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Digital logic in
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The C8P DF is designed to be the "Brains" of the home of the future and the small business office of the future!
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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 46.

JUST ONE OF THE MANY desoldering tech- 

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A stamped self-addressed envelope must accompany all submitted manuscripts and/or artwork or photographs if their return is desired should they be rejected. We disclaim any responsibility for the loss or damage of manuscripts and/or artwork or photographs while in our possession or otherwise.
**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 cryptoanalysts 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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CIRCLE 54 ON FREE INFORMATION CARD
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 milliamper-hours is 70 mm long, 20 mm wide, and only 0.8 mm thick (2.4 × 0.8 × 0.03 inches approximately). Not exactly paper-thin, but no thicker than about 15 pages of this magazine. Voltage is a standard 1.5.

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-watt—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
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 VALUOUS**

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 positioned 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 bleb 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 Nakamichi, 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 12,000cpr, so we have over 2000cpr 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 $2.50 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.

**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 adapter.

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 fit virtually anything battery powered. Radio Shack sells a similar 4 volt adapter 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 line 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.

**DAK INDUSTRIES INCORPORATED**

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10845 Vanowen St., North Hollywood, CA 91605

November 1979
NRI training in TV and Audio Servicing keeps up with the state of the art. Now you can learn to service video cassette and disc systems.
You build color TV, hi-fi, professional instruments.

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

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

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

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

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

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

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

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

Free Catalog...No Salesman Will Call
Send today for our free 100-page catalog which shows all the kits and equipment, complete lesson plans, and convenient time payment plans for courses to fit your needs and budget. Or explore the opportunities in other NRI home study courses like Microcomputers & Microprocessors, CB and Mobile Radio, Aircraft and Marine Radio or Complete Communications. Send the postage-paid card today and get a head start on the state of the art. If card has been removed, write to:

NRI Schools
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3939 Wisconsin Ave.
Washington, D.C. 20016
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 symphony 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.

**DC transmission links may end future widespread blackouts**

An experiment now under way in the Communications District facility in Englewood (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.
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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.
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 $6.30 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 nostalgic 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 transmitted 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 - (Tb/Ta)) X 100 where Ta = temperature of the light and Tb = 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 absorbance. 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 photons 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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We hope you'll shop around. Because, frankly, CIE isn't for everyone.

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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 Confucius 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 locate one. The local 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 amateurs" 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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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 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-wave antenna, and it will undoubtedly perform as advertised.
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MICROPROCESSORS AND MICROCOMPUTERS AND SWITCHING MODE POWER SUPPLIES. By Texas Instruments, Inc. 216 pp. illus. This book describes the latest developments in microprocessors and microcomputers, and discusses the latest switching mode power supplies. The book is divided into two parts: microprocessors and microcomputers, and switching mode power supplies. Each part is further divided into several chapters, each covering a specific topic in detail. This book is a valuable tool for engineers and scientists working in the field of microprocessors and microcomputers.

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ELECTRONIC DISPLAYS. By E G Yablon and Texas Instruments Incorpor. 720 pp. illus. This book describes the latest developments in electronic displays, including all types of display technologies. The book is divided into two parts: general principles and display technologies. Each part is further divided into several chapters, each covering a specific topic in detail. This book is a valuable tool for engineers and scientists working in the field of electronic displays.

594/668 Pub. Pr., $15.00 Club Pr., $13.50

DIGITAL FILTERS. By A Antoniou, 524 pp. illus. This book includes a comprehensive treatment of digital filters, including all types of filter architectures and designs. The book is divided into two parts: filter fundamentals and filter design techniques. Each part is further divided into several chapters, each covering a specific topic in detail. This book is a valuable tool for engineers and scientists working in the field of digital filters.

937/953 Pub. Pr., $18.95 Club Pr., $16.50

BUCBBAUM'S COMPLETE HANDBOOK OF PHOTONIC REFERENCE DATA. By W H Bucbbaum, 2nd Ed. 645 pp. 371 illus. 70 tables. This book is a comprehensive reference for photonic and photonics-related technologies. It covers the fundamentals of photonic devices and systems, including all types of photonic components and devices. The book is divided into two parts: photonic components and photonic systems. Each part is further divided into several chapters, each covering a specific topic in detail. This book is a valuable tool for engineers and scientists working in the field of photonic and photonics-related technologies.

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ELECTRONICS ENGINEER'S HANDBOOK. Editor-in-Chief. D. G. Fink. 2,104 pp., 2,026 illus. Huge in every sense, this instant-reference volume gives you every latest essential in the field, 2,100 formulas and equations, a 2,500-item bibliography, and every illustration you need to clarify all of modern electronics.

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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.

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Pick up a supply from your Perma Power distributor!

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 x 3” high x 1 1/4” deep housed in a black plastic case with a metallic front panel. 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 ½ inch clearance between the coil and the magnets. As the car moves, the driveshaft rotates and the magnets induce

continued on page 36
Now you can detect deception with the push of a button... anywhere, 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, it is important... 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 audiable “microtremor” in the voice. All that was needed was a device sensitive enough to pick up and record these involuntary 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 filling 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. See how 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 family member 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 goes 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 makes it possible for you to really relax and enjoy life more... simply return it within 30 days for a prompt, courteous refund.

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IT GIVES YOU AN HONEST ANSWER EVEN IF SOMEONE ELSE DOESN’T!

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<td>CM-300 MODULAR PROTOTYPE BOARD 1.020 TEST POINTS, 188 separate 5 point terminals plus 2 horizontal bus lines of 40 common test points each.</td>
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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 brake 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 fill 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 firewall 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 dash. 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 you have obtained this, 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.
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** Available 1st Quarter, 1979.

The fun way into computers.
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 IN.

