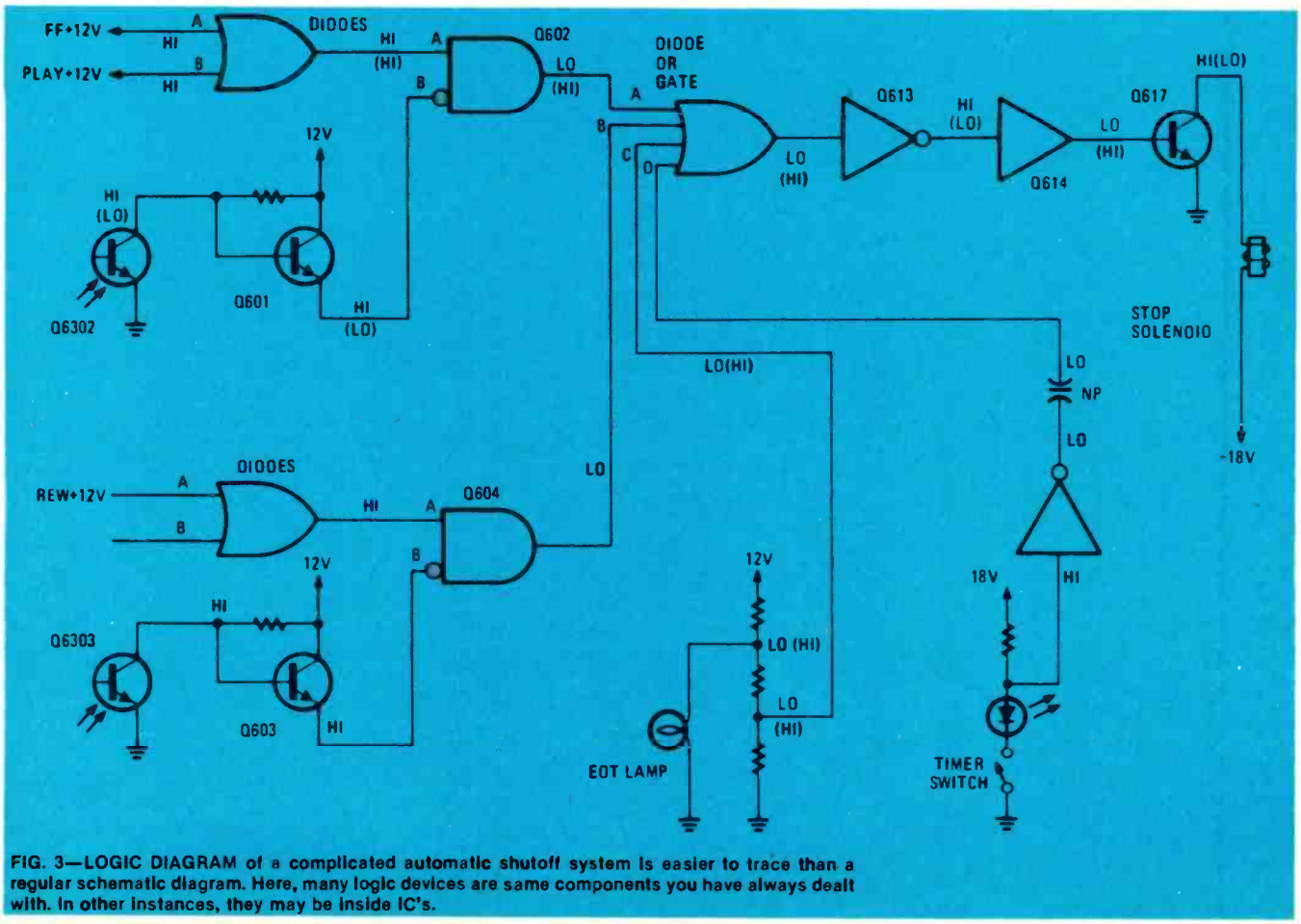


FIG. 3—LOGIC DIAGRAM of a complicated automatic shutoff system is easier to trace than a regular schematic diagram. Here, many logic devices are same components you have always dealt with. In other instances, they may be inside IC's.

high following Q614, which turns on transistor Q617. Current through the coil pulls the solenoid in, tripping the STOP mechanism.

Each of these "in action" logic levels goes on your schematic in parentheses, as shown in Fig. 3.

Turn to the input-B branch. Logic low at the AND-gate output means at least one of the gate inputs must be low. But which one? In this case, it is the automatic shutoff for the end of rewind. You can tell because the REWIND switch places 12 volts on one OR-gate input, which then delivers logic high at its output.

This makes input A of the AND gate go high. The AND gate is thus "armed," (in digital parlance, this is called *enabling the gate).* But the AND gate is still not operative during Rewind. Therefore, the gate must be seeing logic low internally from input B. Because of the Not-input configuration, the actual B input must be high during normal operation.

Transistor Q603 is connected as an emitter-follower. This means it acts merely as a pass-along amplifier. It does not invert (see Fig. 1-b). Logic high at its emitter (the output), then, suggests logic high at its base (the input).

Transitor Q6303 is a light-sensitive transistor that acts as a variable resistor. It forms a divider with the resistor from the 12-volt line. With the transistor dark, as it is while the tape runs through the transport, resistance is high. Thus, logic high is maintained at the base of Q603, as long as opaque tape intervenes between the sensing transistor and the (EOT) light.

Now, trace the action of this automatic Stop arrangement. When tape comes to the end at the takeup reel, a transparent trailer lets light fall on the EOT transistor. Resistance goes way down. This brings logic low to the base of Q603, and logic low to input B of AND gate Q604. The Not-input inverts the logic low, making it logic high inside the gate. Input A is already at logic high. This is an AND gate, so logic high at both inputs turns it on.

Logic high from the AND-gate output goes to input B of the large OR gate. A logic-high output develops. And you already know how the rest of the gates pull in the Stop Solenoid. The VCR thus returns to its STOP mode when the tape is fully rewound.

Branch A from the OR gate operates almost the same as branch B just described. The difference is that either the PLAY button or the FAST-FORWARD button enables an AND gate through its input A. Then, when all the tape has been used up from the supply reel in the cassette, EOT sensing changes logic high to logic low at AND-gate input B. The AND gate—through its Not-input—turns on, Initiating the Stop-Solenoid sequence.

Tracing and testing

Both low and high logic states consist merely of DC voltage levels. You could use a DC voltmeter when you need to check gate operation. In some digital systems, a voltmeter *can* do the job. In other systems, digital states occur and change very rapidly, and a voltmeter can't keep up.

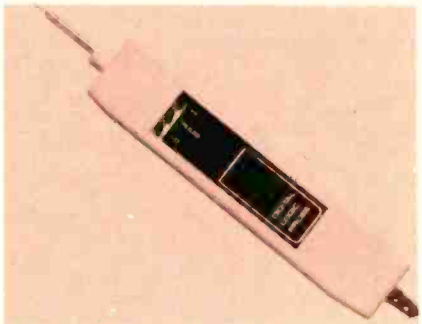
A device called a *logic probe* takes the place of a voltmeter rather handily. It contains circuitry that senses either logic-low or logic-high conditions when you touch the probe to a test point (the input or output of a gate). A light-emitting diode (LED) turns on when the probe touches logic high. The LED extinguishes on logic low. You can trace low or high conditions even though the logic changes too quickly for a voltmeter. You just need to know the gates and what to expect at their inputs and outputs.

In many digital-logic systems, however, the voltage levels switch from low to high and back *very* rapidly. The logic consists actually of voltage *pulses,* which are often very precisely timed. You need an *oscilloscope* to view these logic levels.

Exactly when a gate turns on and off depends on the timing of its inputs. A dual-trace scope, with a bandwidth to 15 or 20 MHz, is absolutely vital in comparing logic timing. A scope with even more traces comes in handy for some digital diagnosis, but you can manage with two in VCR servicing.

Let's now turn our attention back to what I call a steady-state logic system. Figure 3 is an example of this. Only in one branch (D) does a pulse get involved, The others are run by logic "states."

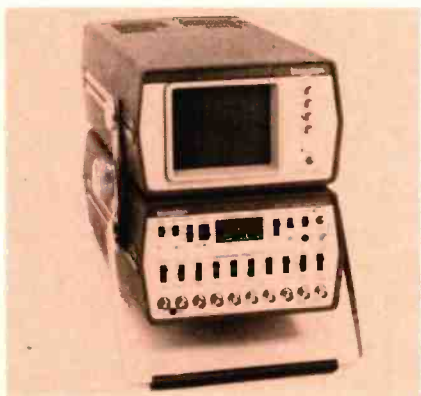
You have to see how you can trace your way through a string of logic gates to



LOGIC PROBE by Continental Specialties speeds digital-logic troubleshooting.

determine whether each gate is functioning properly or not. With this knowledge of logic tracing, you can then analyze pulse-handling logic systems more readily. A logic probe is the test instrument to use in this case.

Remember that every gate in a system always exhibits one of two output states—low or high. Either state may be



MULTITRACE SCOPE by Gould aids analysis in complex digital pulse stages and circuits, but dual-trace model suffices for VCR diagnosis.

"normal." So, consider "normal" whichever state exists during regular system operation.

Generally, a gate itself is considered to be off when its output is logic low, and on when its output is logic high. In that case, on may be the so-called normal condition for a gate (or off may be). Hence, you should test every gate for both conditions. To accomplish this, you will have to operate the system in both states—active and inactive—as you check the gate output. If you do not follow this procedure thoroughly, you may not find out whether the gate functions altogether properly.

Refer again to Fig. 3. Start by assuming the VCR is in a "normal" operating state for the Fast-Forward end-of-tape branch. This is the sensing branch that connects to input A of the diode-OR gate.

Insert a cassette, and start the cassette tape on Fast Forward by depressing that particular pushbutton on the VCR's front panel.

Touch your logic probe to input A of the first OR gate, where the FAST-FORWARD switch applies 12 volts. When you examine the manufacturer's schematic and the VCR itself, you will discover that this OR gate actually consists of two diodes. Figure 4 is a detailed partial schematic diagram of this sensing system.

Input A is the anode end of diode D601. Output (C) is the cathode end, where it and D602 join. Your logic probe should light up at both ends of D601, verifying that the switch does apply logic high and that the "gate" is passing it along. The probe should also show logic high at input A of the AND gate (see Fig. 3). Finding where to touch the probe

reveals again that logic gates are not necessarily inside an IC. As it happens, in the video recorder section chosen for this demonstration, the AND gate is transistor Q602. Figure 4 shows the hookup.

The A′ input, the one that enables the transistor—which makes it ready for AND-gate operation—actually is the collector-supply connection. Diode D601 carries logic high from the FAST-FORWARD switch to the collector-supply resistor—input A′.

The B′ input, meanwhile, is at the transistor base. That's why input B′ happens to be shown in the logic symbol as an inverting (Not) input. A common-emitter stage always inverts its input logic. For now, your logic probe at input B′, the base of Q602, shows logic high.

The transistor conducts; in fact, it saturates, dropping voltage low (near ground potential)at the collector. Hence, the probe fails to light up at that point, signifying logic low at output C′ of the Q602 AND gate.

As you find the multi-input OR gate of Fig. 3 in the VCR, you will see it consists of several diodes connected just like the two-diode OR gate in Fig. 4. The inputs are the anode ends; the output is the cathodes tied together. The A input for

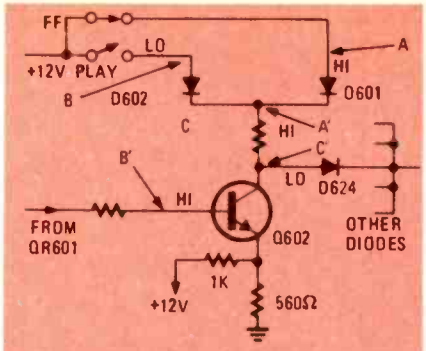


FIG. 4—SCHEMATIC DIAGRAM shows discrete components that form some logic circuits. As you can see, not all logic gates are in an IC.

this Diode-OR gate is diode D624. Your logic probe at its anode (the input) end shows low. But why does the probe show low at the cathode (the output) end? Because only a high positive voltage (logic high) on the anode makes the diode conductive, which turns the Diode-OR gate on from this particular input.

(I hope you realize from all this discussion how really simple and sensible digital logic is. Of course, the concept is new. It's vital that you learn to think in these new "gate" concepts. Gates do seem more complicated when there are groups of them inside IC's that are designed for special purposes. But it all remains just digital logic and based on the primary gates we have been looking at here.)

So, now we proceed to the next step in diagnosing Fig. 3. Touch your logic probe to the input of NOT gate Q613. This input happens to be the base of a transistor. The probe should read low (DC voltage at the base is low).

The NOT gate Q613 inverts the logic. In other words, voltage at the collector (the output) is high because the transistor is not conducting. Your logic probe should light up when you touch it to the collector of Q613.

The same is true at the base (the input) of NOT gate Q614. And because Q614 inverts the logic, the output (the collector) of Q614 should register logic low; the probe does not light up there.

Of course, Q617 is, in effect, another NOT gate, albeit one that can handle the heavy current drawn (later) by the solenoid coil. No current flows in Q617 right now, because of the logic low on its base. Therefore, your logic probe finds logic high on the collector of Q617. So far, everything appears OK.

Tracing the opposite mode

If all logic is correct from start to finish, the stages are ready to perform their shutoff function. But suppose the tape reaches its Fast-Forward end and the stages do not return the machine to Stop. How do you find out why this happens? By again tracing the logic through every gate. I suggest you follow this hypothetical malfunction in Fig. 3.

Start at the end-of-tape phototransistor sensor. Light reaches it through a transparent strip on the end of the tape. The phototransistor resistance goes low, as does voltage across it. Your logic probe therefore should not light up (logic low). If the probe does illuminate, you have already found the trouble.

Low logic across Q6302 should be passed on as logic low at the emitter of Q601 and at the base (input B) of AND gate Q602. If the FAST-FORWARD switch is OK, logic should still be high at input A (the end of the load resistor) of AND gate Q602. Low at the Q602 base should bring about logic high at the collector (the output) of Q602. Your logic probe should light up when you touch it there.

Logic high passes through the Diode-OR gate because high positive DC forward-biases the diode that serves as input A for this gate. Your logic probe should find logic high at the input to NOT gate Q613. If not, the diode is probably open.

At the input to NOT gate Q614, your probe should now register logic low. Suppose it does not. And suppose you find logic high at both input and output of NOT gate Q613. The NOT gate fails to invert. Because Q613 is a transistor, with logic high on its input (the base) it should run saturated. Voltage tests show it does not. The transistor proves defective. You replace it. Meanwhile, what happened in the rest of the system as a result of the failure at Q613?

Here's what occurred: Q614 found logic high on its base, just as if the end-of-tape sensor were inactive. Logic low remained on the base of Q617, and no current flowed to pull in the Stop Solenoid. Automatic shutoff failed. So the transport mechanism could keep tugging on the tape in the cassette, perhaps eventually breaking it.

However, with your trusty logic probe, you quickly found your way to the trouble. Plus you did it a lot faster than you might have had you been thinking of the system in old-fashioned analog terms. Digital logic can actually be easier and faster to troubleshoot, once you come to understand it. **R-E**

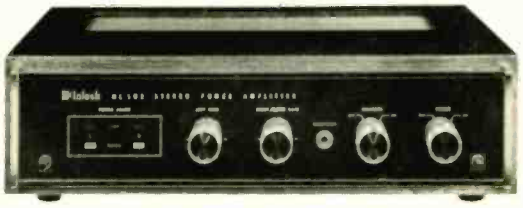
SOLID STATE NEWS

Semiconductor devices

RCA has introduced the *Switchmax* series of fast-switching transistors for off-line power supplies and other high-voltage switching applications. The family initially has eight transistors, 2N6671 through 2N6678, with saturation-current ratings between 5 and 15 amps. These devices are tri-metal and glass-passivated with high safe-operating-area ratings. The transistors are 100% tested at both 25°C and 100°C and/or 125°C, and are particularly suited for inverter/converter circuits and pulse-width-modulated regulators. Their V_{CEV} ratings are 450 to 650 volts. The 450-volt, 5-amp 2N6671 transistor is priced at $3.82 each in hundreds of quantities, and the 650-volt, 15-amp 2N6678 costs $9.90. RCA Solid State Division, Box 3200, Somerville, NJ 08876.

Semicon, Inc., is producing a series of press-fit silicon rectifiers for use in alternators, battery chargers and other chassis-mount power-rectifier applications. The SR5005 series rectifiers are packaged in DO21 cases, and are rated at 50 amps at 150°C. Their peak-surge current rating is 600 amp, with voltage ratings to 400 volts.

The SR5005 rectifiers cost $1.50 each in hundred quantities. For literature, write Semicon, Inc., 10 North Avenue, Burlington, MA 01803. **R-E**



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McINTOSH Model MC-502 Power Amplifier

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

THIS IS THE FIRST TIME THAT WE'VE EVER tested a McIntosh hi-fi stereo product. In the past, McIntosh Laboratories Inc. (2 Chambers Street, Binghampton, NY 13903) has relied more upon word-of-mouth customer endorsement than upon published test reports. Evidently the system works, for it has been said that "once a Mac customer always a Mac customer." Sometimes we hear of McIntosh equipment owners who have been using the same amplifier day after day for 10 and even 20 years without ever having had a service problem. Now that we have had a chance to put one of the company's latest amplifiers through its paces, we begin to understand why this is so.

The *model MC-502* amplifier, shown in Fig. 1, has an anodized gold and black front panel. Those of you who are familiar with other McIntosh products will immediately recognize a family resemblance. McIntosh has developed a system of equipment installation into the cabinetry that is called the *Panloc* system; and all the necessary hardware, slides, etc., that are required to install this amplifier are included, even down to different-length screws for different wood-panel thicknesses, along with lucid instructions.

Front-panel controls include a rotary POWER on/off switch, a SPEAKER on/off switch, and separate input-level controls for left and right channels. A headphone jack is located between these two pairs of rotary controls. At the left end of the panel, contained in a rectangular outlined area, are two pairs of indicator lights (one pair green, the other red) that constitute the visual representation of a unique *Power-Guard* circuit. When the amplifier is operating within its limits, the green lights stay on. Any attempt to over-drive the amplifier causes the upper red lights to come on and extinguishes the lower pair of lights. The small pushbutton-like protrusions at the lower right and left-hand sides of the panel are part of the previously mentioned *Panlock* equipment retaining system. Depressing these two "push buttons" allows the instrument slide to be locked firmly into place, or it can be unlocked so that the chassis can slide forward, thus providing access to the rear panel even after installation.

The amplifier's rear panel, shown in Fig. 2, contains a four-terminal speaker-connection strip, an unswitched AC receptacle, a line fuseholder, the necessary left and right INPUT phono jacks, an INPUT LEVEL slide switch that selects either 0.75-volt or 2.5-volt input sensitivity and a MODE switch to select either the stereo or mono modes. With this switch set to the MONO position; the two amplifier channels are bridged to provide double the available power from either channel at 8 ohms. When the amplifier is used in the mono mode, the single speaker is connected between the two "hot" terminals of the speaker strip.

Construction and circuitry

Figure 3 is an internal view of the chassis. Separate left-hand and right-hand channel-driver PC boards flank the generous-sized power transformer. Large-sized heat sinks (two-per-channel) are located at the rear of the unit, flanking the pair of 10,000-μF filter capacitors that form part of the ±40-volt DC power supply for the output stages. Electronically regulated power supplies are used to deliver ±15 volts for all op-amps.

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McINTOSH MC-502
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Each channel consists of an input preamplifier, a power amplifier section, three separate protection circuits and a phase inverter that is integral with the left channel and is used when the monophonic bridged mode is selected.

Each of the power amplifier sections consists of four stages of amplification. A low-noise differential pair of transistors is used as an input stage. The two outputs of this stage are combined in a current mirror circuit that drives the second Class-A voltage amplifier. This stage, in turn, feeds complementary-emitter followers that drive the complementary-emitter-follower output stages. Bias for the

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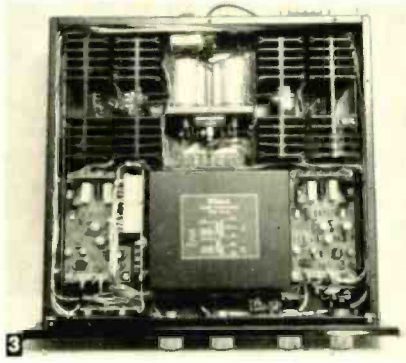

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driver and output stages is provided in the base circuit of the driver transistors, using a temperature-sensitive transistor that is thermally coupled to the output-transistor heat sinks.

The first of the three protection circuits is called a *Sentry Monitor* that senses the current flow in the output-stage transistors. The second protection circuit is the one referred to earlier as the *Power-Guard* circuit. The *model*

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

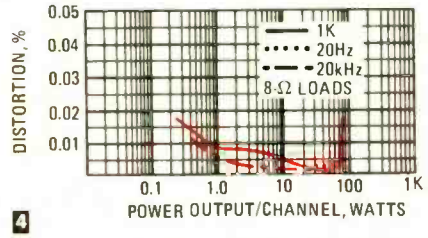
Power Output (Stereo): 75 watts-per-channel, 2.7- to 4-ohm loads; 50 watts-per-channel, 8-ohm loads; minimum continuous power output-per-channel, 20 Hz to 20 kHz, both channels driven. **Power Output (Mono, Bridged):** 150 watts into 8-ohm loads, minimum continuous power, 20 Hz to 20 kHz. **Rated Harmonic Distortion:** 0.025. **Rated IM Distortion:** 0.02%, any combination of frequencies from 20 Hz to 20 kHz. **Frequency Response:** 20 Hz to 20 kHz, +0, −0.25 dB; 10 Hz to 100 kHz, +0, −3 dB. **Hum and Noise:** 95 dB below rated power output. **Damping Factor:** greater than 50. **Input Impedance:** 75,000 ohms. **Input Sensitivity for Rated Output:** 0.75 volt or 2.5 volt (switchable). **Dimensions:** front panel, 16 inches W × 3⅜ inches H; chassis, 14¾ inches H × 2⅜ inches H × 14½ inches D. (including connectors). **Net Weight:** 27 lbs. **Suggested Retail Price:** $699.

MC-502 amplifier, as well as other McIntosh amplifiers, has a built-in waveform comparator that compares the waveform of the output signal with that of the input signal. If the difference between these two signals reaches 0.5% (or the equivalent of 0.5% harmonic distortion) a red limit indicator light illuminates on the front panel, warning that this distortion level has been reached. Even if the user should insist upon trying to drive the amplifier farther into clipping or distortion, the *Power-Guard* circuitry acts to limit the *input* signal dynamically so that amplifier cannot be overdriven. Since the circuit's is action reduces *input*-signal levels, there is no way the amplifier can be sent into audible clipping. Because the *Power-Guard* circuit does not begin to operate until the limits of the amplifier have been exceeded, the rated power-output capability of the *model MC-502* is never affected.

The third control circuit is the speaker protection and turn-on delay circuit. This fast-acting circuit detects the presence of any DC component at the speaker terminals (for whatever reason), and reacts in milliseconds by triggering a heavy-duty relay through which signals normally pass before reaching the output terminals. Speakers remain disconnected until the cause of the DC problem has been corrected or eliminated. The relay also closes approximately two seconds after amplifier turn-on and releases almost instantly when power is turned off. This prevents any turn-on or turn-off transients from reaching and possibly damaging the speakers.

Lab measurements

Table I summarizes the major performance measurements made in our lab. In checking out the power-output values obtained for both 8-ohm and 4-ohm operation, you must remember that the amplifier is only rated at 50 watts-per-channel and 75 watts-per-channel at these impedances. Figure 4 is a graph showing the power output vs. harmonic distortion, ranging from 250 mW to beyond the rated output; while Fig. 5 shows the same data for 4-ohm loads. The apparent rise in distortion at low power levels is, in reality, the noise floor of the amplifier circuit measured by our distortion analyzer; but even this combination of noise and harmonic distortion did not exceed a 0.02% measurement at the lower power-output levels.



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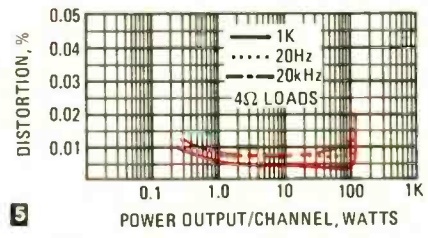

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While no graph is provided for monophonic (bridged-mode) operation, we did measure its monophonic output capability using 8-ohm loads, and obtained nearly 225 watts at 1 kHz, 210 watts at 20 Hz and just over 200 watts at a 20-kHz test frequency before observing the 0.02% rated harmonic distortion figure.

Returning once more to 8-ohm stereophonic operation, we measured distortion vs. frequen-

TABLE 1

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **McIntosh Laboratory, Inc.** Model: **MC-502**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	80.6	Excellent
RMS power/channel, 8-ohms, 20 Hz (watts)	60.5	Excellent
RMS power/channel, 8-ohms, 20 kHz (watts)	80.0	Excellent
RMS power/channel, 4-ohms, 1 kHz (watts)	110.0	Excellent
RMS power/channel, 4-ohms, 20 Hz (watts)	97.0	Excellent
RMS power/channel, 4-ohms, 20 kHz (watts)	105.0	Excellent
Frequency limits for rated output (Hz–kHz)	10–60	Excellent
Dynamic headroom (dB)	2.36	Nonrated
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.002	Superb
Intermodulation distortion, rated output (%)	0.003	Superb
Harmonic distortion at 1-watt output, 1 kHz (%)	0.008	Superb
Intermodulation distortion at 1-watt output (%)	0.007	Superb
DAMPING FACTOR AT 8 OHMS, 50 Hz	100	Excellent
COMPONENT MATCHING CHARACTERISTICS		
Input sensitivity (mV for 1-watt output)	105/360	
Input impedance (ohms)	75K	
Output load impedance, stereo (ohms)	2.7 to 8	
Output load impedance, mono (ohms)	8	
Frequency response (Hz to kHz, ± 1 dB)	7–130	Excellent
Signal-to-noise, referenced to 1 watt out, 0.5volt-in, "A"-weighted (dB)	93	Excellent
Signal-to-noise, referenced to 1 watt out at minimum volume ("A"-weighted)	97	Excellent
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Front panel layout		Very good
Thermal characteristics		Excellent
Protection circuitry		Superb
Design and construction		Excellent
Ease of servicing		Excellent

TABLE 2

OVERALL PRODUCT ANALYSIS

Retail price	**$699**
Price category	**Medium/High**
Price/performance ratio	**Excellent**
Styling and appearance	**Excellent**
Sound quality	**Excellent**
Mechanical performance	**Excellent**

Comments: McIntosh Laboratory's enviable reputation for products that stand up under years and years of continuous usage is clearly deserved, judging from the construction and performance of the *model MC-502* medium-powered amplifier. Other amplifiers we have tested incorporate some form of power limiting that prevents severe clipping, but the McIntosh "*power-guard*" circuit is the only circuit we have seen that not only performs on the test bench under static-signal conditions, but works equally well under music-signal input. You cannot send this amplifier into severe distortion levels no matter how hard you drive it.