At this point, the four important bus signals for interfacing are IN, OUT, WR and 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 IN, OUT, WR and 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 2¹⁶ or 65,536 different memory locations. Once the 16-bit address is specified either the WR (write) or the 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 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.

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.

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

---

**TABLE 1—TRS-80 EXPANSION CONNECTOR SIGNALS**

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

**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.
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 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.

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 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 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 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 1/4 watt, 5%
R1, R8—1000 ohms
R2, R3—220 ohms
R4, R5—47,000 ohms
R6—1000 ohms
R7—2200 ohms
C1—2200 µF, 16 volts, electrolytic, axial leads
C2, C4—0.1 µF, 50 volts, disc ceramic
C3, C6—1 µF, 35 volts, tantalum electrolytic
C7—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 SN74LS8)
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—SN74040 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 (Agat 516AG-10D or equal)
S04—high-quality 8-pin DIP socket (Agat 508 AG-10D or equal)
PL1—Molex right-angle 6-pin connector (PN 09-75-1081) optional.
Requires 1-mating female housing (PN 09-70-7061) 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 to 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. Sam and Co.) is available for $7.95 plus 95¢ 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 supply directly to the interface breadboard without it.

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 at 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 logic 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 SN7411S23 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 "A7," "A6," "A5," "A4," and "A3." 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.
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 memory, 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

FRED BLECHMAN, K6UGT

for tone dialing! The Weboor unit also has a hold button even though your phone does not. The Freedom Dialer and Weboor 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 signaling 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 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>
<thead>
<tr>
<th>MANUFACTURER OR SOURCE</th>
<th>MODEL NAME OR NUMBER</th>
<th>DISPLAY DESCRIPTION</th>
<th>DISPLAY METHOD</th>
<th>INTERFACE</th>
<th>REMARKS &amp; FOOTNOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>BELL &amp; HOWELL PROGRAMS</td>
<td>9723</td>
<td>60</td>
<td>12</td>
<td>NO DISPLAY</td>
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</tr>
<tr>
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<td>13</td>
<td>LED</td>
<td>3 8 5/8 5/8</td>
</tr>
<tr>
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<td>185.95</td>
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<td>13</td>
<td>LED</td>
<td>3 8 5/8 5/8</td>
</tr>
<tr>
<td>ELECTRONIC DIALER 32</td>
<td>109.95</td>
<td>12</td>
<td>13</td>
<td>LED</td>
<td>3 8 5/8 5/8</td>
</tr>
<tr>
<td>DELUXE ELECTRONIC DIALER</td>
<td>279.95</td>
<td>12</td>
<td>13</td>
<td>LED &amp; DIGIT</td>
<td>3 8 5/8 5/8</td>
</tr>
<tr>
<td>MEMORY PHONE</td>
<td>195.95</td>
<td>12</td>
<td>13</td>
<td>LED</td>
<td>3 8 5/8 5/8</td>
</tr>
<tr>
<td>HOTEL</td>
<td>73.95</td>
<td>16</td>
<td>DISCRETE LED'S FOR READY, PULSE &amp; STORE</td>
<td>2 8 3/4 8 3/4</td>
<td></td>
</tr>
<tr>
<td>HILLSIDE PRODUCTS DIV.</td>
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<td>12</td>
<td>13</td>
<td>LED</td>
<td>3 8 5/8 5/8</td>
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<tr>
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<td>13</td>
<td>LED</td>
<td>3 8 5/8 5/8</td>
</tr>
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<td>13</td>
<td>LED</td>
<td>3 8 5/8 5/8</td>
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<td>12</td>
<td>13</td>
<td>LED</td>
<td>3 8 5/8 5/8</td>
</tr>
<tr>
<td>PARAGONIC CONSUMER AFFAIRS</td>
<td>149.95</td>
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<td>13</td>
<td>LED</td>
<td>3 8 5/8 5/8</td>
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<tr>
<td>RADIO SHACK</td>
<td>59.95</td>
<td>12</td>
<td>13</td>
<td>DIGIT</td>
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<td>239.95</td>
<td>12</td>
<td>13</td>
<td>LED</td>
<td>3 8 5/8 5/8</td>
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<tr>
<td>TECHNOLOGY APPLICATIONS</td>
<td>109.95</td>
<td>12</td>
<td>13</td>
<td>LED</td>
<td>3 8 5/8 5/8</td>
</tr>
<tr>
<td>TWIN TERO NURSE COMP.</td>
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<td>12</td>
<td>13</td>
<td>DIGIT</td>
<td>3 8 5/8 5/8</td>
</tr>
</tbody>
</table>

TABLE 2—DTMF DIALING FREQUENCIES

<table>
<thead>
<tr>
<th>HIGH GROUP</th>
<th>LOW GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1209 HZ</td>
<td>697 HZ</td>
</tr>
<tr>
<td>1336 HZ</td>
<td>697 HZ</td>
</tr>
<tr>
<td>1477 HZ</td>
<td>697 HZ</td>
</tr>
</tbody>
</table>

![Diagram](image)

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

![Diagram](image)

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

![Diagram](image)

**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.

![Diagram](image)

**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.

![Diagram](image)

**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.

Normal 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 dial tone. 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 required 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 multilines, a USOC RJ35X jack will be needed. (See Figs. 3 and 4.) Some parallel-connected units, like the Panasonic Easa-Phone, use 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.
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 resistance 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 until the directory button is depressed for any number that has been affected.

**To be continued.**
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.

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 push-button 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 sitting 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 x 2 x 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.

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.

LEWIS A. HARLOW

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 frequency. 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.

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.

![Diagram of Oscillator and Bias Circuits](image)
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 copy 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 low logic. 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 low input 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 (Metal-Oxide Silicon) materials, others offer bipolar-type TTL (Transistor-Transistor Logic) 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 interchangables 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.
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 system 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 burn-out 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 0.
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 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 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 “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 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, you should be able to trouble-shoot the system to the point of logic failure.

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.

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 Vcbo 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.
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, Binghamton, 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 McIntosh 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 push-button-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 the 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.

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 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 X 3½ inches H, chassis, 14¾ inches H X 2¼ inches H X 14½ inches D. (including connectors). Net Weight: 27 lbs. Suggested Retail Price: $699.
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 overloaded.

Since the circuit’s 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 the 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 1 summarizes the major performance measurements made in our lab. In checking 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.

While no graph is provided for monophonic

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<td>RMS power/channel, 8-ohms, 20 kHz (watts)</td>
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<td>RMS power/channel, 4-ohms, 1 kHz (watts)</td>
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<td>RMS power/channel, 4-ohms, 20 kHz (watts)</td>
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<th><strong>DISTORTION MEASUREMENTS</strong></th>
<th><strong>R-E</strong></th>
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<tr>
<td>Harmonic distortion at rated output, 1 kHz (%)</td>
<td>0.002</td>
</tr>
<tr>
<td>Intermodulation distortion, rated output (%)</td>
<td>0.003</td>
</tr>
<tr>
<td>Harmonic distortion at 1-watt output, 1 kHz (%)</td>
<td>0.008</td>
</tr>
<tr>
<td>Intermodulation distortion at 1-watt output (%)</td>
<td>0.007</td>
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<td>Input impedance (ohms)</td>
<td>75K</td>
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<td>Output load impedance, stereo (ohms)</td>
<td>2.7 to 8</td>
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<td>Output load impedance, mono (ohms)</td>
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<th><strong>EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN</strong></th>
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Comments:

McIntosh Laboratories' 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 not 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.
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 IHE 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 components—-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 at 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 amplitude 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.

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 stereoscopic 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 besides providing improved stereoscopy, has facilities for time-base correction, grain and noise reduction, image outlining and color correction.
ONKYO (42-07 20th Ave. Long Island City, NY 11103) was one of the first companies to incorporate an advanced form of AFC (Automatic Frequency Control) 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 "blind" filter switch; a MUTE/LOCK switch; an AM/FM SELECTOR switch, and a large fly-wheel-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 "lind 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.

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 cross-talk 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 a bit of second harmonic of the 5-kHz signal and 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.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>RADIO-ELECTRONICS PRODUCT TEST REPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer: Onkyo</td>
<td>Model: T-4090</td>
</tr>
<tr>
<td><strong>FM PERFORMANCE MEASUREMENTS</strong></td>
<td>R-E</td>
</tr>
<tr>
<td><strong>SENSITIVITY, NOISE AND FREQUENCY FROM INTERFERENCE</strong></td>
<td>R-E Measurement</td>
</tr>
<tr>
<td>HF Sensitivity, Mono (µVXkHz)</td>
<td>1.7 (9.8)</td>
</tr>
<tr>
<td>Sensitivity, ±30 dB (µVXkHz)</td>
<td>4.0 (17.2)</td>
</tr>
<tr>
<td>50 dB quieting signal, mono (µVXkHz)</td>
<td>2.2 (12.0)</td>
</tr>
<tr>
<td>50 dB quieting signal, stereo (µVXkHz)</td>
<td>50.0 (34.7)</td>
</tr>
<tr>
<td>Maximum S/N ratio, mono (dB)</td>
<td>79</td>
</tr>
<tr>
<td>Maximum S/N ratio, stereo (dB)</td>
<td>71.5</td>
</tr>
<tr>
<td>Capture Ratio (dB)</td>
<td>1.4</td>
</tr>
<tr>
<td>AM suppression (dB)</td>
<td>55</td>
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<tr>
<td>Image rejection (dB)</td>
<td>95</td>
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<tr>
<td>IF rejection (dB)</td>
<td>96</td>
</tr>
<tr>
<td>Spurious rejection (dB)</td>
<td>95</td>
</tr>
<tr>
<td>Alternate channel selectivity (dB)</td>
<td>72</td>
</tr>
<tr>
<td><strong>FIDELITY AND DISTORTION MEASUREMENTS</strong></td>
<td>R-E</td>
</tr>
<tr>
<td>Frequency response, 50 kHz to 15 kHz (±dB)</td>
<td>1.0</td>
</tr>
<tr>
<td>Harmonic distortion, 1kHz, mono (%)</td>
<td>0.047</td>
</tr>
<tr>
<td>Harmonic distortion, 1kHz, stereo (%)</td>
<td>0.10</td>
</tr>
<tr>
<td>Harmonic distortion, 1kHz, stereo (%)</td>
<td>0.08</td>
</tr>
<tr>
<td>Harmonic distortion, 1kHz, stereo (%)</td>
<td>0.11</td>
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<tr>
<td>Harmonic distortion, 6 kHz, mono (%)</td>
<td>0.12</td>
</tr>
<tr>
<td>Harmonic distortion, 6 kHz, stereo (%)</td>
<td>0.28</td>
</tr>
<tr>
<td>Distortion at 50 dB quieting, mono (%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Distortion at 50 dB quieting, stereo (%)</td>
<td>0.35</td>
</tr>
<tr>
<td><strong>STEREO PERFORMANCE MEASUREMENTS</strong></td>
<td>R-E</td>
</tr>
<tr>
<td>Stereo threshold (µV) (dB)</td>
<td>4.0 (17.2)</td>
</tr>
<tr>
<td>Separation, 1 kHz (dB)</td>
<td>46</td>
</tr>
<tr>
<td>Separation, 100 Hz (dB)</td>
<td>39</td>
</tr>
<tr>
<td>Separation, 10 kHz (dB)</td>
<td>40</td>
</tr>
<tr>
<td><strong>MISCELLANEOUS MEASUREMENTS</strong></td>
<td>R-E</td>
</tr>
<tr>
<td>Muting threshold (µV) (dB)</td>
<td>4.0 (17.2)</td>
</tr>
<tr>
<td>Dial calibration accuracy (±kHz @ MHz)</td>
<td>100</td>
</tr>
<tr>
<td><strong>EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION</strong></td>
<td>R-E</td>
</tr>
<tr>
<td>Control layout</td>
<td>Very good</td>
</tr>
<tr>
<td>Ease of tuning</td>
<td>Excellent</td>
</tr>
<tr>
<td>Accuracy of meters or other tuning aids</td>
<td>Excellent</td>
</tr>
<tr>
<td>Usefulness of other controls</td>
<td>Very good</td>
</tr>
<tr>
<td>Construction and internal layout</td>
<td>Excellent</td>
</tr>
<tr>
<td>Ease of servicing</td>
<td>Excellent</td>
</tr>
<tr>
<td>Evaluation of extra features, if any</td>
<td>Very good</td>
</tr>
<tr>
<td><strong>OVERALL FM PERFORMANCE RATING</strong></td>
<td>R-E</td>
</tr>
</tbody>
</table>