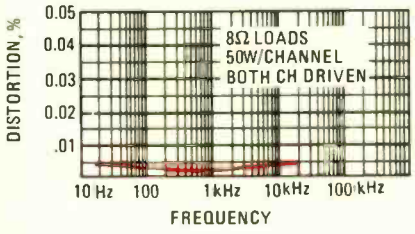
We appreciated the less obvious design touches almost as much as the more obvious ones. For example, providing the amp with a choice of basic sensitivity levels for rated output was a wise decision, especially in view of the widely varying gain between some more popular preamplifier-control units. Used with McIntosh preamps, the amplifier's input sensitivity would be set to the 2.5-volt position for best overall signal-to-noise ratio; but many other preamps cannot deliver this level with convenient control settings or with low enough distortion, and hence the 0.75-volt sensitivity setting was included.

From time to time, McIntosh has questioned the need for wide bandwidth in audio amplifiers. In this design they have achieved response to beyond 100,000 Hz without sacrificing other parameters. The sound quality when the amplifier is used to drive good speaker systems can only be described as highly accurate and neutral. Transient response is excellent, and the amplifier handles musical waveforms fully as accurately as it does our laboratory test signals.

McIntosh uses the term "performance limits" in describing its specifications. This means that each amplifier must perform better than the published specs. Our sample certainly did and by a wide margin. Even more important, we suspect that several years from now, judging by its construction and its quality components, if we were to put it back on the bench and in our listening room, it would still sound exactly as good.

cy for a constant output of 50 watts-per-channel, with both channels driven. The results are shown in Fig. 6 and, even at the extreme test frequencies of 20 Hz and 20 kHz, harmonic distortion was lower than the manufacturer's published specs by a factor of better than 4:1.

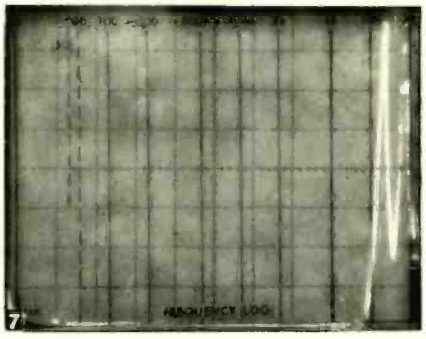
Intermodulation distortion, measured in accordance with the SMPTE method, was very nearly as low as harmonic distortion at rated output, and for a rated IM distortion of 0.02%, we had to drive the amplifier until it delivered 78 watts-per-channel into 8-ohm loads. Interestingly enough, McIntosh is one of the few manufacturers who quote IM distortion not

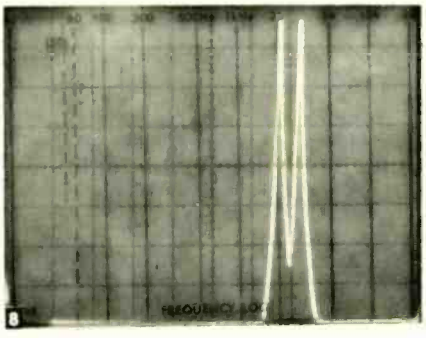


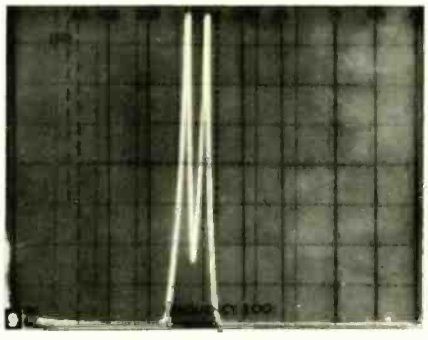
only for the two SMPTE measurement methods (which involves a low- and high-frequency combination in the ratio of 4:1 in amplitude) but for *any* combination of frequencies within the audio band. Putting this broad statement to the test, we first measured IM using the CCIF method, in which two frequencies separated by 1 kHz are applied to the amplifier and any resulting 1-kHz beat component (difference frequency) is filtered and expressed as a percentage of the peak equivalent input signal. Three pairs of high-frequency signals were used. With 9-kHz and 10-kHz signals applied, the CCIF IM measured 0.0009%. Switching to frequencies of 14 kHz and 15 kHz, the IM measured 0.001%; while with high frequencies of 19 kHz and 20 kHz, the IM measurement was 0.0011%.

We took the IM two-tone measurement idea a step farther and, instead of limiting our results to include only a 1-kHz beat frequency between the two test frequencies, we decided to apply the new IHF measurement technique. This technique requires that *all* difference frequencies observed must be summed (taking the square root of the sum of the squares of the individual amplitudes of generated difference components up to the fifth order).

To arrive at a solution, it was necessary to use a spectrum analyzer. We adjusted the sensitivity of the analyzer so that the desired output tones would be displayed over the scope's full available dynamic range. Each horizontal line shown in Figs. 7, 8 and 9 corresponds to 10 dB of amplitude for a total available dynamic range of 80 dB, using 19-kHz and 20-kHz test tones, we swept the display linearly from 0 Hz to 10 kHz. Figure 7 shows no visible spurious intermodulation compo-

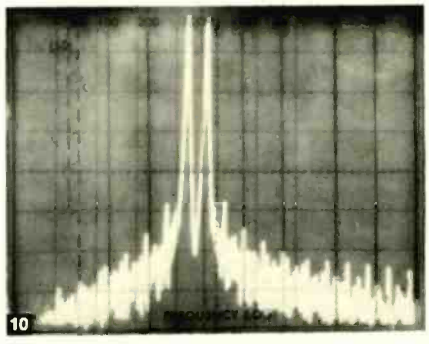






nents—at least none that were within 80 dB of the desired reference tones. Since the 80-dB value corresponds to a 0.01% level, we can assume that, with these two test frequencies, the intermodulation distortion was less than 0.01%. How much less is impossible to guess because of the dynamic range limitation of the analyzer. Nor was there any evidence of intermodulation components when 14-kHz and 15 kHz or 9-kHz and 10-kHz test-tone pairs were used, as shown in Figs. 8 and 9 respectively.

To show that this measurement method actually does work, we cranked up the input levels until the *Power-Guard* circuitry began to operate and continued to turn it up beyond that point. Since the *Power-Guard* circuit automatically limits additional increases in input level, the very *worst* results we obtained are shown in the scope photo of Fig. 10, which shows a pair of intermodulation sidebands at 8 kHz and 10 kHz, plus some much lower ampli-



tude components at other frequencies above and below the test frequencies. Both the significant intermodulation components are approximately 48 dB below reference-signal level and, since there are two components, we must add 3 dB for an equivalent amplitude; this brings the difference between the desired and undesired signal amplitudes to 45 dB, or the equivalent of 0.56%. All this means is that no matter how hard you drive this amplifier, there is no way it can be forced to produce more than 0.56% intermodulation distortion under any drive circumstances. This type of measurement is believed to provide a better correlation between the way an amplifier sounds and the way it measures than the more traditional harmonic distortion and SMPTE intermodulation distortion measurement methods.

Summary

Our overall product analysis is found in Table 2, together with summary comments concerning its sonic qualities and expected durability. If ever an amplifier could be described as having fail-safe design, this unit qualifies. The fact that it also sounds as good as it does indicates that its suggested retail price of just under $700, although somewhat higher than for most separate amplifiers at this power-output level, is not unreasonable. After all, you get what you pay for. **R-E**

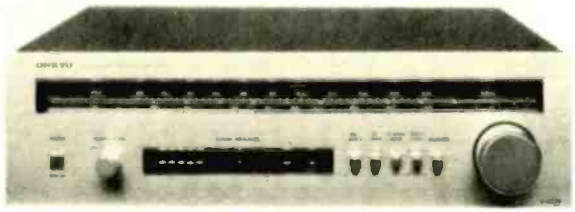
Compatible 3-D TV system is introduced in Australia

A new 3-dimensional electronic stereoscopic television system is being installed by Station TVN-9, Sydney, Australia, for experimental stereoscopic color TV broadcasting. The "new" in the system is that it is compatible. The ordinary viewer sees a normal color TV picture, perhaps with slight fringes in the foreground and background if he looks hard for them. With the special red-cyan glasses supplied for the purpose, the stereo viewer sees a true three-dimensional picture.

The system was developed by Digital Optical Technology Systems (DOTS) of Amsterdam, Netherlands, and is being handled in this country by Ancom Inc. of Scarsdale, NY.

The secret of the new process is that the stereo effect is applied only to the out-of-focus areas of the image in the foreground and background. The viewer sees the main, or sharply focused, portions of the picture as he would on ordinary TV. The slight fringing that he may or may not notice in the foreground and background disappears if he puts on the special red-cyan glasses, and the background seems to recede and the foreground come forward, producing true stereoptic vision.

All the equipment for the new system is installed at the TV station—the only thing necessary at the receiving end is the tinted glasses. (Incidentally, another difference between this and older 3-D approaches—instead of the cheap throwaway cardboard glasses of the old 3-D movies, the viewer is expected to buy his own high-grade comfortable ones, which may cost from $5 to $7.) There are two approaches, an optical and a more highly sophisticated and expensive digital electronic one, which beside providing improved stereoscopy, has facilities for time-base correction, grain and noise reduction, image outlining and color correction. **R-E**



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CIRCLE 107 ON FREE INFORMATION CARD

ONKYO T-4090 AM/FM Tuner

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

ONKYO (42-07 20th AVE., LONG ISLAND CITY, NY 11105) was one of the first companies to incorporate an advanced form of AFC (*A*utomatic *F*requency *C*ontrol) circuitry that is based upon a quartz crystal reference oscillator into many of their receiver and tuner products. The elegance and accuracy of that tuning system along with the panel layout and the measured performance of the T-4090 suggest that the tuner is worth a good deal more than its moderate suggested retail price.

There are no conventional tuning meters on the T-4090's front panel. Instead, mounted behind an opening along the lower section of the front panel, are five LED's that illuminate, one by one, as the strength of incoming signals increases. In that same window area are LED's that illuminate next to the words TUNED and LOCKED. When the tuning knob is touched, the quartz-lock tuning feature is deactivated. As the dial pointer approaches perfect tuning, the LED above the word TUNED illuminates. Releasing the tuning knob activates the quartz-lock AFC feature, which then completes the center-of-channel tuning job, causing the LOCKED light to come on. If the user releases the tuning knob when it is either slightly higher or lower in frequency than it should be, an appropriate green arrow to either side of the TUNED light flashes the direction the tuning knob should be turned.

Other controls along the lower portion of the panel include a POWER on/off pushbutton; a continuously variable audio OUTPUT LEVEL control; a RECORD CHECK pushbutton switch (that turns on a built-in 440 Hz tone set to the equivalent of 50% FM modulation and which is useful for presetting tape deck recording levels); a DE-EMPHASIS switch with 25 or 75 microsecond positions; a STEREO NOISE or "blend" filter switch; a MUTE/LOCK switch; an AM/FM SELECTOR switch, and a large flywheel-coupled tuning knob.

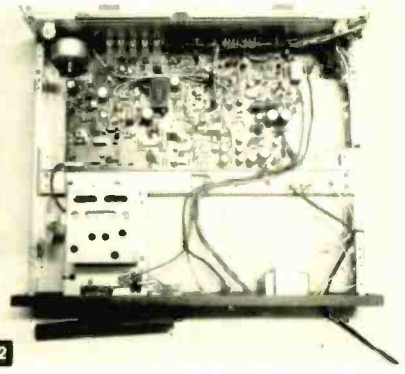
The low, long profile of the front panel of the Onkyo T-4090, pictured in Fig. 1, is visually enhanced by a relatively thin dial-glass area that extends almost the full length of the panel. Behind that clear glass are linearly inscribed FM and AM frequency notations that are clearly illuminated when power is applied to the tuner.

The rear panel of the Onkyo T-4090 has antenna terminals for connection of 75-ohm, 300-ohm FM or external AM transmission lines. A pivotable ferrite bar antenna is provided for local AM reception. A three-position slide switch, located near the pair of audio output jacks determines the sensitivity of the sensing switch associated with the tuning knob. That switch helps to compensate for differences in "hand capacitance" of different people using the control and is adjusted so that when the knob is released, "locking" action of the quartz-lock tuning system takes place without undue delay. In our tests, the switch was left in its mid setting.

Circuit highlights

An internal view of the T-4090 chassis is pictured in Fig. 2. While no schematic diagram is supplied with the tuner, the owner's manual sheds some light on circuit design. The first stage of the FM front end employs a dual-gate metal oxide field effect transistor. FM local oscillator circuitry is hermetically sealed to insure against drift caused by changes in humidity or temperature. A phase-lock-loop IC circuit is used in the multiplex decoder section of the tuner. All of the components of the tuner are contained on a single large circuit board, with the exception of the separate shielded front-end visible in Fig. 2.

RADIO-ELECTRONICS AUDIO LAB
R.E.A.L. SOUND RATES
ONKYO T-4090
EXCELLENT



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MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FM TUNER SECTION:
Usable Sensitivity: mono, 9.8 dBf (1.7 μV); stereo, 17.2 dBf (4 μV). **50 dB Quieting Sensitivity:** mono 14.7 dBf (3 μV); stereo, 36 dBf (35 μV) **Signal-to-noise Ratio:** mono, 76 dB; stereo, 68 dB. **Capture Ratio:** 1.3 dB. **Image Rejection:** 90 dB. **IF Rejection:** 100 dB. **Spurious Rejection:** 95 dB. **Alternate Channel Selectivity:** 70 dB. **AM Suppression:** 55 dB. Harmonic Distortion, 1 kHz mono, 0.1%; stereo, 0.25%. **Stereo Separation:** 40 dB at 1 kHz; 35 dB at 70 Hz to 10 kHz. **Muting Threshold:** 17.2 dBf (4.0 μV). **Stereo Threshold:** 17.2 dBf (4 μV). **Frequency Response:** 30 Hz to 15 kHz, +0.5, −1.5 dB.

AM TUNER SECTION:
Usable Sensitivity: 25 μV. **Image Rejection:** 50 dB. **IF Rejection:** 40 dB. **S/N Ratio:** 45 dB. **Harmonic Distortion:** 0.7%.

GENERAL SPECIFICATIONS:
Power Requirements: 120 volts 60 Hz. **Output Level:** FM, 0 to 1.5 volts; AM, 0 to 0.5 volts. **Dimensions:** 16½ W × 5 H × 15¾ inches deep. **Weight:** 13 lbs. **Suggested Retail Price:** $339.95.

FM Performance measurements

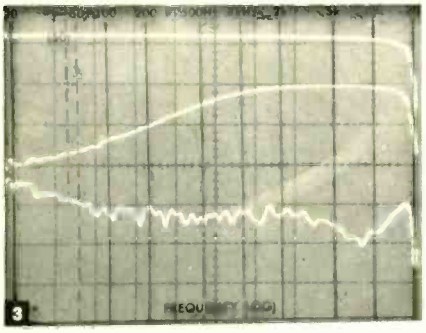
A summary of our test measurements of the FM section of the Onkyo T-4090 will be found in Table I. Comparing our results with those claimed by the manufacturer, it is immediately apparent that the tuner did better than claimed for most of the important specifications. 50 dB quieting and maximum signal-to-noise were particularly impressive, both in mono and stereo, for a tuner in this price category; and distortion figures exceeded published claims by at least a factor of two-to-one.

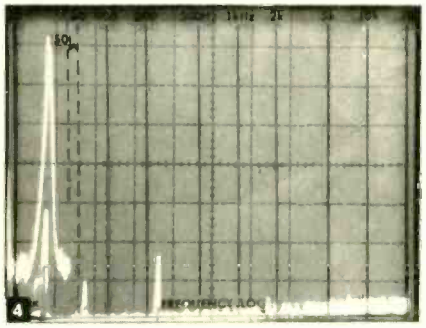
Stereo separation was particularly good at the high end of the spectrum, as can be seen by examining Fig. 3, which shows the frequency response (upper trace), maximum separation (lower trace) and separation when the MPX blend circuit is employed (middle trace).

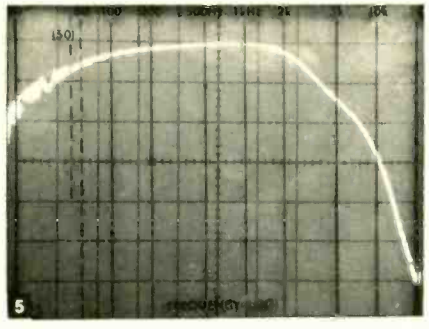
Figure 4 is a spectrum analysis of the crosstalk components that appear in the "non modulated" output channel of the tuner when the opposite channel is modulated with a 5-kHz

tone, in stereo, at full modulation. In Fig. 4, the frequency sweep is *linear* (rather than logarithmic, as in Fig. 3) from 0 Hz to 50 kHz, while vertical sensitivity of the display remains at 10 dB-per-division. The tall spike at the left is the reference or desired 5-kHz output. The lower spike, contained within the taller one, is the amount of 5 kHz coming out of the opposite channel and, as can be seen, is some 44 dB lower (an excellent separation value at 5 kHz). The only additional components from the unmodulated channel output are a bit of second harmonic of the 5-kHz signal and a somewhat greater-amplitude 19-kHz pilot signal component.

The frequency response of the AM tuner was essentially no better or worse than that obtained from most high-fidelity tuners and receivers, with a −6 dB roll-off occurring at around 3 kHz. Dial calibration was extremely accurate for both the FM and AM frequency scales. Results of our AM frequency response measurements are shown in Fig. 5.







Summary

Our overall product evaluation of the Onkyo T-4090 will be found in Table II. Perhaps the most outstanding point about this tuner is that it is extremely easy to use and tune correctly. Considering that the tuner has only one degree of selectivity, we feel that the designers have come up with a good choice in IF bandwidth characteristics to provide lowest distortion reception and a minimum of interference problems. **R-E**

TABLE 1

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Onkyo** Model: **T-4090**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
IHF Sensitivity, Mono: (μV)(dBf)	1.7 (9.8)	Excellent
Sensitivity, Stereo (μV) (dBf)	4.0 (17.2)	Excellent
50 dB quieting signal, mono (μV)(dBf)	2.2 (12.0)	Superb
50 dB quieting signal, stereo (μV)(dBf)	30.0 (34.7)	Very good
Maximum S/N ratio, mono (dB)	79	Excellent
Maximum S/N ratio, stereo (dB)	71.5	Excellent
Capture Ratio (dB)	1.4	Very good
AM suppression (dB)	55	Good
Image rejection (dB)	95	Excellent
IF rejection (dB)	96	Excellent
Spurious rejection (dB)	95	Excellent
Alternate channel selectivity (dB)	72	Very good
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50Hz to 15 kHz (±dB)	1.0	Very good
Harmonic distortion, 1kHz, mono (%)	0.047	Superb
Harmonic distortion, 1kHz, stereo (%)	0.10	Excellent
Harmonic distortion, 100 Hz, mono (%)	0.08	Superb
Harmonic distortion, 100 Hz, stereo (%)	0.11	Excellent
Harmonic distortion, 6 kHz, mono (%)	0.12	Very good
Harmonic distortion, 6 kHz, stereo (%)	0.28	Very good
Distortion at 50 dB quieting, mono (%)	1.0	Good
Distortion at 50 dB quieting, stereo (%)	0.35	Very good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV) (dBf)	4.0 (17.2)	Excellent
Separation, 1 kHz (dB)	46	Excellent
Separation, 100 Hz (dB)	39	Very good
Separation, 10 kHz (dB)	40	Superb
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	4.0 (17.2)	Excellent
Dial calibration accuracy (±kHz @ MHz)	100	Excellent
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		Very good
Ease of tuning		Excellent
Accuracy of meters or other tuning aids		Excellent
Usefulness of other controls		Very good
Construction and internal layout		Very good
Ease of servicing		Excellent
Evaluation of extra features, if any		Very good
OVERALL FM PERFORMANCE RATING		Excellent

TABLE 2

OVERALL PRODUCT ANALYSIS

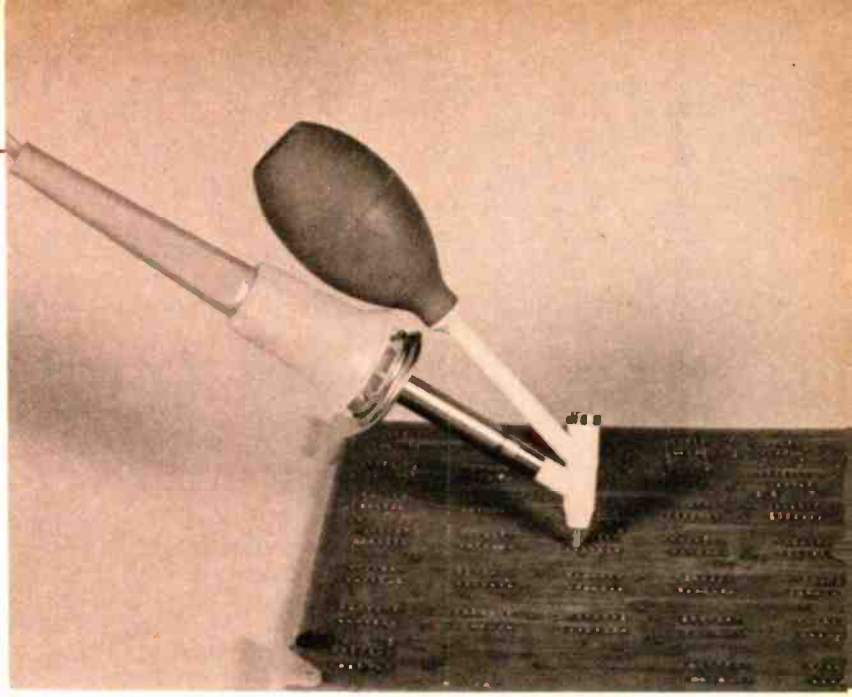
Retail price	$339.95
Price category	Medium
Price/performance ratio	Excellent
Styling and appearance	Excellent
Sound quality	Excellent
Mechanical performance	Very good

Comments: Frequency synthesized tuners (which the Onkyo T-4090 is not) offer perfect center-of-channel tuning that, in turn, results in lowest-distortion reception of FM stations. Many of these costly tuners tend to sacrifice ultimate signal-to-noise and selectivity as a trade-off for the frequency synthesis. In that regard, the Onkyo T-4090 tends to provide the best of both worlds. While not a true frequency synthesis tuning device, its quartz-lock tuning system proves to be fully as accurate in being able to zero in on exact center-of-channel tuning as are the crystal-controlled frequency synthesis units now available.

To be sure, the T-4090 lacks such features as selectable IF bandwidth, which is sometimes of benefit when you are trying to single out relatively weak signals that are close in frequency to stronger nearby stations. In our listening tests, such problems of this sort that we did encounter were easily overcome through the use of a reasonably directional outdoor antenna.

We found the tuning indicators and LED signal strength indicators to be fully as effective, and perhaps more so, than conventional meters. While many tuners equipped with such sophisticated tune-lock schemes as Onkyo's "quartz lock" (those schemes are often given other names) often end up tuning into signals at anything but the optimum lowest-distortion point, such was not the case with the Onkyo T-4090. When we tuned for lowest distortion (with the aid of lab equipment) with the lock feature temporarily defeated and then activated the lock circuit, the distortion readings remained exactly the same.

All of the factory-set levels, such as stereo threshold and muting threshold, were ideally set for the sensitivity and quieting characteristics of this tuner which, in themselves are excellent. In short, here is a mid-priced tuner devoid of many frills and fancy digital readouts, but one that delivers FM reproduction that is limited only by the quality of the program source and broadcasting station's practices.



All About Desoldering

Careless desoldering procedures can do more damage to circuits and components than haphazard soldering. Correct desoldering involves five easy-to-master steps.

EARL R. SAVAGE, K4SDS

SOONER OR LATER, WE ALL ARE FACED with the task of getting a component off a PC board. It may be modifying a circuit, replacing a defective part or salvaging parts from a useless board, but the job is pretty much the same. Only the big corporations can afford to toss out a board when some component on it goes west. The rest of us must repair them.

Time was when no one gave much thought to *de*soldering. Heat the solder, unwrap the lead and the job was done. Now, it is not quite that simple. PC boards and small multi-lead parts complicate the process.

Of course, desoldering and removing a resistor or capacitor presents no special problem. It can be done with your regular soldering iron. About the only precaution is to avoid over-heating. Transistors and IC's are another matter, so we'll concentrate on those toughies. Even so, the tools and techniques discussed here can be used with all kinds of components.

Removing a transistor from a PC board can be a hassle, especially if the transistor is to be used again. Desoldering a TO-5 package can be a pain. Trying to get a DIP off undamaged can cause ulcers. Of course, there are right ways and wrong ways to go about anything and special desoldering tools can make all the difference.

Once you start looking around, there are many desoldering devices available. Each one has a particular job or jobs for which it is especially suited. Choosing the wrong one for the task at hand can be as bad as trying to do with just your old soldering iron.

Generally, the phases of desoldering go like this:

1. Remove the excess solder
2. Straighten bent pins
3. Heat all leads *simultaneously*
4. Pull out component
   (Steps No. 3 and No. 4 must be done *together*
5 Clean out the holes

To help you choose the right tools and techniques, we'll examine the major types available today. Before we get started, though, a word of advice: Desoldering requires two hands and then some. You won't be able to do that job and hold the board, too. Some type of board holder is all but essential. PanaVise makes a couple of excellent holders, one of which is shown in Fig. 1. Another is the Third Hand and, of course, you can devise your own holder.

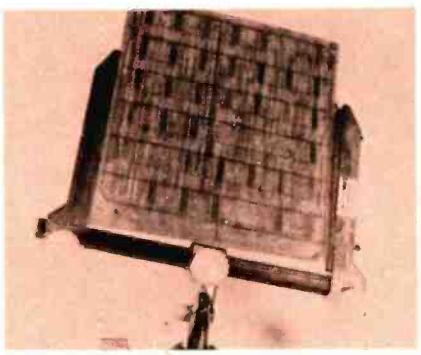


FIG. 1—CIRCUIT BOARD HOLDER makes desoldering task easier.

Solder removal

Do not be misled—there is no method that will remove *all* of the solder *every time*. Some techniques remove more solder than others but even the best will usually leave enough to stick the pin to the pad or to the edge of the hole.

Nevertheless, the first step is to remove all the solder you can. With some of the procedures, you can bypass this step initially but if the component is to be replaced, the old solder will have to be removed anyway. You may as well do it sooner instead of later.

Solder can be removed very effectively with the combination iron and vacuum bulb shown in Fig. 2. Both Weller and Ungar makes these devices (see list of suppliers). You can get this device all-in-one or just the bulb and tip attachment

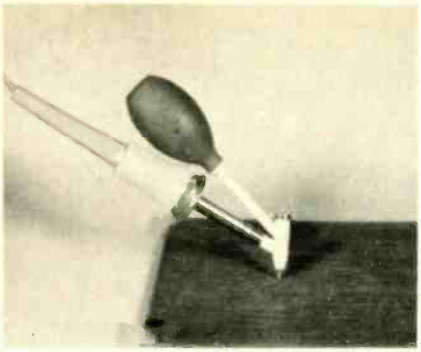


FIG. 2—COMBINATION SOLDER IRON and vacuum bulb is one of the most effective ways to remove solder.

if you already have the right iron.

Using the vacuum iron is fairly simple. Squeeze the bulb, place the hot tip over the soldered pin and release the bulb when the solder is molten. Then, eject the solder into a metal waste container. This system is quite effective. Incidentally, for those who are interested, Ungar also makes a motor-driven vacuum iron system!

At this point you can see that removing solder puts you on the horns of a dilemma. The hotter the solder, the more you remove. Also, the hotter the solder, the more likely you are to damage the board and/or component. The trick, of course, is to hit a happy medium. This applies to the vacuum iron *and* to the other techniques below.

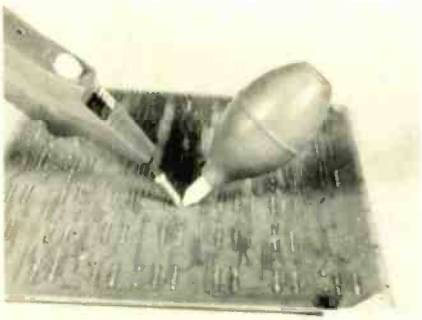


FIG. 3—SEPARATE VACUUM BULB and solder iron is not as effective as combination unit since each tip must make room for the other. Also, two hands are required for this method.

Before you tackle one of your good boards with any of these procedures, it is a very good idea to practice on an old board. This way you can get a "feel" for what is too little heat and what is too much. Without some practice you won't necessarily ruin a board or component, but go slowly at first. Also do not reheat a pin right away when you want to give it another try. Move on to another pin and let that one cool completely before reheating.

Figure 3 shows a very similar method of solder removal. In this case, you use your regular iron and a separate vacuum bulb. Since the bulb tip and the iron must make way for each other, this system is not quite as effective as the combination vacuum iron. However, the separate bulb will get up most of the solder.

A stronger vacuum is produced by a "gun" such as the one in Fig. 4. More suction seems to make up, in part at least, for the fact that the tip and the iron are separate. The vacuum gun pictured is the smaller of two from Radio Shack.

Another approach to solder removal is shown in Fig. 5. Here, a wire braid is placed on the solder and heated. The molten solder is absorbed—soaked up—by the braid. Properly used, the braid will take up most of the solder. The trick with the braid is *not* to pull on it so that it is long and thin. Rather, bunch it up a bit so the fine wires are not too close together. Desoldering braid is produced by several manufacturers under various names. If you have some old coaxial cable laying around, the braid from it works well, too.

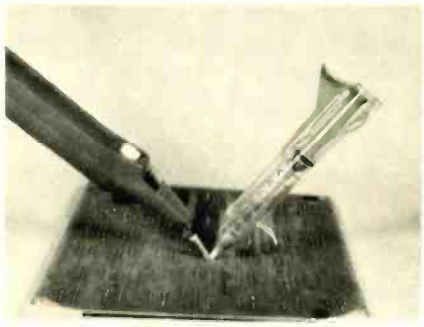


FIG. 4—VACUUM "GUN" is spring loaded and produces a strong vacuum.

The final solder removal method to be considered is the "melt-and-brush." The procedure is to melt the solder and then brush it away with a steel brush soldering tool. While this method is better than none, it does have several disadvantages. First, melt-and-brush leaves more solder on the connection than the other methods. Second, you must be *very* careful where you brush the molten solder—it can cause shorts on the board and it can burn your hand or arm. Safety goggles are recommended with this technique.

Perhaps one more *so-called* desoldering method should be mentioned. There are those who have tried melting the solder and tapping the board on the workbench. They frequently achieve these results: solder flying in all directions with much left on the board, cracked or broken board and damaged components. *Not recommended.*

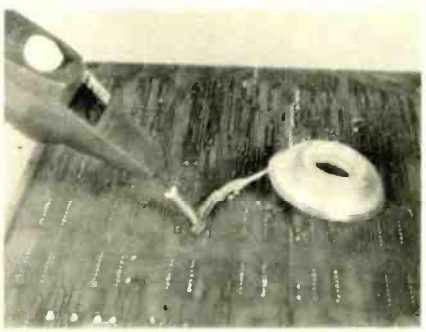


FIG. 5—DESOLDERING BRAID soaks up excess solder when heat is applied.

FIG. 6—PINS AND LEADS must be straightened before components can be removed.

Straightening bent pins

A law of electronics states that a sharply bent wire cannot be pulled through a small hole. It is even worse when there are 16 bent wires attached to one object. Therefore, pins and wires must be straightened if there is to be any hope of removing components.

If the leads on your board were not bent flat before soldering, you are somewhat ahead. Even so, be sure that all are relatively straight. Some pins and wires may have become pushed aside in handling before and/or after soldering.

Whether you must straighten one pin or all of them, one of the most convenient methods is illustrated in Fig. 6. After the solder is molten, a pocket knife blade is slipped under the pin and twisted in the proper direction. Any steel blade will serve as well. The typical soldering-aid tool won't work very well if the leads are flat on the board.

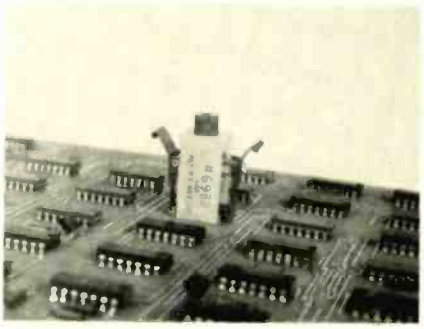


FIG. 7—DIP EXTRACTOR is spring loaded and pulls out the IC as soon as the solder melts.

Pulling the component

You are now almost ready to remove the old component. Only two steps remain and they must be taken *together*. A force must be applied to separate the component from the board *while* ALL pins are again heated to remelt the remaining solder. To do all this at the same time, you will need some devices to help unless you have a half-dozen hands.

You should set up the pulling force *before* you apply heat. Otherwise, it is likely that you will have to do it again. An excellent means of applying this force to

an IC is shown in Fig. 7. It is Ungar's spring-loaded extractor that will fit 8-, 14- and 16-pin DIP's. (Another is available for TO-5's.) This extractor exerts sufficient force to pull the IC at the first instant of solder melt.

Simultaneous reheating

The remaining solder must be melted again in order to release the component. Obviously, all the leads must be heated at the same time. With a regular soldering iron, this task is *very* difficult on a transistor. On a DIP, it is all but impossible.

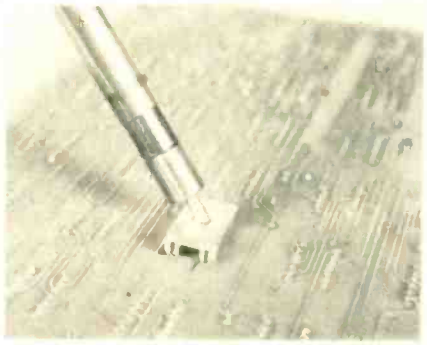


FIG. 8—DIP DESOLDERING TIP heats all pins at the same time

The trouble with a normal soldering tip is that the solder on the first lead cools while you are heating the second or third. You must resist the temptation to heat the first one more so it will stay molten longer. So much heat will surely destroy the component and/or damage the board.

There are two reasonable ways to heat all the leads simultaneously. One is to use a special iron tip. The one in Fig. 8 is Ungar's tip for DIP's. That tip as well as others for transistors and TO-5's fits the same iron that holds the vacuum bulb tip.

Another method for heating all the leads is to use a torch. Radio Shack's little butane torch is shown in Fig. 9. The trick in this method is to keep the flame moving—just go around the leads in a slow circle or rectangle until the puller pops the component out. Be very careful or you will burn the board.

Cleaning up

The old part is out. Now, you are ready to install the new one but it won't fit. If you look closely, you will find that the holes are completely or partially filled with solder. You might have thought that by now all of it would be gone—no such luck! But don't lose heart.

Mounting holes can be cleaned out in several ways. The vacuum iron (Fig. 2) can be used to *blow* the molten solder out. Just heat and *then* squeeze the bulb. The separate bulb (Fig. 3) can be used in this same manner if you move quickly. When using either of these devices, however, be very careful of what is in the path of the air and molten solder.

A much more satisfactory way to clean the holes is to use a drill. The bit must be very fine—usually No. 56 (46 thousandths of an inch). It is all but impossible to use a manual drill or a regular 1/4-inch shop hand drill without breaking such a small bit. A bit in a pin vise can be used with much patience and care.

Perhaps the most effective drilling procedure is to use the set-up shown in Fig. 10. That is Wahl's drill-head attachment that slips right on their cordless Iso-Tip iron. It comes complete with a No. 56 bit and makes short work of PC holes.

Radio Shack's cordless drill/saw, performs well but you will have to put a shim (aluminum foil) around the shank of the No. 56 bit in order for the chuck to hold it. If you have a Moto-Tool or similar hand-held grinder/drill, it will also do the job effectively.

TABLE 1

Endeco (Enterprise Development Corp., 5127 E. 65th St., Indianapolis, IN 46220)
CIRCLE NO. 94 ON FREE INFORMATION CARD

500 Series Vacuum Iron	19.66
510 20W/40W Vacuum Iron	24.75

PanaVise (2850 29th Street, Long Beach, CA 90806)
CIRCLE NO. 95 ON FREE INFORMATION CARD

315 Circuit board holder	18.98
366 Wide opening head	14.49
(either of the above requires one of several bases)	

Radio Shack (One Tandy Center, Ft. Worth, TX 76102)
CIRCLE NO. 96 ON FREE INFORMATION CARD

64-2085 Vacuum gun	6.29
64-2086 Bulb	2.19
64-2090 Braid	1.49
64-2091 Mini vacuum gun	4.29
64-2164 Butane torch	6.95
64-2178 Cordless drill	15.95

Ungar (Eldon Industries Inc., P.O. Box 6005, Compton, CA 90220)
CIRCLE NO. 97 ON FREE INFORMATION CARD

5011-5014 Braid	1.42-1.62
6946 TO-5 Desoldering tip	3.92
6948 DIP desoldering tip	4.38
6982 DIP extractor	3.68
6983 TO-5 extractor	5.80
7800 Hot-Vac vacuum iron	24.72
7805 Bulb	2.52

Wahl (2902 Locust St., Sterling, IL 61081)
CIRCLE NO. 98 ON FREE INFORMATION CARD

6500 PC Drill Attachment	10.95

Weller (Cooper Group, P.O. Box 728, Apex, NC 17502)
CIRCLE NO. 99 ON FREE INFORMATION CARD

DS40 Vacuum Iron	30.10
DS60 Vacuum Iron, temperature controlled	38.10
DS-TCP Desoldering Kit and station	74.40

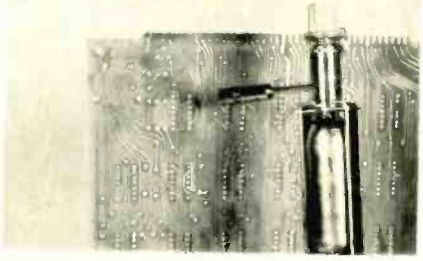


FIG. 9—BUTANE TORCH also melts the solder on all the pins at the same time. Extreme caution must be observed to prevent damage to the PC board and component.

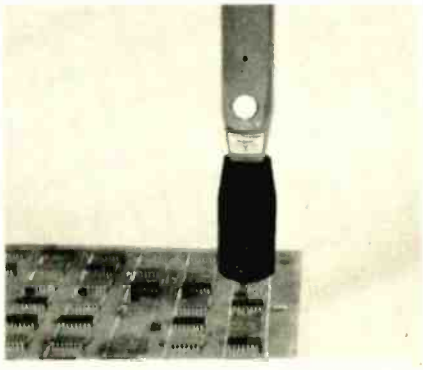


FIG. 10—PC DRILL attachment for Wahl's *Iso-Tip* soldering iron quickly cleans holes or makes new ones.

Sources

In order to help you identify and find the tools mentioned here, they are listed in Table 1. The prices indicated are the latest available but they are subject to change, of course.

Many of you will be able to get these items locally. They are carried by stores, distributors and mail order suppliers. If you cannot locate what you want, write the manufacturer. (Or, you can circle the corresponding number on the free information card.—*Editor*) **R-E**

BURR-BROWN APPLICATION NOTE

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protect op amps from overloads

JERALD GRAEME, Burr-Brown Research Corp.

THOUGH ENGINEERS ARE BECOMING MORE AND more aware of the subtleties of operational-amplifier characteristics, there are still far too many situations where op-amps are being destroyed by voltage and current overloads. This is due, in part, to the proliferation of op-amps in unusual applications.

Some overload conditions are obvious: input breakdown under excessive input voltages or output overheating under short circuits. Most op-amps are protected to some degree against these two conditions.

Other overload conditions, however, are less evident. These include voltages maintained by capacitors after the power supplies are turned off. A voltage retained at an amplifier input by a capacitor or other source can forward-bias and destroy a substrate junction when the negative supply voltage becomes less negative than the input voltage.

To help prevent op-amp failures like these, there are several protection circuits that the designer can build. They will guard op-amps against power-supply faults and input and output overloads.

PROTECTION FROM POWER-SUPPLY FAULTS

The most common power-supply faults in op-amp circuits are supply reversals and voltage transients. Damage from these overloads is prevented by the circuits shown in Fig. 1. To protect against damage by voltage reversal, a diode is added In series with each power supply to block reverse current flow (Fig. 1-a). This protection also prevents forward-bias of an integrated-circuit substrate junction, since a reverse-biased diode will now disconnect the negative supply. However, for the latter protection alone, resistors can be added in series with the inputs to limit the substrate current to a few milliamperes.

Protection against transient voltages is provided by the Zener diode clamps and the voltage-absorbing FET current

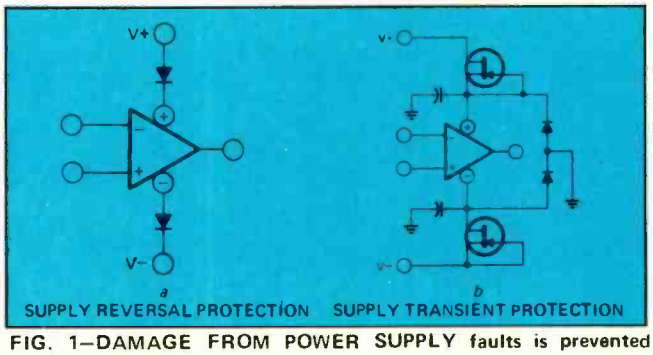

FIG. 1—DAMAGE FROM POWER SUPPLY faults is prevented because diodes block currents during voltage reversals as shown in *a*, and clamp the power supply terminals to limit transient voltages as shown in *b*.

sources (Fig. 1-b). The Zener diodes have "on" voltages that are greater than the normal supply voltages but less than the maximum supply ratings on the op-amp. Thus, the Zener diodes will be off under normal supply voltages, and they will clamp the supply transient voltages.

The current-source-connected FET's are chosen with I_{DSS} levels above the normal current drains of the op-amp. Below the I_{DSS} level, the FET's are below pinchoff and appear as small resistances in series with the supply lines. If transients appear on the supply lines, the Zener diodes turn on to clamp the supply voltages, and their current drains raise the FET currents to I_{DSS}. Now the FET's are in pinchoff and they appear as high-impedance current sources to support excess voltages. As long as the transients do not cause voltage breakdown in the FET's, the transient currents are limited to I_{DSS}.

KEEPING INPUT VOLTAGES AT SAFE LEVELS

Overload conditions at op-amp inputs are essentially those of excessive common-mode and differential voltages. Either can induce a voltage breakdown that will damage

or destroy the input transistors. Because of the precise matching needed between the input transistors, even minor damage from breakdown can significantly degrade the DC input characteristics of the op-amp. Such damage can result from quite moderate differential input voltages, since bipolar transistors typically have about a 6V emitter-base breakdown voltage. Input stages with FET's are less vulnerable to overloads of this magnitude, but they are more sensitive to the low-energy, high-voltage discharges that are frequently encountered.

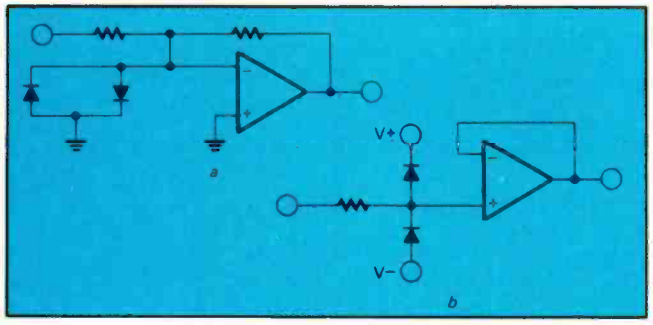

FIG. 2—INPUT CLAMPS protect against any level of input transient voltage that does not force excessive current through the diodes from the input resistor, in either the inverting (shown in *a*) or non-inverting (shown in *b*) configuration.

Protection from very high input voltages is provided[1] by the diode clamps shown in Fig. 2. For both the inverting and noninverting configurations, the diodes limit the voltages reaching the amplifiers to safe levels without restricting signal swing. Input transients of thousands of volts can be withstood in this manner, so long as the diode currents are adequately limited by the input resistors. To permit amplifier common-mode swing in the noninverting configuration, the clamp diodes are connected to the power supplies rather than to ground (Fig. 2-b). Here, however, diode leakages will add to the input error current.

Input protection against differential signals up to the level of power-supply voltages is usually incorporated in op-amps. However, larger voltage overloads can still damage the amplifiers. Further protection against differential voltage overloads can be provided (Fig. 3-a) so long as the overloads don't raise either input beyond the supply-voltage levels. Where this latter condition is possible, the supply-level clamps shown in Fig. 2-b should be added.

Once again, diode clamps are used as in Fig. 2-a, but in this case (Fig. 3-a) the current-limiting resistance is divided equally between the two inputs. Thus, the error-voltage drops produced with the input bias currents will tend to match and cancel. Some error will remain, however, due to the differences in input bias currents.

Another error with this clamp circuit can result from the input current that it draws under overload. This current can be a serious error in comparator circuits, where high input resistance is needed in the overload state. To lower the overload input current, the values of input resistors can be increased, but this also increases the error voltage produced by the input offset current of the op-amp.

The weaknesses of the clamp circuit in Fig. 3-a can be avoided[2] with a second protection circuit (Fig. 3-b). In this case the differential input voltage is limited by a high-resistance divider for low current under overload. In normal operation the large resistors would develop significant error voltages, but they are shunted by low FET resistances. Specifically, DC error would be significant only at the comparator trip point, where the added voltage would produce an offset. But with the protection circuit, the differential input voltage at the trip point is zero, leaving the diodes off, and hence providing zero gate bias for the FET's.

With this bias, both FET's have a low channel resistance, r_{on}, that produces only a small error voltage because of the input bias current. When the input signal moves away from the trip point, the gate-source voltage of one FET or the other increases. This, in turn, increases the channel resist-

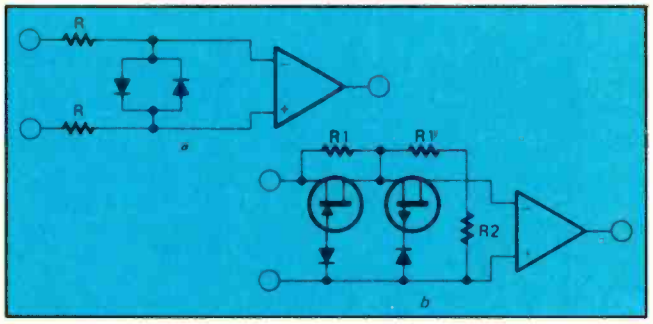

FIG 3—THE EFFECT of differential input overloads can be eliminated by one of these two protection circuits. Amplifier input voltage can be reduced by either clamping as shown in *a*, or by selectively dividing as shown in *b*.

ance of the FET until it reaches the megohm level of r_{ds} at pinchoff. Then, the input current must flow through the resistor in parallel with this FET and through the other FET, which is zero-biased. This, in effect, leaves an input divider, R2/ (R1 + R2), to reduce the input signal.

The most common types of output overloads are excess power dissipation and output-stage breakdown when the output is shorted. Most op-amps incorporate current-limiting circuits to control power dissipation. External current limits can be added if they are not in the op-amp or if a lower level of limiting current is desired to protect a load. Also, such a reduced current limit may be needed when the output is shorted to a point above or below ground potential. In this case the added potential may increase the output-stage dissipation. And if the output is shorted to a voltage beyond the power-supply levels, voltage breakdown can result.

LIMITING OUTPUT CURRENTS

One way of providing an external current limit is to connect current sources in series with the power supplies (Fig. 4). When the supply-current drains are below the design level of the current sources, the transistors add low resistances in series with the supplies. The bipolar-transistor current sources are then in saturation, adding resistances equal to r_{sat} plus 10 ohms, and the FET's are not yet in pinchoff, so they each add a resistance of r_{on}. Provided these small resistances are bypassed, they have little effect on performance. When the supply currents reach the predetermined operating levels of the current sources, the transistors start to operate in their constant-current mode—with very high output resistances. Only a small additional current is then needed to develop large voltage drops across the current sources and reduce the supply voltage.

A somewhat simpler external current limit is provided if a single current source is added in series with the output. This simplicity stems from the ability of an FET to operate in an inverted mode, so that only one FET is necessary

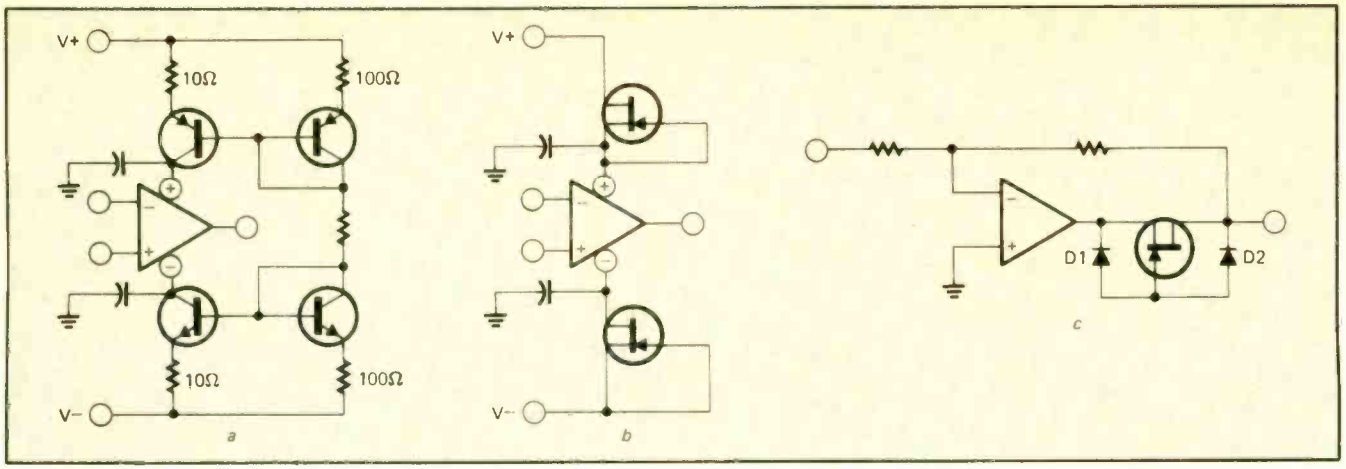

FIG 4--PRECISE SELECTABLE CURRENT LIMITING results when current sources are added in series with the power supplies as shown in *a* and *b*. To limit both current polarities, an FET current source in series with the output may be added as shown in *c*.

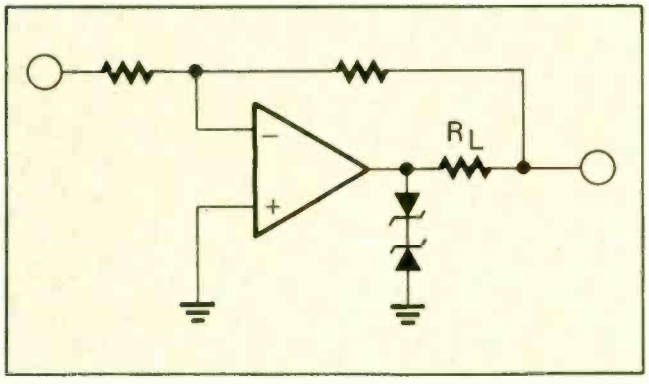

FIG. 5--PROTECTION FROM EXCESSIVE VOLTAGES that may be connected accidentally to the output is provided by Zener-diode clamps.

(Fig. 4-c). For currents flowing into the output terminal, D2 is reverse-biased, and the voltage on the FET produces gate-drain leakage current that is conducted by D1. For this low diode current, the voltage D1 is too low to forward-bias the gate-source junction, but the diode does connect the gate to the source. As before, the FET operates as a current source.

Once again, the series resistance added by the FET is low (r_{on}) until limiting occurs at I_{DSS}. Since this resistance is inside the amplifier feedback loop, its effect is divided by the loop gain. When the output current reverses and flows out of the output terminal, D1 turns off and D2 conducts the leakage current. In this way the gate is connected to the drain for an inverted FET current source. Thus, the circuit works for both polarities of output current.

If an output short circuit or an inductive load causes the output voltage to exceed one of the power-supply levels, the output stage can be damaged by voltage breakdown. Protection against such an overload can be provided by Zener clamps (Fig. 5).

With the Zener diodes, the op-amp output terminal cannot be pulled beyond selectable voltage levels, and the excess voltage is absorbed by R_L. The current-limiting resistor, R_L, should be made large enough to protect the Zener diodes, but not so large as to develop a swing-limiting voltage in normal operation. Since R_L is in the feedback loop, its contribution to output impedance is diminished by the loop gain.