**TABLE 2**

<table>
<thead>
<tr>
<th>OVERALL PRODUCT ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Retail price</strong></td>
</tr>
<tr>
<td><strong>Price category</strong></td>
</tr>
<tr>
<td><strong>Price/performance ratio</strong></td>
</tr>
<tr>
<td><strong>Styling and appearance</strong></td>
</tr>
<tr>
<td><strong>Sound quality</strong></td>
</tr>
<tr>
<td><strong>Mechanical performance</strong></td>
</tr>
</tbody>
</table>

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 and 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 tuned for lowest distortion (with the aid of labor 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 modifing 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 desoldering. 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 overheating. Transistors and IC's are another matter, so we'll concentrate on those toughness. 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.

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
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, if you are interested, Unger 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.

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 solder 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 soldered 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.

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.

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.

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.

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 1/8-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.

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)
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 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.

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

AUDIOPHILE DISC CATALOG, Stadlau Disc 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 "Adagio for Strings"; and "Sambatuquu," Latin rhythms from Brazil. Several audio and demo test records are also available.—Audio-Technica, U.S., Inc., 33 Shiwassee Ave., Fairlawn, OH 44313.

CIRCLE 141 ON FREE INFORMATION CARD
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/serviceing 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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CIRCLE 66 ON FREE INFORMATION CARD
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 Faro. 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.

![Diagram of circuit](image)

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 11 and S2, 12. 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 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 miniature 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 straightforward 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 manners of time and the self-addressed stamped envelope continued on page 80
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<td>Dual Trace 30MHz</td>
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Additional Memory, $19.95 postpaid & handling

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HOBBY CORNER
continued from page 77

Soldering iron

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 workshop! 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.
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NOVEMBER 1979

81
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.

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—0.033 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.
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. The filter or filter capacitor does not affect the sweep or high voltage. If either is shorted, it loads 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.

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**service questions**

**SHORTEST 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 faint light of the internal gas 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 shortest picture-tube elements. One thing is definite: try because you can't hurt the tube.

---

**MINITAPE RECORDER**

Who handles the "Compu-Dict" minitape recorder from Compu-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.
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 25 years ago, and cost well into the thousands of dollars. A case in point is Elecraft's Bearcat 220 20-channel crystal-less scanner for aircraft, marine, and public service (see 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.

You can use the same dual-voice-coil speaker to get better sound from CB. Remove the existing dash mono speaker (either 6 X 9 or 4 X 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
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FIG. 3

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.

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 7/16-24 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.)
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, the MK5009 generates frequencies that are not multiples of ten.

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Frequency</th>
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<tr>
<td>D3 D2 D1 D0</td>
<td>MHz</td>
</tr>
<tr>
<td>0 0 0 0</td>
<td>1 MHz</td>
</tr>
<tr>
<td>0 0 0 1</td>
<td>100 kHz</td>
</tr>
<tr>
<td>0 0 1 1</td>
<td>1 kHz</td>
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<tr>
<td>0 1 0 0</td>
<td>100 Hz</td>
</tr>
<tr>
<td>1 0 0 0</td>
<td>10 Hz</td>
</tr>
<tr>
<td>1 1 1 1</td>
<td>0.1 kHz</td>
</tr>
<tr>
<td>1 0 0 0</td>
<td>0.01 Hz</td>
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</table>

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. 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. Once the MK5009 has been programmed, the interrupt flip-flop (SN7474) is cleared by the second output 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 000070 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

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*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.
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 305 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 11111111. 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 00000010100, 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
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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 bunched 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.")
John Simonton's time-proven design provides two envelope generators VCA, VCO & VCF in a low cost, easy to use package. Use alone with its built-in ribbon controller or modify to use with guitar, electronic piano, polytonic keyboards, etc.

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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 OM-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-ioding temperatures as irons rest in holder and an automatic power boost when irons are removed for work. The units insure a lessened mV leakage, low operating costs and reduced energy usage. The model 4422 uses XTradur or Duratherm plug tips and is suitable for touch-ups and light work. The model 4423, with 1/4-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 synchronous 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

CIRCLE 153 ON FREE INFORMATION CARD

as-per-division; a continuously variable vernier control; X 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 X 288 mm X 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

CIRCLE 154 ON FREE INFORMATION CARD

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.

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 2½ 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.

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 ½-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-

International's 6024B 40 Channel CB Frequency Meter

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Complete with connecting cable, dummy load, rechargeable battery and charger. $448

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NOVEMBER 1979

91
One method of constructing a time-of-day clock would be to program the MK5009 for a 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, 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.