Note that a high voltage on the output terminal also raises the voltage on the inverting amplifier input through the voltage divider formed by the feedback resistors. While this voltage is reduced by the divider, it can sometimes break down the input stage. If this is a possibility, input protection should be used. **R-E**

References:

1. Tobey, G., Graeme, J., Huelsman, L., *Operational Amplifiers; Design and Applications,* McGraw-Hill, New York (1971).

2. Accardi, L., "Modified 710 Maintains Accuracy at High Input Voltages," EEE, October (1970).

Solid State News

Z-80-based systems

Futuredata (formerly known as Microkit) has announced four Z-80-based product-development systems: *Microsystem/12* and *Microsystem/15* are tape-based, and *Microsystem/20* and *Microsystem/30* are disc-based.

The systems include a CPU with up to 56K of memory, a 960-character CRT, ASCII keyboard, a cassette tape or dual floppy disc, and operating-system software and documentation. An in-circuit emulator, line printers, BASIC and extended BASIC compilers, and RDOS disc operating system and a word processor are available as options. Plug-in modules convert the systems to 8080 or 6800 processors.

The systems contain two RS-232 serial ports, an 8-bit parallel TTL I/O port, a reala-time clock, a PROM bootstrap, memory write-protect under software control, eight-level vectored interrupts, DMA, and complete disc and tape operating systems and monitor, debugger, editor, assembler and copy utility.

For additional information, contact Futuredata Computer Corporation, 11205 South La Cienega Boulevard, Los Angeles, CA 90045.

Regulator-bridge combination

The Fairchild Integrated Circuits Group has developed the SH1705, a 5-volt, 5-amp voltage regulator in a 4-pin TO-3 package. Its novelty stems from a built-in fullwave diode-rectifier bridge. The device can dissipate 50 watts and has built-in protection against short circuits and thermal overload. The SH1705 is priced at $6.50 each in 100 quantities. Request details from Fairchild Camera and Instrument, Integrated Circuits Group, 313 Fairchild Drive, Mountain View, CA 94042. **R-E**

Innovations

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AUDIOPHILE DISC CATALOG, *StandarDisc International Reference Series,* lists analog recordings of classical symphonic, ensemble and solo performances (Gale label); direct-to-disc recordings of rock, ragtime, jazz, violin and chamber music (Umbrella label); direct-to-disc pressings from RCA and Toshiba EMI; and a digitally mastered Telarc album. Some of the titles are: "Hello Hank Jones/Clifford Jordan," a jazz work; the Tokyo String Ensemble playing Samuel Barber's "Adaglo for Strings"; and "Sambatuque," Latin rhythms from Brazil. Several audio and demo test records are also available.—**Audio-Technica, U.S., Inc.,** 33 Shiawassee Ave., Fairlawn, OH 44313.

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BOOK CATALOG, *Number 16,* contains 51 pages describing full inventory of books and manuals ranging from amateur radio license study guides to vacuum tubes. Both a table of contents and an author and title cross-reference are given. *The Complete Handbook of Electrical and House Wiring, Practical Test Equipment You Can Build, Beginner's Guide to Microprocessors* are just a few of the titles contained in this catalog, which also lists schematic/servicing manuals for color and black and white TV's, radio, CB's, etc. A separate order form is included.—**TAB Books,** Blue Ridge Summit, PA 17214.

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CAMERA REPAIR, *Careers in Camera Repair,* brochure contains 4 pages describing the opportunities in the growing field of photo equipment technology. It covers the training avenues open to aspiring technicians in a variety of fields. The camera field enjoys a wide scope of career possibilities in science, research, government and education.—**National Camera Technical Training Div.,** 2000 West Union Ave., Englewood, CO 80110. **R-E**

CIRCLE 146 ON FREE INFORMATION CARD

hobby corner

Here's the answer to last month's Mystery Light puzzle

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

LAST MONTH I TOLD YOU ABOUT A MYSTERious light box submitted by Tom Faron. I told you what it *looks* like and what it does. As you recall, the question was: *how* does it work?

A few of you sent in workable solutions but others missed the boat. In case you did not figure out the puzzle, here is the way Tom made his box.

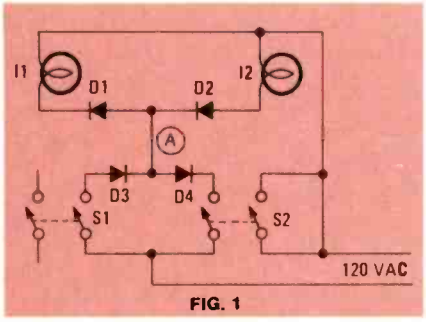

FIG. 1

First, let's examine the *actual* circuit that is shown in Fig. 1. Remember: this is *not* what you see when you look at the clear plastic box, but we will come back to that later.

The real trick is diodes (D1–D4), which provide independent control of the lamps by the switches. Switch S1 controls lamp I1 and S2, I2. The wire labelled *A* functions as a dual-lane highway for the current.

The result is that, with only two wires between the switches and the lamps, you can turn both lamps off, both on, or either one on by itself. Note that this circuit will not function properly with a DC voltage applied.

Now all this would not be so tricky if Tom had not put it in a clear plastic box so that it *appears* that he has nothing to hide. But he does hide several things and here is how he does it.

Of course, the diodes are a dead giveaway so they are hidden in the wire connections. The diodes are of the subminiature variety and they are soldered in with very short leads. Since all the wiring is done with insulated wire, Tom's use of heat-shrink tubing insulation over each diode makes it look like a plain insulated solder joint. In fact, even after you know the diodes are in there, their shapes are hard to see.

The second deception is in the selection and wiring of the switches. SPST switches are all that the circuit requires but DPST switches are used. The straight-through side of the AC line is routed through the switches and "dummy-wired" to the unused contacts. Actually, all the switch contacts are jumble-wired and it takes a sharp eye to discover that one side of the line is not broken at all.

Tom's final deception lies in his choice of lamps. They burn at only about half-brightness in this circuit (because of the diodes, each one can get current for only half the AC waveform). Since this, too, would be a giveaway to the circuit, he chose an uncommon lamp—in this case, a clear 7½ watt lamp. Any bulb will work but pick an unusual one so that the observer is not likely to say right away: "Hey, those bulbs are not as bright as they are supposed to be!"

There you have the solution to the mystery light box. Put one together and you can have some fun with your "smart" friends. Thanks, Tom, for sharing your circuit.

If you liked this puzzle circuit and have one of your own, send it along and we'll see if other readers can figure out how it works.

The mailbag

We really do enjoy and appreciate the many letters and questions that you send in. Since so many of you take the time to write, I think you would like to know what kind of letters we get from other readers. Well, the letters and cards can be divided into three groups. There are the *simple*, the *interesting*, and the *impossible*!

The simple ones ask things like parts sources (that answer was covered in an earlier column, and the answer is magazine ads, mail order catalogs and local suppliers). Another example is inquiries for information that is readily available in any common reference. Come now; every serious hobbyist should have a few basic reference books. On IC's, for instance, Don Lancaster has written an excellent series of *Cookbooks* (TTL, CMOS, etc.) and there are many others from which to choose.

Normally, you don't hear about the simple ones but from time to time, we do discuss some of the interesting letters and questions. They are the ones that raise unusual problems and offer solutions to others. But you don't hear about the third type either—the impossible ones are just that.

Some of the impossibles are from folk who build a project out of this column, other articles or, even, other magazines. They find that it doesn't function properly and write to find out why not. (Did you ever try to troubleshoot a project from 2,000 miles away?) Then, there are letters that indicate a lack of understanding of basic electronics or, even, electricity.

Those are impossible because a response would be as long as a book—half of a book, at least. I'm not making fun of those writers—all of us were like that when we started out. The thing is that one must attempt to grow in knowledge as he gains in experience. Reading only "how-to-do-it" articles simply will not build a sufficient knowledge base for anything more than dabbling in electronics.

Well, what to do? Here are some of the many possibilities:

- Read and study the theory or "how it works" sections of construction articles. Passing up those paragraphs will cost you in the long run.
- Give special attention to the articles you find on basic electronics and theory. Every new idea you understand will be needed and valuable sooner or later.
- Begin a study program if you want to do more than dabble in electronics someday. This is a necessity whether you want to make a living in this fascinating field or simply be a competent hobbyist. There are many approaches to a study program: planned serious reading and study entirely on your own; following a plan designed by experts (Heath, American Radio Relay League and others); night classes offered by your local public schools or a Junior/Community College.

Remember the old adage: "If it's worth doing, it's worth doing *well*." Electronics is not all parts, tools and instruments. That's a large and fun portion of it but unless it stands on a good knowledge base, it is quite limited.

Start your own collection of reference books. Undertake a study program. Get the most out of your hobby.

Getting back to the subject of letters *per se*, there are two more points of importance: the matters of time and the self-addressed stamped envelope

continued on page 80

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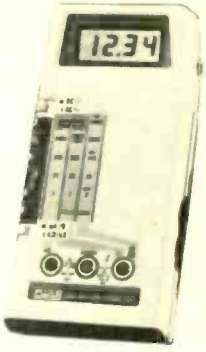

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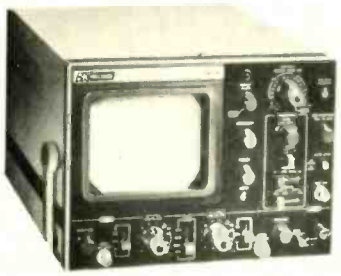

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	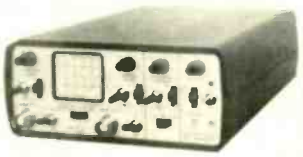	
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ADVANCE ELECTRONICS

(SASE). There is a difference between writing a magazine business office about your subscription or whatever and writing to the author of an article.

Most of the guys whose articles you read make their living at some other job and do their writing "on the side." (This one is no exception.) The result is, of course, that the time available for answering letters is quite limited. We really enjoy your cards and letters and hope that you will keep sending them. However, please understand if there is not enough time to answer every one of them. If you do want a reply, you must enclose an SASE. All letters to this column should be sent to: Hobby Corner, **Radio-Electronics,** 200 Park Ave. South, New York, NY 10003.

Soldering irons

A while back I wore out my last fine tip for my favorite soldering pistol. I couldn't find a single replacement within a 50-mile radius.

As I was looking, I kept seeing these little cordless irons and, finally, I decided to take the plunge and buy one. After all, it would be nice not to have a line cord dragging over the workbench. I bought a Wahl *Iso-Tip* outfit—iron, recharging stand and several tips.

Oh, boy! "Cordlessness," which I had expected to be *the* advantage, has turned out to be just the icing on a very big cake. Why hadn't someone *told* me about these things?

So, I had better tell anyone who hasn't already discovered it: these irons are the eighth wonder of the workbench! I'll hold on to my regular gun (formerly small) for larger soldering jobs, but I have found my bench companion.

Not only does my new iron *not* drag a cord around the bench *but* it is also lightweight. The pushbutton control is more convenient than a trigger, and makes it much easier to control the tip temperature. A wide variety of tip shapes can be interchanged quickly since they are spring-loaded. The tip sticks out less from your hand, resulting in better balance and control. The iron heats up much faster than any iron I have used before. The built-in light is located nearer the tip so that I can better see what I'm doing.

Well, I wish I had discovered this iron when it first came out. Give one a try; there are several manufacturers. The Wahl comes in a number of models—three that are especially interesting for hobbyist use. These are *models 7500, 7700,* and *7800,* which are the same except for their recharging time—overnight, 4 hours and 1 hour, respectively.

If you haven't already done so, take a good look at these cordless soldering irons. You may be pleasantly surprised as I was. **R-E**

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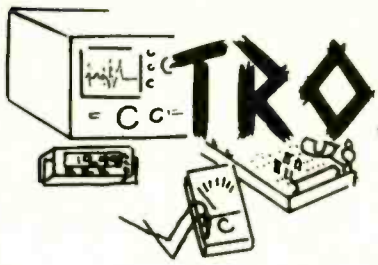

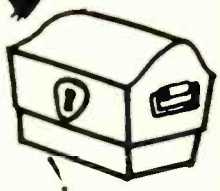

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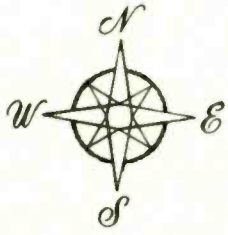

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service clinic

The boost voltage can provide a valuable servicing clue.

JACK DARR, SERVICE EDITOR

THE BOOST VOLTAGE IN A TUBE-TYPE TV set is very important. The voltage is used for several purposes, and it also provides a very valuable service clue. The circuit that produces the boost voltage is very complex and precisely timed, but in actual operation, it's quite simple if you know both what it is and how it works.

The horizontal-output tube pumps a short current pulse into the flyback transformer. This "charges" the windings as well as the yoke winding that sweeps the beam from center-screen to the right side. This charge is in the form of an electromagnetic field. Almost all the energy pumped in is concentrated in it. At the end of this time period, the output tube is suddenly cut off.

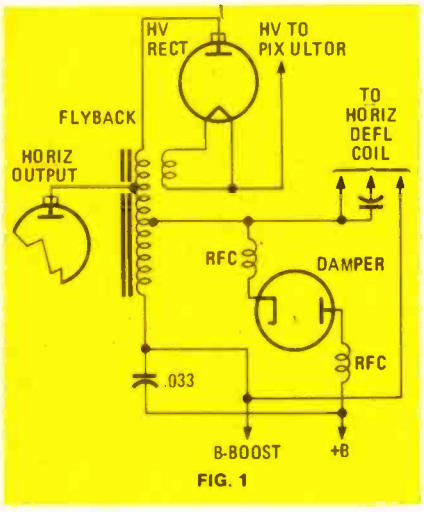

FIG. 1

The energy must go somewhere. So it collapses back into the windings, developing a voltage as it does. Since the collapse happens very fast, quite a high voltage pulse is developed. There's no need to waste this energy, so it is used. A "damper" tube is added across this voltage that rectifies it and also damps unwanted ringing. By connecting a capacitor across the damper tube (one end to the B+ line and the other to the flyback as in Fig. 1) the energy appears as a charge on this capacitor. Since the other end of the capacitor is at B+ voltage, the charge effectively "boosts" the B+ voltage, usually by a bit more than double. Here are some ballpark figures: with the B+ at +400 volts, the total boost would be +850 volts.

The capacitor used is fairly small—.033 μF, etc. You identify it by finding the capacitor that's connected to the boost voltage on one end and the B+ voltage on the other end. The boost voltage is actually the instantaneous *plate* voltage of the output tube! So if there is a fault in the boost circuit, this causes a loss of sweep width, part of the high voltage, and several other things.

If the problem is located anywhere in this stage, read the B+ voltage first to make sure and read the boost voltage second. If the boost voltage is normal, but there's still no high voltage, you have already checked out the flyback, the output and damper tube; the yoke, the boost capacitor, and so forth. The problem must then be in the high voltage section itself. Technicians write letter after letter listing all the DC voltages but not the boost! Remember to check this.

You can lose the boost voltage for several reasons; for example, with an open boost capacitor, there's no place for the charge to develop. Your clue is: the boost terminal will read only B+ voltage. Another cause is a shorted winding in the yoke. This kills the flyback pulse that provides the boost. The clue will be that the output-tube cathode current is well above normal. Disconnecting one lead of the yoke lets this current drop to less than normal. Try this quick check: Disconnect both leads to the yoke. Tack in the winding of another yoke approaching the value of the original yoke. Turn the set on. If the boost voltage returns, the original yoke is bad. The test yoke can be left on the bench and hooked up with jumpers. Leave the original on the tube until you're sure (this may save you from having to converge the set.) A leaky or shorted boost capacitor also makes the output tube current go way up. (Check this before you fool with the yoke; it's easier!) Another quick check: Pull the damper tube and measure the resistance between the plate and cathode terminals on the socket. This resistance must be very high, if you read only a few hundred-ohms, lift one end of the capacitor and check it.

One of the odd things that can happen is a completely dead stage. The B+ voltage reads normal, but zero voltage appears on the boost terminal. This can be due to a dead damper tube. All the current in the entire stage flows *through* the damper tube. This symptom is easy to check. If the heater *is* lit, but there's zero voltage on the damper cathode, try putting in a new tube. The cathode ribbon inside the tube may be broken. If this isn't the trouble, check the small "hash chokes" that are often used in the plate and cathode leads of the damper for opens.

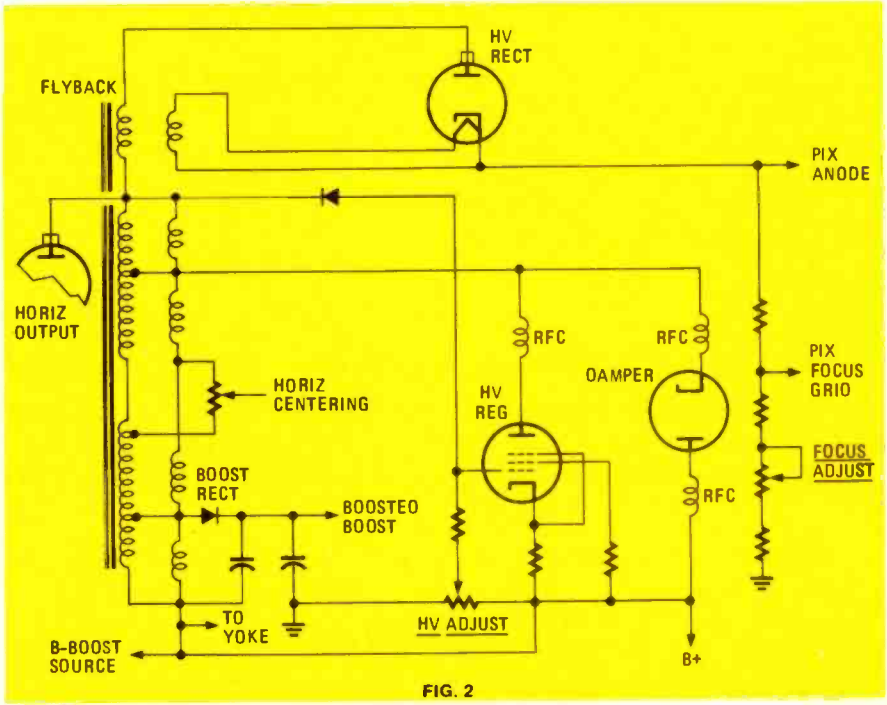

FIG. 2

Boosted-boost

Most color sets have a dual boost circuit (Fig. 2). Since the DC voltage on the bottom of the flyback still has a sizable pulse voltage in it, connecting a rectifier to it will develop extra boost. The input filter capacitor is connected back to the boost and the reaction is the same as before. For less confusion, the original boost voltage is called "raw boost" and the other is known as boosted-boost, high boost, etc. Some diagrams use "B+" for the DC supply, "B++" for the raw boost and "B+++" for the high boost. Ballpark values will be +800–850 volts for the raw boost and 1000–1200 volts for the boosted-boost.

This boosted-boost is used for the picture tube screen grids. It is a dry circuit with practically no current drain. If only the boost voltage shows here, the rectifier may be open or shorted. Since both ends of this circuit are far above ground, this does not cause an overload. You just lose the boosted-boost. Substitute a new rectifier; these are hard to check with an ohmmeter. It's highly advisable to observe correct polarity when you install the rectifier. Otherwise it won't work too well!

Solid-state sets

Solid-state TV sets also use the boost voltage to feed the picture tube screen. In these sets, however, the boost circuit is not as complex as in the tube-type sets. A rectifier is connected to a tap on the flyback where there is a suitably high voltage pulse. The resulting DC is filtered. The filter capacitor usually returns to ground. An open rectifier or filter capacitor does not affect the sweep or high voltage . If either is shorted, it overloads the output stage and can even blow the transistor. If the rectifier diode is shorted and the filter capacitor is good, the high pulse is shunted to ground through the capacitor, creating an overload.

To make a quick check, disconnect the rectifier and recheck it. If the high voltage and sweep come back, the rectifier is bad. Without any screen voltage on the picture tube, a raster won't appear, but the voltages will be OK. **R-E**

service questions

SHORTED PICTURE TUBE

This old GE black-and-white set lost the high voltage. A 22K resistor in-series with the high-voltage lead burned up. I replaced it and the new one burnt up. Plenty of high-voltage occurred after I pulled the anode lead from the picture tube. I also took off the picture-tube socket, and it still pulls the high voltage down to zero. Have you ever seen a tube like this one, and can it be fixed?—J.H., Rochester, NY.

Maybe. I've seen very few picture tubes with this kind of a short. You could try measuring from the anode to ground and to all other electrodes in the tube. If you get a reading, a flake of the internal dag coating may have fallen into the gun. If so, *maybe* you could blow it out by charging up a big electrolytic and discharging it across the shorted picture-tube elements. One thing is definite: try because you can't hurt the tube.

MINITAPE RECORDER

Who handles the "Compur-Dict" minitape recorder from Compur-Werk, München, West Germany? I need a schematic and a substitute IC for the original, which I think is bad. The IC is a 14-pin DIP, No. TAA-611B12.—W.J., San Francisco, CA.

I can't help you on the schematic. I have never heard of this unit or the company, and it's not listed in Sams. However (and I don't really believe this), when I looked the IC number up in a Sylvania *ECG Guide*, there it was! This IC can be replaced by an ECG-1113, which is a 2.5-watt amplifier also contained in a 14-pin DIP case.

continued on page 89

communications corner

Receivers are getting more complex, but they're also doing a lot more. Plus getting better sound from your mobile CB rig and a VHF/CB marine antenna.

HERB FRIEDMAN, COMMUNICATIONS EDITOR

HOW TIMES HAVE CHANGED. UNTIL THE advent of transistors an electronic hobbyist or technician could simply glance at the schematic of anything and not only know how it worked, but know how each individual component functioned in the overall circuit.

Recently, my pocket radio went dead. Checking the schematic I found the radio consisted of two integrated circuits and a handful of associated components. The schematic showed two rectangles for the IC's, and there was no way on this earth I knew what was going on or how to go about fixing it, since a check with my local service parts distributor showed neither IC was referenced in a replacement guide.

Actually, that small pocket radio is just a harbinger of what's coming into the marketplace. Using large-scale integration—LSI—much modern low-cost equipment has circuits that would have filled a floor rack 25 years ago, and cost well into the thousands of dollars. A case in point is Electra's *Bearcat 220* 20-channel crystal-less scanner for aircraft, marine, and public service (see Fig. 1).

FIG. 1

Obviously, if it can cover the AM aircraft band as well as the marine and public service FM bands, the circuit must be quite sophisticated. Well, it's that, and more.

The schematic is two full-size blueprints packed with those infamous IC rectangles that tell you nothing about the circuit. One page is devoted exclusively to the keyboard, read-only memories, microprocessor, control ROM's, RAM interface, programmable RAM, and a voltage regulator. It's all very well documented, in *computerese*. A graduate engineer with an M.S. might be able to figure out what's going on.

The *Bearcat 220* is probably the easiest to operate of all the computerized scanners. For example, at the touch of a button labeled AIRCRAFT, the microprocessor automatically switches in AM detection, tunes the front end to the 118–136 MHz aircraft band, and starts a repeating search-scan from end to end. If the search stops on an active frequency, the user can program the frequency into one of 20 channel memories by the simple touch of an ENTER button.

The same is true of the marine frequencies. Touch a button labeled MARINE and the microprocessor switches in the FM detector, tunes the front end to the 156.05–157.480 and 160.625–162.025 MHz marine band, and then search-scans these frequencies automatically. Again, an active frequency is programmed into a memory by simply touching the ENTER button.

I won't go into the rest of the features because they're similar to other computerized scanners. The big difference in the model 220 is coverage of the aircraft band and the automatic search-scan of the aircraft and marine bands. Naturally, the monitor receiver can be manually programmed to search between any two specific frequencies in any band.

What's really interesting about the *Bearcat 220* is not how much it does at the touch of a button or two, but how much hardware goes into making operation so easy. As I said, the schematic is enormous. If the IC's that just went into the microprocessor circuits were replaced with discrete components they would probably number in the thousands and only the military would be able to afford the price. Fact is, on second thought, just a few years ago probably only the military had equipment of this caliber.

CB Stereo

No, there's no such thing as stereo CB . . . yet!, but you can take a leaf out of a stereo autosound installer's handbook and get better, cleaner, mobile CB reception. First, the sound coming out of those itty-bitty speakers mounted on the bottom of most mobile CB transceivers just plain stinks. It's so poor that what we accept as "good" for CB would flunk out for any radio reception other than a VHF walkie-talkie.

Second, the new intermediate and elf-size American cars generally have only enough room for a single speaker in the dash. If the owner installs stereo autosound he generally feeds stereo to the rear, but can't get stereo into the dash because there's room for only one speaker. To get some sound up front, he substitutes a dual-*voice-coil* (not *dual cone*) speaker for the mono speaker supplied with the car (see Fig. 2). The left output is fed to one voice coil, the right output to the other. The speaker blends the two to generate a mono signal from the stereo input: the rear and/or sides still get a stereo feed.

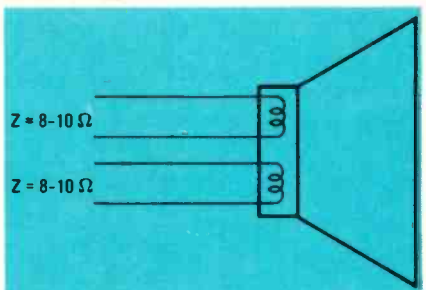

FIG. 2

You can use the same dual-voice-coil speaker to get better sound from CB. Remove the existing dash mono speaker (either 6 × 9 or 4 × 10) and substitute a dual-voice-coil speaker such as those available from Radio Shack. Types with 8-ohm voice coils are 40-1261, 40-1268 and 40-1243. Connect one pair of voice coil terminals to the radio (use the existing wires); connect the remaining voice coil terminals to the CB transceiver through a mini-plug connected to the transceiver's REMOTE or EXTERNAL SPKR jack. When you insert the plug, the transceiver's internal speaker will (usually) be disconnected and the received signal will be heard in the dash speaker. The dash speaker, being larger, and of considerably better quality than the speakers built into CB rigs, will deliver a cleaner sound. Most important, it will radiate upwards, or out towards you, rather than down at

the floor and be absorbed by the carpet.

One note of caution. Few Radio Shack or other parts distributor employees will have the vaguest idea what you're talking about if you ask for a dual-voice-coil speaker. More likely, they know it as a "multi-impedance speaker". The two sets of voice coils, either 8 or 10 ohms each, was originally intended to be connected in series or parallel to match speaker circuits with 4, 8, 16, or 5, 10, 20 ohms. Forget all this impedance matching nonsense; few modern autosound equipments are that fussy. Use each voice coil for either 4- or 8-ohm circuits. Figure 3 shows a dual voice coil speaker. Note the two sets of terminals.

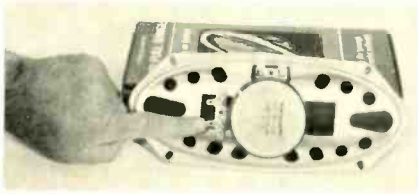

FIG. 3

CB/VHF-marine antenna

If your boat is beginning to resemble an antenna farm, or your customers are complaining that between CB and marine radio they spend more time lowering and raising masts than they do simply enjoying their boat, then its time to look into the Antenna Specialists Co. model ASM-107 CB/VHF antenna.

The ASM-107 is a rather clever idea. Basically, it's a 151–161-MHz VHF-marine antenna and a CB antenna sharing a common vertical element and transmission line. The transmission line connects to a special coupler that splits the feed to two coaxial cables: one for the CB, the other for the VHF radio. The coupler actually consists of two filters that isolate the two radios. RF from the CB rig is blocked from the VHF radio and can flow only to the antenna. Similarly, RF from the VHF radio is blocked from the CB rig and also flows only to the antenna. It works the same way for receiving. The coupler directs received VHF signals to the VHF radio, and CB signals to the CB transceiver.

The coupler, which is potted in clear plastic to prevent tampering, has two attached coaxial cables and a UHF connector. The attached cables connect to the CB and VHF radios and can be extended if required by the individual antenna installation.

The UHF connector is for the coaxial cable attached to the antenna. This cable length is critical and must not be changed from that supplied by the factory. Though the plastic-encased coupler is waterproof, the UHF connector is not, so the coupler should be installed inside the cabin.

Coming up, we will feature an inexpensive device that converts many imported-type CB antennas—which are by now falling apart—to a simple mounting for a standard $^{3}/_{8}$-24 thread such as used by most fiberglass, continuously-loaded, and top-loaded antennas. In the works is a gadget that gives a digital readout of Morse code transmissions in sentence form (not letter by letter). We're just waiting on a working model; one like you or I might purchase in a store. (It's often amazing how many hand-tooled samples never work when produced on an assembly line.) **R-E**

"I feed my problems into this computer and all it does is multiply them!"

8080 *Real-time clocks—how they work and the software requirements.*

D. LARSEN, C. TITUS, R. RONY and J. TITUS*

THERE ARE DIFFERENT TYPES OF REAL-time clocks. Perhaps the simplest type that can be built is a *free-running real-time clock*. Figure 1 shows the schematic diagram. The heart of this circuit is the Mostek Corporation's MK5009, which is driven by a 1-MHz quartz crystal. This device contains several divide-by-10 counters, one of which you can select to drive the output of the MK5009. There are four digital inputs to the device that are used to select the required decade counter. The truth table for these inputs and the resulting output frequencies are shown in Table 1. For input values greater than 1000_2, the MK5009 generates frequencies that are not multiples of ten.

TABLE 1

Inputs				Frequency
D3	D2	D1	D0	
0	0	0	0	1 MHz
0	0	0	1	100 kHz
0	0	1	0	10 kHz
0	0	1	1	1 kHz
0	1	0	0	100 Hz
0	1	0	1	10 Hz
0	1	1	0	1 Hz
0	1	1	1	0.1 Hz
1	0	0	0	0.01 Hz

As shown in Fig. 1, a 4-bit latch (SN7475) is used in the real-time clock interface between the 8080 microcomputer and the MK5009. This latch is used to program the MK5009 for a particular frequency. The output of the MK5009 clocks a D-type flip-flop whose output goes to some additional interrupt-interface hardware. Let's assume that this hardware produces a RST7 instruction when the 8080 acknowledges the interrupt.

Instructions that can be used to program the MK5009 are shown in Table 2. In this program, after the stack pointer is loaded, the A-register is loaded with the value 00000011_2. This value is transferred to output port 305, which is the SN7475 latch in the real-time clock interface. The four least-significant bits of this value are the only bits within the 8-bit byte that are actually latched by the SN7475, and the MK5009 is programmed for 1-kHz operation by this value, 0011_2. Once the MK5009 has been programmed, the interrupt flip-flop (SN7474) is cleared by the second OUT instruction and the interrupt is enabled (EI).

In 1 ms or less, the 8080 is interrupted by the real-time clock. We have assumed that when the real-time clock interrupts the 8080, it is vectored to memory location $000\ 070_8$ by the interrupt hardware. This is where the real-time clock interrupt-service subroutine must be stored in memory. In this subroutine, the 8080 may have to transfer some data between itself and a peripheral device, or it may simply turn some lights and values on or off. However, once the 8080 has performed these tasks, the interrupt flip-flop (the SN7474 IC) shown in Fig 1 is cleared and the interrupt is re-enabled. The 8080 then returns to the program that was interrupted by the real-time clock.

A characteristic of this real-time clock is that it is *free-running*, which means you cannot turn it off or stop it. The clock will always generate a squarewave with a frequency of 1 kHz. The only way that you can prevent the 8080 from being

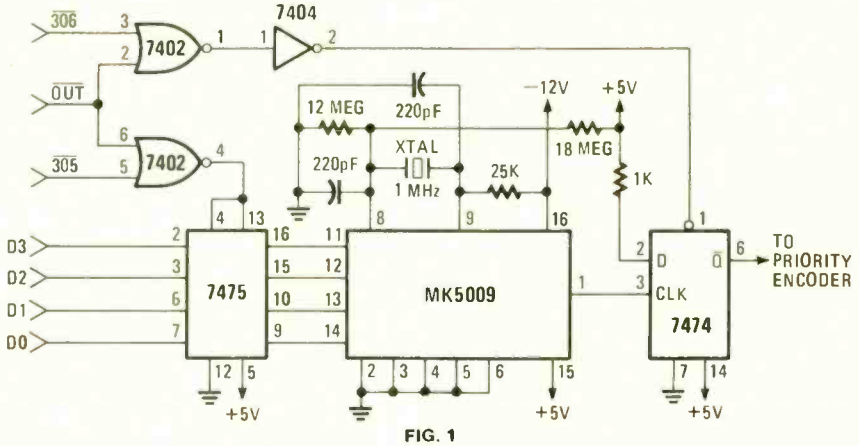

FIG. 1

TABLE 2

```
                *000 000
START,          LXISP       /LOAD THE STACK POINTER WITH A
                STACK       /R/W MEMORY ADDRESS BECAUSE IN-
                0           /TERRUPTS CAN OCCUR.
                MVIA        /THEN LOAD THE A REGISTER WITH
                003         /00000011.
                OUT         /OUTPUT THIS VALUE TO THE
                305         /MK5009 (1 KHZ OPERATION)
                OUT         /CLEAR THE FLIP-FLOP THAT IS
                306         /WIRED TO THE MK5009
                EI          /ENABLE THE INTERRUPT
                •           /THEN EXECUTE THE REMAINDER
                •           /OF THE PROGRAM.
                •

                *000 070
RTCISS,         •           /THE REAL-TIME CLOCK INTERRUPTED
                •           /THE MICROCOMPUTER, SO SERVICE
                •           /SOME OF THE PERIPHERAL DEVICES
                OUT         /THEN CLEAR THE FLIP-FLOP THAT
                306         /CAUSED THE INTERRUPT (MK5009)
                EI          /RE-ENABLE THE INTERRUPT
                RET         /AND RETURN TO THE TASK THAT
                            /WAS INTERRUPTED.
```

*This article is reprinted courtesy American Laboratories. Dr. Rony, Department of Chemical Engineering, and Mr. Larsen, Department of Chemistry, are with the Virginia Polytechnic Institute & State University. Both Dr. C. Titus and Mr. J. Titus are with Tychon, Inc.

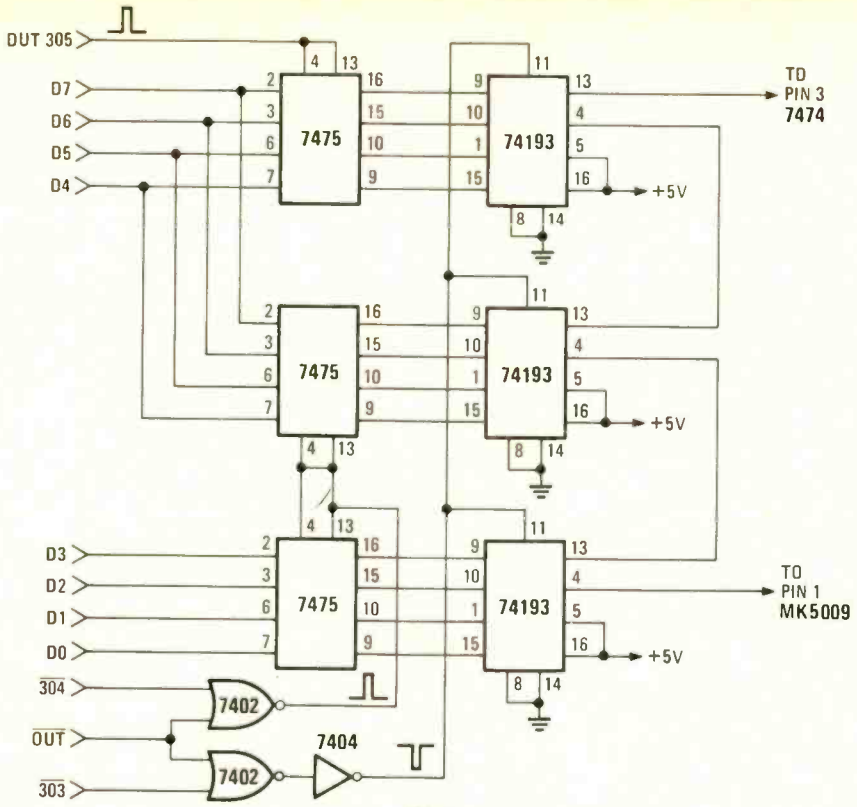

FIG. 2

interrupted by the clock is to disable the interrupt by executing a DI instruction. The limitation of this real-time clock is that it can only be programmed to generate the frequencies listed in Table 1.

How can this device be used to generate an interrupt every 15 or 20 ms? One practical method would be to add some *programmable down-counters* to the real-time clock. You can use the MK5009 to clock these counters, and when they have counted down to 0, the interrupt flip-flop is clocked so that an interrupt occurs. The latches and counters are wired to the 8080 and the MK5009, as shown in Fig. 2. The content of the A-register is latched by this interface when an OUT 304 instruction or an OUT 305 instruction is executed. When an OUT 303 Instruction is executed, the content of the latches is loaded into the counters. Since three 4-bit counters are used, the counters can be loaded with any number between 0 and 111111111111_2. This means that by placing these three counters between the MK5009 and the interrupt flip-flop, the MK5009 can generate a maximum of 4096 output pulses before an interrupt will occur.

Once these counters and latches are added to the interface, you still have to write a program that will *program* the real-time clock for a 15- or 20-ms interval. For a 20-ms interval, the software in Table 3 can be executed. This software loads the counters with the number 000000010100_2 and also programs the MK5009 for 1-kHz operation (1-ms time interval). An OUT 303 instruction must also be executed.

continued on page 92

computer products

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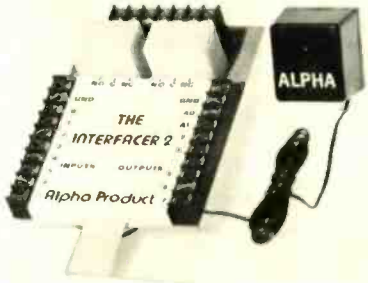
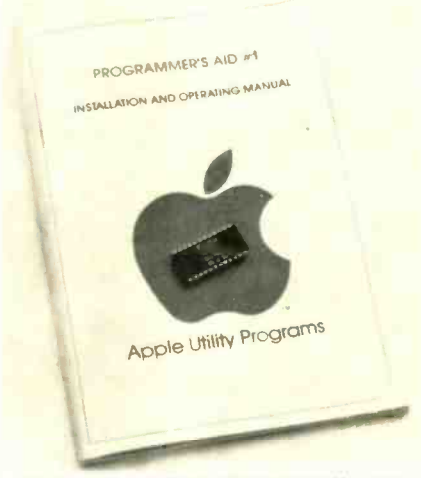
INPUT/OUTPUT INTERFACE MODULE, *Interfacer 2,* is designed for use with Radio-Shack's TRS-80 computer. The module provides 16 I/O channels (8 input and 8 output) that can be used to control and drive many peripheral devices, such as appliances, motors, solenoids and LED's; it can also be used to sense switch closures, photosensors or logic levels. The *Interfacer 2* plugs directly into TRS-80's edge connector, with I/O control provided by Level II BASIC I/O commands. Two outputs are SPDT relay switches; the other 6 are TTL-level switches, with control capability for 6 additional relays provided externally. Two inputs are optoisolated; all 8 inputs accept either contract closure or TTL-level logic. The module comes assembled and tested, and includes power supply, cable and user's manual. Price: $85, plus $3 shipping and handling.—**Alpha Product Co.,** 85-71 79th St., Woodhaven, NY 11421.



CIRCLE 121 ON FREE INFORMATION CARD

APPLE SOFTWARE, *Programmer's Aid #1,* is a ROM-based software package designed for use with Apple II's integral BASIC. The following utility programs are included: built-in graphics programs that enable you to draw from 53,000 screen locations to create detailed graphics, curves, etc., in one of 4 colors; a dynamic RAM tester that detects memory errors and displays location of malfunction; and a relocator routine that allows a program to be moved to a different location in memory. Other routines include Appleodeon that converts the Apple II into a programmable musical instrument: RENUMBER (changes program line numbers); APPEND (to load new program into memory) and VERIFY (to indicate program has been saved on tape). Price: $50.—**Apple Computer, Inc.,** 10260 Bandley Drive, Cupertino, CA 95014.



CIRCLE 122 ON FREE INFORMATION CARD

MEMORY BOARD, *DBM-1,* comes as a kit or assembled, is S-100 bus-compatible and allows computer to be used as a memory emulator during program development in small dedicated systems. The 2K byte board can be accessed by both a development and an application computer to eliminate time-consuming EPROM programming. Development computer loads memory with applications program to be executed by target computer. During debugging operations, com-

continued on page 96

SERVICE QUESTIONS

continued from page 83

HUM PROBLEM SOLVED

I wrote you asking about a hum problem in an RCA model CTC-38. You suggested checking all filter capacitors and resoldering the ground connections. I tried all this, to no avail. Then, I read a "Reader Question" on this identical problem, and that solved it, the filter choke was shorted!—T. H., Pontiac, MI.

Glad you got it fixed, even if you did have to go all the way around Robin Hood's barn to do it!

DOUBLE PICTURES

On this Panasonic black-and-white portable, I get two complete vertical pictures on the screen. The top picture is pretty good, the bottom picture is compressed, and there is a noticeable flicker. The vertical-hold pot has no effect, but other controls do work somewhat. I checked the transistors and so on. What is this?—K. L., San Diego, CA.

Since you wrote that the vertical oscillator is running at *30* Hz instead of 60 Hz, this is why two *full* pictures show up on the screen. Something is throwing the *time constant* of the vertical oscillator off, making it run too slow. The "natural period" should approach 60 Hz, even with no sync. Since this is an R–C time constant, it's unlikely that one of the *capacitors* is raised in value, which is necessary to slow up the time. Therefore, one of the resistors in the network has probably risen in value, something that often happens. Check all the resistors, since most of them are critical!

REPLACEMENT TRANSISTORS

I have this funny RCA model CTC-25 that works for a couple of hours, then the audio motorboats. I suspected the output transistor, so I changed it and the driver too. The audio now works loud and clear! The reason I changed those parts was because I managed to blow the originals by letting a test lead slip! However, when the set was cool, all the DC voltages on both the driver and output were right on the button. When the motorboating started, the voltages all bounced like crazy.

Now, this is what's bugging me: The DC voltages around the new transistors aren't right. I used an RCA SK-3021 for the output transistor and a Sylvania ECG-123A for the driver. The sound is perfect and the set keeps on working! What happened to the voltages?—A. C., Gainesville, FL.

Well, generally I'd say, "If it works that well and nothing smokes, take it!" However, the driver is directly coupled to the output. Sometimes a new driver can *change* the DC voltages on the output. This seems to be due to a slightly different beta.

MIXER TRANSISTOR BLOWS

Here's a real oddball! In a Sylvania model D-12, mixer transistor Q202 was blown. After I replaced it, the set worked OK for a couple of weeks, then Q202 blew again! I replaced it again and checked the DC voltages, which were all OK except for the collector voltage which read 17. If I let it alone, everything is OK. When I change channels, out goes Q202! Help!—L. M., Knoxville, TN.

The only thing that's out of the ballpark here is that low collector voltage on Q202. This could mean that this transistor is drawing too much current. Check the *emitter* voltage; if it is high, this could be causing your problem. Something may have upset the base bias, which comes from the +21-volt line through a voltage divider, which is composed of a 15K resistor and a 2200-ohm resistor. Check these resistors.

My copy of the Sylvania Service Hints does not show anything on this precisely; however it does refer to a D-12-3 chassis that apparently has a 20-volt *Zener* diode "mounted on tuner chassis." If this diode is not being used on your chassis, try adding one just to see if it helps.

(Feedback: "That was it! I added a Zener diode, and no more problems.") **R-E**

new products

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside the back cover.

VCR MAINTENANCE KIT, *model QM-95*, contains all the necessary components for cleaning a videocassette recorder. The kit includes *model*

CIRCLE 151 ON FREE INFORMATION CARD

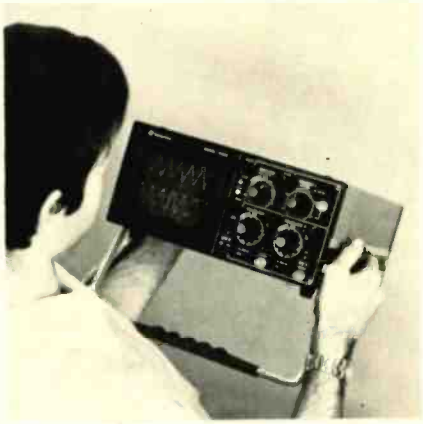
QM-103 tape head cleaner, *model QM-505* foam swabs for cleaning tape debris, an antistatic dust cloth and a screwdriver for removing headcover screws.—**Nortronics Co., Inc.**, 8101 10th Ave. N., Minneapolis, MN 55427.

SOLDERING STATIONS, *Stedi-Heat models 4422, 4423*, provide low-idling temperatures as irons rest in holder and an automatic power boost when irons are removed for work. The units

CIRCLE 152 ON FREE INFORMATION CARD

insure a lessened mV leakage, low operating costs and reduced energy usage. The *model 4422* uses *XTradur* or *Durotherm* plug tips and is suitable for touch-ups and light work. The *model 4423*, with ⅛-inch tips, is designed for high-speed applications. Prices: *model 4422*, $40.35; *model 4423*, $42.00.—**Hexacon Electric Co.**, 161 W. Clay Ave., Roselle Park, NJ 07204.

DUAL-TRACE 20-MHZ OSCILLOSCOPE, *model 1032A*, features 10 trigger modes, including independent dual triggering for simultaneous viewing of asynchronous signals. Among the unit's other features are a vertical sensitivity range from 5 mv-per-division to 20 volts-per-division; a sweep speed range from 0.5 second-per-division to 1



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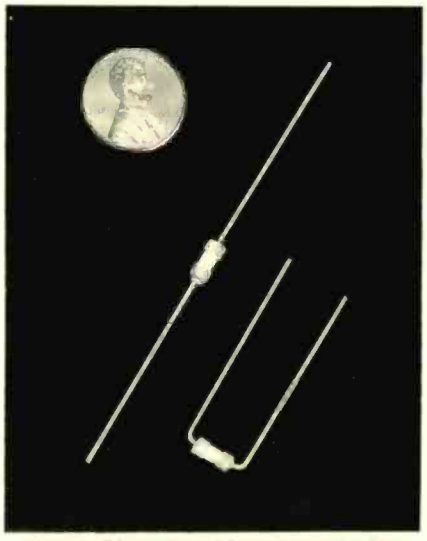
μs-per-division; a continuously variable vernier control; × 10 magnification; a 17.5-ns risetime; and 7 display modes, including Channel 1, Channel 2, chopped, alternate, add, subtract, and X-Y modes. The *model 1032A* measures 133 mm × 288 mm × 393 mm, weighs 7 kg, and its rugged construction provides effective RFI shielding and meets MIL-T-2800 Class 3 and Class 5 requirements. Suggested retail price, $895.—**Ballantine Laboratories, Inc.**, Box 97, Boonton, NJ 07005.

SUBMINIATURE HIGH-AMPERAGE FUSES; three picofuses, rated at 20A, 25A and 30A, for 35-volt or more operation; can withstand vibrations from 10–200 Hz at 20 G's per method 204A and shock of 78 G's for 11 ms per method 202B of MIL-STD-202. Can operate in temperature



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range from −55°C to 125°C. The fuses meet moisture-resistance requirements of method 106B of MIL-STD-202.—**Littelfuse, Inc.**, 800 E. Northwest Highway, Des Plaines, IL 60016. **R-E**

radio products

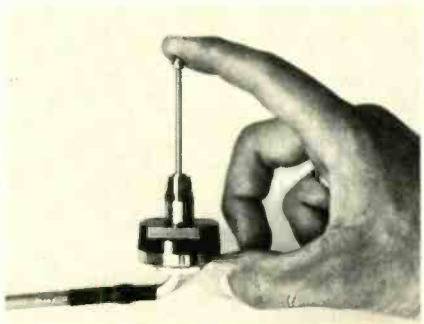
SSB/AM CB TRANSCEIVER, *model PC-201,* is a deluxe, full-feature unit that offers Channel 9 priority capability, RF gain, clarifier, volume, squelch, TX-RX indicator and warning lights, switch-selectable noise blanker and limiter, plus a back-lighted S-meter. Provides an RF output of 4 watts AM and 12 watts SSB peak-envelope-power. The unit also contains a public address provision, and comes with mounting bracket and plug-in mike. Suggested retail price: $299.95—**NDI,** 22125½ S. Vermont, Torrance, CA 90502.

CIRCLE 111 ON FREE INFORMATION CARD

PORTABLE SCANNER RADIO, *Bearcat Thin Scan,* provides 4-channel monitoring on both the 36—44 MHz and 152—164 MHz bands. Sensitivity is 0.6 μv. The scanner features lockout control for bypassing frequencies, can be operated externally as well as from batteries, and has a flexible antenna. There are jacks for a battery charger, earphone and external speaker. The unit comes in a rugged metal case with an aluminum front cover, measures only 2¾ by 1 inch, weighs 10 oz., and sells for a suggested retail price of $149.95.—**Electra Company,** Div. Masco Corp. of Indiana, 300 E. County Line Rd., Cumberland, IN 46229.

CIRCLE 112 ON FREE INFORMATION CARD

900-MHZ MOBILE ANTENNA, *model ASP-900,* is a quarter-wave, unity-gain antenna covering the 806-896-MHz frequency range. The antenna features a low-profile mount that fits the standard ¾-inch hole. It comes with a 17-foot coax cable with attached PL-259 connector. Also available is the *model ASP-900N* antenna with type-N male connector. Suggested retail prices: *model ASP-900,* $21.50; *model ASP-900N,* $30.—**The Antenna Specialists Co.,** 12435 Euclid Ave., Cleveland, OH 44106. **R-E**



CIRCLE 113 ON FREE INFORMATION CARD

COMPUTER CORNER

continued from page 87

Are there any other values that could have been used to program the real-time clock for a 20-ms interrupt? Actually, 200_{10} could have been loaded into the counters, and the MK5009 would have been programmed for 10-kHz operation (0.1-ms time interval). A value of 2000_{10} could also be used if the MK5009 is programmed for 100-kHz operation (0.01-ms time interval).

When the real-time clock interrupts the 8080, the 8080 services some peripheral devices and then clears the interrupt flip-flop (OUT 306). The count is then transferred from the latches to the counters when the OUT 303 instructon is executed. This must be done because the counters, after counting to zero, are next decremented to 11111111111_2. Therefore, if the counters were not reloaded, the 8080 would be interrupted 4096 clock pulses later, rather than the count in the latches. After re-enabling the interrupt, the 8080 returns to the interrupted task.

Adding the three 4-bit counters to the real-time clock interface has increased its capabilities. Intervals of from 1 μs to 4.096×10^5 seconds can be timed.

Another real-time clock application is as a *time-of-day clock*. This type of clock is simply a peripheral device, or a series of memory locations, in which the current time of day is stored and updated. The time can be updated every second or $^1/_{100}$ second, depending on the hardware, software and uses of the clock.

One method of constructing a time-of-day clock would be to program the MK5009 for 1-Hz operation and then wire the output of the MK5009 to a *counter chain* or *divider chain*. These chains consist of a divide-by-10 counter and a divide-by-6 counter for seconds, a divide-by-10 counter and a divide-by-6 counter for minutes, and a divide-by-4 counter and a divide-by-6 counter for hours. Instead of using a divide-by-4 counter and a divide-by-6 counter for a 24-hour format, a divide-by-4 and a divide-by-3 counter could be used for a 12-hour format. The counter outputs could be wired through tri-state interface devices to the microcomputer's data bus. The microcomputer would then have to execute some accumulator I/O or memory-mapped I/O instructions to read the time from the time-of-day clock. By using this method, *no* interrupts are required and the software instructions for reading the time are very simple. Additional instructions could be added so that you can enter a time into the microcomputer via a CRT or teletypewriter. This time would then be written out to the time-of-day clock, so that it is programmed for the correct time when the microcomputer is started. This can only be done if programmable counters are used in the time-of-day clock interface. Of course, an MK5009 does not have to be used as a 1-Hz clock source. A 60-Hz signal could be derived from the 110- to 220-VAC power lines and then be divided by 60 before being applied to the counter chain. **R-E**

TABLE 3

```
                *000 000
START,          LXISP     /LOAD THE STACK POINTER WITH A
                STACK     /R/W MEMORY ADDRESS BECAUSE IN-
                0         /TERRUPTS CAN OCCUR.
                MVIA      /THEN LOAD THE A REGISTER WITH
                003       /0000 0011, TO PROGRAM THE MOST
                OUT       /SIGNIFICANT COUNTER WITH 0
                305       /WHEN THE MK5009 (1 KHZ).
                MVIA      /THEN LOAD THE A REGISTER WITH
                024       /00010100 SO THAT THE TWO LEAST
                OUT       /SIGNIFICANT COUNTERS ARE
                304       /LOADED WITH DECIMAL 20.
                OUT       /CLEAR THE INTERRUPT FLIP-FLOP
                306
                OUT       /THEN TRANSFER THE CONTENT OF
                303       /THE LATCHES TO THE COUNTERS.
                EI        /ENABLE THE INTERRUPT AND
                •         /THEN EXECUTE THE REMAINDER
                •         /OF THE PROGRAM.
                •

                *000 070
RTCISS,         •         /THE REAL-TIME CLOCK INTERRUPTED
                •         /THE MICROCOMPUTER, SO SERVICE
                •         /SOME OF THE PERIPHERAL DEVICES
                OUT       /THEN CLEAR THE FLIP-FLOP THAT
                306       /CAUSED THE INTERRUPT AND
                OUT       /RELOAD THE COUNTERS WITH
                303       /THE CONTENT OF THE LATCHES.
                EI        /RE-ENABLE THE INTERRUPT
                RET       /AND RETURN TO THE TASK THAT
                          /WAS INTERRUPTED.
```

PLUG IT IN AND TAKE COMMAND

X-10 Remote Control For Lights and Appliances

NO WIRES NO HASSLES

System X-10 requires no special wiring or complicated installation. Simply plug a Command Console into your wall outlet in any desired location in your home. Plug each Lamp or appliance into the appropriate module and then plug that module into any wall outlet. Any number of Command Consoles may be used in a single system.