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TABLE 3

<table>
<thead>
<tr>
<th>START:</th>
<th>RTCISS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOAD THE STACK POINTER WITH</td>
<td>*000 070</td>
</tr>
<tr>
<td>R/W MEMORY ADDRESS BECAUSE IN-</td>
<td>/THE REAL-TIME CLOCK INTERRUPTED</td>
</tr>
<tr>
<td>/TERRUPTS CAN OCCUR.</td>
<td>/THE MICROCOMPUTER, SO SERVICE</td>
</tr>
<tr>
<td>THEN LOAD THE A REGISTER WITH</td>
<td>/SOME OF THE PERIPHERAL DEVICES</td>
</tr>
<tr>
<td>/000 0011, TO PROGRAM THE MOST</td>
<td>/THEN CLEAR THE CHIP-FLOP THAT</td>
</tr>
<tr>
<td>SIGNIFICANT COUNTER WITH 0</td>
<td>/ CAUSED THE INTERRUPT AND</td>
</tr>
<tr>
<td>WHEN THE MK5009 (1 KHZ).</td>
<td>/RELOAD THE COUNTERS WITH</td>
</tr>
<tr>
<td>THEN LOAD THE A REGISTER WITH</td>
<td>/THE CONTENT OF THE LATCHES,</td>
</tr>
<tr>
<td>/00010100 SO THAT THE TWO LEAST</td>
<td>/RE-ENABLE THE INTERRUPT</td>
</tr>
<tr>
<td>SIGNIFICANT COUNTERS ARE</td>
<td>/AND RETURN TO THE TASK THAT</td>
</tr>
<tr>
<td>LOADED WITH DECIMAL 20.</td>
<td>/ WAS INTERRUPTED.</td>
</tr>
</tbody>
</table>

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Try this exciting new hobby! Build your own electronic concert organ. It's easy. No technical knowledge required. Just follow the clearly pictured instructions of the famous Wersi do-it-yourself system. Choose from seven different models. Send $2.00 (refundable) with coupon for colorful 104 page catalog.

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X-10 Remote Control For Lights and Appliances

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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, 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 4½" 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 - 1/2 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: - 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.
Please include $3.00 shipping and handling on all orders.
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 feature aural key press feedback. 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 10 %/inch reels. Both units (the model GX-635DB has additional built-in dual-process Dolby noise reduction) provide two speeds (7 /4 ips and 3 /4 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.

**CIRCLE 131 ON FREE INFORMATION CARD**

**CIRCLE 132 ON FREE INFORMATION CARD**

**ASCII encoded keyboards as low as $65.**

The RCA VP-601 keyboard has a 58 key typewriter format for alphanumeric entry. The VP-611 ($15 additional) offers the same typewriter format plus an additional 16 key calculator type keypad.

Both keyboards feature modern flexible membrane key switches with contact life rated at greater than 5 million operations, plus two key rollover circuitry.

A finger positioning overlay combined with light positive activation key pressure gives good operator "feel", and an on-board tone generator gives aural key press feedback.

The unitized keyboard surface is spillproof and dustproof. This plus the high noise immunity of CMOS circuitry makes the VP-601 and VP-611 particularly suited for use in hostile environments.

The keyboards operate from a single 5 volt, DC power supply, and the buffered output is TTL compatible. For more information contact RCA VIP Marketing, New Holland Avenue, Lancaster, PA. Telephone (717) 291-5848.

*Optional user price. Dealer and OEM prices available.

**CIRCLE 133 ON FREE INFORMATION CARD**

Specifications include: frequency response, 30 Hz-27 kHz ±3 dB; wow-and-flutter, less than 0.03% at 7 /4 ips; S/N ratio, better than 62 dB (weighted) distortion, less than 0.5% at 7 /4 ips. The decks come in a wood-grain vinyl enclosure with brushed aluminum front panel. They measure 17.4 X 19 X 10.1 inches, and weigh 46½ lbs. Suggested retail prices: model GX-635D, $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 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 23/4 X 10 3/4 X 13 inches. The model GS401C measures 24 3/4 X 13 3/4 X 11 1/2 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 Shlawassee, Akron, OH 44313.
WOODSTOCK, Bmakma Research of America, prices: King Snake cable, mates with screw-type terminals; both fits CIRCLE 200 available ings, and has SPEAKER CABLE /CONNECTORS. King Snake MINIMUM BILLING 525.001 any modification gold-plated by RB-20 BT-30 BW-2630 BITS 200 BITS 25e 20e 25e 20e soldering or INGS. Also AVAILABLE model -200 -26, 28 & 30 BITS SHIPPING CHARGE respectively. 4C8 The pin plug are se- model... AWG... MODEL THE CITY ZONE THE GOVERNMENT AWG WAY Albert... 11,r_... It actually get r=... the spade plug pin plug are se- ... waste your money. And because Unified Way is re-created each year with a combination of old and new volunteers, it doesn't become over populated with huge staffs of people who might actually get in the way of progress. So it doesn't strangle you in red tape. All of which means that because of what Elson Way doesn't do, it can do a much better job at what it does. Helping people. Thanks to you it makes for of us.

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CIRCLE 60 ON FREE INFORMATION CARD
computer 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 moves. Sixteen-key touchpad keyboard allows selection of Chess, The Game of Knights, Amazon Queen and Survival. Suggested retail prices: Second Edition, $179.95; ComputChess 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 the bottom of the case. The plastic case can be cut to fit keyboard. The CE-18 measures 18 W X 19 D X 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 recording capability, is leaderless, and comes in a protective plastic storage box.—Misco, Inc., 963 Holmdel Rd., Holmdel, NJ 07733.