TOTAL CONVENIENCE

With System X-10 you can operate almost every light and electrical appliance in your home without leaving the comfort of your easy chair. Imagine turning on a TV set or stereo, even dimming a light, in the next room without moving from your chair.
Think of the money you can save on electric bills with System X-10. Turn off heaters or appliances from any location in your home without a lot of running around.

DELUXE ULTRASONIC COMMAND SYSTEM

The Console controls all modules from its built-in keyboard, plus it completely controls all modules from its wireless hand held ultrasonic control unit. Simply aim the hand held unit at the Console, press any appropriate Command button to turn on and off, dim and brighten lights, or turn on and off appliances. Hand held unit operates at distances of up to thirty feet, line of sight of console (does not operate through walls). A worthwhile addition to any existing X-10 system or an excellent way to begin.

STANDARD COMMAND CONSOLE

Fully controls all modules as above system, but will not respond to hand held remote unit commands - may be intermixed with the deluxe Command System or used separately to form independent control systems.

MICROPROCESSOR BASED DESIGN

The BSR X-10 System uses the latest digital techniques for trouble-free operation. Digital pulse codes are sent through the house power lines to assure reliable control throughout the system. Amazingly compact. The Command Consoles measure only 4¾" X 3½" X 3½".

LAMP MODULE

Each module will control any incandescent lamp rated up to 300 watts from control signals received from the Command units. Functions include on and off, brighten and dim. UL listed.

APPLIANCE MODULE

Each module receives signals from the Command units to turn appliances on and off; such as TV, stereo, fan, etc. Maximum appliance ratings: Resistive load - 15 amps. Motor load - ⅓ HP, Incandescent lamp - 500 watts. UL listed.

WALL SWITCH MODULE

Receives signals from the Command units to control incandescent lamps normally operated by a wall switch up to 500 watts. Installs just like any normal wall switch. Functions include on and off by remote or local control and brighten and dim by remote control. UL listed.

GETTING STARTED

Deluxe-Ultrasonic starter kit includes: 1-Deluxe Ultrasonic Command Console, 1-Hand Held Remote Unit, 2-Lamp Modules, 1-Appliance Module. Only $112.95
Standard starter kit includes: 1-Standard Command Console, 2-Lamp Modules, 1-Appliance Module. Only $87.95
Extra Lamp, Appliance or Wall Switch Modules only $16.00 each.
Extra Deluxe Ultrasonic Command Console with Hand Held Remote Unit, $64.95.
Extra Standard Command Console $39.95.
Please include $3.00 shipping and handling on all orders.

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_____Deluxe Ultrasonic Console with Handheld Remote Unit ..... $54.95 each
_____Standard Command Console ..... $39.95 each

Payment Enclosed ☐ Bill my MASTER CHARGE ☐ VISA ☐ RE-E

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Name _____

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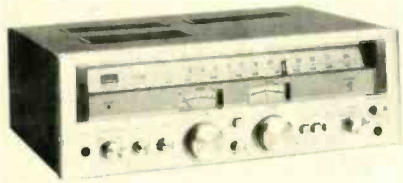
City _____ State _____ Zip _____

Add $3.00 Shipping and Handling. N.Y.S. Res. add sales tax.

stereo products

More information on stereo products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside the back cover.

AM/FM STEREO RECEIVER, *models G-4500, G-3500.* The *model G-4500* (shown) provides 40 watts-per-channel minimum RMS into 8 ohms 20 Hz-20 kHz, with 0.1% THD; the *model G-3500* provides 26 watts-per-channel. Both receivers

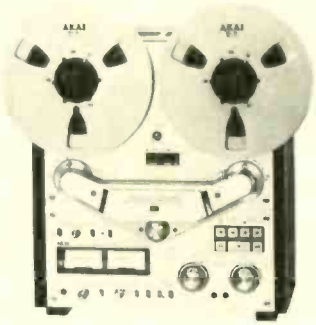


CIRCLE 131 ON FREE INFORMATION CARD

offer a tuner IHF sensitivity of 1.95 μV and an FM tuner selectivity of 50 dB, with less than 0.15% THD. Other features include FM muting switch, stereo indicator, 40-dB stereo separation, bass and treble controls, tape monitor, mode and loudness switches, and a balance control. Both units have separate signal-strength and center-tune meters; the phono sections provide an RIAA equalization accuracy of ±0.5 dB, a 75-dB S/N ratio and more than 200-mV input capability; and a separate microphone input. The *models G-4500* and *G-3500* come housed in simulated walnut cabinets. Suggested retail prices: the *model G-4500,* $320; the *model G-3500,* $270.—**Sansui Electronics Corp.,** 55-11 Queens Blvd., Woodside, NY 11377.

REEL-TO-REEL TAPE DECKS, *models GX-635D* (shown) and *GX-635DB,* are four-track, two-channel decks accommodating up to 10½-inch reels. Both units (the *model GX-635DB* has additional built-in dual-process Dolby noise reduction) provide two speeds (7½ ips and 3¾ ips) and six heads; and feature a direct-drive capstan servomotor and separate reel motors. Each deck contains the following features: a real-time counter, record-mute control, mike/line mixer, bias and equalization switches, variable pitch control, and sound-on-sound controls. The front panel also contains a volume switch, timer recording switch and two VU meters.

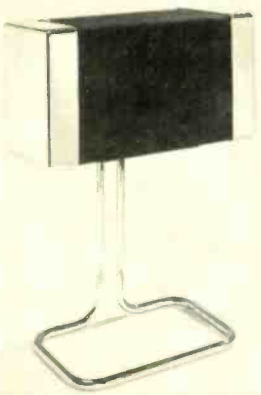
Specifications include: frequency response, 30 Hz–27 kHz ±3 dB; wow-and-flutter, less than 0.03% WRMS at 7½ ips; S/N ratio, better than 62 dB (weighted) distortion, less than 0.5% at 7½ ips. The decks come in a wood-grain vinyl enclosure with brushed aluminum front panel. They measure 17.4 × 19 × 10.1 inches, and weigh 46¼ lbs. Suggested retail prices: *model GX-635D,*



CIRCLE 132 ON FREE INFORMATION CARD

$995; *model GX-635DB,* $1095.—**Akai America, Ltd.,** 2139 E. Del Amo Blvd., Compton, CA 90224.

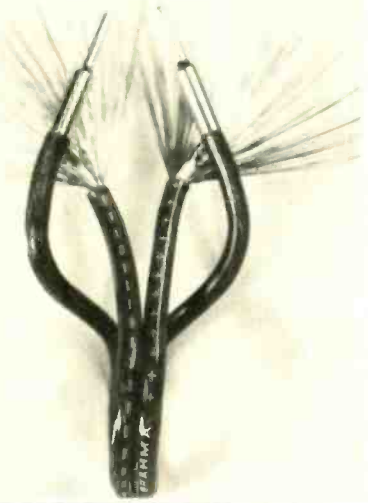
HI-FI SPEAKER SYSTEMS, *models GS401A* (shown) and *GS401C,* are British-manufactured speakers, each featuring two 200-mm woofers, a 100-mm mid-range cone and a 19-mm dome tweeter; and containing mid-range and treble balance controls. Both units provide a frequency response of 35 Hz—20 kHz ±5 dB, with 475-Hz



CIRCLE 133 ON FREE INFORMATION CARD

and 5-kHz crossover frequencies. (Recommended use is with amplifiers rated at 200 watts-per-channel RMS into 8 ohms.) The *model GS401A* comes in a black-and-chrome enclosure with matching chrome base, and measures 23¾ × 10¾ × 13 inches. The *model GS401C* measures 24⅜ × 13¼ × 11⅛ inches, and is housed in walnut veneer. Suggested retail prices: *model GS401A,* $525; *model GS401C,* $495; *model GB101 base,* $75.—**Gale Electronics, Ltd.,** distributed by Audio Potentials, 61 Shiawassee, Akron, OH 44313.

SPEAKER CABLE/CONNECTORS. *King Snake* cable comes in 30-foot lengths, is colored black with white lettering and negative/positive markings, and has pure copper inner stranding. Also available are the *model GP-200* and *model GS-200* modification gold-plated plugs. The pin plug fits any pushbutton terminal; the spade plug mates with screw-type terminals; both are secured by soldering or crimping. Suggested retail prices: *King Snake* cable, $12; *models GP-200* and *GS-200*, 20¢ and 25¢ each, respectively.—**Brahma Research of America**, 408 Main St., Woodstock, GA 30188. **R-E**



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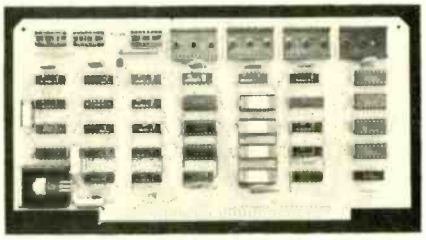
COMPUTER PRODUCTS

continued from page 88

puter can be halted to change the program using development computer's monitor commands. The *DBM-1* can be used as a normal system memory when not implemented in program development. One or two EPROM sockets interface *DBM-1* to application computer, with interface



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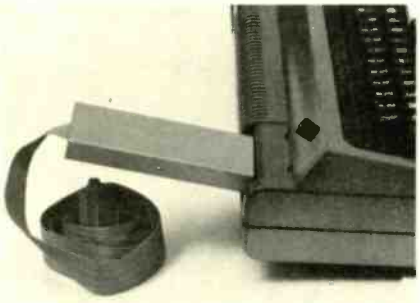
resembling 270, 2758, 2716 and TMS 2716 EPROM's. Also included is a hardware address trap to suspend operation of target processor. Two *DBM-1*s can be cascaded for applications requiring up to 4K memory. Prices: kit, $190; assembled, $270; manual, $8 (refundable with order).—**Pragmatic Designs, Inc.**, 711 Stierlin Rd., Mountain View, CA 94043.

PARALLEL-LINE PRINTER INTERFACE, *TRS-80 Print Module,* plugs directly into back of TRS-80 computer, eliminating the need for the expansion interface. All line print commands in Level II



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BASIC are compatible. The *Print Module* has a suggested retail price of $99.95.—**American Micro Products,** 6550 Tarnef, M/S 11, Houston, TX 77074.

DISC-BASED TRS-80 SOFTWARE package is a disc-based language and utility package for use with Radio Shack's TRS-80 system. Written by Microsoft, the programs are designed for use with TRS-80 systems provided with 32K RAM, one or more system drives and TRS DOS. Included on the diskette are the following: a machine-code compiler for ANSI FORTRAN X.39; a Macro Assembler using Zilog mnemonics; a Subroutine Library relocatable linkable modules for FORTRAN or assembler program, including double precision, square root, etc.; a Linking Loader to link-edit and load FORTRAN and assembler modules for execution; a Disk Text Editor, to create and modify FORTRAN and assembler programs and can also be used as general-purpose text editor. Package comes with full documentation and is available for $325, plus $2 ($5 outside U.S.).—**Lifeboat Associates,** 164 W. 83rd St., New York, NY 10024.

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COMPUTER CHESS GAME, *CompuChess Second Edition,* lets you play multiple chess games on 6 selectable proficiency levels: Levels 1 to 5 are practice games; Level 6 is designed for problem solving. *CompuChess Second Edition* comes with chess set and offers the following capabilities: flashing hyphen (i.e., to signal possible checkmate), plus pawn, castle and en-passant

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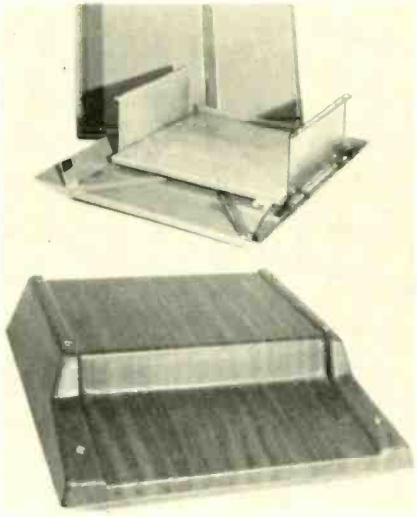
moves. Sixteen-key touchpad keyboard allows selection of Chess, The Game of Knights, Amazon Queen and Survival. Suggested retail prices: *Second Edition,* $179.95; *CompuChess* I, $135.95.—**DataCash Systems, Inc.,** P.O. Box 65, Largo, FL 33540.

MICROPROCESSOR CASE, *Computer Enclosure CE-18,* has an unplated metal chassis that can be adjusted to fit either single-board or multi-board systems, and can be modified for connector-mounted systems. The keyboard can either stand alone or be mounted on stand-offs from



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the bottom of the case. The plastic case can be cut to fit keyboard. The *CE-18* measures 18 W × 19 D × 8 inches H. Suggested retail price: $54.95.—**JRF-Tronics, Inc.,** 1061 N. Shepard, Unit D, Anaheim, CA 92806.

DIGITAL TAPE CASSETTE is designed for use in TRS-80, Apple II, PET and Ohio Scientific microcomputers. Cassette tape provides 10 minutes

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recording capability, is leaderless, and comes in a protective plastic storage box.—**Misco, Inc.,** 963 Holmdel Rd., Holmdel, NJ 07733. **R-E**

books

MICROPROCESSORS FROM CHIPS TO SYSTEMS, by Rodnay Zaks. SYBEX, Inc., 2161 Shattuck Ave., Berkeley, CA 94704. 416 pp. 5½ × 8½ in. Softcover $9.95.

This book is written for those with little or no background in microprocessor technology and will be of interest to students, hobbyists, as well as engineers. It presents system concepts and the techniques and components used to create them, and the student will become familiar with all aspects of microprocessor system operation, use and design. Chapter structure is progressive, moving from the basics to increasingly advanced applications. Chapter 7 shows how to interface the basic system to peripherals (including the S-100 bus), and Chapter 8 presents programming fundamentals. Several appendixes, an index and a bibliography are contained in the back of the book.

TESTS-ANSWERS FOR FCC FIRST AND SECOND CLASS COMMERCIAL LICENSES, by Warren Weagant. Command Productions, Box 26348, San Francisco, CA 94126. 6 × 9 in. 200 pp. Softcover $9.95.

This illustrated test and answer guide is designed to thoroughly prepare the reader for both the FCC First and Second Class Operator's License exams. Included are all 15 multiple-choice examinations based on the actual FCC test—from basic electricity to advanced solid-state circuitry to commercial TV broadcasting. The book also contains helpful information on how to set up your own home-study program, and features a "Self-Study Ability Test" that determines your preparedness for the course of study.

RUNNING PRESS GLOSSARY OF COMPUTER TERMS, by John Prenis. Running Press, 38 S. 19th St., Philadelphia, PA 19103. 86 pp. 5 × 8 in. Softcover $1.95.

From "asterisk" to "zero suppression," this glossary attempts to take the mystery out of computer language. Definitions are kept simple and direct wherever possible. An attempt has been made to cover all terms a layman will need, and if a technical term is used to define a more advanced term the simpler version is included elsewhere with its own definition. The Appendix contains a handy key to the ASCII code.

THE SCIENCE OF HIGH FIDELITY, by Kenneth W. Johnson and Willard C. Walker. Kendall/Hunt Publishing Co., 2460 Kerper Blvd., Dubuque, IA 52001. 519 pp. 8½ × 11 in. Softcover, $14.95.

Based on a college physics course demonstrating the interrelated aspects of the laws of physics and audio systems, this book also takes a look at the consumer education aspects of high fidelity. Chapters 3, 4, 5, 7, 9, and 11 are concerned with physical concepts and laws underlying all audio systems; Chapters 2, 6, 8, 10, 12, 13, and 14 deal with the actual components and with consumer aspects. The book contains many photographs, drawings, charts and schematics, and a glossary of terms is included in the back.

THE RADIO AMATEUR'S HANDBOOK, Fifty-fifth (1978) Edition. Edited by Tony Dorbuck and the Headquarters Staff of the American Radio Relay League, Newington, CT 06111. 6½ × 9½ in. 711 pp., including index. Softcover, $8.50 in U.S. and Possessions, $9.50 in Canada and $10.50 elsewhere. Hardcover clothbound,

continued on page 98

BOOKS

continued from page 97

$13.50 in U.S. and Possessions, $14.50 in Canada and $15.50 elsewhere.

Since prospective radio licensees must now have a fuller comprehension of radio theory as a result of changes in the FCC testing procedure, this comprehensive volume contains new and revised theoretical sections, as well as interesting construction projects. Much new material is included on radio design techniques and methods; semiconductors and antennas; satellites, TVI, gasoline-powered generators, as well as transverters and power supplies. Many drawings, photos and charts complement the text.

TEST AND TROUBLESHOOTING HANDBOOK, by A. K. Guthrie. General Electric Mobile Radio Dept., Box 4197, Lynchburg, VA 24502. 30 pp. 5½ × 8½ in. Softcover $2.50.

Designed as a timesaving guide for two-way radio FM service technicians, this book tells how to develop a systematic approach to standard troubleshooting procedures. It also shows how to run tests, interpret them and compare results with characteristics of published specifications. The book also includes a section on test equipment.

CUSTOMER RELATIONS FOR THE TECHNICIAN, by Dick Glass. SWR Printing Co., P.O. Box 1224, Barberton, OH 44203. 40 pp. 5½ × 8½ in. Softcover $7; $3.50 in quantities over 20.

This book is crammed with helpful information and sound advice for service technicians who need a "shot in the arm" about their profession. Written in breezy, confident style, it contains handy hints on how to improve customer relations as a primary stepping stone to upgrading one's self image as well as reaping possible financial rewards. A self-quiz plus the answers are contained in the back. **R-E**

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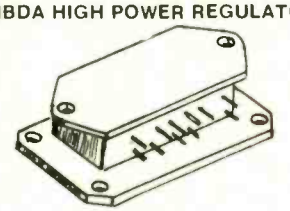

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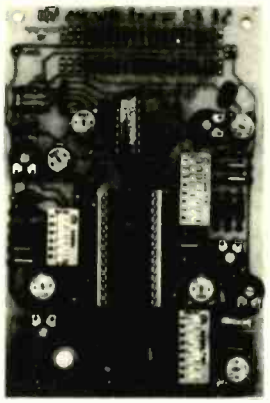

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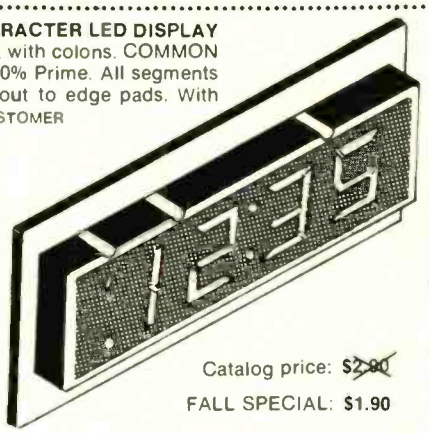

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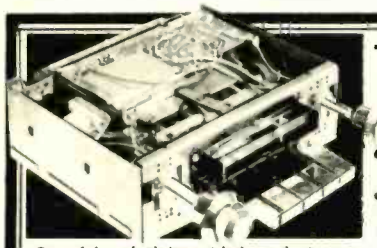

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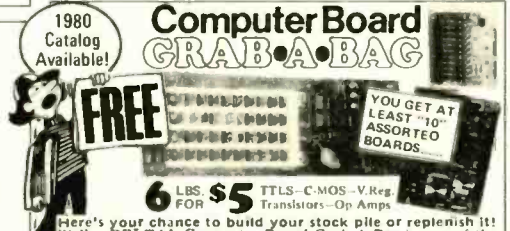

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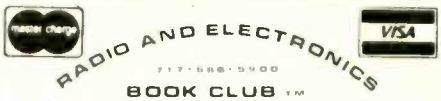

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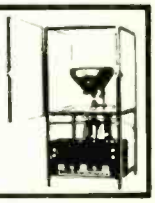

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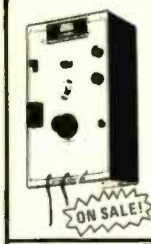

— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors. Size: 3¾" x 6¼" x 2"

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CONNECTORS

25 Pin-D Subminiature

DB25P (as pictured)	PLUG (Meets RS232)	$2.95
DB25S	SOCKET (Meets RS232)	$3.50
DB51226-1	Cable Cover for DB25P or DB25S	$1.75

PRINTED CIRCUIT EDGE-CARD

156 Spacing-Tin-Double Read-Out — Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30 SE	PINS (Solder Eyelet)	$1.95
18/36 SE	PINS (Solder Eyelet)	$2.49
22/44 SE	PINS (Solder Eyelet)	$2.95
22/44 WW	PINS (Wire Wrap)	$3.95
50/100 WW (.125 Spacing)	PINS (Wire Wrap) R681-1	$6.95

4-Digit Clock Kit

- Bright .357" ht. red display
- Sequential flashing colon
- 12 or 24 hour operation
- Extruded aluminum case (black)
- Pressure switches for hours, minutes & hold functions
- Includes all components, case and wall transformer
- Size: 3¼ x 1¾ x 1¼

JE730 ..... $14.95

Jumbo 6-Digit Clock Kit

- Four .630"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾ x 3¾ 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

REMOTE CONTROL TRANSMITTER & RECEIVER

$19.95

Digital Stopwatch Kit

- Use Intersil 7205 Chip
- Plated thru double-sided P.C. Board
- LED display (red)
- Times to 59 min. 59.59 sec. with auto reset
- Quartz crystal controlled
- Three stopwatches in one: single event, split (cummulative) & taylor (sequential timing)
- Uses 3 penlite batteries
- Size: 4.5" x 2.15" x .90"

JE900 $39.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

8080A	CPU	$ 7.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	4.95
8238	System Controller	5.95
8251	Prog. Comm. I/O (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. I/O (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS—MISCELLANEOUS

Z80(780C)	CPU	$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	16K*	EPROM	49.95
(2716)	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

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 Encoder Keyboard Kit

The JE610 62-Key ASCII Encoder 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

REGULATED POWER SUPPLY NEW

JE200 5V-1 AMP 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 & instructions
- Size: 3½"x5"x2"H

JE200 $14.95

JE205 ADAPTER BOARD — Adapts to JE200 — ±5V, ±9V and ±12V

- DC/DC converter w/ +5V input
- Toriodal hi-speed switching XMFR
- Short circ. protection
- PC Brd. construction
- Piggy-back to JE200 board
- Size: 3½"x2"x 9/16"h

JE205 $12.95

$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage — Add 5% plus $1 Insurance (if desired)

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

FREE 1980 CATALOG

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PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
ADVERTISED PRICES GOOD THRU NOVEMBER

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 modern 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 —8 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

COMPUTER CASSETTES

- 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- PLASTIC CASE INCLUDED 12 CASSETTE CAPACITY
- ADDITIONAL CASSETTES AVAILABLE #C-15-$2.95 ea

CAS-6 $14.95

(Case and 6 Cassettes)

SUP 'R' MOD II

UHF Channel 33 TV Interface Unit Kit

Wide Band B/W or Color System

★ Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SDL-20, TRS-80, Challenger, etc.

MOD II is pretuned to Channel 33 (UHF).

★ Includes coaxial cable and antenna transformer.

MOD II $29.95 Kit

ULTRA-VIOLET PRODUCTS, INC.

EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch
- Special conductive foam liner eliminates static build-up
- Built-in safety lock to prevent UV exposure
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips

UVS-11E $69.95

IDEAL FOR TRS 80 CASSETTE CONTROLLER

"Plug/Jack Interface to any computer system requiring remote control of cassette functions"

The CC100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.