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CIRCLE 127 ON FREE INFORMATION CARD
CIRCLE 128 ON FREE INFORMATION CARD

COMPUTER PRODUCTS continued from page 88

resembling 270, 2758, 2716 and TMS 2716 EPROM's. Also included is a hardware address trap to suspend operation of target processor. Two DBM-fs 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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Shutting down at just $92.95 for a Level "A" operating system, you can now build the exact computer you want. Explorer/85 kit contents will also include, if ordered, 8085-based 8-bit disk small business system...yet you're never forced to buy anything you don't want and you can expand in small, affordable steps.

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For just $92.95 plus the cost of a power supply, keyboard, terminal and RF modulator, if you don't have them already, Explorer lets you begin computing on a significant level. This book contains introductory computer concepts 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 E. 19th St., Philadelphia, PA 19103. 86 p. $5 x 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. This appendix contains a handy key to the ASCII code.


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, 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-seventh Edition. Edited by Tony Drobuck and the Headquarters Staff of the American Radio Relay League, Newington, CT 06111. 6'/2 in x 9'/2 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.

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Netronics R&D Ltd., Dept. RE-11, 333 Litchfield Road, New Milford, Ct 06776.

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ADVANCE ELECTRONICS

BOOKS continued from page 97

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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, TV, gasoline-powered generators, as well as transistors and power supplies. Many drawings, photos and charts complement the text.


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 results 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 X 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-quizz plus the answers are contained in the back.

R-E
DECEMBER 1979

Projection TV In A Kit
R-E report on the circuitry and features of a new projection color TV kit. Three prefocussed projection tubes deliver a bright sharp picture.

Repackaging PC Boards
How to make working equipment to your specifications by interconnecting bits and pieces of surplus circuit cards.

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Build these accessories for your percussion synthesizer.

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A hi-fi amplifier you'll want to build.

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Interface your TRS-80 to the "real world" the faster and easier way.

A P has the hardware you need to build the interface breadboard described in the article on page 43.

The Jumper. A 24" 40 conductor flat ribbon cable assembly with a socket connector on one end, a card-edge connector on the other. It's preassembled and every line is pretested. 924150-24 $11.95

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NOVEMBER 1979 103
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<thead>
<tr>
<th>Part No.</th>
<th>Cable Length</th>
<th>Connectors</th>
<th>Price</th>
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<td>10 ft</td>
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<td>4 ft</td>
<td>50-pin</td>
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<td>D52SP</td>
<td>12 ft</td>
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<td>DIP Jumpers</td>
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<td>1 ft</td>
<td>$1.95 ea.</td>
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<tr>
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<td>0.1/4-2</td>
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<td>0.1/4-3</td>
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**Microprocessor Components**

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<td>6800</td>
<td>6-bit microprocessor for microcomputers</td>
<td>$7.95</td>
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<tr>
<td>6812</td>
<td>8-bit microprocessor</td>
<td>$3.95</td>
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<td>6805</td>
<td>Digital Microprocessor for microcomputers</td>
<td>$2.95</td>
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<tr>
<td>6809</td>
<td>8-bit microprocessor</td>
<td>$1.95</td>
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<tr>
<td>6811</td>
<td>8-bit microprocessor</td>
<td>$2.95</td>
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- Completely Assembled
- Battery Operated

**Digital Watchstop**

- Uses Internal D.C. Power
- Placed through double-sided P.C. Board
- LED display (red)
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**FREQUENCY COUNTER KIT**

**Outstanding Performance**

**Incredible Price** **$89.95**

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- Frequency range: 6 KHz to 65 MHz (500 MHz with CT-600)
- Resolution: 10 Hz to 0.1 sec gate, 1 Hz to 1 sec gate
- Readout: 8 digit, *0* LED, direct readout in accuracy adjustable to 0.5 ppm
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- 60 mHz counter kit
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- Clock with 10 min. display: 12/24 hour
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**Hard to find PARTS**

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- Complete three regulated power supply provides 6 to 18 volts at 200 mA, switching circuitry. Includes power supply, complete kit. PS-3LT

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- Projects up to 600 yards. Use for security alarms, etc.

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100 W 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
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- Power supply: ±40V @ 5 amp

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 36 4-color LED (15 per channel) to indicate the sound level output of your amplifier from -36dB to +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 relay 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.

SPECS:
- 15 STEPS
- LED POWER INDICATOR
- For Home Audio Preamplifiers
- For Power Amplifiers
- 6-12V D.C. Power
- 50mA Total Current
- Separate Channel Indicators
- Full Color Display
- Easy to Install

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, PCB 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% THD harmonic distortion between 100Hz and 10KHz.

BATTERY POWERED FLUORESCENT LANTERN

MODEL 886 R

FEATURES:
- Circuitry designed for operation by high efficiency, high power silicon transistor which enable illumination maintenance in a standard level even the battery supply drops to a certain low voltage.
- 9W cool/daylight miniature fluorescent tube.
- 6 x 1/2UM (size 0) dry cell battery.
- Easy sliding door for changing batteries.
- Stainless reflector with wide angle incandescent luminous projection.

$32.50 PER KIT

STEREO AMPLIFIER

60 W +

60 W

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 electronic condenser. Element built-in plastic coated and tender edge connectors (single sided) to allow any kind of standard components to fit board.

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 needed. Pulse rate 3Hz @ 5V 20mA.

LCD CLOCK MODULE!

- 0.5" LCD 4 digits display + Xtal 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.

MINI-SIZED I.C. AM RADIO

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

LINEAR SLIDE POT

5000 SINGLE Metal Case 2' Long

2 FOR $1.20

CONDENSE MICROPHONE

Sub-Mini Size

FET Transistor Built-In

$2.50 each
FLUORESCENT LIGHT DRIVER KIT
12V DC POWERED
Lights up 8 to 15 Watt Fluorescent Light Tubes. Ideal for camps, outdoor, auto 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!
LCO Quartz Alarm Chronograph with calendar and dual time zone! Works is 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 chronos up to 1/10 sec. indicated by 10-second arrows! • Lep time (with chronos running uninterrupted) • Time displays by LCD format hour, min. sec. Day of the week and AM/PM. • Calendar gives out date-day and year. Dual time zone for any two cities of the world at your own choice. • With light switch to allow you to set 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 overloaded to protect your amplifier as well as your speakers. A must for GCL circuits.
KIT FORM $9.75 EA.

"FISHER" 30 WATT STEREO AMP
MAIN AMP (15Wx2)
Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply ± 16V DC (not included). Power board with (KF 1% ± 5% Voltage gain 33dB ± 20kHz - 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. Also tone control, all electronic parts, as well as PC Board. Less than 0.5% harmonic distortion at full power 1/2% response from 20-100,000 Hz. This amplifier has QUASIS- Complimentary class B output. Output max is with (110 watt RMS) at 4Ω. ONLY $23.50 each

HICKOK LX303 DIGITAL LCD MULTIMETER
- 3¾ digits display = 200 hours 9v battery. ½ Auto-zero; polarity overrange indication • 100MV DC F.S. sensitivity • 19 ranges and 11000, VAC. • 1 V to 10000 • 0.1 V to 500 V. • Resistance: 0.1 to 20 MΩ. ±0.1% current: 0.01 A to 100 MA
OUR PRICE $71.45

PUSH-BUTTON SWITCH
N/0Open Contact
Color: Red, White, Blue, Green, Black 3/$1.00
N/C/Close also Available
50c 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!
Solid state sound indicator operating voltage 6V DC 30mA. Small size approx. ¼”x1¼”.
Model EB2116 (Continuous)
Model EB2126 (Fast Pulse)
$3.80 EACH

ELECTRET CONDENSER MICROPHONE W-TIE CLIP
Sensitivity: 65dB = 3dB (1KHz) Impedance: 600 OHM Freq Response: Material: Aluminum 5000-15000 Hz Cond. 10 ft. Length $19.50 EACH

ELECTRONIC ALARM SIREN COMPLETE UNIT
Ideal for use with an Alarm Unit or hookup to your car back-up to make a reverse indicator. Light Output 6000. Voltage supply 12V
AU-999 $7.50

Many TRANSFORMER KITS AVAILABLE
ALL 117 VOLT INPUT
0V 4 AMP $5.50 EA.
30V CT 4 AMP $10.50 EA.
48V CT 3 AMP $10.50 EA.
24V CT 3 AMP $7.50 EA.
12V CT 3 AMP $5.50 EA.
12V CT 2 AMP $5.50 EA.
12V CT 1 AMP $2.50 EA.
24V CT 1 AMP $2.50 EA.
6V CT 1 AMP $2.00 EA.

AC POWER SUPPLY W Type Transformer
12V/AC Output 200 MA $2.75 EA.
16V CT AC Output 100 MA $2.10 EA.
12V DC Output 100 MA $2.00 EA.
12V DC Output 120 MA $2.00 EA.
12V DC Output 120 MA $2.00 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 fountain. Unit operates by 9-12V 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 Interchangeable Audio amp designed with a mic jack, a mini toggle switch 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.
For 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 condenser 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 #FM22 KIT FORM $7.95

REGULATED DUAL VOLTAGE SUPPLY KIT
±4 30V DC 800 MA adjustable, fully regulated by Fairchild 739M and 79M voltage regulator IC. Kit includes all electronic parts, filter capacitors, IC's, heat sinks and PC board.
$12.50 PER KIT

Rechargeable Ni-Cd Batteries Pk
6AA Ni-Cd in a flat pack gives you a total of 7.2V 450MA output $8.25 PER PK

BECKMAN FET LIQUID CRYSTAL DISPLAY
Overall size 2" x 1 2/5"-0.5" characters reflective type.
Model 737-01 — for clock 4 digits with PM, alarm, sound source, clock indicator,_FM
Model 739-04 — for panel meter 4 digits
Model 739-03 — for panel meter 3 ½ digits with ± sign and range indicator.
All displays include bezel connectors and front bezel. With data sheets. Your choice — any model $7.50 EACH

POWER SUPPLY KIT
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 @ 2.5A $5.00 each

I.C. TEST CLIPS
Same as the EZ clips $2.75
With 20" Long Leads $3.00
In Black/Red Colors $4.00 each

SOUND GENERATOR I.C.
Creates almost any type of sound — gun shot, explosion, train, car crash, star war, birds, organ etc. A built-in audio amplifier provides high level output. Operates from one 9V battery or 28 pin dip; we supply the data. $2.90 EACH

ELECTRONIC SWITCH KIT
CONDESOR 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 6V 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 20-20000 Hz ± 0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuations. Specifications: • T.H.D. less than 0.05% • T.L.M. less than 0.05% • Frequency response: DC to 100kHz ± 0.5dB • RAIA deviation: ±0.02dB ± S/N ratio: better than 70dB • Sensitivity: Phone 2MV 47K/Aux. 100MV 100K • Output level: 1.5V — Max. output: 15V • Tone control: bass ±10dB @ 50Hz/treble ±10dB @ 15Hz • Power supply: ±24 D.C. @ 0.5A Kit comes with regulated 350 mA power supply. All you need is a 48V C.T. transformer @ 0.5A
ONLY $44.50

SOLID STATE ELECTRONIC BUZZER
Mini size 1" x 3/4" x 3/4" Supply voltage 1.5V - 12V Voltage for Alarm or Tone Indicator
$1.50 each

FORMULA INTERNATIONAL INC.
11/79

CIRCLE 30 ON FREE INFORMATION CARD
We supply the S-100 rev.11

Why S-100? Because S-100 machines are not consumer toys — but flexible, pro-level systems that are easy to upgrade, modify, and adapt to specific applications. Over the years the S-100 bus has proven to be the ideal choice for commercial, industrial, and scientific applications.