#CC-100 $29.50

new

Micro-Miniature Joystick

- 2 each 100K pots (Linear Taper)
- Printed Circuit Board Mount
- Size: 1" x 1-3/16" x 1-3/16"

Micro-Miniature Joystick $4.95

7400 TTL

		SN7470N	.29		
		SN7472N	.29		
SN7400N	.16	SN7473N	.35	SN74160N	.89
SN7401N	.18	SN7474N	.35	SN74161N	.89
SN7402N	.18	SN7475N	.49	SN74162N	1.95
SN7403N	.18	SN7476N	.35	SN74163N	.89
SN7404N	.18	SN7479N	5.00	SN74164N	.89
SN7405N	.20	SN7480N	.50	SN74165N	.89
SN7406N	.29	SN7482N	.99	SN74166N	1.25
SN7407N	29	SN7483N	.59	SN74167N	1.95
SN7408N	.20	SN7485N	.79	SN74170N	1.59
SN7409N	.20	SN7486N	.35	SN74172N	6.00
SN7410N	.18	SN7489N	1.75	SN74173N	1.25
SN7411N	.25	SN7490N	.45	SN74174N	.89
SN7412N	25	SN7491N	.59	SN74175N	.79
SN7413N	.40	SN7492N	.43	SN74176N	.79
SN7414N	.70	SN7493N	.43	SN74177N	.79
SN7416N	.25	SN7494N	.65	SN74179N	1.95
SN7417N	.25	SN7495N	.65	SN74180N	.79
SN7420N	.20	SN7496N	.65	SN74181N	1.95
SN7421N	.29	SN7497N	3.00	SN74182N	.79
SN7422N	.39	SN74100N	.89	SN74184N	1.95
SN7423N	.25	SN74107N	.35	SN74185N	1.95
SN7425N	.29	SN74109N	.59	SN74186N	9.95
SN7426N	29	SN74116N	1.95	SN74188N	3.95
SN7427N	.25	SN74121N	.35	SN74190N	1.25
SN7429N	.39	SN74122N	39	SN74191N	1.25
SN7430N	.20	SN74123N	.49	SN74192N	.79
SN7432N	.25	SN74125N	.49	SN74193N	.79
SN7437N	.25	SN74126N	.49	SN74194N	.89
SN7438N	.25	SN74132N	.75	SN74195N	69
SN7439N	.25	SN74136N	.75	SN74196N	89
SN7440N	.20	SN74141N	.79	SN74197N	.89
SN7441N	.89	SN74142N	2.95	SN74198N	1.49
SN7442N	.49	SN74143N	2.95	SN74199N	1.49
SN7443N	.75	SN74144N	2.95	SN74S200	4.95
SN7444N	.75	SN74145N	.79	SN74251N	.99
SN7445N	.75	SN74147N	1.95	SN74279N	.79
SN7446N	.69	SN74148N	1.29	SN74283N	2.25
SN7447N	.59	SN74150N	.89	SN74284N	3.95
SN7448N	.79	SN74151N	.59	SN74285N	3.95
SN7450N	.20	SN74152N	59	SN74365N	69
SN7451N	.20	SN74153N	.59	SN74366N	69
SN7453N	.20	SN74154N	.99	SN74367N	.69
SN7454N	.20	SN74155N	.79	SN74368N	.69
SN7459A	.25	SN74156N	.79	SN74390N	1.95
SN7460N	20	SN74157N	.65	SN74393N	1.95

C/MOS

CD4000	.23			CD4070	55
CD4001	.23			CD4071	23
CD4002	.23	CD4028	.89	CD4072	49
CD4006	1.19	CD4029	1.19	CD4076	1.39
CD4007	.25	CD4030	.49	CD4081	.23
CD4009	.49	CD4035	.99	CD4082	.23
CD4010	.49	CD4040	1.19	CD4093	99
CD4011	.23	CD4041	1.25	CD4098	2.49
CD4012	.25	CD4042	99	MC14409	14.95
CD4013	.39	CD4043	.89	MC14410	14.95
CD4014	1.39	CD4044	89	MC14411	14.95
CD4015	1.19	CD4046	1.79	MC14419	4.95
CD4016	.49	CD4047	2.50	MC14433	19.95
CD4017	1.19	CD4048	1.35	MC14506	75
CD4018	.99	CD4049	.49	MC14507	99
CD4019	.49	CD4050	.49	MC14562	14.50
CD4020	1.19	CD4051	1.19	MC14583	3.50
CD4021	1.39	CD4053	1.19	CD4508	3.95
CD4022	1.19	CD4056	2.95	CD4510	1.39
CD4023	.23	CD4059	9.95	CD4511	1.29
CD4024	.79	CD4060	1.49	CD4515	2.95
CD4025	.23	CD4066	79	CD4518	1.29
CD4026	2.25	CD4068	39	CD4520	1.29
CD4027	.69	CD4069	.45	CD4566	2.25

74C00

74C00	.39			74C163	2.49
74C02	.39			74C164	2.49
74C04	.39	74C85	2.49	74C173	2.60
74C08	.49	74C90	1.95	74C192	2.49
74C10	39	74C93	1.95	74C193	2.49
74C14	1.95	74C95	1.95	74C195	2.49
74C20	.39	74C107	1.25	74C922	7.95
74C30	.39	74C151	2.90	74C923	6.25
74C42	1.95	74C154	3.00	74C925	8.95
74C48	2.49	74C157	2.15	74C926	8.95
74C73	89	74C160	2.49	80C95	1.50
74C74	89	74C161	2.49	80C97	1.50

LINEAR

78MG	1.75			LM710N	79
LM106H	99			LM711N	.39
LM300H	.80	LM340K-18	1.35	LM723N/H	.55
LM301CN/H	.35	LM340K-24	1.35	LM733N	1.00
LM302H	.75	LM340T-5	1.25	LM739N	1.19
LM304H	1.00	LM340T-6	1.25	LM741CN/H	35
LM305H	.60	LM340T-8	1.25	LM741-14N	.39
LM307CN/H	.35	LM340T-12	1.25	LM747N/H	.79
LM308CN/H	1.00	LM340T-15	1.25	LM748N/H	.39
LM309H	1.10	LM340T-18	1.25	LM1310N	1.95
LM309K	1.25	LM340T-24	1.25	LM1458CN/H	.59
LM310CN	1.15	LM358N	1.00	MC1488N	1.95
LM311N/H	.90	LM370N	1.95	MC1489N	1.95
LM312H	1.95	LM373N	3.25	LM1496N	95
LM317K	6.50	LM377N	4.00	LM1556V	1.75
LM318CN/H	1.50	LM380N	1.25	MC1741SCP	3.00
LM319N	1.30	LM380CN	.99	LM2111N	1.95
LM320K-5	1.35	LM381N	1.79	LM2901N	2.95
LM320K-5.2	1.35	LM382N	1.79	LM3053N	1.50
LM320K-12	1.35	NE501N	8.00	LM3065N	1.49
LM320K-15	1.35	NE510A	6.00	LM3900N(3401)	59
LM320K-18	1.35	NE529A	4.95	LM3905N	1.49
LM320K-24	1.35	NE531H/V	3.95	LM3909N	1.25
LM320T-5	1.25	NE536T	6.00	MC5558V	59
LM320T-5.2	1.25	NE540L	6.00	8038B	4.95
LM320T-8	1.25	NE544N	4.95	LM75450N	.49
LM320T-12	1.25	NE550N	1.30	75451CN	.39
LM320T-15	1.25	NE555V	39	75452CN	.39
LM320T-18	1.25	NE556N	.99	75453CN	.39
LM320T-24	1.25	NE560B	5.00	75454CN	.39
LM323K-5	5.95	NE561B	5.00	75491CN	.79
LM324N	1.49	NE562B	5.00	75492CN	.89
LM339N	.99	NE565N/H	1.25	75493N	.89
LM340K-5	1.35	NE566CN	1.75	75494CN	.89
LM340K-6	1.35	NE567V/H	99	RC4136	1.25
LM340K-8	1.35	NE570N	4.95	RC4151	3.95
LM340K-12	1.35	LM703CN/H	.69	RC4194	4.95
LM340K-15	1.35	LM709N/H	.29	RC4195	4.49

74LS00TTL

74LS00	29			74LS138	.89
74LS01	29	74LS47	.89	74LS139	89
74LS02	.29	74LS51	29	74LS151	.89
74LS03	29	74LS54	29	74LS155	89
74LS04	.35	74LS55	.29	74LS157	.89
74LS05	35	74LS73	.45	74LS160	1.15
74LS08	.29	74LS74	.45	74LS161	1.15
74LS09	.35	74LS75	.59	74LS162	1.25
74LS10	.29	74LS76	.45	74LS163	1.15
74LS11	.75	74LS78	.49	74LS164	1.25
74LS13	.59	74LS83	.89	74LS175	.99
74LS14	1.25	74LS85	1.25	74LS181	2.49
74LS15	.35	74LS86	.45	74LS190	1.15
74LS20	29	74LS90	.59	74LS191	1.15
74LS21	.35	74LS92	.75	74LS192	1.15
74LS22	.35	74LS93	.75	74LS193	1.15
74LS26	.35	74LS95	.99	74LS194	1.15
74LS27	35	74LS96	1.15	74LS195	1.15
74LS28	.35	74LS107	.45	74LS253	.99
74LS30	.29	74LS109	.45	74LS257	.89
74LS32	.35	74LS112	.45	74LS258	1.75
74LS37	.45	74LS123	1.25	74LS260	.69
74LS40	.35	74LS125	.89	74LS279	.75
74LS42	.89	74LS132	.99	74LS367	.75
		74LS136	.49	74LS368	75
				74LS670	2.49

INTERNATIONAL TIME ZONE CLOCK

- Four individually programmed clocks to time zone of your choice
- Single synch. switch to synchronize time zones
- Alterable vinyl lettering (change zone identity lettering when desired)
- Hrs., minutes & seconds displayed for each zone
- Hi-bright LED digits (.6" character height)
- Continuous AM or PM indication using 12 hr. format

SPECIFICATIONS:
Power: Wall plug transformer input voltage 117VAC60Hz output voltage 12VAC 60Hz.
Case: Standard: wood molding w/simulated walnut finish red plexiglass lens. Black textured ABS back.
Dimensions: 5" x 18"

T2-4 Assembled. $159.95

DIGITAL STOP TIMER OR CLOCK

- 10 hour stopwatch timer
- 12 or 24 hour operation
- 6 function controls: fast, slow, hold, reset, 12/24 hour and 5/6 digit
- Large .560" red display
- 50Hz or 60Hz operation
- Includes mounting bracket
- Size: 4" x 2" x 5"

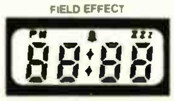
JB1001A Assembled . . . $59.95

DISCRETE LEDS

.200" dia.			**.125" dia.**		
XC556R	red	5/$1	XC209R	red	5/$1
XC556G	green	4/$1	XC209G	green	4/$1
XC556Y	yellow	4/$1	XC209Y	yellow	4/$1
XC556C	clear	4/$1			
.200" dia.			**.185" dia.**		
XC22R	red	5/$1	XC526R	red	5/$1
XC22G	green	4/$1	XC526G	green	4/$1
XC22Y	yellow	4/$1	XC526Y	yellow	4/$1
.170" dia.			XC526C	clear	4/$1
MV10B	red	4/$1	**.190" dia.**		
.085" dia.			XC111R	red	5/$1
MV50	red	6/$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	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.49	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.49	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	.99
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	1.50
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	1.50
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (± 1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

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

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL STANDARD (GOLD)

8 pin SG	$.30	.27	.24	24 pin SG	$.70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.65	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

8 pin WW	$.39	.38	.31	22 pin WW	$.95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40
20 pin WW	.85	.79	.72				

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
DS0026CH	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			XR2242CP	1.50
XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55			XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	3.95
XR567CP	.99	XR2207	3.85	XR4194	4.95
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.95	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.95	XR2212	4.35	XR4739	1.15
XR1489	1.95	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1.00
				1N4003	200 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N3600	50	200m	6/1.00
1N757	9.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N759	12.0	400m	4/1.00	1N4154	35	10m	12/1.00
1N959	8.2	400m	4/1.00	1N4733	5.1	1w	.28
1N965	15	400m	4/1.00	1N4734	5.6	1w	.28
1N5232	5.6	500m	.28	1N4735	6.2	1w	.28
1N5234	6.2	500m	.28	1N4736	6.8	1w	.28
1N5235	6.8	500m	.28	1N4738	8.2	1w	.28
1N5236	7.5	500m	.28	1N4742	12	1w	.28
1N5242	12	500m	.28	1N4744	15	1w	.28
1N5245	15	500m	.28	1N1183	50 PIV	35 AMP	1.60
1N456	25	40m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N458	150	7m	6/1.00	1N1185	150 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1186	200 PIV	35 AMP	1.80
1N4001	50 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C36M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369A	4/1.00	MPS3705	5/1.00	2N5087	4/1.00
MPS2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2484	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2906	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2907	5/1.00	2N3711	5/1.00	PN5134	5/1.00
PN2907 Plastic	7/1.00	2N3724A	.65	PN5138	5/1.00
2N2925	5/1.00	2N3725A	1.00	2N5139	5/1.00
MJE2955	1.25	2N3772	2.25	2N5210	5/1.00
2N3053	2/1.00	2N3823	1.00	2N5449	3/1.00
		2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/35V	.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

FREQUENCY COUNTER KIT

Outstanding Performance

Incredible Price $89.95

CT-50

The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 mHz and up to 600 mHz with the CT-600 option. Large Scale Integration, CMOS circuitry and solid state display technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation. Features of the CT-50 include: large 8 digit LED display, RF shielded all metal case, easy pushbutton operation, automatic decimal point, fully socketed IC chips and input protection to 50 volts to insure against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step by step instructions guide you to a finished unit you can rely on. **Order your today!**

SPECIFICATIONS:
Frequency range: 6 Hz to 65 mHz, 600 mHz with CT-600
Resolution: 10 Hz @ 0.1 sec gate, 1 Hz @ 1 sec gate
Readout: 8 digit, 0.4" high LED, direct readout in mHz
Accuracy: adjustable to 0.5 ppm
Stability: 2.0 ppm over 10° to 40° C, temperature compensated
Input: BNC, 1 megohm/20 pf direct, 50 ohm with CT-600
Overload: 50VAC maximum, all modes
Sensitivity: less than 25 mv to 65 mHz, 50-150 mv to 600 mHz
Power: 110 VAC 5 Watts or 12 VDC @ 400 ma
Size: 6" x 4" x 2", high quality aluminum case, 2 lbs
ICS: 13 units, all socketed

CT-50, 60 mHz counter kit	$89.95
CT-50WT, 60 mHz counter, wired and tested	159.95
CT-600, 600 mHz scaler option, add	29.95
CB-1, Color TV calibrator-stabilizer	$14.95
DP-1, DC probe, general purpose probe	12.95
HP-1, High impedance probe, non-loadir	15.95

CAR CLOCK

The UN-KIT, only 5 solder connections

Here's a super looking, rugged and accurate auto clock which is a snap to build and install. Clock movement is completely assembled—you only solder 3 wires and 2 switches, takes about 15 minutes! Display is bright green with automatic brightness control photocell—assures you of a highly readable display, day or night. Comes in a satin finish anodized aluminum case which can be attached 5 different ways using 2 sided tape. Choice of silver, black or gold case (specify).

DC-3 kit, 12 hour format	$22.95
DC-3 wired and tested	$29.95
110V AC adapter	$5.95

Under dash car clock

12/24 hour clock in a beautiful plastic case features 6 jumbo RED LEDS, high accuracy (1min/mo.), easy 3 wire hookup, display blanks with ignition, and super instructions. Optional dimmer automatically adjusts display to ambient light level.

DC-11 clock with mtg. bracket	$27.95
DM-1 dimmer adapter	2.50

PRESCALER

Extend the range of your counter to 600 mHz. Works with any counter. Includes 2 transistor pre-amp to give super sens, typically 20 mv at 150 mHz. Specify ÷10 or ÷100 ratio.

PS-1B, 600 mHz prescaler	$59.95
PS-1BK, 600 mHz prescaler kit	49.95

OP-AMP SPECIAL

741 mini dip	12/$2.00
B1-FET, mini dip, 741 type	10/$2.00

VIDEO TERMINAL

A completely self-contained, stand alone video terminal card. Requires only an ASCII keyboard and TV set to become a complete terminal unit. Two units available, common features are: single 5V supply, XTAL controlled sync and baud rates (to 9600), complete computer and keyboard control of cursor. Parity error control and display. Accepts and generates serial ASCII plus parallel keyboard input. The 3216 is 32 char. by 16 lines, 2 pages with memory dump feature. The 6416 is 64 char. by 16 lines, with scrolling, upper and lower case (optional) and has RS-232 and 20ma loop interfaces on board. Kits include sockets and complete documentation.

RE 3216, terminal card	$149.95
RE 6416, terminal card	189.95
Lower Case option, 6416 only	13.95
Power Supply Kit	14.95
Video/RF Modulator, VD-1	6.95
Assembled, tested units, add	60.00

CALENDAR ALARM CLOCK

The clock that's got it all: 6-.5" LEDs, 12/24 hour, snooze, 24 hour alarm, 4 year calendar, battery backup, and lots more. The super 7001 chip is used. Size: 5x4x2 inches.
Complete kit, less case (not available)

DC-9	$34.95

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain. 1 W in for 8 out, 2 in for 15 out, 4 W in for 30 out. Max. output of 35 W. Incredible value, complete with all parts, less case and T-R relay

PA-1, 30 W pwr amp kit	$22.95
TR-1, RF sensed T-R relay kit	6.95

FM MINI MIKE KIT

A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

FM-3 kit	$12.95
FM-3 wired and tested	16.95

CLOCK KITS

our Best Seller your Best Deal

Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six .4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors: silver, gold, bronze, black, blue (specify).

Clock kit, 12/24 hour, DC-5	$22.95
Clock with 10 min. ID timer, 12/24 hour, DC-10	27.95
Alarm clock, 12 hour only, DC-8	24.95
12V DC car clock, DC-7	27.95

For wired and tested clocks add $10.00 to kit price.

Hard to find PARTS

LINEAR ICs		**REGULATORS**	
301	$ .35	78MG	$1.25
324	1.50	723	.50
380	1.25	309K	.85
380-8	.75	7805	.85
555	.45	78L05	.25
556	.85	7905	1.25
566	1.15	7812	.85
567	1.25	7912	1.25
1458	.50	7815	.85
3900	.50	**TTL ICs**	
CMOS ICs		74S00	.35
4011	.20	7447	.65
4013	.35	7475	.50
4046	1.85	7490	.50
4049	.40	74196TI	1.35
4518	1.25	**SPECIAL ICs**	
5369	1.75	11C90	13.50
TRANSISTORS		10116	1.25
2N3904 type	10/1.00	4511	2.00
2N3906 type	10/1.00	5314	2.95
NPN 30W Pwr	3/1.00	5375AB	2.95
PNP 30W Pwr	3/1.00	7001	6.50
2N3055	.60	4059 ÷ N	9.00
UJT 2N2646 type	3/2.00	7208	17.95
FET MPF102 type	3/2.00	**LEDs**	
UHF 2N5179 type	3/2.00	Jumbo red	8/1.00
MRF-238 RF	11.95	Jumbo green	6/1.00
SOCKETS		Jumbo yellow	6/1.00
8 pin	10/2.00	Mini red	8/1.00
14 pin	10/2.00	Micro red	8/1.00
16 pin	10/2.00	BiPolar	.75
24 pin	4/2.00	**FERRITE BEADS**	
28 pin	4/2.00	With info. specs	15/1.00
40 pin	3/2.00	6 hole balun	5/1.00

Ramsey's famous MINI-KITS

FM WIRELESS MIKE KIT

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.
FM-1 kit $2.95 FM-2 kit $4.95

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See music come alive! 3 different lights flicker with music. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300W. Great for parties, band music, nite clubs and more.
Complete kit, ML-1 $7.95

LED BLINKY KIT

A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts.
Complete kit, BL-1 $2.95

VIDEO MODULATOR KIT

Converts any TV to video monitor. Super stable, tunable over ch. 4-6. Runs on 5-15V, accepts std. video signal. Best unit on the market!
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MOS Static RAM's

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2102LFPC 1K 350NS (Low Power)	$1.19
2102-1PC 1K 450NS	~~.99~~ 0.94
P2111-25 250 ns (256 x 4)	$2.50
P2112-35 350 ns (256 x 4)	$2.50
2114 4K (1K x 4) 300NS	~~$7.95~~ $5.75

MOS Dynamic RAM's

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4K 4027 4K (4K x 1) 300NS 16 PIN	$3.50
16K 416-5 16K (16K x 1) 300NS 16 PIN	$10.95
TMS4060-30 4K (300 NS) 22 PIN	$3.95
TMS4060-20 4K (200 NS) 22 PIN	$4.95

UART's

Part No.	Price
AYS-1013A	$4.50
AY3-1015	$5.50

1K CMOS RAM

Part No.	Price
5101 450NS (Low Power)	~~$4.50~~ $3.95

4K CMOS RAM

Part No.	Price
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8259	14.95	SCP1856LE	1.95
		SCP1858LE	1.95
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2N3055	.69	70V	NPN	TO-3
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2N3772	1.95	100V	NPN	TO-3
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7443N	35	Excess 3 to decimal decoder
7450N	12	Exp. dual 2 x 2 input and or invert gate
7453N	12	Exp. 4 x 2 input and or invert gate
7460N	12	Dual 4 input expander
7464N	09	4-2-3-2 Input and or invert gate
7465N	09	4-2-3-2 Input and or invert gate o/c
7482N	29	2 Bit binary full adder
74156N	24	Dual 2 to 4 line decoder/demultiplexer o/c
74176N	29	Presettable decade counter
74182N	29	Look ahead carry generator
74195N	29	4 Bit Parallel in, parrallel out s/r
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74H03N	09	Quad 2 input nand gate o/c
74H05N	09	Hex inverter o/c
74H12N	09	Triple 3 input nand gate o/c
74H15N	09	Triple 3 input and gate o/c
74H73N	09	Dual J—K Master slave flip flop
74H65N	09	4-2-3-2 Input and or invert
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FND567	.500	Common Cathode (high brightness)		$1.29
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IL1	Opto Coupler	1500V	.49
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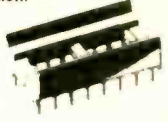

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4012	.22	4035	.97	74C02	.27	74C173	1.30
4013	.40	4042	.85	74C08	.30	74C174	1.20
4016	1.20	4044	.85	74C10	.27	74C175	1.20
4015	1.00	4045	.45	74C14	1.20	74C192	1.30
4018	.45	4046	1.95	74C20	.27	74C193	1.40
4017	1.05	4049	.75	74C42	.90	74C901	.50
4018	.90	4050	.45	74C73	.75	74C902	.50
4019	.45	4051	1.10	74C74	.50	74C914	1.90
4020	1.10	4053	1.10	74C83	1.30		
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4023	.22						

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800	.15	.35	1.00	2.50	10.50	16.50
1000	.20	.45	1.25	3.00	12.50	20.00

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.1 uf 25V ceramic capt ..... 16/$1.00, $5.00/100

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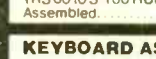

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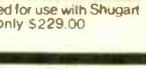

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1781 Dual Floppy	29.95
1791 Dual Floppy	39.95

TV INTERFACES

Pixie Verter	8.50
TV-1 Video Interface	8.95
Microverter	35.00
M&R Modulator	35.00

SPECIAL PURCHASE (while supply lasts)

21L02-4 (450 ns) 100 @ 99¢ ea.
21L02-2 (250 ns) 100 @ $1.15 ea.
TMS4060 NL 4K Dynamic RAMS (pullouts) $1.95 ea.
1488 Line Receiver 100 @ 75¢ ea.
1489 Line Driver 100 @ 75¢ ea.
1489 House Marked 100 @ 50¢ ea.
1496 L Demodulator 25 @ 75¢ ea.

COMPUTER SPECIALS

	LIST	SALE
Apple II Plus w/16K	1195.	990.
PET 2001-16N	995.	895.
Exidy Sorcerer w/8K	895.	795.
Compucolor II w/8K	1495.	1395.
Cromemco Sys III	5990.	4990.
Horizon I w/16K	1599.	1349.
TEI PI208 w/32K dual Floppy & CRT (1 avail.)	4995	2995
Pascal Microengine	2995	2395

IPSi 1620 Diablo RO	3295. 2695.
Anadex DP 8000	995. 895.
Centronics Micro P-1	595. 395.
Centronics Micro S-1	595. 525.
Soroc IQ 120	995. 850.
Teletype Model 43	1349. 1150.
HiPlot Plotter	1085. 899.
HiPlot Digitizer	795. 735.
Intertube II	895. 784.

• LED's • OPTOISOLATERS •

LEDS Red Yellow Green	185
MCT 2 Photo XSTR HFE 250..30V	99
4N25 Photo XSTR HFE 250..30V	1.29
4N33 Photo Darlington	1.75
FPT 1108 Photo XSTR Flat Lense	SALE 4/1.00

MONTHLY IC SPECIALS

LF13508 JFET Anlog Multi 8 bit	8.95
ICM7208 Seven Decade Counter	17.95
ICM7207 Oscillator Controller	8.95
ICM7045 Precision Stp/Watch Timer	22.95
ICL7107 3½ Digit A/D (LED)	14.95
ICL8211 Voltage Reference	1.95
LM380 Battery OP. Audio Amp	3/1.00
LM1850 Ground Fault IC	3/1.00
LM1800 Phase Lock Loop FM Stereo	3/1.00
LM1820 AM Radio	3/1.00
DS3625 Dual Mot Sense Amp	2.50

TV CHIPS/SOUND

AY-38500-1 6 Games B/W	$4.95
AY-38515 Color Converter	2.95
AY-38603-1 Roadrace Game	8.95
AY-38605-1 Warplane Game	9.50
AY-38606-1 Wipeout Game	9.50
AY-38607-1 Shooting Gallery	8.95
AY-38910 Gemini, Cricket Sound Generator	12.95
SN76477 TI Sound Generator	3.95
MM5320/21 TV Synch Gen.	9.95
MM5369 Prescaler	3.95
LM1889 RF Modulator	3.95
MM571000 NSC Color TV Game	6.95
MM5 7104 Clock Gen	3.75
RF Modulator w/Audio	8.95

All Shipments F.O.B. ca. UPS. Orders under $100.00 add 5% handling and postage. Orders over $100.00 add 2.5% handling & postage. Master Charge and American Express COD accepted w 25% deposit. California Residents add 6% tax. Foreign Orders add 8% handling. All parts prime factory tested guaranteed. Add .35 cents for Data.

Minimum parking duty runs from Mail Order Pricing. All prices subject to change without notice.

P. O. BOX 17329 Irvine, California 92713 Phone (714) 558-8813 TWX: 910-595-1565

Retail Store Open Mon. – Sat.
Located at 1310 "B" E. Edinger,
Santa Ana, CA 92705

CIRCLE 34 ON FREE INFORMATION CARD

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

SANWA

COMPACT — LIGHTWEIGHT — ULTRA SLIM
BATTERY CHECKER — LED TESTER
T-55D (w/o temp probe) **$44.50**
T-55THD (temp probe) **$66.50**

SPECIFICATIONS
Ranges
DC Voltage: 150mV, 500mV, 1.5V, 6V, 15V, 50V, 250V, 1kV (All 20k Ω /V)
25kV *Using HV probe)
DC Current: 50μA, 2.5mA, 25mA, 250mA (500mV drop)
AC Voltage: 15V, 500V, (9k Ω /V)
AC Current: 6mA, 6A (2V and 55mV drop)
Resistance: 10kΩ 100kΩ
1MΩ 5MΩ (max. calbtn)
100Ω 1kΩ
10kΩ 50kΩ (mid scale)
10kΩ 100kΩ
Load Current: 30mA 3mA 300mA
Load Voltage: 3V 3V 3V
Decibels: —10 to+55dB
Batt Check: 0.9 to 1.5V (10Ω load)
LED Check: (Available)
Temperature: —50° to +100°C and 0° to +200°C
Probe not supplied with T-55D)
Accuracy
DC Voltage: ±2.5% f.s.d.
DC Current: ±2.5% f.s.d.
Batt Check: ±2.5% f.s.d.
AC Voltage/Power on 1.5V range: ±5% f.s.d.
AC Voltage/Power above 15V range: ±3.5% f.s.d.
AC Current: ±5% f.s.d.
Resistance/Temperature: ±3% of arc

Dimensions: 146 x 97 x 28mm thick
Weight: 240g
Instrument supplied with Batteries 1.5V (UM-3 or R6)x2
Fuse & Spare: 500mA 250V
Temperature Probe: (T-55THD only)

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

PROFESSIONAL CASE

for our 0-30V Power Supply. It is a nice looking metal cast case with giant 4" volt/amp meter; output blinding post and fuse holder, on/off switch and line cord! **ONLY $21.50 EA.**

CASE 030

GIANT SIZE VU METER

1MA movement 3½" scale length. Scale in VU —20db to +3db. Meter face 5⅛"x2⅜" with a "smoke" plastic cover.