We are expanding the options for S-100 systems by using the experience we’ve acquired in the past, mixing in the best technology offered by the present, and building products for the future. Products that meet, and often exceed, the demands of the new wave of S-100 professionals.

When you move up to S-100, move up to the Compupro™ line from Godbout Electronics.

NEW! The Godbout Box!

At last — a high quality, industrial grade home for your computer. Includes power supply. Use for either desk or rack mount. Check your local computer store for details, or write us direct...this is a product that has been needed for a long time, and we’re filling that need in style.

...AND DON’T FORGET OUR MEMORIES!

All our memory boards are fully static, 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 11 Econorams™:

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CIRCLE 51 ON FREE INFORMATION CARD

CIRCLE 7 ON FREE INFORMATION CARD
GIANT INFLATION FIGHTIN’ MONEY SAVIN’
“PRE HOLIDAY” SPECIALS

BURROUGHS
CONSTANT VOLTAGE
5-12-24V TRANSFORMER
Only 24.95
* With Resonant 2.5mF & 660VAC Oil input
Constant Voltage Capacitor

This low cost universal supply transformer is ever-essential!
Input: 60 or 120 VAC 60Hz Output: 5VDC & 24VDC EVA
max: 200RMS, 0.15A, 12 VDC & 0.5A, 24VDC & 0.5A, 5mA
Ideal for multiple voltage computer systems: R90: 3
24V: 1.5V Wash: 2W, 600VAC 15mA. With diagram & data sheets.
Cat. No.: R920662

5 WATT MONO AMPLIFIER
Only $4.88 each 2 for $8.00

FRAME FILM STRIP PROJECTOR WITH CASE
High quality ELBA VIP 35mm projector with feature. 12VAC 50mca, AC/DC power, remote mech.
In advance the film strip and wind it on power supply and film, type COAX PLUG-FOREIGN ORDER 2563
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31 z{s
21
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144004 400
144001
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unspeakable finish
film
in. 2c9li insulation
in. 2e9li insulation
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SINGLE PIN RED
MICRO 700 RED
JUMBO RED
JUMBO RED
1946 MICRO YELLOW
2CU
MICR
1
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35mm

HY - GAIN
LED CLOCK KIT

HY GAIN
LED WATCH GUTS

1800 DEGREE SOLAR
FURNACE
Only $595

STEREO AM-FM
MPX TUNER/AMPLIFIER

TOP SHELF CONSTRUCTION at this bargain basement price! Features include: Top Load Design, Pushbutton Operation, Tape Monitor, and dual remote. This unit can be used as a receiver, pre-amp, and mixer. It can be used with 12VDC bells, remote volume, remote play/pause and remote stop. Also features a metal case with shock plastic tape compartment and keys with weatherproof control: 3-1/4 x 1-11/16 x 5-5/8. Wt: 2 lbs. 12 oz.
Cat. No.: R9208961

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TERMS: Add Postage: Retail: Net 30
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MINIMUM ORDER: $5 Wakefield, MA

CIRCLE 15 ON FREE INFORMATION CARD

NOVEMBER 1979

113
For faster service

USE ZIP CODE on all mail

Give to the college of your choice.

<table>
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<th>Item</th>
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<td>VACO QUICK-CHANGE MAGNETIC SCREWDRIVER</td>
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<td>BATTERY SAVING DC ADAPTOR</td>
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<tr>
<td>Stereo Linear Slide Pots</td>
<td>$1.99</td>
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ITC EXCLUSIVE! NEVER BEFORE NEVER AGAIN

SOLID STATE DIGITAL AMPLIFIER $12.95

HUNDREDS OF DOLLARS IN PRECISION PARTS

IDEAL FOR EXPERIMENTORS — CONTAINS 69 TRANSISTORS, 175 RESISTORS, 45 DIODES, 14 50K POTS, 41 SILVER MICA CAPS, 11 WIREWOUND RESISTORS, 4 MYLAR CAPACITORS, 1 BRIDGE RECTIFIER, 6 COILS, 1 RELAY, 1 24 VOLT POWER SUPPLY, AND ASSORTED SWITCHES, CONNECTORS, HEAT SINKS, AND, OTHER COMPONENTS. CONTAINS BUILT-IN 24 V POWER SUPPLY.

CSC EXPERIMENTORS BREADBOARDING KIT $15.95

BREADBOARD START BREADBOARDING EVEN BEFORE YOU GET ALL YOUR PARTS; OR SKETCH A WORKING BREADBOARD TO SAVE IT FOR LATER

WORKPADS

PRE-DRILLED MATCHBOARD KIT INCLUDES:

ONE EXP300 TWO MATCHBOARDS, ONE EXP300 BREADBOARD, ONE SCRATCHPAD WORKPAD

BELL & HOWELL PARABOLIC MIKE

Complete with Stand and Plug

SOLD FOR $23.95

injectorall No. 650 photo-etch kit

For Printed Circuits with Negative Acting Resist. Produce professional quality printed circuits. No Darkroom Necessary.

TONEGEN SOFT DOME TWEETER

Complete with Mesh Screen

SUPER BRISK HIGHS

$9.95

ITC ELECTRONIC SUPERMARKET

2772 W. Olympic Blvd.
Los Angeles, CA 90006
(213) 388-0621

Minimum Order $5.00. Please add $2.00 postage and handling. California residents add 6% Sales Tax. VISA/Master Charge:

State number and expiration date, OEM and institutional inquiries invited.
Low-Power Schottky ICs

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Hall-Effect Sensors

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Open-Collector Output

V to F, F to V Converter

4000-Series CMOS ICs

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BIFET Op Amps

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High Linearity and Accuracy

4900CJ: accepts analog voltage and generates linear output proportional to input frequency. Operates with up to 10 kHz. With data: 14-pin DIP.

4900 Series

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