SPECIAL $8.50 Each

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

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

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

MARK IV KIT $31.50

30W + 30W STEREO HYBRID AMPLIFIER KIT

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

$32.50 PER KIT

BATTERY POWERED FLUORESCENT LANTERN

MODEL 888 R

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

$10.50 EA

STEREO AMPLIFIER 60 W + 60 W

COMPLETED UNIT — NOT A KIT!

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

5W AUDIO AMP KIT

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

PROFESSIONAL PANEL METERS

Type MU-52E

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

All meters white face with black scales. Plastic cover.

JUMBO 1" LED ALARM CLOCK MODULE

Assembled — not a kit!

Features: 1/ 4 digits red LED display • 12 hours real time format • 24 hours alarm audio output (just add speaker)

- Count down timer 59 mins.
- 12-16V AV 50/60 Hz Input
- 10 min. snooze control

$8.50 EACH Transformer **$1.75**
#FCM 701

DIGITAL AUTO SECURITY SYSTEM

4 DIGITS PERSONAL CODE!!
SPECIAL $19.95

- proximity triggered
- voltage triggered
- mechanically triggered

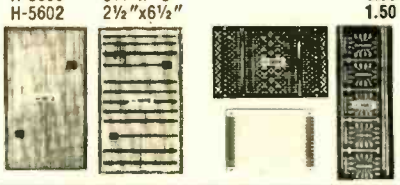
This alarm protects you and itself! Entering protected area will set it off, sounding your car horn or siren you add. Any change in voltage will also trigger the alarm into action. If cables within passenger compartment are cut, the unit protects itself by sounding the alarm. **3-WAY PROTECTION!**

All units factory assembled and tested — Not a kit!

UNIVERSAL PROTOBOARDS "CIRCUIT FIT"

All Boards are made of High Quality G10 Fiberglass and Phenolic. Pre-drilled in .042" diameter holes on 0.1" centers with the plated copper eyelet and finger edge connectors (single sided) to allow any kind of standard components to fit board.

Part No.	Size	Holes	Price Fiberglass	Phenolic
U.S.P. 723	2"x2.8"	529	$ 1.27	$ .50
U.S.P. 724	2.8"x3.7"	750	2.42	.80
U.S.P. 725	3.7"x5.5"	1500	4.89	1.38
U.S.P. 728	7"x9.6"	6240	19.50	10.40
H-5612	3½"x 6"			1.70
H-5615	3½"x 6"			1.70
H-5606	3¼"x 5"			1.50
H-5602	2½"x6½"			1.50



PROFESSIONAL FM WIRELESS MICROPHONE

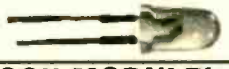
TECT model WEM-16 is a factory assembled FM wireless microphone powered by an AA size battery. Transmits in the range of 88-108MHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case; mike is 6¼" long. With a standard FM radio, can be heard anywhere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

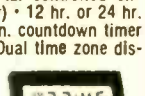
2 for $2.20



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

CONDENSER MICROPHONE

Sub-Mini Size
FET Transistor Built-in **$2.50 each**

FLUORESCENT LIGHT DRIVER KIT

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

With Case Only
$6.50 Per Kit

THE MOST ADVANCED TIMEPIECE OF ITS KIND IN THE WORLD!

LCD Quartz Alarm Chronograph with calendar and dual time zone!! Watch is the same as Seiko but you pay a lot more for the name!

• 24 hour alarm • Chronograph counts up to 12 hrs., 59 mins. 59.9 sec. • Precision of chrono up to 1/10 sec. indicated by 10 moving arrows!! • Lap time (with chrono running uninterrupted) • Time displays by LCD for hour, min., sec., day, date of the week and AM/PM. • Calendar gives out date-day • Dual time zone for any two cities of the world at your own choice. • With light switch to allow you to see the time in the dark!

One Year Full Warranty

Regular Price $85.50
SPECIAL $49.95

ELECTRONIC DUAL SPEAKER PROTECTOR

Cut off when circuit is shorted or over load to protect your amplifier as well as your speakers. A must for OCL circuits.

KIT FORM
$8.75 EA.

"FISHER" 30 WATT STEREO AMP

MAIN AMP (15W x 2)
Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply ± 16V DC (not included). Power band with (KF 1% ± 3dB). Voltage gain 33dB. 20Hz - 20KHz.

Super Buy
Only $18.50

SUPER 15 WATT AUDIO AMP KIT

Uses STK-015 Hybrid Power Amp
Kit includes: STK-015 Hybrid IC, power supply with power transformer, front Amp with tone control, all electronic parts as well as PC Board. Less than 0.5% harmonic distortion at full power ½dB response from 20-100,000 Hz. This amplifier has QUASI — Complimentary class B output. Output max is watt (10 watt RMS) at 4Ω. ONLY
$23.50 each

HICKOK LX303 DIGITAL LCD MULTIMETER

• 3½ digits display • 200 hours 9V battery life • Auto zero; polarity; overrange indication • 100MV DC F.S. sensitivity • 19 ranges and functions • D.C. volt: 0.1 MV to 1000V • A.C. volt: 0.1 V to 600 V • Resistance: 0.1Ω to 20 MΩ • D.C current: 0.01 A to 100 MA

OUR PRICE $71.45

PUSH-BUTTON SWITCH

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

HEAVY DUTY CLIP LEADS

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

MANY SOUND DECISIONS!

$3.60 EACH

Solid state sound indicator operating voltage 6V DC 30μA. Small size approximately ¾"x1¼".
Model EB2116 (Continuous)
Model EB2126 (Slow Pulse)
Model EB2136 (Fast Pulse)

ELECTRET CONDENSER MICROPHONE W TIE-CLIP

Sensitivity: 65dB ± 3dB (At 1KHz)
Impedance: 600 OHM Freq. Response:
Material: Aluminum 50 15,000 Hz
Cord: 10 ft. Length $ 19.50 EACH

ELECTRONIC ALARM SIREN

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

AU-999 $7.50

Sub Mini Size
PANEL METER
500 UA
ONLY $1.60 ea.

TRANSFORMERS

ALL 117 VOLT INPUT

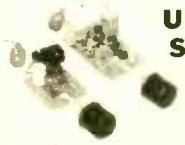
30V	4 AMP	$8.50 EA.
36V CT	3 AMP	$10.50 EA.
48V CT	3 AMP	$10.50 EA.
24V CT	3 AMP	$10.50 EA.
24V CT	0.8 AMP	$2.50 EA.
12V CT	0.5 AMP	$2.50 EA.
12V CT	120 MA	$1.80 EA.

AC POWER SUPPLY

Wall Type Transformer

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

ULTRASONIC SWITCH KIT



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

WE FOUND THE CASE FOR THE FM MIC!

Small nice looking aluminum case size like a pack of cigarettes. It is an Intercom. Audio amp inside with a mic jack, a mini toggle sw on top, can be used for many projects. We give you the circuit data as well. SPECIAL PRICE 2 for $4.99

SOUND ACTIVATED SWITCH

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

$1.75 ea. 2 for $3.00

FM WIRELESS MIC KIT

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

REGULATED DUAL VOLTAGE SUPPLY KIT

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

Rechargeable NI-CD Batteries Pak
6AA NI-CD in a flat pack gives you a total of 7.2V 450MA output
$5.25 PER PACK

BECKMAN FET LIQUID CRYSTAL DISPLAY

Overall size 2" x 1.2" 0-5" characters reflective type.
Model 737-01 — for clock 4 digits with PM, alarm, snooze, colen indicators.
Model 739-04 — for panel meter 4 digits.
Model 739-03 — for panel meter 3½ digits with ± sign and over range indicator.
All displays include zeber connectors and front bezel. With data sheets.
Your choice — any model $7.50 EACH

POWER SUPPLY KIT

0-30V D.C. REGULATED
Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts.
Transformer for Power Supply, 2 AMP 24V x 2 $8.50

0-30 Power Supply
$10.50 each

I.C. TEST CLIPS

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

SOUND GENERATOR I.C.

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

ELECTRONIC SWITCH KIT

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

1 WATT AUDIO AMP

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

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

Incorporates brand-new D.C. design that gives a frequency response from DHz — 100KHz ±0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuation!
Specifications: • T.H.D. less than .005% • T.I.M. less than .005% • Frequency response: DC to 100KHz ±0.5dB • RIAA deviation: ±0.2dB • S/N ratio: better than 70dB • Sensitivity: Phono 2MV 47K/Aux. 100MV 100K • Output level: 1.3V • Max. output: 15V • Tone control: bass ±10dB @ 50Hz/treble ±10dB @ 15Hz • Power supply: ±24 D.C. @ 0.5A
Kit comes with regulated power supply, all you need is a 48V C.T. transformer @ 0.5A
ONLY $44.50
X'former

SOLID STATE ELECTRONIC BUZZER

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

$1.50 each

FORMULA INTERNATIONAL INC. 11/79

	SHIPPING AND HANDLING CHARGES Under $50.00 purchase	Over $50.00 purchase
Inside California	10%	5%
Outside Calif. (Includes Mexico & Canada)	15%	10%
Overseas	25%	20%

Minimum Order $10.00/Calif. Residents Add 6% Sales Tax
Phone Orders Accepted on Visa or MC ONLY, NO C.O.D./Store Hours 10-7 Mon. thru Sat.

Send $1.00 For Detailed Catalogue

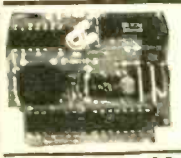
12603 CRENSHAW BLVD., HAWTHORNE, CA 90250
PHONE: (213) 973-1921 • (213) 679-5162

CARBON FILM 1/4W-5% Resistors

OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS	OHMS
2.7	11	47	200	820	3600	15K	62K	270K
3.0	12	51	220	910	3900	16K	68K	300K
3.3	13	56	240	1000	4300	18K	75K	330K
3.6	15	62	270	1100	4700	20K	82K	360K
3.9	16	68	300	1200	5100	22K	91K	390K
4.3	18	75	330	1300	5600	24K	100K	430K
4.7	20	82	360	1500	6200	27K	110K	470K
5.1	22	91	390	1600	6800	30K	120K	510K
5.6	24	100	430	1800	7500	33K	130K	560K
6.2	27	110	470	2000	8200	36K	150K	620K
6.8	30	120	510	2200	9100	39K	160K	680K
7.5	33	130	560	2400	10K	43K	180K	750K
8.2	36	150	620	2700	11K	47K	200K	820K
9.1	39	160	680	3000	12K	51K	220K	910K
10	43	180	750	3300	13K	56K	240K	1.0M

HIGH QUALITY·· LOW O E M PRICE

5 for .25 one value | 10 for .40 one value | 100-$1.60 - 1000 at $14. 100 per value



CMOS BOARD $2.95

CONTAINS:
4553 3 digit decade counter
4511 4bit latch 7 seg. decoder driver for LED display
4040 oscillator w/14 stage binary counter.
4011 CMOS gate
2 switches, resistors, capacitors.
HP 2 digit LED display

RCA to220 8A,600V TRIAC ea.99¢ ten-$9.50 $89/c

BISTABLE RELAY SPDT 6VDC 200 ohm coils 1 mfd, 20 watt NC contacts Long life (5 10^6 ops) open High speed (500 Hz) Hermetically sealed 3/8x3/8x3/4" $2.95ea

OPTO ISOLATOR FCD820 6PIN DIP WILL DRIVE A TTL GATE WITH TEN MA LED CURRENT 69¢ea ten $6

Ge or Si SIGNAL DIODES High quality, marked computer grade signal diodes. Leads trimmed for PCB mounting.... 40 for $2

P.U.T. PROGRAMMABLE UNIJUNCTION Prime 2N6026 50¢ea., ten $4 - 100-$30 Motorola no. 19328

VOICE ACTUATED SWITCH 95¢ea

COMPLETELY ASSEMBLED ON CIRCUIT BOARD AS SHOWN CONTAINS CRYSTAL MICROPHONE, GAIN CONTROL, TRANSISTOR AMPLIFIER AND 4 AMP SCR, WHICH IS TURNED ON BY AUDIO FROM MICROPHONE.....REQUIRES 5-15 VDC FOR OPERATION.

MICROPHONE CAN BE REPLACED BY CDS PHOTOCELL FOR LIGHT ACTUATION.

DIP BRIDGE 50¢ea. 1A, 100V Varo VM18 ten $4 - 100-$30 removed from boards

VIBRASONIC dual delay $12 95

DIODE ARRAY 10 1N914's 20 PIN PACKAGE with PINS SPACED .1" IN TWO STAGGERED ROWS 25¢ each 10 - $2.25

special 20¢ ea. 10 - $1.50 $12.50/c CLAIREX DUAL CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS

SUPER SAVER

DIGITAL IC's

81047	1020 BIT SHIFT REGISTER	TO-88	$4.00
CD4011	CMOS QUAD 2 INPUT NAND	DIP	.19
CD4012	DUAL 4 INPUT NAND	DIP	.19
CD4013	DUAL TYPE "D" FLIP FLOP	"	.32
CD4022	DIVIDE BY 8 COUNTER DECODER	"	.50
CD4025	CMOS 3 INPUT NOR GATE	DIP	.19
CD4553	3 DIGIT DECADE COUNTER	"	3.50
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2MR811	QUAD MOS INTERFACE	"	.50
MM5059	1024 BIT STATIC SHIFT REG.	"	3.50
EP300	(2MR5316) MOS BUS DRIVER	"	1.00
LU321	DUAL JK FF UTILOGIC	"	.25
8200	TTL PIN COMPATIBLE W/7400	"	.16
7402	QUAD 2 INPUT NOR GATE	DIP	.13
7475	QUAD LATCH TTL	"	.40
74S95	DIVIDE BY 12 COUNTER	DIP	.40
74170	(8270) SHIFT REG.	"	.36
81L02	16 x 4 STATIC RAM 450NS	"	1.35
2114	4K STATIC 300NS NAM	"	8.00
	LINEAR IC'S		
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TDA2020	8GS 20W AUDIO AMP	DIP	4.95
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AAM-1	MPC4070 1W AUDIO AMP	"(8)	.40
LM305	PRECISION V REG.	TO-5	.50
LM107	OP-AMP	"	.50
LM308AH	MICROPWR OP-AMP	"	3.00
UA715	81-BIPERI 100V/US OP-AMP	TO-89	2.00
MC1303	DUAL STEREO AMPLIFIER	DIP	2.00
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LM4581	6.4V, .002% REFERENCE		.45
ER902	27 V DIAC		.35
1N4728A	3.3V, 1W ZENER		.15
1N4762A	12V, 1W ZENER		.15
1N5235B	6.8V, .5W ZENER		.15
*R612A	600VOLTS, 3 AMP RECTIFIER		.50
T813A	13V, 1W ZENER		.15
1N3718	TUNNEL DIODE		.75
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MPSA55	PNP 60V,.1A,.3W	TO-92	.15
2N3639	PNP 60V,.1A,.5W	TO-92	.15
2N4248	PNP 40V,.1A,.2W	TO-92	.10
2N4400	NPN 40V,.1A,.2W	TO-92	.10
2N4037	NPN 30V,.2A,.3W	TO 106	.15
2N5138	PNP 30V,.1A,.3W	TO-106	.15
2N3572	NPN 25V,.1A,.3W	TO-92	.20
2N5964	NPN 150V,.1A,.5W	TO-92	.20
D41D1	PNP 30V, 1A, 6W	TO220	.50
T1P126	PNP DARL. 80V, 5A, 65W	TO220	.60
MJE800	NPN DARL. 60V, 5A, 65W, TO73		.60
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NEW! HIGH-PERFORMANCE S-100 MOTHERBOARDS

19 slot: $174 unkit, $214 assm
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(Unkits have edge connectors and termination resistors pre-soldered in place for easy assembly.)

These 3rd generation motherboards are shielded, terminated, and designed to work with the latest 5 and 10 MHz CPUs coming on line. Fits In Godbout, Vector, IMSAI, TEI, and similar enclosures. These high quality products are a welcome addition to any system — or the start of a great one.

2S "Interfacer" S-100 I/O board $189 unkit, $249 assm, $324 CSC*

Dual serial port with 2 full duplex parallel ports for RS-232 handshake. Crystal timebase. Baud rates to 19.2 KBaud selectable for each port, much more. This no-excuses serial board does things the others only dream about.

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All our memory boards are fully static, are zip along with 5 MHz systems, include a 1 year warranty, and are available in 3 different configurations. Here are just some selections from our roster of 14 Econorams**....

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32K Econoram X	S-100	$529	$649	$789
24K Econoram XII	S-100 (1)	$329	$419	$519
16K Econoram XIV	S-100 (2)	$289	$349	$448
16K Econoram XV-16	Heath H8 (3)	$329	$395	n/a
32K Econoram XV-32	Heath H8 (3)	$599	$729	n/a

Notes
(1) Bank select board — 2 independent banks addressable on 8K boundaries.
(2) Extended addressing (24 address lines).
(3) Bank select option for implementing memory systems greater than 64K.
* CSC boards are qualified under our high-reliability Certified System component program (200 hour burn-in, replacement in event of failure within 1 year of invoice date)
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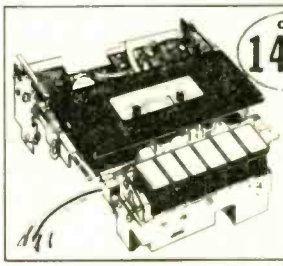

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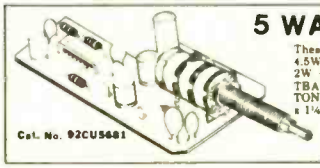

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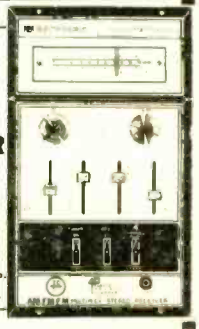

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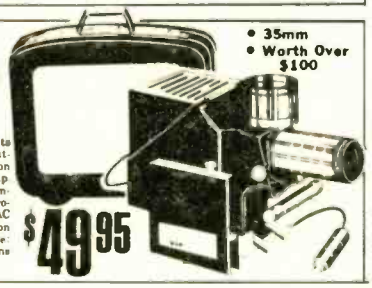

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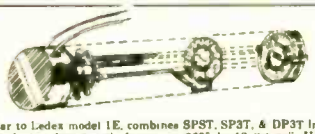

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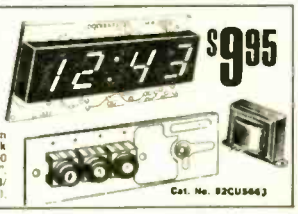

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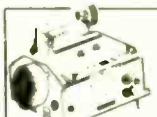

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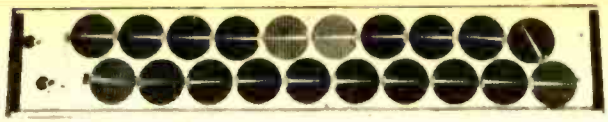

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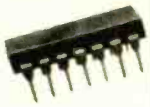

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74LS30	276-1914	.59
74LS32	276-1915	.69
74LS47	276-1916	1.29
74LS51	276-1917	.59
74LS73	276-1918	.69
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4023	276-2423	.69
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4028	276-2428	1.29
4046	276-2446	1.89
4511	276-2447	1.69
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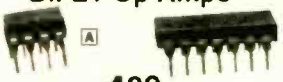

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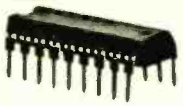

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74LS03	.25	74LS109	.50	74LS196	1.75
74LS04	.40	74LS112	.50	74LS197	1.75
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74LS08	.35	74LS114	.50	74LS240	4.00
74LS09	.27	74LS122	.50	74LS241	4.00
74LS10	.35	74LS124	1.35	74LS242	4.00
74LS11	.75	74LS125	.90	74LS243	4.00
74LS12	.30	74LS126	.50	74LS244	4.50
74LS13	.60	74LS132	1.00	74LS247	1.42
74LS14	1.25	74LS136	.50	74LS248	2.50
74LS20	.30	74LS138	.95	74LS253	1.00
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74LS30	.30	74LS153	1.00	74LS261	2.35
74LS32	.40	74LS154	1.50	74LS266	.55
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74LS51	.35	74LS163	1.25	74LS368	.85
74LS54	.35	74LS164	1.35	74LS670	2.75
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74LS73	.45	74LS168	1.10	74LS373	3.05
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74LS76	.45	74LS173	1.50	74LS668	1.25
74LS83	.90	74LS174	1.35	81LS95	1.25
74LS85	1.50	74LS175	1.35	81LS96	1.55
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7403	.20	7470	.30	74155	.70
7404	.20	7472	.25	74157	.60
7405	.20	7473	.35	74160	.85
7406	.16	7474	.35	74161	.75
7407	.16	7475	.45	74162	1.95
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7409	.20	7480	.59	74164	.89
7410	.20	7481	1.20	74165	.95
7411	.25	7482	.99	74166	1.45
7412	.25	7483	.60	74170	1.60
7413	.35	7485	.65	74173	.99
7414	.60	7486	.35	74174	.85
7416	.19	7489	1.75	74175	.70
7417	.25	7490	.45	74176	.80
7420	.20	7491	.55	74177	.75
7423	.22	7492	.45	74180	.65
7425	.20	7493	.45	74181	1.75
7426	.32	7494	.49	74182	.89
7427	.25	7495	.65	74190	1.25
7430	.25	7496	.65	74191	.95
7432	.25	7497	3.50	74192	.75
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CD4008	.25	CD4025	.26	CD4071	.26
CD4009	.45	CD4026	2.00	CD4081	.79
CD4010	.45	CD4027	.65	CD4082	.29
CD4011	.28	CD4028	.85	CD4510	.95
CD4012	.25	CD4030	.45	CD4516	.55
CD4013	.35	CD4035	.90	CD4518	.68
CD4014	1.25	CD4040	1.10	CD4522	.45
CD4015	1.20	CD4044	.79	CD4526	.42
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CD4017	1.10	CD4046	1.70	CD4529	.25
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311N-8	.90	556N	.88	3900	.75
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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.

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

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A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program luader/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. A Godbout 8K RAM board is available for $135.00. 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 $12.50 for easy connection between the **Super Elf** and the **Super Expansion Board.**

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7445N	.69	LM340K-5	1.35	CD4035	1.02						
7447N	.60	LM340K-8	1.35	CD4040	1.02						
7448N	.69	LM340K-12	1.35	CD4042	.71						
7450N	.17	LM340K-15	1.35	CD4043	.63						
7474N	.29	LM340K-24	1.35	CD4044	.63						
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6809	27.00	5 185 MHz	4.50
Z80	14.75	5.7143 MHz	4.50
Z80A	18.75	6 5536 MHz	4.50
8212	2.90	14.31818 MHz	4.75
8214	4.00	18 432 MHz	4.50
8216	2.90	22 1184 MHz	4.50
8224	2.90		
8228	5.35		
8251	8.50		
8253	15.00	KEYBOARD ENCODERS	
8255	9.25	AY5-2376	$12.50
8257	19.50	AY5-3600	17.95
8259	19.50	74C922	5.50
1802CP		74C923	5.50
pair	13.95	HD0165-5	6.95
1802DP			
pair	17.95		
1861P	11.50	D Connectors RS232	
CDP1802CD	19.95	DB25P	2.95
CDP1802D	25.00	DB25S	3.95
CDP1861	12.95	Cover	1.50
6820	9.95	RS232 Complete Set	6.50
6850	12.95	DE9S	1.95
6502	12.50	DA15P	2.10
6504	10.50	DA15S	3.10
6522	13.60		
		TRANSISTORS	
UART/FIFO		2N1893	.40
AY5-1013	5.50	2N2222A	.18
AY5-1014	7.50	2N2369	.30
3341	6.95	2N2904A	.20
		2N2907A	.25
PROM		2N3053	.40
1702A	3.95	2N3638	.25
2708	10.50	2N3643	.25
2716T1	48.00	2N3904	.18
2716 Intel	48.00	2N3906	.18
2732	115.00	2N3055	.89
2758	22.50	2N4400	.25
8741A	65.00	2N4401	.25
6748	75.00	2N4402	.20
8755A	65.00	TIP31	.60
N82S23	3.95	TIP33A	1.00
N82S123	3.50		

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 8.75
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LEDS
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Green, Orange, Yellow Jumbo .25
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(specify red, amber, green, yellow, clear)

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3 pos. slide .25
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Portobraces 100A Logic
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Model 10 Trigger
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Multimeter $56.95
Clock Calendar Kit $29.95
2.5 MHz Frequency Counter
Kit $37.80
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12 6V CT 600 ma 3.75
12V 250 ma wall plug 2.95
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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

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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	
FND359 9 digit display			.80	
7520 Claross photocells			.39	
TIL311 Hex			9.50	
MAN3640	CC	30	1.10	
MAN4510	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			

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600 MHz
9 DIGITS

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1 GHz
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K-7000 kit	79.95	550 MHz	7	5-20 mV	10-30 mV	20-50 mV to 550 MHz	1-10 mV	(2) 1.1 SEC	10 Hz	10 Hz	100 Hz 550 MHz	1.6 PPM	5.24288 MHz	NO	YES OPTION $15.
7010 *7010.1	145.00 225.00	600 MHz	9	5-20 mV	10-30 mV	20-40 mV to 600 MHz	1-10 mV	(3) 1.1.10 SEC	1Hz	1 Hz	10 Hz 600 MHz	1 PPM 0.1 PPM	10 MHz	YES OPTION $25.	YES OPTION $15.
8010 *8010.1	325.00 405.00	1 GHz	9	1-10 mV	5-20mV	10-35 mV	1-10 mV	(8) 01-20 SEC	1 Hz	1 Hz	10 Hz 1 GHz	1 PPM 0.1 PPM	10 MHz	YES STD	YES OPTION $39.

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